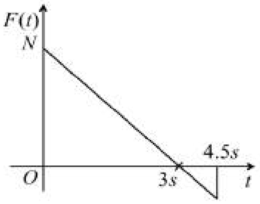
WORK ENERGY AND POWER

1. Ten litre of water per second is lifted from well through 20 m and delivered with a velocity of 10 ms^{-1}, then the power of the motor is
   a) 1.5 kW b) 2.5 kW c) 3.5 kW d) 4.5 kW
2. A glass ball is dropped from height 10 m. If there is 20% loss of energy due to impact, then after one impact, the ball will be upto
   a) 2 m b) 4 m c) 6 m d) 8 m
3. Under the action of a force, a 2 kg body moves such that its position x as a function of time t is given by $x = t^3/3$, where x is in metre and t in second. The work done by the force in the first two seconds is
   a) 1.6 J b) 16 J c) 160 J d) 1600 J
4. A truck of mass 30,000 kg moves up an inclined plane of slope 1 in 100 at a speed of 30 $kmph$. The power of the truck is (Given $g = 10\ ms^{-2}$)
   a) 25 kW b) 10 kW c) 5 kW d) 2.5 kW
5. A body of mass 2kg makes an elastic collision with another body at rest and continues to move in the original direction with one fourth of its original speed. The mass of the second body which collides with the first body is
   a) 2 kg b) 1.2 kg c) 3 kg d) 1.5 kg
6. Two masses of 1 g and 4g are moving with equal kinetic energies. The ratio of the magnitudes of their linear momenta is
   a) 4 : 1 b) $\sqrt{2} : 1$ c) 1 : 2 d) 1 : 16
7. An elastic ball is dropped from a height h and it rebounds many times from the floor .If the coefficient of restitution is e, the times interval between the second and the third impact, is
   a) ev/g b) e^2v/g c) $e^2\sqrt{\left(\frac{8h}{g}\right)}$ d) $e^2\sqrt{\left(\frac{h}{g}\right)}$
8. The potential energy of a system increases if work is done
   a) Upon the system by a conservative force b) Upon the system by a non-conservative force
   c) By the system against a conservative force d) By the system against a non-conservative force
9. A force of $2\hat{i} + 3\hat{j} + 4\hat{k}\ N$ acts on a body for 4 second, produces s displacement of $(3\hat{i} + 4\hat{j} + 5\hat{k})m$. The power used is
   a) 9.5 W b) 7.5 W c) 6.5 W d) 4.5 W
10. The decrease in the potential energy of a ball of mass 20 kg which falls from a height of 50 cm is
    a) 968 J b) 98 J c) 1980 J d) None of these
11. A man does a given amount of work in 10 s. Another man does the same amount of work in 20 s. The ratio of the output power of first man to the second man is
    a) 1 b) $\frac{1}{2}$ c) $\frac{2}{1}$ d) None of these
12. In two separate collisions, the coefficient of restitutions e_1 and e_2 are in the ratio 3:1.In the first collision the relative velocity of approach is twice the relative velocity of separation ,then the ratio between relative velocity of approach and the relative velocity of separation in the second collision is
    a) 1:6 b) 2:3 c) 3:2 d) 6:1

13. A dam is situated at a height of 550 m above sea level and supplies water to a power house which is at a height of 50 m above sea level. 2000 kg of water passes through the turbines per second. What would be the maximum electrical power output of the power house if the whole system were 80% efficient?

a) 8 MW b) 10 MW c) 12.5 MW d) 16 MW

14. A block of mass 2 kg is free to move along the x- axis. It is at rest and from $t = 0$ onwards it is subjected to a time-dependent force $F(t)$ in the x- direction. The force $F(t)$ varies with t as shown in the figure. The kinetic energy of the block after 4.5 seconds is



a) 4.50 J b) 7.50 J c) 5.06 J d) 14.06 J

15. A ball of mass m falls vertically to the ground from a height h_1 and rebound to a height h_2. The change in momentum of the ball on striking the ground is

a) $mg(h_1 - h_2)$ b) $mg(\sqrt{2gh_1} + \sqrt{2gh_2})$

c) $m\sqrt{2g(h_1 + h_2)}$ d) $m\sqrt{2g}(h_1 + h_2)$

16. The quantity that is not conserved in an inelastic collision is

a) Momentum b) Kinetic energy c) Total energy d) All of these

17. A particle of mass m at rest is acted upon by a force F for a time t. Its kinetic energy after an interval t is

a) $\frac{F^2t^2}{m}$ b) $\frac{F^2t^2}{2m}$ c) $\frac{F^2t^2}{3m}$ d) $\frac{Ft}{2m}$

18. The kinetic energy k of a particle moving along a circle of radius R depends upon the distance s as $k = as^2$. The force acting on the particle is

a) $2a\frac{s^2}{R}$ b) $2as\left[1 + \frac{s^2}{R^2}\right]^{1/2}$ c) $2as$ d) $2a$

19. If the linear momentum is increased by 50%, then kinetic energy will be increased by

a) 50% b) 20% c) 125% d) None of these

20. A ship weighing 0.3×10^8 kg-wt is pulled by a force of 0.5×10^5 N through a distance of 3 m. If the ship were originally at rest and water-resistance is negligibly small, then the ship will acquire a speed of

a) 0.1 ms^{-1} b) 1 ms^{-1} c) 1.5 ms^{-1} d) 12 ms^{-1}

21. The power of a water pump is 200 kW. If $g = 10\text{ms}^{-2}$, then the amount of water it can raise in 1 min to a height of 10 m is

a) 2000 L b) 1000 L c) 100 L d) 1200 L

22. An athlete in the Olympic covers a distance of 100 m in 10 s. His kinetic energy can be estimated to be in the range

a) 200 J-500 J b) 2×10^5 J $-$ 3×10^5 J c) 20000 J$-$50000 J d) 2000 J $-$ 5000 J

23. Two springs have their force constants as $k_1$and $k_2 (k_1 > k_2)$, when they are stretched by the same force

a) No work is done in case of both the springs b) Equal work is done in case of both the springs

c) More work is done in case of second spring d) More work done in case of first spring

24. A light inextensible string that goes over a smooth fixed pulley as shown in the figure connects two blocks of masses 0.36kg and 0.72kg.Taking g=10ms^{-2} ,find the work done (in joule)by string on the block of mass 0.36kg during the first second after the system is released from rest .

a) 8 J b) 9 J c) 7 J d) 0.48 J

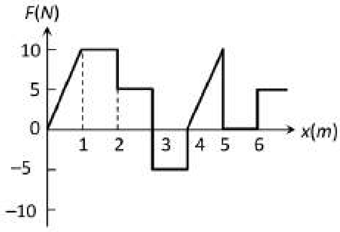
25. A 10 $H.P.$ motor pumps out water from a well of depth $20m$ and fills a water tank of volume 22380 *litres* at a height of 10 m from the ground. The running time of the motor to fill the empty water tank is ($g = 10ms^{-2}$)

a) 5 *minutes* b) 10 *minutes* c) 15 *minutes* d) 20 *minutes*

26. A body of mass 'M' collides against a wall with a velocity v and retraces its path with the same speed. The change in momentum is (take initial direction of velocity as positive)

a) Zero b) $2Mv$ c) Mv d) $-2\ Mv$

27. The relationship between the force F and position x of a body is as shown in figure. The work done in displacing the body from $x = 1m$ to $x = 5m$ will be



a) 30 J b) 15 J c) 25 J d) 20 J

28. Two masses of 1 g and 4 g have same kinetic energy what is the ratio of their momenta?

a) $\frac{1}{2}$ b) $\frac{1}{4}$ c) 2 d) 4

29. A particle is released from a height s. At certain height its kinetic energy is three times its potential energy. The height and speed of the particle at that instant are respectively

a) $\frac{s}{4}, \frac{3gs}{2}$ b) $\frac{s}{4}, \frac{\sqrt{3gs}}{2}$ c) $\frac{s}{2}, \frac{\sqrt{3gs}}{2}$ d) $\frac{s}{4}, \frac{\sqrt{3gs}}{2}$

30. Quantity/Quantities remaining constant in a collision is/are

a) Momentum, kinetic energy and temperature
b) Momentum but not kinetic energy and temperature
c) Kinetic energy and temperature but not momentum
d) None of the above

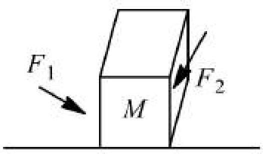
31. If two balls each of mass 0.06 kg moving in opposite directions with speed 4 m/s collide and rebound with the same speed, then the impulse imparted to each ball due to other is

a) 0.48 $kg\text{-}m/s$ b) 0.24 $kg\text{-}m/s$ c) 0.81 $kg\text{-}m/s$ d) Zero

32. An apple gives 21 kJ energy to a boy. How much height he can climb by using this energy if his efficiency is 28% (mass of boy = 40 kg)

a) 22.5 m b) 15 m c) 10 m d) 5 m

33. A body of mass M is moving with a uniform speed of 10 m/s on frictionless surface under the influence of two forces F_1 and F_2. The net power of the system is



a) $10\ F_1F_2M$ b) $10(F_1 + F_2)M$ c) $(F_1 + F_2)/M$ d) Zero

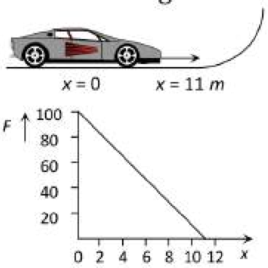
34. A spring of spring constant $5 \times 10^3 \text{Nm}^{-1}$ is stretched initially by 5 cm from the unstretched position. Then the work required to stretch it further by another 5 cm is

a) 12.50 N-m b) 18.75 N-m c) 25.00 N-m d) 6.25 N-m

35. A 10 m long iron chain of linear mass density 0.8 kg m^{-1} is hanging freely from a rigid support. If g = 10 ms^{-2}, then the power required to lift the chain upto the point of support in 10 s is

a) 10 W b) 20 W c) 30 W d) 40 W

36. A toy car of mass 5 kg moves up a ramp under the influence of force F plotted against displacement x. The maximum height attained is given by



a) $y_{\max} = 20m$ b) $y_{\max} = 15m$ c) $y_{\max} = 11m$ d) $y_{\max} = 5m$

37. A spring when stretched by 2 mm its potential energy becomes 4 J. If it is stretched by 10 mm, its potential energy is equal to

a) 4 J b) 54 J c) 415 J d) None

38. Two particles of masses m_1 and m_2 in projectile motion have velocities $\vec{v}_1$ and $\vec{v}_2$ respectively at time $t = 0$. They collide at time t_0. Their velocities becomes $\vec{v}_1{}'$ and $\vec{v}_2{}'$ at time $2t_0$ while still moving in air. The value of $|(m_1\overrightarrow{v_1}' + m_2\overrightarrow{v_2}')| - (m_1\overrightarrow{v_1} + m_2\overrightarrow{v_2})$ is

a) Zero b) $(m_1 + m_2)gt_0$ c) $2(m_1 + m_2)gt_0$ d) $\frac{1}{2}(m_1 + m_2)gt_0$

39. A machine which is 75 percent efficient, uses 12 joules of energy in lifting up a 1 kg mass through a certain distance. The mass is then allowed to fall through that distance. The velocity at the end of its fall is (in ms^{-1})

a) $\sqrt{24}$ b) $\sqrt{32}$ c) $\sqrt{18}$ d) $\sqrt{9}$

40. Two bodies having same mass 40 kg are moving in opposite directions, one with a velocity of 10 m/s and the other with 7 m/s. If they collide and move as one body, the velocity of the combination is

a) 10 m/s b) 7 m/s c) 3 m/s d) 1.5 m/s

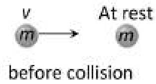
41. An engine develops 10 kW of power. How much time will it take to lift a mass of 200 kg to a height of 40 m $(g = 10\, m/sec^2)$

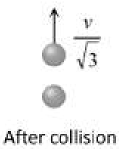
a) 4 sec b) 5 sec c) 8 sec d) 10 sec

42. A big ball of mass M, moving with velocity u strikes a small ball of mass m, which is at rest. Finally small ball obtains velocity u and big ball v. Then what is the value of v

a) $\frac{M-m}{M+m}u$ b) $\frac{m}{M+m}u$ c) $\frac{2m}{M+m}u$ d) $\frac{M}{M+m}u$

43. A mass 'm' moves with a velocity 'v' and collides inelastically with another identical mass. After collision the Ist mass moves with velocity $\frac{v}{\sqrt{3}}$ in a direction perpendicular to the initial direction of motion. Find the speed of the 2nd mass after collision



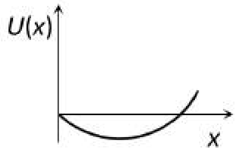


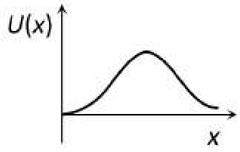
a) $\frac{2}{\sqrt{3}}v$ b) $\frac{v}{\sqrt{3}}$ c) v d) $\sqrt{3}\,v$

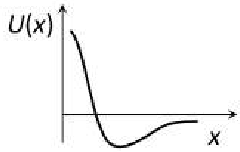
44. A rifle bullet loses $1/20^{th}$ of its velocity in passing through a plank. The least number of such planks required just to stop the bullet is

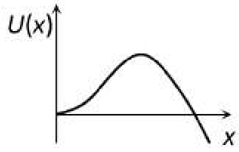
a) 5 b) 10 c) 11 d) 20

45. A particle which is constrained to move along the x-axis, is subjected to a force in the same direction which varies with the distance x of the particle from the origin as $F(x) = -kx + ax^3$. Here k and a are positive constants. For $x \geq 0$, the functional from of the potential energy $U(x)$ of the particle is

a) 

b) 

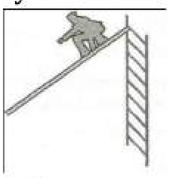
c) 

d) 

46. A particle of mass m is moving in a circular path of constant radius r such that its centripctal acceleration a_c is varying with time t as $a_c = k^2rt^2$. the power is

a) $2\pi mk^2r^2t$ b) mk^2r^2t c) $\frac{mk^4r^2t^5}{3}$ d) Zero

47. In a children's park, there is a slide which has a total length of 10 m and a height of 8.0 m. A vertical ladder is provided to reach the top. A boy weighing 200 N climbs up the ladder to the top of the slide and slides down to the ground. The average friction offered by the slide is three-tenth of his weight. The work done by the slide on the boy as he comes down is



a) Zero b) +600 J c) −600 J d) +1600 J

48. According to work-energy theorem, the work done by the net force on a particle is equal to the change in its

a) Kinetic energy b) Potential energy c) Linear momentum d) Angular momentum

49. A particle is moving under the influence of a force given by $F = kx$ where k is a constant and x is the distance moved. The energy (in joules) gained by the particle in moving from $x = 0$ to $x = 3$ is

a) 2.5 k b) 3.5 k c) 4.5 k d) 9 k

50. A force $\mathbf{F} = (2\hat{\imath} + 4\hat{\jmath})$N displaces the body by $\boldsymbol{s} = (3\hat{\jmath} + 5\hat{\boldsymbol{k}})$m in 2 s. Power generated will be

a) 11 W b) 6 W c) 22 W d) 12 W

51. The kinetic energy acquired by a mass m in travelling a certain distance d starting from rest under the action of a constant force is directly proportional to

a) $\sqrt{m}$ b) Independent of m c) $1/\sqrt{m}$ d) m

52. A spring of spring constant $5 \times 10^3 \text{Nm}^{-1}$ is stretched initially by 5 cm from the unstretched position. Then the work required to stretch it further by another 5 cm is

a) 12.50 N-m b) 18.75 N-m c) 25.00 N-m d) 6.25 N-m

53. An automobile weighing 1200 kg climbs up a hill that rises 1 m in 20 s. Neglecting frictional effects. The minimum power developed by the engine is 9000 W. If $g = 10\text{ms}^{-2}$, then the velocity of the automobile is

a) 36 km h^{-1} b) 54 km h^{-1} c) 72 km h^{-1} d) 90 km h^{-1}

54. A body at rest explodes into two equal parts. Then,

a) They move with different speeds in different directions.
b) They move with different speeds in same direction
c) They move with same speed in same directions
d) They move with same speed in opposite directions

55. A bomb is kept stationary at a point. It suddenly explodes into two fragments of masses $1g$ and $3g$. The total K.E. of the fragments is $6.4 \times 10^4\ J$. What is the K.E. of the smaller fragment

a) $2.5 \times 10^4\ J$ b) $3.5 \times 10^4\ J$ c) $4.8 \times 10^4\ J$ d) $5.2 \times 10^4\ J$

56. A car of mass m is driven with an acceleration a along a straight level road against a constant external resistive force R. When the velocity of the car is v, the rate at which engine of the car is doing work, will be

a) $R \cdot v$ b) $ma \cdot v$ c) (R+ma)$\cdot v$ d) $(ma - R) \cdot v$

57. A 60 kg man runs up a staircase in 12 seconds while a 50 kg man runs up the same staircase in 11 seconds. The ratio of the rate of doing their work is

a) 6 : 5 b) 12 : 11 c) 11 : 10 d) 10 : 11

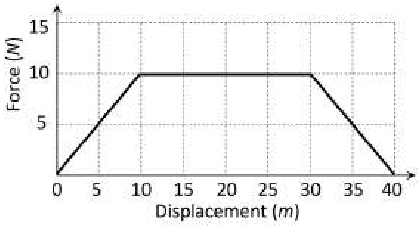
58. A car of mass 1000 kg accelerates uniformly from rest to a velocity of 54 km/hour in $5s$. The average power of the engine during this period in watts is (neglect friction)

a) 2000 W b) 22500 W c) 5000 W d) 2250 W

59. In the stable equilibrium position, a body has

a) Maximum potential energy b) Minimum potential energy
c) Minimum kinetic energy d) Maximum kinetic energy

60. Adjacent figure shows the force-displacement graph of a moving body, the work done in displacing body from $x = 0$ to $x = 35\ m$ is equal to



a) 50 J b) 25 J c) 287.5 J d) 200 J

61. Power supplied to a particle of mass 2 kg varies with time as $P = \frac{3t^2}{2}$ watt. Here t is in second. If the velocity of particle at $t = 0$ is $v = 0$, the velocity of particle at time $t = 2$ s will be

a) 1 ms^{-1} b) 4 ms^{-1} c) 2 ms^{-1} d) $2\sqrt{2}$ ms^{-1}

62. A light and a heavy body have equal kinetic energy. Which one has a greater momentum

a) The light body b) The heavy body
c) Both have equal momentum d) It is not possible to say anything without additional information

63. A metal ball of mass 2 kg moving with a velocity of 36 km/h has an head on collision with a stationary ball of mass 3 kg. If after the collision, the two balls move together, the loss in kinetic energy due to collision is

a) 40 J b) 60 J c) 100 J d) 140 J

64. If the momentum of a body is increased by 100%, then the percentage increase in the kinetic energy is

a) 150% b) 200% c) 225% d) 300%

65. A spring of 40 mm long is stretched by the application of a force. If 10 N force required to stretch the spring through 1 mm, then work done in stretching the spring through 40 mm

a) 84 J b) 68 J c) 23 J d) 8 J

66. A steel ball of mass 5 g is thrown downward with velocity 10 ms^{-1} from height 19.5 m. It penetrates sand by 50 cm. The change in mechanical energy will be ($g = 10ms^{-2}$)

a) 1 J b) 1.25 J c) 1.5 J d) 1.75 J

67. A mass of 20 kg moving with a speed of 10 m/s collides with another stationary mass of 5 kg As a result of the collision, the two masses stick together. The kinetic energy of the composite mass will be

a) 600 $Joule$ b) 800 $Joule$ c) 1000 $Joule$ d) 1200 $Joule$

68. From a waterfall, water is falling down at the rate of 100 kg/s on the blades of turbine. If the height of the ball is 100 m, then the power delivered to the turbine is approximately equal to

a) 100 kW b) 10 kW c) 1 kW d) 1000 kW

69. The block of mass M moving on the frictionless horizontal surface collides with the spring of spring constant k and compresses it by length L. The maximum momentum of the block after collides is

a) $\sqrt{MkL}$ b) $\frac{kL^2}{2M}$ c) Zero d) $\frac{ML^2}{k}$

70. A long spring, when stretched by x cm has a potential energy U. On increasing the length of spring by stretching to nx cm, the potential energy stored in the spring will be

a) $\frac{U}{n}$ b) nU c) n^2U d) $\frac{U}{n^2}$

71. A variable force, given by the 2-dimensional vector $\vec{F} = (3x^2\hat{\imath} + 4\hat{\jmath})$, acts on a particle. The force is in newton and x is in metre. What is the change in the kinetic energy of the particle as it moves from the point with coordinates (2,3) to (3,0) (The coordinates are in metres)

a) $-7\,J$ b) Zero c) $+7\,J$ d) $+19\,J$

72. A steel ball of radius 2 cm is at rest on a frictionless surface. Another ball of radius 4 cm moving at a velocity of 81 cm/sec collides elastically with first ball. After collision the smaller ball moves with speed of

a) 81 cm/sec b) 63 cm/sec c) 144 cm/sec d) None of these

73. A body of mass m kg is lifted by a man to a height of one metre in 30 sec. Another man lifts the same mass to the same height in 60 sec. The work done by them are in the ratio

a) 1: 2 b) 1: 1 c) 2: 1 d) 4: 1

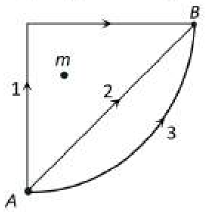
74. A mass m moves with a velocity v and collides inelastically with another identical mass. After collision the 1st mass moves with velocity $\frac{v}{\sqrt{3}}$ in a direction perpendicular to the initial direction of motion. Find the speed of the second mass after collision.

a) v b) $\sqrt{3}\,v$ c) $\frac{2}{\sqrt{3}}v$ d) $\frac{v}{\sqrt{3}}$

75. A stone tied to a string of length L is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at its lowest position and has a speed u. The magnitude of the change in its velocity as it reaches a position where the string is horizontal is

a) $\sqrt{u^2 - 2gL}$ b) $\sqrt{2gL}$ c) $\sqrt{u^2 - gL}$ d) $\sqrt{2(u^2 - gL)}$

76. If W_1, W_2 and W_3 represent the work done in moving a particle from A to B along three different paths 1, 2 and 3 respectively (as shown) in the gravitational field of a point mass m, find the correct relation between W_1, W_2 and W_3



a) $W_1 > W_2 > W_3$ b) $W_1 = W_2 = W_3$ c) $W_1 < W_2 < W_3$ d) $W_2 > W_1 > W_3$

77. A point mass of 1 kg collides elastically with a stationary point mass of 5 kg. After their collision, the 1 kg mass reverses its direction and moves with a speed of 2 ms^{-1}. Which of the following statements(s) is/are correct for the system of these two masses?

a) Total momentum of the system is 3 $kg - ms^{-1}$

b) Momentum of 5 kg mass after collision is 4 $kg - ms^{-1}$

c) Kinetic energy of the centre of mass is 0.75 j

d) Total kinetic energy of the system is 4 j

78. A 0.5 kg ball is thrown up with an initial speed 14 m/s and reaches a maximum height of 8.0m. How much energy is dissipated by air drag acting on the ball during the ascent

a) 19.6 $Joule$ b) 4.9 $Joule$ c) 10 $Joule$ d) 9.8 $Joule$

79. A man does a given amount of work in 10 sec. Another man does the same amount of work in 20 sec. The ratio of the output power of first man to the second man is

a) 1 b) 1/2 c) 2/1 d) None of these

80. A ball of mass 2 kg moving with velocity 3 ms^{-1}, collides with spring of natural length 2 m and force constant 144 Nm^{-1}. what will be length of compressed spring?

a) 2 m b) 1.5 m c) 1 m d) 0.5 m

81. A ball of mass 10 kg is moving with a velocity of 10 m/s. It strikes another ball of mass 5 kg which is moving in the same direction with a velocity of 4 m/s. If the collision is elastic , their velocities after the collision will be, respectively

a) 6 m/s, 12 m/s b) 12 m/s, 6 m/s c) 12 m/s, 10 m/s d) 12 m/s, 25 m/s

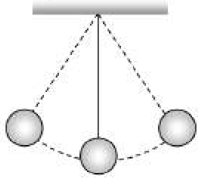
82. An electric immersion heater of 1.08 kW is immersed in water. After the water has reached a temperature of 100°C, how much time will be required to produce 100 g of steam

a) 210 s b) 105 s c) 420 s d) 50 s

83. If the heart pushes 1 cc of blood in 1 s under pressure $20000 Nm^{-2}$,the power of heart is

a) 0.02 W b) 400 W c) 5×10^{-10}W d) 0.2 W

84. What is the velocity of the bob of a simple pendulum at its mean position, if it is able to rise to vertical height of 10 cm (Take $g = 9.8\ m/s^2$)



a) 0.6 m/s b) 1.4 m/s c) 1.8 m/s d) 2.2 m/s

85. A bullet hits and gets embedded in a solid block resting on a frictionless surface .In this process which one of the following is correct?

a) Only momentum is conserved

b) Only kinetic energy is conserved

c) Neither momentum nor kinetic energy is conserved

d) Both momentum and kinetic energy are conserved

86. Power applied to a particle varies with time as $P = (3t^2 - 2t + 1)$ watt, where t is in second. Find the change in its kinetic energy between $t = 2$ s and $t = 4$ s

a) 32 J b) 46 J c) 61 J d) 100 J

87. A bag (mass M) hangs by a long thread and a bullet (mass m) comes horizontally with velocity v and gets caught in the bag. Then for the combined (bag + bullet) system

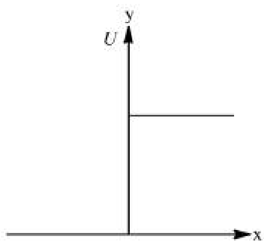
a) Momentum is $\frac{mvM}{M+m}$ b) Kinetic energy is $\frac{mv^2}{2}$

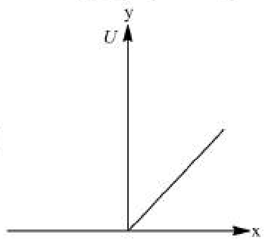
c) Momentum is $\frac{mv(M+m)}{M}$ d) Kinetic energy is $\frac{m^2v^2}{2(M+m)}$

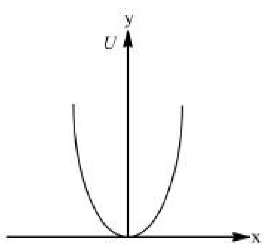
88. Which of the following is a unit of energy

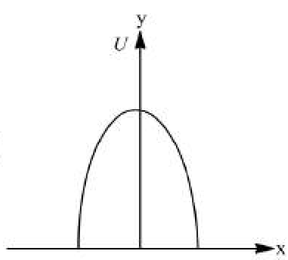
a) Unit b) Watt c) Horse Power d) None

89. Which of the following graphs show variation of potential energy (U) with position x.

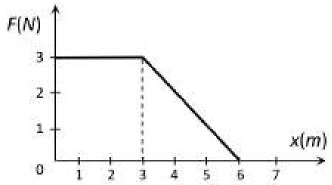
a) 

b) 

c) 

d) 

90. A force F acting on an object varies with distance x as shown here. The force is in $newton$ and x in $metre$. The work done by the force in moving the object from $x = 0$ to $x = 6m$ is



a) $4.5\,J$ b) $13.5\,J$ c) $9.0\,J$ d) $18.0\,J$

91. Two identical mass M moving with velocity u_1 and u_2 collide perfectly inelastically. The loss in energy is

a) $\frac{M}{2}(u_2 - u_1)^2$ b) $\frac{M}{2}(u_1 - u_2)^2$ c) $\frac{M}{4}(u_1 - u_2)^2$ d) $\frac{M}{4}(u_2 - u_1)^2$

92. A particle P moving with speed v undergoes a head–on elastic collision with another particle Q of identical mass but at rest. After the collision

a) Both P and Q move forward with speed $\frac{v}{2}$
b) Both P and Q move forward with speed $\frac{v}{\sqrt{2}}$
c) P comes to rest and Q moves forward with speed v
d) P and Q move in opposite directions with speed $\frac{v}{\sqrt{2}}$

93. Work done in time t on a body of mass m which is accelerated from rest to a speed v in time t_1 as a function of time t is given by

a) $\frac{1}{2}m\frac{v}{t_1}t^2$ b) $m\frac{v}{t_1}t^2$ c) $\frac{1}{2}\left(\frac{mv}{t_1}\right)^2 t^2$ d) $\frac{1}{2}m\frac{v^2}{t_1^2}t^2$

94. A spring with spring constant k when stretched through 1 cm, the potential energy is U. If it is stretched by 4 cm. The potential energy will be

a) $4U$ b) $8U$ c) $16U$ d) $2U$

95. A body of mass m_1, moving with a velocity 3 ms^{-1} collides with another body at rest of mass m_2. After collision the velocities of the two bodies are 2 ms^{-1} and 5 ms^{-1} respectively along the direction of motion of m_1 The ratio m_1/m_2 is

a) $\frac{5}{12}$ b) 5 c) $\frac{1}{5}$ d) $\frac{12}{5}$

96. If a force F is applied on a body and it moves with a velocity v, the power will be

a) $F \times v$ b) F/v c) F/v^2 d) $F \times v^2$

97. A time t=0 s Particle starts moving along the x-axis. If its kinetic energy increases uniformly with time t, the net force acting on it must be proportional to

a) $\sqrt{t}$ b) Constant c) t d) $\frac{1}{\sqrt{t}}$

98. A particle of mass M starting from rest undergoes uniform acceleration. If the speed acquired in time T is V, the power delivered to the particle is

a) $\frac{MV^2}{T}$ b) $\frac{1}{2}\frac{MV^2}{T^2}$ c) $\frac{MV^2}{T^2}$ d) $\frac{1}{2}\frac{MV^2}{T}$

99. A ball is dropped from a height h. If the coefficient of restitution be e, then to what height will it rise after jumping twice from the ground

a) $eh/2$ b) $2eh$ c) eh d) e^4h

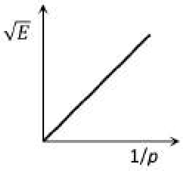
100. The spring extends by x on loading, then energy stored by the spring is :
(If T is the tension in spring and k is spring constant)

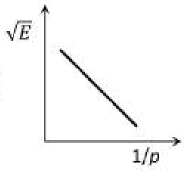
a) $\frac{T^2}{2k}$ b) $\frac{T^2}{2k^2}$ c) $\frac{2k}{T^2}$ d) $\frac{2T^2}{k}$

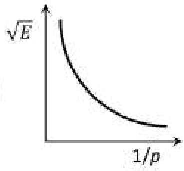
101. An engine pump is used to pump a liquid of density ρ continuously through a pipe of cross-sectional area A. If the speed of flow of the liquid in the pipe is v, then the rate at which kinetic energy is being imparted to the liquid is

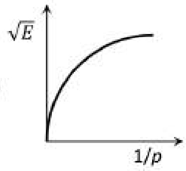
a) $\frac{1}{2}A\rho v^3$ b) $\frac{1}{2}A\rho v^2$ c) $\frac{1}{2}A\rho v$ d) $A\rho v$

102. The graph between $\sqrt{E}$ and $1/p$ is (E = kinetic energy and p = momentum)

a) 

b) 

c) 

d) 

103. A bullet moving with a speed of 100 ms^{-1} can just penetrate two planks of equal thickness. Then the number of such planks penetrated by the same bullet when the speed is doubled will be

a) 4 b) 8 c) 6 d) 10

104. A body at rest breaks up into 3 parts. If 2 parts having equal masses fly off perpendicularly each after with a velocity of 12 m/s, then the velocity of the third part which has 3 times mass of each part is

a) $4\sqrt{2}\ m/s$ at an angle of 45° from each body
b) $24\sqrt{2}\ m/s$ at an angle of 135° from each body
c) $6\sqrt{2}\ m/s$ at 135° from each body
d) $4\sqrt{2}\ m/s$ at 135° from each body

105. The kinetic energy K of a particle moving in straight line depends upon the distance s as :
$K = as^2$
The force acting on the particle is

a) $2\ as$ b) $2\ mas$ c) $2a$ d) $\sqrt{as^2}$

106. A vertical spring with force constant k is fixed on a table .A ball of mass m at a height h above the free upper end of the spring falls vertically on the spring, so that the spring is compressed by a distance d. The net work done in the process is

a) $mg(h+d)+\frac{1}{2}kd^2$ b) $mg(h+d)-\frac{1}{2}kd^2$ c) $mg(h-d)-\frac{1}{2}kd^2$ d) $mg(h-d)+\frac{1}{2}kd^2$

107. The energy required to accelerate a car from 10 m/s to 20 m/s is how many times the energy required to accelerate the car from rest to 10 m/s

a) Equal b) 4 times c) 2 times d) 3 times

108. If a body looses half of its velocity on penetrating 3 cm in a wooden block, then how much will it penetrate more before coming to rest

a) 1 cm b) 2 cm c) 3 cm d) 4 cm

109. When U^{238}nucleus originally at rest, decays by emitting an alpha particle having a speed u
The recoil speed of the residual nucleus is

a) $\frac{4u}{238}$ b) $-\frac{4u}{234}$ c) $\frac{4u}{234}$ d) $-\frac{4u}{238}$

110. A body of mass m_1 moving with uniform velocity of 40 m/s collides with another mass m_2 at rest and then the two together begin to move with uniform velocity of 30 m/s. The ratio of their masses $\frac{m_1}{m_2}$ is

a) 0.75 b) 1.33 c) 3.0 d) 4.0

111. A man running has half the kinetic energy of a boy of half his mass. The man speeds up by 1 ms^{-1} and then has KE as that of the boy. What were the original speeds of man and the boy?

a) $\sqrt{2}ms^{-1}; 2\sqrt{2}-1ms^{-1}$
b) $(\sqrt{2}-1)ms^{-1}, 2(\sqrt{2}-1)ms^{-1}$
c) $(\sqrt{2}+1)ms^{-1}; 2(\sqrt{2}+1)ms^{-1}$
d) None of the above

112. A plate of mass m, length b and breadth a is initially lying on a horizontal floor with length parallel to the floor and breadth perpendicular to the floor. The work done to erect it on its breadth is

a) $mg\left[\frac{b}{2}\right]$ b) $mg\left[a+\frac{b}{2}\right]$ c) $mg\left[\frac{b-a}{2}\right]$ d) $mg\left[\frac{b+a}{2}\right]$

113. Which of the following is not a conservative force

a) Gravitational force
b) Electrostatic force between two charges
c) Magnetic force between two magnetic dipoles
d) Frictional force

114. The work done against gravity in taking 10 kg mass at 1m height in 1 sec will be

a) 49 J b) 98 J c) 196 J d) None of these

115. An athlete in the Olympic games covers a distance of 100 m in 10 s. His kinetic energy can be estimated to be in the range

a) $2 \times 10^5 J - 3 \times 10^5 J$ b) $20{,}000\, J - 50{,}000\, J$ c) $2{,}000\, J - 5{,}000\, J$ d) $200\, J - 500\, J$

116. In an elastic collision of two particles the following is conserved

a) Momentum of each particle b) Speed of each particle

c) Kinetic energy of each particle d) Total kinetic energy of both the particles

117. A particle moves under the effect of a force $F = Cx$ from $x = 0$ to $x = x_1$. The work done in the process is

a) Cx_1^2 b) $\frac{1}{2}Cx_1^2$ c) Cx_1 d) Zero

118. A mass of 0.5 kg moving with a speed of 1.5 m/s on a horizontal smooth surface, collides with a nearly weightless spring of force constant $k = 50\ N/m$. The maximum compression of the spring would be

a) 0.15 m b) 0.12 m c) 1.5 m d) 0.5 m

119. An object of mass $3m$ splits into three equal fragments. Two fragments have velocities $v\hat{j}$ and $v\hat{i}$. The velocity of the third fragment is

a) $v(\hat{j} - \hat{i})$ b) $v(\hat{i} - \hat{j})$ c) $-v(\hat{i} + \hat{j})$ d) $\frac{v(\hat{i} + \hat{j})}{\sqrt{2}}$

120. A spring of force constant 800 Nm^{-1} has an extension of 5 cm. the work done in extending it from 5 cm to 15 cm is

a) 16 J b) 8 J c) 32 J d) 24 J

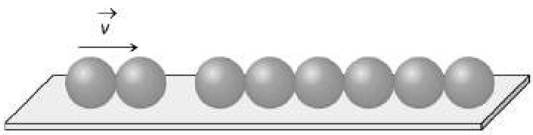
121. A 50 kg man with 20 kg load on his head climbs up 20 steps of 0.25m height each. The work done in climbing is

a) 5 J b) 350 J c) 100 J d) 3430 J

122. A body moves a distance of 5m along a straight line under the action of a force of 10 N. If the work done is 25 J, then the angel which the force makes with the direction of motion of the body is

a) 0° b) 30° c) 60° d) 90°

123. Six identical balls are linked in a straight groove made on a horizontal frictionless surface as shown. Two similar balls each moving with a velocity v collide elastically with the row of 6 balls from left. What will happen



a) One ball from the right rolls out with a speed $2v$ and the remaining balls will remain at rest

b) Two balls from the right roll out with speed v each and the remaining balls will remain stationary

c) All the six balls in the row will roll out with speed $v/6$ each and the two colliding balls will come to rest

d) The colliding balls will come to rest and no ball rolls out from right

124. Power of water pump is 2 kW. If $g = 10\ m/sec^2$, the amount of water it can raise in one minute to a height of 10 m is

a) 2000 *litre* b) 1000 *litre* c) 100 *litre* d) 1200 *litre*

125. A light and a heavy body have equal momenta. Which one has greater K.E.

a) The light body b) The heavy body c) The K.E. are equal d) Data is incomplete

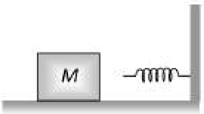
126. A bomb of 12 kg divides in two parts whose ratio of masses is 1 : 3. If kinetic energy of smaller part is 216 J, then momentum of bigger part in $kg - m/sec$ will be

a) 36 b) 72 c) 108 d) Data is incomplete

127. A 10 kg object collides with stationary 5 kg object and after collision they stick together and move forward with velocity 4 ms^{-1}.what is the velocity with which the 10 kg object hit the second one?

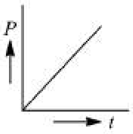
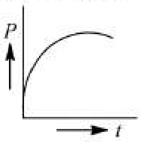
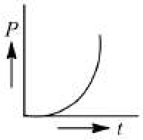
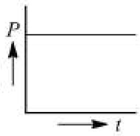
a) 4 ms^{-1} b) 6 ms^{-1} c) 10 ms^{-1} d) 12 ms^{-1}

128. The block of mass M moving on the frictionless horizontal surface collides with the spring of spring constant K and compresses it by length L. The maximum momentum of the block after collision is



a) Zero b) $\frac{ML^2}{K}$ c) $\sqrt{MK}\,L$ d) $\frac{KL^2}{2M}$

129. A motor drives a body along a straight line with a constant force. The power P developed by the motor must vary with time t as shown in figure

a) 
b) 
c) 
d) 

130. A car weighing 1400 kg is moving at a speed of 54 kmh^{-1} up a hill when the motor stops. If it is just able to reach the destination which is at a height of 10 m above the point, then the work done against friction (negative of the work done by the friction) is [Take g = 10ms^{-2}]

a) 10 kJ b) 15 kJ c) 17.5 kJ d) 25 kJ

131. The potential energy of a weight less spring compressed by a distance a is proportional to

a) a b) a^2 c) a^{-2} d) a^0

132. Consider the following statements. A and B and identify the correct answer given below.

I. Body initially at rest is acted upon by a constant force. The rate of change of its kinetic energy varies linearly with time.

II. When a body is at rest, it must be in equilibrium.

a) A and B are correct b) A and B are wrong

c) A is correct and B is wrong d) A is wrong and B is correct

133. A bullet of mass a and velocity b is fired into a large block of mass c. The final velocity of the system is

a) $\frac{c}{a+b}.b$ b) $\frac{a}{a+c}.b$ c) $\frac{a+b}{c}.a$ d) $\frac{a+c}{a}.b$

134. It is observed that the force required to tow a boat at constant velocity is proportional to the velocity. It takes 16 HP to tow a boat at a velocity of 2 kmh^{-1}. The horse power required to tow this boat at a velocity of 3 kmh^{-1} is

a) 9 b) 18 c) 36 d) 72

135. A body moving with velocity v has momentum and kinetic energy numerically equal. What is the value of v

a) 2 m/s b) $\sqrt{2}\, m/s$ c) 1 m/s d) 0.2 m/s

136. Under the action of a force F=Cx, the position of a body changes from 0 to x.The work done is

a) $\frac{1}{2}Cx^2$ b) Cx^2 c) Cx d) $\frac{1}{2}Cx$

137. When a body moves with some friction on a surface

a) It loses kinetic energy but momentum is constant

b) It loses kinetic energy but gains potential energy

c) Kinetic energy and momentum both decrease

d) Mechanical energy is conserved

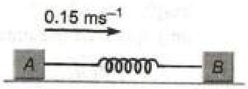
138. A running man has the same kinetic energy as that of a boy of half his mass. The man speed up by 2 ms^{-1} and the boy changes his speed by x = ms^{-1}, so that the kinetic energies of the boy and the man are again equal. Then x in ms^{-1} is

a) $-2\sqrt{2}$ b) $+2\sqrt{2}$ c) $\sqrt{2}$ d) 2

139. The coefficient of restitution e for a perfectly elastic collision is

a) 1 b) 0 c) ∞ d) -1

140. Two rectangular blocks A and B of masses 2kg and 3 kg respectively are connected by spring of spring constant 10.8 $\text{Nm}^{-1}$and are placed on a frictionless horizontal surface. The block A was given an initial velocity of 0.15 ms^{-1} in the direction shown in the figure. The maximum compression of the spring during the motion is



a) 0.01 m b) 0.02 m c) 0.05 m d) 0.03 m

141. A ball dropped from a height of 2 m rebounds to a height of 1.5 m after hitting the ground. Then the percentage of energy lost is

a) 25 b) 30 c) 50 d) 100

142. The power of pump, which can pump 200 kg of water to a height of 50 m in 10 sec, will be

a) 10×10^3 $watt$ b) 20×10^3 $watt$ c) 4×10^3 $watt$ d) 60×10^3 $watt$

143. A bomb at rest explodes into 3 parts of the same mass.
The momentum of the 2 parts is $-2p\hat{I}$ and $p\hat{j}$. The momentum of the third part will have a magnitude of

a) p b) $\sqrt{3p}$ c) $p\sqrt{5}$ d) zero

144. $4m^3$ of water is to be pumped to a height of 20m and forced into a reservoir at a pressure of 2×10^5 Nm^{-2} The work done by the motor is (external pressure= 10^5Nm^{-2})

a) 8×10^5J b) 16×10^5J c) 12×10^5J d) 32×10^5J

145. If a lighter body (Mass M_1 and velocity V_1) and a heavier body (mass M_2 and velocity V_2) have the same kinetic energy, then

a) $M_2V_2 < M_1V_1$ b) $M_2V_2 = M_1V_1$ c) $M_2V_1 = M_1V_2$ d) $M_2V_2 > M_1V_1$

146. If we throw a body upwards with velocity of 4 m/s, at what height does its kinetic energy reduce to half of the initial value (Taking $g = 10\ ms^{-1}$)

a) 4 m b) 2 m c) 1 m d) 0.4 m

147. A ball of mass m moving with velocity V, makes a head on elastic collision with a ball of the same mass moving with velocity $2V$ towards it. Taking direction of V as positive velocities of the two balls after collision are

a) $-V$ and $2V$ b) $2V$ and $-V$ c) V and $-2V$ d) $-2V$ and V

148. A box of mass 50 kg is pulled up on an incline 12 m long and 2 m high by a constant force of 100 N from rest. It acquires a velocity of 2 ms^{-1} on reaching the top. Work done against friction ($g = 10\ \text{ms}^{-2}$) is

a) 50 J b) 100 J c) 150 J d) 200 J

149. A body moves a distance of 10 m along a straight line under the action of a force of 5 N. If the work done is 25 $joules$, the angle which the force makes with the direction of motion of the body is

a) 0° b) 30° c) 60° d) 90°

150. A car is moving with a speed of 100 kmh^{-1}. If the mass of the car is 950 kg, then its kinetic energy is

a) 0.367 M J b) 3.67 J c) 3.67 M J d) 367 J

151. If a body of mass 3 kg is dropped from the top of a tower of height 25 m, then its kinetic energy after 3 s will be

a) 1126 J b) 1048 J c) 735 J d) 1296 J

152. A position-dependent force $F = 3x^2 - 2x + 7$ acts on a body of mass 7 kg and displaces it from $x = 0$ m to $x = 5m$. The work done on the body is x' joule. If both F and x are measured in SI units, the value of x' is

a) 135 b) 235 c) 335 d) 935

153. Consider the following statements A and B and identify the correct answer

III. In an elastic collision, if a body suffers a head on collision with another of same mass at rest, the first body comes to rest while the other starts moving with the velocity of the first one

IV. Two bodies of equal mass suffering a head on elastic collision merely exchange their velocities.

a) Both A and B are true b) Both A and B are false
c) A is true and B is false d) A is false but B is true

154. A bullet of mass 0.02 kg travelling horizontally with velocity 250 ms^{-1} strikes a block of wood of mass 0.23 kg which rests on a rough horizontal surface. After the impact, the block and bullet move together and come to rest after travelling a distance of $40m$. The coefficient of sliding friction of the rough surface is ($g = 9.8\ ms^{-2}$)

a) 0.75 b) 0.61 c) 0.51 d) 0.30

155. A 2 kg block slides on a horizontal floor with a speed of 4 m/s. It strikes a uncompressed spring, and compresses it till the block is motionless. The kinetic friction force is 15 N and spring constant is 10,000 N/m. The spring compresses by

a) 5.5 cm b) 2.5 cm c) 11.0 cm d) 8.5 cm

156. Which of the following statements are incorrect?

(i)If there were no friction, Work need to be done to move a body up an inclined plane is zero.

(ii)If there were no friction, moving vehicles could not be stopped even by locking the brakes.

(iii)As the angle of inclination is increased, the normal reaction on the body placed on it increases.

(iv)A duster weighing 0.5 kg is pressed against a vertical board with a force of 11 N. If the coefficient of friction is 0.5, the work done in rubbing it upward through a distance of 10 cm is 0.55J.

a) (i)and(ii) b) (i),(ii),(iv) c) (i),(iii),and(iv) d) All of these

157. A force of 5 N acts on a 15 kg body initially at rest. The work done by the force during the first second of motion of the body is

a) 5 J b) $\frac{5}{6}J$ c) 6 J d) 75 J

158. A wooden block of mass M rests on a horizontal surface. A bullet of mass m moving in the horizontal direction strikes and gets embedded in it. The combined system covers a distance x on the surface. If the coefficient of friction between wood and the surface is μ, the speed of the bullet at the time of striking the block is (where m is mass of the bullet)

a) $\sqrt{\frac{2Mg}{\mu m}}$ b) $\sqrt{\frac{2\mu mg}{Mx}}$ c) $\sqrt{2\mu gx}\left(\frac{M+m}{m}\right)$ d) $\sqrt{\frac{2\mu mx}{M+m}}$

159. A mass of M kg suspended by a weightless string. The horizontal force that is required to displace it until the string makes an angle of 45^0 with the initial vertical direction is

a) $Mg(\sqrt{2}+1)$ b) $Mg\sqrt{2}$ c) $\frac{Mg}{\sqrt{2}}$ d) $Mg(\sqrt{2}-1)$

160. A rock of mass m is dropped to the ground from a height h. A second rock with mass 2m is dropped from the same height. When second rock strikes the ground, what is its kinetic energy?

a) Twice that of the first rock b) Four times that of the first rock

c) The same as that of the first rock d) Half that of the first rock

161. A 2 kg ball moving at 24 ms^{-1}undergoes inelastic head-on collision with a 4 kg ball moving in opposite direction at 48 ms^{-1}.if the coefficient of restitution is 2/3,their velocities in ms^{-1}after impact are

a) $-56,-8$ b) $-28,-4$ c) $-14,-2$ d) $-7,-1$

162. A ball moving with speed v hits another identical ball at rest. The two balls stick together after collision. If specific heat of the material of the balls is S, the temperature rise resulting from the collision is

a) $\frac{v^2}{8S}$ b) $\frac{v^2}{4S}$ c) $\frac{v^2}{2S}$ d) $\frac{v^2}{S}$

163. A body moves from a position $\boldsymbol{r_1}$= ($2\hat{\boldsymbol{\imath}}-3\hat{\mathbf{j}}-4\hat{\mathbf{k}}$) m to a position, **r2**= (3$\hat{\imath}$-43$\hat{\jmath}$-5$\hat{k}$) m under the influence of a constant force **F**= ($4\hat{\boldsymbol{\imath}}-4\hat{\mathbf{j}}+5\hat{\mathbf{k}}$) N. The work done by the force is

a) 57 J b) 58 J c) 59 J d) 60 J

164. A man starts walking from a point on the surface of earth (assumed smooth) and reaches diagonally opposite point. What is the work done by him

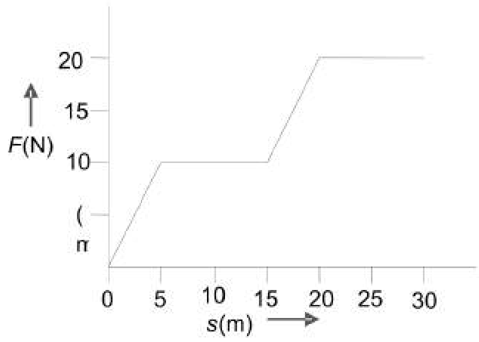
a) Zero b) Positive c) Negative d) Nothing can be done

165. The height of the dam, in a hydroelectric power station is 10 m. In order to generate 1 MW of electric power,

The mass of water (in kg) that must fall per second on the blades of the turbines is

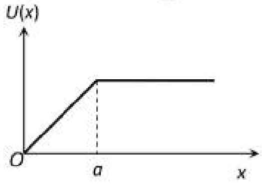
a) 10^6 b) 10^5 c) 10^3 d) 10^4

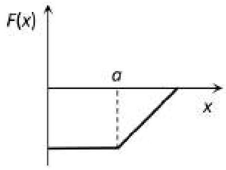
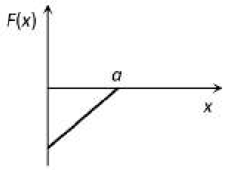
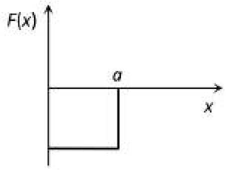
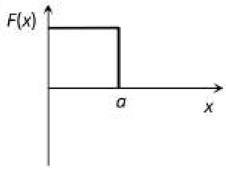
166. The work done by force acting on a body is as shown in the graph. The total work done in covering an initial distance of 20 m is



a) 225J
b) 200J
c) 400J
d) 175J

167. The potential energy of a system is represented in the first figure. The force acting on the system will be represented by



a) 
b) 
c) 
d) 

168. In elastic collision
a) Both momentum and kinetic energies are conserved
b) Both momentum and kinetic energies are not conserved
c) Only energy is conserved
d) Only mechanical energy is conserved

169. A motor is used to deliver water at a certain rate through a given horizontal pipe. To deliver n-times the water through the same time the power of the motor must be increased as follows
a) n times
b) n^3times
c) n^4 times
d) n^2 times

170. A particle of mass m moving with velocity v strikes a stationary particle of mass $2m$ and sticks to it. The speed of the system will be
a) $v/2$
b) $2v$
c) $v/3$
d) $3v$

171. The human heart discharges 75 cc of blood through the arteries at each beat against an average pressure of 10 cm of mercury. Assuming that the pulse frequency is 72 per minute the rate of working of heart in watt, is (Density of mercury =13.6 g/cc and g = 9.8 ms^{-2})
a) 11.9
b) 1.19
c) 0.119
d) 119

172. A ball is dropped from a height h on a floor of coefficient of restitution e.The total distance covered by the ball just before second hit is
a) $h(1-2e^2)$
b) $h(1+2e^2)$
c) $h(1+e^2)$
d) he^2

173. A mass of $M\ kg$ is suspended by a weightless string. The horizontal force that is required to displace it until the string makes an angle of 45° with the initial vertical direction is
a) $Mg\sqrt{2}$
b) $\frac{Mg}{\sqrt{2}}$
c) $Mg(\sqrt{2}-1)$
d) $Mg(\sqrt{2}+1)$

174. The power supplied by a force acting on a particle moving in a straight line is constant. The velocity of the particle varies with the displacement x as
a) $x^{1/2}$
b) x
c) x^2
d) $x^{1/3}$

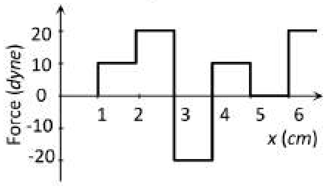
175. A body of mass M moves with velocity v and collides elastically with a another body of mass $m(M >> m)$ at rest then the velocity of body of mass m is

a) v b) $2v$ c) $v/2$ d) Zero

176. Power supplied to a particle of mass 2 kg varies with time as $P = t^2/2$ watt, where t is in second. If velocity of particle at $t = 0$ is $v = 0$, the velocity of particle at $t = 2$s will be

a) 1 ms^{-1} b) 4 ms^{-1} c) 2 ms^{-1} d) $2\sqrt{2} \text{ ms}^{-1}$

177. The relationship between force and position is shown in the figure given (in one dimensional case). The work done by the force in displacing a body from $x = 1\ cm$ to $x = 5\ cm$ is



a) $20\ ergs$ b) $60\ ergs$ c) $70\ ergs$ d) $700\ ergs$

178. A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done in pulling the entire chain on the table?

a) 7.2 J b) 3.6 J c) 120 J d) 1200 J

179. It is easier to draw up a wooden block along an inclined plane than to haul it vertically, principally because

a) The friction is reduced b) The mass becomes smaller

c) Only a part of the weight has to be overcome d) 'g' becomes smaller

180. A body of mass M is hung by a long thread and a bullet of mass m hits it horizontally with a velocity v and gets embedded in the body. Then for the body and the bullet system

a) Momentum= $\left(\frac{Mm}{M+m}\right) v$ b) Kinetic energy= $\frac{1}{2}mv^2$

c) Momentum= $\frac{(M+m)mv}{M}$ d) Kinetic energy= $\frac{m^2v^2}{2(M+m)}$

181. Consider the following two statements

1. Linear momentum of a system of particles is zero

2. Kinetic energy of a system of particles is zero,

Then

a) 1 implies 2 and 2 implies 1 b) 1 does not imply 2 and 2 does not imply 1

c) 1 implies 2 but 2 does not implies 1 d) 1 does not imply 2 but 2 implies 1

182. If F is the force required to keep a train moving at a constant speed v,the power required is

a) $\frac{1}{2}Fv^2$ b) Fv^2 c) $\frac{1}{2}Fv$ d) Fv

183. For inelastic collision between two spherical rigid bodies

a) The total kinetic energy is conserved b) The total mechanical energy is not conserved

c) The liner momentum is not conserved d) The liner momentum is conserved

184. The work done by a force $\vec{F} = (-6x^3 i)N$, in displacing a particle from $x = 4\ m$ to $x = -2\ m$ is

a) $360\ J$ b) $240\ J$ c) $-240\ J$ d) $-360\ J$

185. A bomb of mass M at rest explodes into two fragments of masses m_1 and m_2. The total energy released in the explosion is E. If E_1 and E_2 represent the energies carried by masses m_1 and m_2 respectively, then which of the following is correct?

a) $E_1 = \frac{m_2}{M}E$ b) $E_1 = \frac{m_1}{m_2}E$ c) $E_1 = \frac{m_1}{M}E$ d) $E_1 = \frac{m_2}{m_1}E$

186. A disc of moment of inertia $\frac{9.8}{\pi^2} kg - m^2$ is rotating at 600 rpm. If the frequency of rotation changed from 600 rpm to 300 rpm, then what is the work done?

a) 1467 J b) 1452 J c) 1567 J d) 1632 J

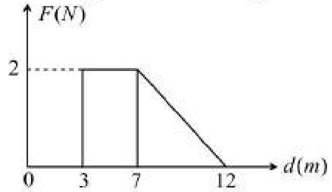
187. The centripetal acceleration of a particle varies inversely with the square of the radius $r$of the circular path .The KE of this particle varies directly as

a) r b) r^2 c) r^{-2} d) r^{-1}

188. A bomb of mass 3.0 kg explodes in air into two pieces of masses 2.0 kg and 1.0 kg. The smaller mass goes at a speed of 80 m/s. The total energy imparted to the two fragments is

a) 1.07 kJ b) 2.14 kJ c) 2.4 kJ d) 4.8 kJ

189. Force F on a particle moving in a straight line varies with distance d as shown in the figure. The work done on the particle during its displacement of 12 m



a) 13 J b) 18 J c) 21 J d) 26 J

190. A body of mass 6 kg is acted upon by a force which causes a displacement in it given by $x\frac{t^2}{4}$ metre where t is the time in second. The work done by the force in 2s is

a) 12 J b) 9 J c) 6 J d) 3 J

191. A particle of mass $m$is being circulated on a vertical circle of radius r. If the speed of particle at the highest point be v, then

a) $mg = \frac{mv^2}{r}$ b) $mg > \frac{mv^2}{r}$ c) $mg < \frac{mv^2}{r}$ d) $mg \geq \frac{mv^2}{r}$

192. A car of mass 1000 kg moves at a constant speed of 20 ms^{-1} up an incline. Assume that the frictional force is 200 N and that $\sin\theta = 1/20$ where, θ is the angel of the incline to the horizontal. The $g = 10\ ms^{-2}$. Find the power developed by the engine

a) 14 kW b) 4 kW c) 10 kW d) 28 kW

193. A particle acted upon by constant forces $4\hat{\imath} + \hat{\jmath} - 3\hat{\jmath}$ and $3\hat{\imath} + \hat{\jmath} - \hat{k}$is displaced from the point $\hat{\imath} + 2\hat{\jmath} + 3\hat{k}$ to the point $5\hat{\imath} + 4\hat{\jmath} + \hat{k}$ .The total work done by the forces in SI unit is

a) 20 b) 40 c) 50 d) 30

194. At a certain instant, a body of mass 0.4 kg has a velocity of $(8\hat{\imath} + 6\hat{\jmath})ms^{-1}$. The kinetic energy of the body is

a) 10 J b) 40 J c) 20 J d) None of these

195. A bullet of mass m moving with velocity v strikes a suspended wooden block of mass M. If the block rises to a height h, the initial velocity of the block will be

a) $\sqrt{2gh}$ b) $\frac{M+m}{m}\sqrt{2gh}$ c) $\frac{m}{M+m}2gh$ d) $\frac{M+m}{M}\sqrt{2gh}$

196. 10 L of water per second is lifted from well through 20 m and delivered with a velocity of $10ms^{-1}$,then the power of the motor is

a) 1.5 Kw b) 2.5 Kw c) 3.5 Kw d) 4.5 Kw

197. A particle moves on a rough horizontal ground with some initial velocity v_0. If $\frac{3}{4}$ th of its KE is lost in friction in time t_0, the coefficient of friction between the particle and the ground is

a) $\frac{v_0}{2gt_0}$ b) $\frac{v_0}{4gt_0}$ c) $\frac{3v_0}{4gt_0}$ d) $\frac{v_0}{gt_0}$

198. An engine of power 7500 W makes a train move on a horizontal surface with constant velocity of 20 ms^{-1}. The force involved in the problem is

a) 375 N b) 400 N c) 500 N d) 600 N

199. A 500 kg car, moving with a velocity of 36 km h^{-1} on a straight road unidirectionally, doubles its velocity in one minute. The power delivered by the engine for doubling the velocity is

a) 750 W b) 1050 W c) 1150 W d) 1250 W

200. The potential energy of a particle in a force field is $U = \frac{A}{r^2} - \frac{B}{r}$, where A and B are positive constants and r is the distance of particle from the centre of the field. For stable equilibrium, the distance of the particle is

a) $B/2A$ b) $2A/B$ c) A/B d) B/A

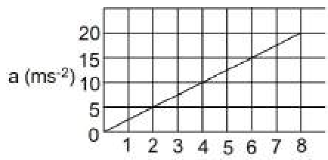
201. The kinetic energy of a body becomes four times its initial value. The new momentum will be
a) Same as the initial value
b) Twice the initial value
c) Thrice the initial value
d) Half of its initial value

202. If force and displacement of particle in direction of force are doubled. Work would be
a) Double
b) 4 times
c) Half
d) 1/4 times

203. A particle is released from a height S.At certain height its kinetic energy is three times its potential energy .The height and speed of the particle at that instant are respectively
a) $\frac{S}{4}, \frac{3gS}{2}$
b) $\frac{S}{4}, \frac{\sqrt{3gS}}{2}$
c) $\frac{S}{2}, \frac{\sqrt{3gS}}{2}$
d) $\frac{S}{4}, \sqrt{\frac{3gS}{2}}$

204. A position dependent force $F = 7 - 2x + 3x^2$ *newton* acts on a small body of mass 2 kg and displaces it from $x = 0$ to $x = 5m$. The work done in *joules* is
a) 70
b) 270
c) 35
d) 135

205. A 10 kg brick moves along an x-axis. Its acceleration as a function of its position is shown in figure. What is the net work performed on the brick by the force causing the acceleration as the brick moves from $x = 0$ to $x = 8.0$m?



a) 4 J
b) 8 J
c) 2 J
d) 1 J

206. A long spring is stretched by 2 cm and its potential energy is U. If the spring is stretched by 10 cm; its potential energy will be
a) U/5
b) U/25
c) 5 U
d) 25 U

207. Two putty balls of equal mass moving with equal velocity in mutually perpendicular directions, stick together after collision. If the balls were initially moving with a velocity of $45\sqrt{2}\ ms^{-1}$ each, the velocity of their combined after collision is
a) $45\sqrt{2}\ ms^{-1}$
b) $45\ ms^{-1}$
c) $90\ ms^{-1}$
d) $22.5\sqrt{2}\ ms^{-1}$

208. A particle free to move along the x-axis has potential energy given by $U(x) = k[1 - \exp(-x^2)]$ for $-\infty \leq x \leq +\infty$, where k is a positive constant of appropriate dimensions. Then
a) At point away from the origin, the particle is in unstable equilibrium
b) For any finite non-zero value of x, there is a force directed away from the origin
c) If its total mechanical energy is $k/2$, it has its minimum kinetic energy at the origin
d) For small displacements from $x = 0$, the motion is simple harmonic

209. When a spring is stretched by a distance x,it exerts a force, given by $F = (-5x - 16x^3)$N
The work done ,when the spring is stretched from 0.1 m to 0.2 m is
a) 8.7×10^{-2}J
b) 12.2×10^{-2}J
c) 8.7×10^{-1} J
d) 12.2×10^{-1}J

210. In a head on elastic collision of a very heavy body moving at v with a light body at rest, velocity of heavy body after collision is
a) v
b) $2v$
c) Zero
d) $\frac{v}{2}$

211. A bullet is fired from a rifle. If the riffle recoils freely, then the kinetic energy of the rifle is
a) Less than that of the bullet
b) More than that of the bullet
c) Same as that of the bullet
d) Equal or less than that of the bullet

212. A rubber ball is dropped from a height of 5 m on a planet where the acceleration due to gravity is not known. On bouncing, it rises to1.8 m. The ball loses its velocity on bouncing by a factor of
a) 16/25
b) 2/5
c) 3/5
d) 9/25

213. A running man has half the kinetic energy of that of a boy of half of his mass. The man speeds up by $1m/s$ so as to have same $K.E.$ as that of the boy. The original speed of the man will be

a) $\sqrt{2}\, m/s$ b) $(\sqrt{2}-1)\, m/s$ c) $\frac{1}{(\sqrt{2}-1)} m/s$ d) $\frac{1}{\sqrt{2}}\, m/s$

214. A body of mass 10 kg is moving on a horizontal surface by applying a force of 10 N in forward direction. If body moves with constant velocity, the work done by force of fiction for a displacement of 2m is

a) −20 J b) 10 J c) 20 J d) −5 J

215. An engine pumps up 100kg of water through a height of 10 m in 5 s. Given that the efficiency of engine is 60%.
If g=$10ms^{-2}$,the power of the engine is

a) 3.3 KW b) 0.33 KW c) 0.033KW d) 33KW

216. A rectangular plank of mass m_1 and height a is kept on a horizontal surface. Another rectangular plank of mass m_2 and height b is placed over the first plank. The gravitational potential energy of the system is

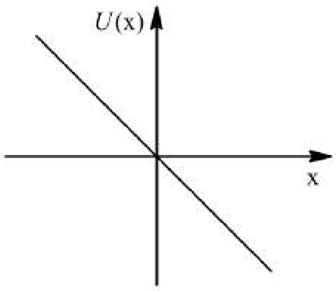
a) $m_1 + m_2(a+b)$ b) $\left[\frac{m_1 m_2}{2} a + m_2 \frac{b}{2}\right]$

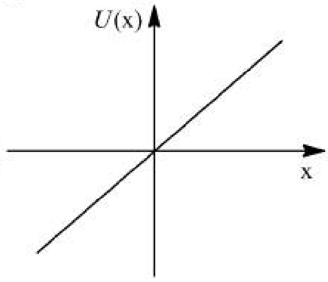
c) $\left[\left(\frac{m_1}{2} + m_2\right) a + m_2 \frac{b}{2}\right]$ d) $\left(\frac{m_1}{2} + m_2\right) a + m_1 \frac{b}{2}$

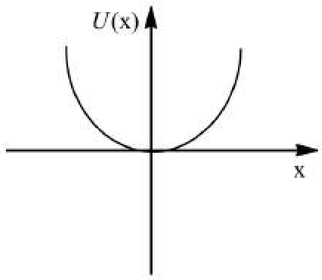
217. A ball of mass m moves with speed v and strikes a wall having infinite mass and it returns with same speed then the work done by the ball on the wall is

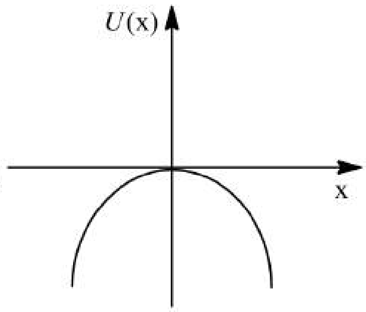
a) Zero b) $mv\, J$ c) $m/v.J$ d) $v/m\, J$

218. A particle is placed at the origin and force $F = kx$ is acting on it (where k is positive constant).if $u(0) = 0$.the graph $u(x)$ versus x will (where u is potential energy function)

a) 

b) 

c) 

d) 

219. A bucket full of water weighs 5 kg, it is pulled from a well 20 m deep. There is a small hole in the bucket through which water leaks at a constant rate of $0.2kgm^{-1}$ .The total work done in pulling the bucket up from the well is ($g = 10ms^{-2}$)

a) 600 J b) 400 J c) 100 J d) 500 J

220. If a body of mass 200 g falls from a height 200 m and its total P.E. is converted into K.E. at the point of contact of the body with earth surface, then what is the decrease in P.E. of the body at the contact ($g = 10\, m/s^2$)

a) 200 J b) 400 J c) 600 J d) 900 J

221. An electric motor creates a tension of 9000 N in a hoisting cable and reels it in at the rate of 2 ms^{-1}. The power of the electric motor is

a) 18 kW b) 15 kW c) 81 W d) 225 W

222. The potential energy of a particle of mass 5 kg moving in the $x - y$ plane is given by $U = (-7x + 24y)$ J, x and y being in metre. Initially at $t = 0$ the particle is at the origin (0, 0) moving with a velocity of $(2.4\hat{\mathbf{i}} + 0.7\hat{\mathbf{j}})\text{ms}^{-1}$. The magnitude of force on the particle is

a) 25 units b) 24 units c) 7 units d) None of these

223. **Statement I** In an elastic collision between two bodies, the relative speed of the bodies after collision is equal to the relative speed before the collision.

Statement II Inan elastic collision, the linear momentum of the system is conserved.

a) Statement I is true ,statement II is true; statement II is a correct explanation for statement I

b) Statement I is true, Statement II is true; statement II is not correct explanation for statement I

c) Statement I is true, Statement II is false

d) Statement I is false, Statement II is True

224. A body of mass 2 kg is moving with velocity 10 m/s towards east. Another body of same mass and same velocity moving towards north collides with former and coalesces and moves towards north-east. Its velocity is

a) 10 m/s b) 5 m/s c) 2.5 m/s d) $5\sqrt{2}\ m/s$

225. Two bodies of masses $2m$ and m have their K.E. in the ratio 8: 1, then their ratio of momenta is

a) 1 : 1 b) 2 : 1 c) 4 : 1 d) 8 : 1

226. A spring with spring constant k is extended from $x = 0$ to $x = x_1$. The work done will be

a) kx_1^2 b) $\frac{1}{2}kx_1^2$ c) $2kx_1^2$ d) $2kx_1$

227. A spring of spring constant $5 \times 10^3\ N/m$ is stretched initially by 5 cm from the unstretched position. Then the work required to stretch it further by another 5cm is

a) 6.25 N-m b) 12.50 N-m c) 18.75 N-m d) 25.00 N-m

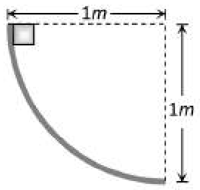
228. A uniform force of 4 N acts on a body of mass 10 kg for a distance of 2.0 m. The kinetic energy acquired by the body is

a) $4 \times 2 \times 2$ J b) $4 \times 4 \times 2 \times 10^8$ erg c) 4×2 J d) $4 \times 4 \times 2$ erg

229. The potential energy function for the force between two atoms in a diatomic molecule is approximately given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$, where a and b are constants and x is the distance between the atoms. If the dissociation energy of the molecule is $D = [U(x = \infty) - U_{\text{at equilibrium}}]$, D is

a) $\frac{b^2}{6a}$ b) $\frac{b^2}{2a}$ c) $\frac{b^2}{12a}$ d) $\frac{b^2}{4a}$

230. A body of mass 2 kg slides down a curved track which is quadrant of a circle of radius 1 $metre$. All the surfaces are frictionless. If the body starts from rest, its speed at the bottom of the track is



a) 4.43 m/sec b) 2 m/sec c) 0.5 m/sec d) 19.6 m/sec

231. A ball is dropped from height 20 m. If coefficient of restitution is 0.9, what will be the height attained after first bounce?

a) 1.62 m b) 16.2 m c) 18 m d) 14 m

232. The bodies of masses 1 kg and 5 kg are dropped gently from the top of a tower. At a point 20 cm from the ground, both the bodies will have the same

a) Momentum b) Kinetic energy c) Velocity d) Total energy

233. You lift a heavy book from the floor of the room and keep it in the book–shelf having a height 2 m. In this process you take 5 $seconds$. The work done by you will depend upon

a) Mass of the book and time taken

b) Weight of the book and height of the book-shelf

c) Height of the book-shelf and time taken

d) Mass of the book, height of the book-shelf and time taken

234. A sphere of mass m moving with a constant velocity u hits another stationary sphere of the same mass. If e is the coefficient of restitution, then the ratio of the velocity of two spheres after collision will be

a) $\frac{1-e}{1+e}$ b) $\frac{1+e}{1-e}$ c) $\frac{e+1}{e-1}$ d) $\frac{e-1}{e+1}t^2$

235. A box is moved along a straight line by a machine delivering constant power. The distance moved by the body in time t is proportional to

a) $1^{1/2}$ b) $t^{3/4}$ c) $t^{3/2}$ d) t^2

236. An engine pumps water continuously through a hole. Speed with which water passes through the hole nozzle is v and k is the mass per unit length of the water jet as it leaves the nozzle. Find the rate at which kinetic energy is being imparted to the water

a) $\frac{1}{2}kv^2$ b) $\frac{1}{2}kv^3$ c) $\frac{v^2}{2k}$ d) $\frac{v^3}{2k}$

237. The area of the acceleration-displacement curve of a body gives

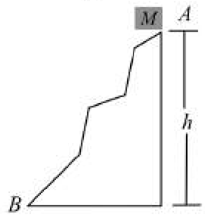
a) Impulse b) Change in momentum per unit mass

c) Change in KE per unit mass d) Total change in energy

238. A car of mass 'm' is driven with acceleration 'a' along a straight level road against a constant external resistive force 'R'. When the velocity of the car is 'V', the rate at which the engine of the car is doing work will be

a) RV b) maV c) $(R+ma)V$ d) $(ma-R)V$

239. In the given curved road, if particle is released from A then



a) Kinetic energy at B must be mgh b) Kinetic energy at B may be zero

c) Kinetic energy at B must be less than mgh d) Kinetic energy at B must not be equal to zero

240. Two springs A and B are identical but A is harder than $B(k_A > k_B)$. Let W_A and W_B represent the work done when the springs are stretched through the same distance and W'_A and W'_B are the work done when these are stretched by equal forces, then which of the following is true

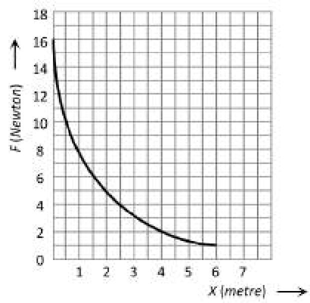
a) $W_A > W_B$ and $W'_A = W'_B$ b) $W_A > W_B$ and $W'_A < W'_B$

c) $W_A > W_B$ and $W'_A > W'_B$ d) $W_A < W_B$ and $W'_A < W'_B$

241. The bob of a simple pendulum (mass m and length l) dropped from a horizontal position strikes a block of the same mass elastically placed on a horizontal frictionless table. The K.E. of the block will be

a) $2\ mgl$ b) $mgl/2$ c) mgl d) 0

242. The relation between the displacement X of an object produced by the application of the variable force F is represented by a graph shown in the figure. If the object undergoes a displacement from $X = 0.5\ m$ to $X = 2.5\ m$ the work done will be approximately equal to



a) $16\ J$ b) $32\ J$ c) $1.6\ J$ d) $8\ J$

243. The potential energy as a function of the force between two atoms in a diatomic molecules is given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$, where a and b are positive constants and x is the distance between the atoms. The position of stable equilibrium for the system of the two atoms is given

a) $x = \frac{a}{b}$ b) $x = \sqrt{\frac{a}{b}}$ c) $x = \frac{\sqrt{3a}}{b}$ d) $x = \sqrt[6]{\left(\frac{2a}{b}\right)}$

244. Consider elastic collision of a particle of mass m moving with a velocity u with another particle of the same mass at rest. After the collision the projectile and the stuck particle move in directions making angles $\theta_1$and $\theta_2$respectively with the initial direction of motion.
The sum of the angles $\theta_1 + \theta_2$

a) 45° b) 90° c) 135° d) 180°

245. If the $K.E.$ of a particle is doubled, then its momentum will

a) Remain unchanged b) Be doubled c) Be quadrupled d) Increase $\sqrt{2}$ times

246. Two springs have force constants k_1 and k_2. There are extended through the same distance x. If their elastic energies are E_1 and E_2, then $\frac{E_1}{E_2}$ is equal to

a) $k_1{:}k_2$ b) $k_2{:}k_1$ c) $\sqrt{k_1}{:}\sqrt{k_2}$ d) $k_1^2{:}k_2^2$

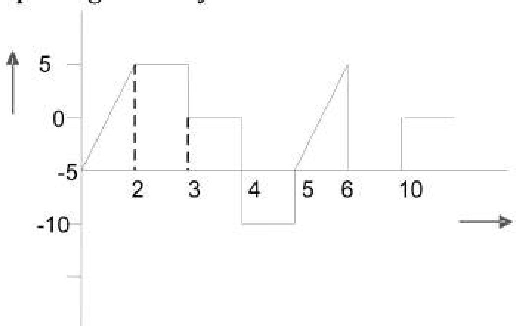
247. A uniform chain of length L and mass M overhangs a horizontal table with its two-third part on the table. The friction coefficient between the table and the chain is μ. The work done by the friction during the period the chain slips off the table is

a) $-\frac{1}{4}\ \mu MgL$ b) $-\frac{2}{9}\ \mu MgL$ c) $-\frac{4}{9}\ \mu MgL$ d) $-\frac{6}{7}\ \mu MgL$

248. If a shell fired from a cannon ,explodes in mid air, then

a) Its total kinetic energy increases
b) Its total momentum increases
c) Its total momentum decreases
d) None of the above

249. The relationship between the force F and position x of a body is as shown in figure. The work done in displacing the body from $x = 1m$ to $x = 5$m will be



a) 30 J b) 15 J c) 25 J d) 20 J

250. A particle is moving under the influence of a force given by $F = kx$, where k is a constant and x is the distance moved. The energy (in joule)gained by the particle in moving from $x = 0\ to\ x = 3\ is$

a) 2 k b) 3.5 k c) 4.5 k d) 9 k

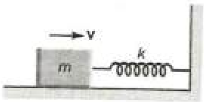
251. A horizontal force of 5N is required to maintain a velocity of 2 m/s for a block of 10 kg mass sliding over a rough surface. The work done by this force in one minute is

a) 600 J b) 60 J c) 6 J d) 6000 J

252. A force of 5N, making an angle θ with the horizontal, acting on an object displaces it by 0.4m along the horizontal direction. If the object gains kinetic energy of 1J, the horizontal component of the force is

a) 1.5 N b) 2.5 N c) 3.5 N d) 4.5 N

253. A block of mass $m = 25$kg sliding on a smooth horizontal surface with a velocity $v = 3\text{ms}^{-1}$ meets the spring of spring constant $k = 100\text{Nm}^{-1}$ fixed at one end as shown in figure. The maximum compression of the spring and velocity of block as is returns to the original position respectively are



a) 1.5 m, $-3\ ms^{-1}$
b) 1.5 m, $0.01\ ms^{-1}$
c) 1.0 m, $3\ ms^{-1}$
d) 0.5 m, $2\ ms^{-1}$

254. Which of the following is not a perfectly inelastic collision
a) Striking of two glass balls
b) A bullet striking a bag of sand
c) An electron captured by a proton
d) A man jumping onto a moving cart

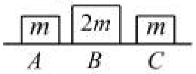
255. A pump motor is used to deliver water at a certain rate from s given pipe. To obtain twice as much water from the same pipe in the same time, power of the motor has to be increased to
a) 16 times
b) 4 times
c) 8 times
d) 2 times

256. A body of mass 1 kg is thrown upwards with a velocity 20 m/s. It momentarily comes to rest after attaining a height of 18 m. How much energy is lost due to air friction ($g = 10\ m/s^2$)
a) 20 J
b) 30 J
c) 40 J
d) 10 J

257. A cylinder of mass 10kg is sliding on a plane with an initial velocity of 10 m/s. If coefficient of friction between surface and cylinder is 0.5, then before stopping it will describe
a) 12.5 m
b) 5 m
c) 7.5 m
d) 10 m

258. Two springs of spring constants 1500 N/m and 3000 N/m respectively are stretched with the same force. They will have potential energy in the ratio
a) 4 : 1
b) 1 : 4
c) 2 : 1
d) 1 : 2

259. Three objects A, B and C are kept in a straight line on a frictionless horizontal surface. These have masses $m, 2m$ and m respectively. The object A moves towards B with a speed 9 m/s and makes an elastic collision with it. Thereafter, B makes completely inelastic collision with C. All motions occur on the same straight line. Find the final speed (in m/s) of the object C



a) 3 m/s
b) 4 m/s
c) 5 m/s
d) 1 m/s

260. Four smooth steel balls of equal mass at rest are free to move along a straight line without friction. The first ball is given a velocity of $0.4\ ms^{-1}$. It collides head on with the second one elastically, the second one similarly with the third and so on. The velocity of the last ball is
a) $0.4 ms^{-1}$
b) $0.2 ms^{-1}$
c) $0.1 ms^{-1}$
d) $0.05 ms^{-1}$

261. A constant power p is applied to a car starting from rest. If v is the velocity of the car at time t, then
a) $v \propto t$
b) $v \propto \frac{1}{t}$
c) $v \propto \sqrt{t}$
d) $v \propto \frac{1}{\sqrt{t}}$

262. A body of mass 3 kg is under a force which causes a displacement in it, given by $s = t^2/3$ (in m). Find the work done by the force in 2 s
a) 2 J
b) 3.8 J
c) 5.2 J
d) 2.6 J

263. A bomb of mass 9 kg explodes into two parts. One part of mass 3 kg moves with velocity 16 m/s ,then the KE of the other part is
a) 162 J
b) 150 J
c) 192 J
d) 200 J

264. A spring gun of spring constant 90 N/cm is compressed 12 cm by a ball of mass 16 g. If the trigger is pulled, the velocity of the ball is
a) 50 ms^{-1}
b) 9 ms^{-1}
c) 40 ms^{-1}
d) 90ms^{-1}

265. A body is initially at rest. It undergoes one-dimensional motion with constant acceleration. The power delivered to it at time t is proportional to
a) $t^{1/2}$
b) t
c) $t^{3/2}$
d) t^2

266. A shell initially at rest explodes into two pieces of equal mass, then the two pieces will
a) Be at rest
b) Move with different velocities in different directions

c) Move with the same velocity in opposite directions
d) Move with the same velocity in same direction

267. The slope of the kinetic energy displacement curve of a particle in motion is
a) Equal to the acceleration of the particle
b) Inversely proportional to the acceleration
c) Directly proportional to the acceleration
d) None of the above

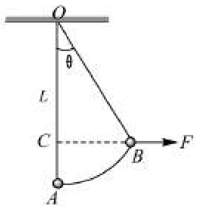
268. From a building two balls A to B are thrown such that A is thrown upwards and B downwards (both vertically). If v_A and v_B are their respective velocities on reaching the ground, then
a) $v_B > v_A$
b) $v_B = v_A$
c) $v_A > v_B$
d) Their velocities depends on their masses

269. A 50 g bullet moving with velocity 10 m/s strikes a block of mass 950 g at rest and gets embedded in it. The loss in kinetic energy will be
a) 100%
b) 95%
c) 5%
d) 50%

270. If the heart pushes 1 cc of blocked in one second under pressure 20000 N/m^2 the power of heart is
a) 0.02 W
b) 400 W
c) 5×10^{-10} W
d) 0.2 W

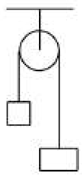
271. A ball is released from certain height. It loses 50% of its kinetic energy on striking the ground. It will attain a height again equal to
a) One fourth the initial height
b) Half the initial height
c) Three fourth initial height
d) None of these

272. An object of mass m is tied to a string of length L and a variable horizontal force is applied on it which starts at zero and gradually increases until the string makes an angel θ with the vertical. Work done by the force F is



a) $mgL(1 - \sin\theta)$
b) mgL
c) $mgL(1 - \cos\theta)$
d) $mgL(1 + \cos\theta)$

273. A light inextensible string that goes over a smooth fixed pulley as shown in the figure connects two blocks of masses 0.36 kg and 0.72 kg. Taking $g = 10\ m/s^2$, find the work done (in joules) by the string on the block of mass 0.36 kg during the first second after the system is released from rest



a) 6 $Joule$
b) 5 $Joule$
c) 8 $Joule$
d) 2 $Joule$

274. A body of mass 2 kg moving with a velocity of 3 m/sec collides head on with a body of mass 1 kg moving in opposite direction with a velocity of 4 m/sec. After collision, two bodies stick together and move with a common velocity which in m/sec is equal to
a) 1/4
b) 1/3
c) 2/3
d) 3/4

275. A particle of mass 100g is thrown vertically upwards with a speed of 5m/s. The work done by the force of gravity during the time the particle goes up is
a) $-1.25\ J$
b) $1.25\ J$
c) $0.5\ J$
d) $-0.5\ J$

276. A neutron makes a head-on elastic collision with a stationary deuteron. The fractional energy loss of the neutron in the collision is
a) 16/81
b) 8/9
c) 8/27
d) 2/3

277. Which among the following, is a form of energy
a) Light
b) Pressure
c) Momentum
d) Power

278. A particle moves in a straight line with retardation proportional to its displacement. Its loss of KE for any displacement x is proportional to

a) x b) x^2 c) x^0 d) e^x

279. A smooth sphere of mass M moving with velocity u directly collides elastically with another sphere of mass m at rest. After collision their final velocities are V and v respectively. The value of v is

a) $\frac{2uM}{m}$ b) $\frac{2um}{M}$ c) $\frac{2u}{1+\frac{m}{M}}$ d) $\frac{2u}{1+\frac{M}{m}}$

280. A body of mass 2 kg is thrown up vertically with kinetic energy of 490 J. The height at which the kinetic energy of the body becomes half of its original value is?

a) 50 m b) 12.25 m c) 25 m d) 10 m

281. A body is moved along a straight line by machine delivering a constant power. The distance moved by the body in time t is proportional to

a) $t^{3/4}$ b) $t^{3/2}$ c) $t^{1/4}$ d) $t^{1/2}$

282. A 2.0 kg block is dropped from a height of 40 cm onto a spring of spring constant $k = 1960\ \text{Nm}^{-1}$. Find the maximum distance the spring is compressed

a) 0.080 m b) 0.20 m c) 0.40 m d) 0.10 m

283. A body of mass m is rest. Another body of same mass moving with velocity v makes head on elastic collision with the first body. After collision the first body starts to moves with velocity

a) v b) Remain at rest c) 2v d) Not predictable

284. A 0.5 kg ball is thrown up with an initial speed 14 ms^{-1} and reaches a maximum height of 8 m. How much energy is dissipate by air drag acting on the ball during the ascent?

a) 19.6 J b) 4.9 J c) 10 J d) 9.8 J

285. The height of the dam, in a hydroelectric power station is 10m. In order to generate 1 MW of electric power, the mass of water (in kg/s) that must fall per second on the blades of the turbines

a) 10^6 b) 10^5 c) 10^3 d) 10^4

286. The potential energy of a particle of mass 5 kg moving in the $x - y$ plane is given by $U = (-7x + 24y)$ J, x and y being in metre. If the particle starts from rest from origin then speed of particle at $t = 2$ s is

a) 5 ms^{-1} b) 01 ms^{-1} c) 17.5 ms^{-1} d) 10 ms^{-1}

287. A rod AB of mass 10 kg and length 4 m rests on a horizontal floor with end A fixed so as to rotate it in vertical plane about perpendicular axis passing through A. If the work done on the rod is 100 J, the height to which the end B be raised vertically above the floor is

a) 1.5 m b) 2.0 m c) 1.0 m d) 2.5 m

288. In the non-relativistic regime, if the momentum, is increased by 100%, the percentage increase in kinetic energy is

a) 100 b) 200 c) 300 d) 400

289. A shell of mass 20 kg at rest explodes into two fragments whose masses are in the ratio 2 : 3. The smaller fragment moves with a velocity of 6 ms^{-1}. The kinetic energy of the larger fragment is

a) 96 J b) 216 J c) 144 J d) 360 J

290. An α-particle of mass $m$suffers one dimensional elastic collision with a nucleus of unknown mass. After the collision the α-particle is scattered directly backward losing 75% of its kinetic energy .then the mass of the nucleus is

a) m b) 2 m c) 3 m d) $\frac{3}{2}m$

291. A bomb of mass 30 kg at rest explodes into two pieces of masses 18 kg and 12kg.The velocity of 18 kg mass is 6 ms^{-1}.The kinetic energy of the other mass is

a) 256 J b) 486 J c) 524 J d) 324 J

292. When a 1.0 kg mass hangs attached to a spring of length 50 cm, the spring stretches by 2 cm. The mass is pulled down until the length of the spring becomes 60 cm. What is the amount of elastic energy stored in the spring in this condition, if $g = 10\ m/s^2$

a) 1.5 $joule$ b) 2.0 $joule$ c) 2.5 $joule$ d) 3.0 $joule$

293. A man pushes a wall and falls to displace it. He does

a) Negative work
b) Positive but not maximum work
c) No work at all
d) Maximum work

294. A spherical ball of mass 20 kg is stationary at the top of a hill of height 100 m. It rolls down a smooth surface to the ground, then climbs up another hill of height 30 m and height of 20 m above the ground. The velocity attained by the ball is

a) $40\ ms^{-1}$
b) $20\ ms^{-1}$
c) $10ms^{-1}$
d) $10\sqrt{30}\ ms^{-1}$

295. The potential energy of a certain spring when stretched through a distance s is 10 J. The amount of work (in joule) that must be done on this spring to stretch it through additional distance s will be

a) 30
b) 40
c) 10
d) 20

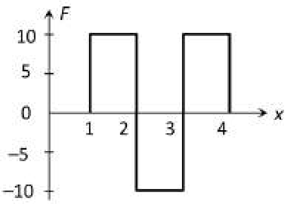
296. A body of mass 3 kg acted upon by a constant force is displaced by s metre, given by relation $s = \frac{1}{3}t^2$, where t is in second. Work done by the force in 2 s

a) $\frac{8}{3}$ J
b) $\frac{19}{5}$ J
c) $\frac{5}{19}$ J
d) $\frac{3}{8}$ J

297. The force constant of a wire is k and that of another wire is $2k$. When both the wires are stretched through same distance, then the work done

a) $W_2 = 2W_1^2$
b) $W_2 = 2W_1$
c) $W_2 = W_1$
d) $W_2 = 0.5W_1$

298. Figure shows the F-x graph. Where F is the force applied and x is the distance covered



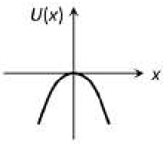
By the body along a straight line path. Given that F is in *newton* and x in *metre*, what is the work done?

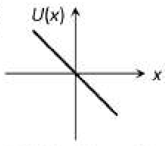
a) $10\ J$
b) $20\ J$
c) $30\ J$
d) $40\ J$

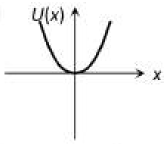
299. A particle is released from a height h, At a certain height; its KE is two times its potential energy. Height and speed of the particle at that instant are

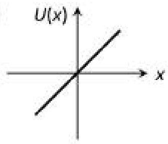
a) $\frac{h}{3}, \sqrt{\frac{2gh}{3}}$
b) $\frac{h}{3}, 2\sqrt{\frac{gh}{3}}$
c) $\frac{2h}{3}\sqrt{\frac{2gh}{3}}$
d) $\frac{h}{3}, \sqrt{2gh}$

300. A particle is placed at the origin and a force $F = kx$ is acting on it (where k is positive constant). If $U(0) = 0$, the graph of $U(x)$ versus x will be (where U is the potential energy function)

a) 

b) 

c) 

d) 

301. If momentum is increased by 20%, then kinetic energy increases by

a) 48%
b) 44%
c) 40%
d) 36%

302. Two spherical bodies of the same mass M are moving with velocities $v_1$and v_2.These collide perfectly inelastically , then the loss in kinetic energy is

a) $\frac{1}{2}M(v_1 - v_2)$
b) $\frac{1}{2}M(v_1^2 - v_2^2)$
c) $\frac{1}{4}M(v_1 - v_2)^2$
d) $2M(v_1^2 - v_2^2)$

303. A person holds a bucket of weight 60 N. He walks 7m along the horizontal path and then climbs up a vertical distance of 5 m. The work done by the man is

a) 300 J
b) 420 J
c) 720 J
d) None of these

304. A coolie 1.5 m tall raises a load of 80 kg in 2 s from the ground to his head and then walks a distance of 40 m in another 2 s. The power developed by the coolie is [$g = 10\ ms^{-2}$]

a) 0.2 kW
b) 0.4 kW
c) 0.6 kW
d) 0.8 kW

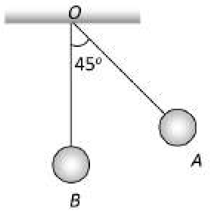
305. A boy of mass 1 kg moves from point $A(2m, 3m, 4m)$ to $B(3m, 2m, 5m)$. During motion of body, a force $\vec{\mathbf{F}} = (2\text{N})\hat{\mathbf{i}} - (4\text{N})\hat{\mathbf{j}}$ acts on it. The work done by the force on the particle displacement is

a) $(2\hat{\mathbf{i}} - 4\hat{\mathbf{j}})$J b) 2 J c) -2 J d) None of these

306. A body of mass $m$accelerates uniformly from rest to v_1 is time t_1. The instantaneous power delivered to the body as a function of time t is

a) $\frac{mv_1 t}{t_1}$ b) $\frac{mv_1^2 t}{t_1^2}$ c) $\frac{mv_1 t^2}{t_1}$ d) $\frac{mv_1^2 t}{t_1}$

307. The bob A simple pendulum is released when the string makes an angle of 45° with the vertical. It hits another bob B of the same material and same mass kept at rest on the table. If the collision is elastic



a) Both A and B rise to the same height b) Both A and B come to rest at B

c) Both A and B move with the same velocity of A d) A comes to rest and B moves with the velocity of A

308. An engine pumps water through a hose pipe. Water passes through the pipe and leaves it with a velocity of 2 m/s. The mass per unit length of water in the pipe is 100 kg/m. What is the power of the engine

a) 800 W b) 400 W c) 200 W d) 100 W

309. A ball of weight 0.1 kg coming with speed 30 m/s strikes with a bat and returns in opposite direction with speed 40 m/s, then the impulse is (Taking final velocity as positive)

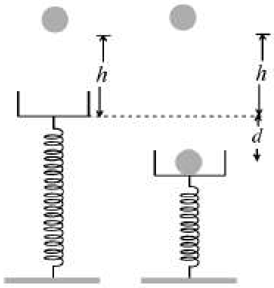
a) $-0.1 \times (40) - 0.1 \times (30)$ b) $0.1 \times (40) - 0.1 \times (-30)$

c) $0.1 \times (40) + 0.1 \times (-30)$ d) $0.1 \times (40) - 0.1 \times (20)$

310. If the kinetic energy of a body is increased 2 times , its momentum will

a) Half b) Remain unchanged c) Be doubled d) increase $\sqrt{2}$ times

311. A vertical spring with force constant K is fixed on a table. A ball of mass m at a height h above the free upper end of the spring falls vertically on the spring so that the spring is compressed by a distance d. The net work done in the process is



a) $mg + (h + d) + \frac{1}{2}Kd^2$ b) $mg(h + d) - \frac{1}{2}Kd^2$

c) $mg(h - d) - \frac{1}{2}Kd^2$ d) $mg(h - d) + \frac{1}{2}Kd^2$

312. A wire of length L suspended vertically from a rigid support is made to suffer extension l in its length by applying a force F. The work is

a) $\frac{Fl}{2}$ b) Fl c) $2Fl$ d) Fl

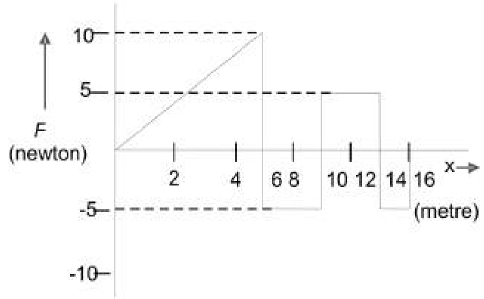
313. An ideal spring with spring constant k is hung from the ceiling and a block of mass M is attached to its lower end. The mass is released with the spring initially unstretched. Then the maximum extension in the spring is

a) $\frac{4Mg}{k}$ b) $\frac{2Mg}{k}$ c) $\frac{Mg}{k}$ d) $\frac{Mg}{2k}$

314. A car manufacturer claims that his car can be accelerated from rest to a velocity of 10 ms^{-1} in 5 s. If the total mass of the car and its occupants is 1000 kg, then the average horse power developed by the engine is

a) $\frac{10^3}{746}$ b) $\frac{10^4}{746}$ c) $\frac{10^5}{746}$ d) 8

315. A particle is acted upon by a force F which varies with position x as shown in figure. If the particle at $x = 0$ has kinetic energy of 25 J, then the kinetic energy of the particle at $x = 16\ m$ is



a) 45 J b) 30 J c) 70 J d) 135J

316. A ball moving with velocity 2 m/s. collides head on with another stationary ball of double the mass. If the coefficient of restitution is 0.5, then their velocities (in m/s) after collision will be

a) 0, 2 b) 0, 1 c) 1, 1 d) 1, 0.5

317. If the water falls from a dam into a turbine wheel 19.6 m below, then the velocity of water at the turbine is ($g = 9.8\ m/s^2$)

a) 9.8 m/s b) 19.6 m/s c) 39.2 m/s d) 98.0 m/s

318. The potential energy function for the force between two atoms in a diatomic molecule is approximately given by $U(x)\frac{a}{x^{12}} - \frac{b}{x^6}$,where a and b are constants and x is the distance between the atoms , If the dissociation energy of the molecule is $D = [U(x = \infty) - U_{\text{atequilibrium}}]$, D is

a) $\frac{b^2}{2a}$ b) $\frac{b^2}{12a}$ c) $\frac{b^2}{4a}$ d) $\frac{b^2}{6a}$

319. A body at rest breaks into two pieces with unequal mass

a) Both of them have equal speeds
b) Both of them move along a same line with unequal speeds
c) Sum of their momentum is non zero
d) They move along different lines with different speeds

320. A body of mass 2 kg moving with a velocity of 3 ms^{-1}collides head on with a body of mass 1 kg moving in opposite direction with a velocity of 4ms^{-1}.After collision two bodies stick together and move with a common velocity which in ms^{-1} is equal to

a) $\frac{1}{4}$ b) $\frac{1}{3}$ c) $\frac{2}{3}$ d) $\frac{3}{4}$

321. When a man increases his speed by 2 ms^{-1}, he finds that his kinetic energy is doubled, the original speed of the man is

a) $2(\sqrt{2} - 1)\ ms^{-1}$ b) $2(\sqrt{2} + 1)\ ms^{-1}$ c) 4.5 ms^{-1} d) None of these

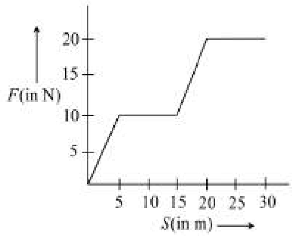
322. A stone is dropped from the top of a tall tower. The ratio of the kinetic energy of the stone at the end of three seconds to the increase in the kinetic energy of the stone during the next three seconds is

a) 1 : 1 b) 1 : 2 c) 1 : 3 d) 1 : 9

323. A mass of 10 g moving with a velocity of 100 cm/s strikes a pendulum bob of mass 10 g. The two masses stick together. The maximum height reached by the system now is ($g = 10\ m/s^2$)

a) Zero b) 5 cm c) 2.5 cm d) 1.25 cm

324. The work done by a force acting on a body is as shown in the graph. The total work done in covering an initial distance of 20 m is



a) $225\ J$ b) $200\ J$ c) $400\ J$ d) $175\ J$

325. A force of 5 N moves the particle through a distance of 10 m. If 25 J of work is performed, then the angle between the force and the direction of motion is

a) 0° b) 90° c) 30° d) 60°

326. An electric pump is used to fill an overhead tank of capacity $9m^3$ kept at a height of 10 m above the ground .If the pump takes 5 min to fill the tank by consuming 10 KW .power the efficiency of the pump should be (Take g=10 ms^{-2})

a) 60 % b) 40 % c) 20 % d) 30 %

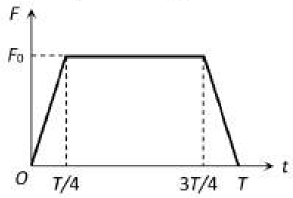
327. A particle is projected at 60° to the horizontal with a kinetic energy K. The kinetic energy at the highest point is

a) K b) Zero c) $\frac{K}{4}$ d) $\frac{K}{2}$

328. Two identical mass m moving with velocities $u_1$and $u_2$collide perfectly inelastically. Find the loss in energy

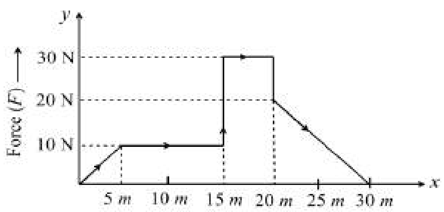
a) $m(u_1 - u_2^2)$ b) $\frac{m}{4}(u_1 - u_2)^2$ c) $\frac{m}{2}(u_1 - u_2)^2$ d) $m(u_1 - u_2)^3$

329. A particle of mass m moving with a velocity u makes an elastic one dimensional collision with a stationary particle of mass m establishing a contact with it for extremely small time T. Their force of contact increases from zero to F_0 linearly in time $T/4$, remains constant for a further time $T/2$ and decreases linearly from F_0 to zero in further time $T/4$ as shown. The magnitude possessed by F_0 is



a) $\frac{mu}{T}$ b) $\frac{2mu}{T}$ c) $\frac{4mu}{3T}$ d) $\frac{3mu}{4T}$

330. Given below is a graph between a variable force (F) (along y-axis) and the displacement (X) (along x-axis) of a particle in one dimension. The work done by the force in the displacement interval between 0 m and 30 m is



a) $275\ J$ b) $375\ J$ c) $400\ J$ d) $300\ J$

331. If velocity of a body is twice of previous velocity, then kinetic energy will become

a) 2 times b) $\frac{1}{2}$ times c) 4 times d) 1 times

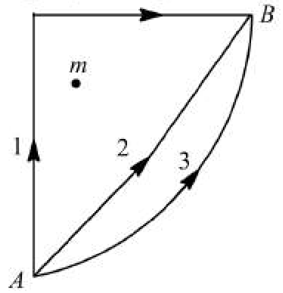
332. The power of a pump, which can pump 200 kg of water to a height of 200 m in 10sec is ($g = 10m/s^2$)

a) 40 kW b) 80 kW c) 400 kW d) 960 kW

333. If a man speeds up by 1ms^{-1}, his KE increase by 44%. His original speed in ms^{-1} is

a) 1 b) 2 c) 5 d) 4

334. If $w_1, w_{2\ and}\ w_3$ represent the work done in moving a particle from A to B along three different paths 1, 2 and 3 respectively(as shown)in the gravitational field of a point mass m. Find the correct relation between $w_1, w_2 and\ w_3$



a) $w_1 > w_2 > w_3$ b) $w_1 = w_2 = w_3$ c) $w_1 < w_2 < w_3$ d) $w_2 > w_1 > w_3$

335. A machine which is 75% efficient uses 12 J of energy in lifting up a 1 kg mass through a certain distance. The mass is then allowed to fall through, that distance. The velocity of the ball at the end of its fall is

a) $\sqrt{24}$ ms^{-1} b) $\sqrt{32}$ ms^{-1} c) $\sqrt{18}$ ms^{-1} d) 3 ms^{-1}

336. 1 kg body explodes into three fragments. The ratio of their masses is 1:1:3. The fragments of same mass move perpendicular to each other with speeds 30ms^{-1}, while the heavier part remains in the initial direction. The speed of heavier part is

a) $\frac{10}{\sqrt{2}}$ ms^{-1} b) $10\sqrt{2}$ ms^{-1} c) $20\sqrt{2}$ ms^{-1} d) $30\sqrt{2}$ ms^{-1}

337. Water falls from a height of 60 m at the rate of 15 kg/s to operate a turbine. The losses due to frictional forces are 10% of energy. How much power is generated by the turbine ($g = 10\ m/s^2$)

a) 12.3 kW b) 7.0 kW c) 8.1 kW d) 10.2 kW

338. In an inelastic collision

a) Only momentum is conserved
b) Only kinetic energy is conserved
c) Neither momentum nor kinetic energy is conserved
d) Both momentum and kinetic energy are conserved

339. A ball is released from the top of a tower. The ratio of work done by force of gravity in first, Second and third second of the motion of the ball is

a) 1:2:3 b) 1:4:9 c) 1:3:5 d) 1:5:3

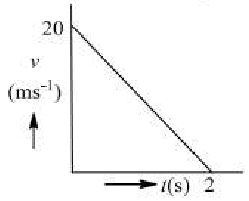
340. If a particle is compelled to move on a given smooth plane curve under the action of given forces in the plane $\vec{\mathbf{F}} = x\hat{\mathbf{i}} + y\hat{\mathbf{j}}$, then

a) $\vec{\mathbf{F}}.\overrightarrow{\mathbf{dr}} = xdx + ydy$
b) $\int \vec{\mathbf{F}}.\overrightarrow{\mathbf{dr}} \neq \frac{1}{2}mv^2$
c) $\vec{\mathbf{F}}.\overrightarrow{\mathbf{dr}} \neq xdx + ydy$
d) $\frac{1}{2}mv^2 \neq \int (xdx + ydy)$

341. Identify the false statement from the following

a) Work-energy theorem is not independent of Newton's second law
b) Work-energy theorem holds in all inertial frames
c) Work done by friction over a closed path is zero
d) No potential energy can be associated with friction

342. Velocity-time graph of a particle of mass 2 kg moving in a straight line is as shown in figure. Work done by all forces on the particle is



a) 400 J b) −400 J c) −200 J d) 200 J

343. If the unit of force and length each be increased by four times, then the unit of energy is increased by

a) 16 times b) 8 times c) 2 times d) 4 times

344. A rod AB of mass $10kg$ and length $4m$ rests on a horizontal floor with end A fixed so as to rotate it in vertical plane about perpendicular axis passing through A. If the work done on the rod is $100\ J$, the height to which the end B be raised vertically above the floor is

a) $1.5\ m$ b) $2.0\ m$ c) $1.0\ m$ d) $2.5\ m$

345. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle, the motion of the particle takes place in a plane. It follows that

a) Its velocity is constant b) Its acceleration is constant

c) Its kinetic energy is constant d) It moves in a straight line

346. From an automatic gun a man fires 360 bullet per minute with a speed of $360\ km/hour$. If each weighs $20\ g$, the power of the gun is

a) $600\ W$ b) $300\ W$ c) $150\ W$ d) $75\ W$

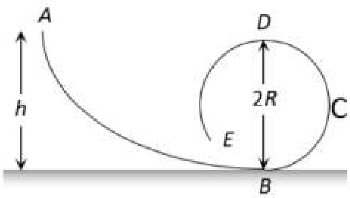
347. A motor of power p_0 is used to deliver water at a certain rate through a given horizontal pipe. To increase the rate of flow of water through the same pipe n times, the power of the motor is increased to p_1. The ratio of p_1 to p_0 is

a) $n : 1$ b) $n^2 : 1$ c) $n^3 : 1$ d) $n^4 : 1$

348. A ^{238}U nucleus decays by emitting an alpha particle of speed $v\ ms^{-1}$. The recoil speed of the residual nucleus is (in ms^{-1})

a) $-4v/234$ b) $v/4$ c) $-4v/238$ d) $4v/238$

349. A frictionless track $ABCDE$ ends in a circular loop of radius R. A body slides down the track from point A which is it a height $h = 5\ cm$. Maximum value of R for the body to successfully complete the loop is



a) $5\ cm$ b) $\frac{15}{4}\ cm$ c) $\frac{10}{3}\ cm$ d) $2\ cm$

350. A ball of mass $2kg$ and another of mass $4kg$ are dropped together from a 60 $feet$ tall building. After a tall of 30 $feet$ each towards earth, their respective kinetic energies will be in the ratio of

a) $\sqrt{2} : 1$ b) $1 : 4$ c) $1 : 2$ d) $1 : \sqrt{2}$

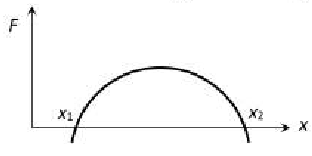
351. A body is initially at rest. It undergoes one-dimensional motion with constant acceleration. The power delivered to it at time t is proportional to

a) $t^{1/2}$ b) t c) $t^{3/2}$ d) t^2

352. A billiards player hits a stationary ball by an identical ball to pocket the target ball in a corner pocket that is at an angle of 35° with respect to the direction of motion of the first ball. Assuming the collision as elastic and that friction and rotational motion are not important, the angle made by the target ball with respect to the incoming ball is

a) 35° b) 50° c) 55° d) 60°

353. The force acting on a body moving along x-axis varies with the position of the particle as shown in the fig



The body is in stable equilibrium at

a) $x = x_1$ b) $x = x_2$ c) Both x_1 and x_2 d) Neither x_1 nor x_2

354. A bullet of mas m moving with velocity v strikes a block of mass M at rest and gets embedded into it. The kinetic energy of the composite block will be

a) $\frac{1}{2}mv^2 \times \frac{m}{(m+M)}$ b) $\frac{1}{2}mv^2 \times \frac{M}{(m+M)}$ c) $\frac{1}{2}mv^2 \times \frac{(M+m)}{(M)}$ d) $\frac{1}{2}Mv^2 \times \frac{m}{(m+M)}$

355. The machine gun fires 240 bullets per minute. If the mass of each bullet is 10 g and the velocity of the bullets is 600 ms^{-1},the power (in KW)of the gun is
a) 43200 b) 432 c) 72 d) 7.2

356. The kinetic energy acquired by a body of mass m in travelling some distance s, starting from rest under the action of a constant force, is directly proportional to
a) m° b) m c) m^2 d) $\sqrt{m}$

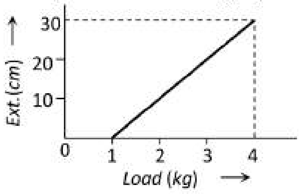
357. Two bodies of masses m_1 and m_2 have equal kinetic energies. If p_1 and p_2 are their respective momentum, then ratio $p_1 : p_2$ is equal to
a) $m_1 : m_2$ b) $m_2 : m_1$ c) $\sqrt{m_1} : \sqrt{m_2}$ d) $m_1^2 : m_2^2$

358. The blocks of mass m each are connected to a spring of spring constant k as shown in figure. The maximum displacement in the block is
a) $\sqrt{\frac{2mv^2}{k}}$ b) $\sqrt{\frac{mv^2}{k}}$ c) $2\sqrt{\frac{mv^2}{k}}$ d) $2\sqrt{\frac{k}{mv^2}}$

359. Two solid rubber balls A and B having masses 200 and 400 g respectively are moving in opposite directions with velocity of A equal to 0.3 m/s. After collision the two balls come to rest, then the velocity of B is
a) 0.15 m/sec b) 1.5 m/sec c) -0.15 m/sec d) None of the above

360. A ball hits a vertical wall horizontally at 10 m/s bounces back at 10 m/s
a) There is no acceleration because $10\frac{m}{s} - 10\frac{m}{s} = 0$
b) There may be an acceleration because its initial direction is horizontal
c) There is an acceleration because there is a momentum change
d) Even though there is no change in momentum there is a change in direction. Hence it has an acceleration

361. The pointer reading v/s load graph for a spring balance is as given in the figure. The spring constant is

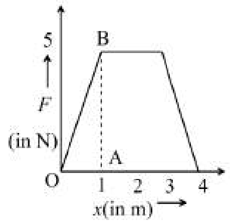


a) 0.1 kg/cm b) 5 kg cm c) 0.3 kg/cm d) 1 kg/cm

362. A body is moving with velocity v, breaks up into two equal parts. One of the part retraces back with velocity v. Then the velocity of the other part is
a) v in forward direction b) $3v$ in forward direction
c) v in backward direction d) $3v$ in backward direction

363. A rope ladder with a length l carrying a man with a mass m at its end is attached to the basket of balloon with a mass M. The entire system is in equilibrium in the air. As the man climbs up the ladder into the balloon, the balloon descends b y a height h. Then the potential energy of the man
a) Increase by $mg(l-h)$ b) Increase by mgl
c) Increases by mgh d) Increases by $mg(2l-h)$

364. The force F acting on a particle moving in a straight line is shown in figure. What is the work done by the force on the particle in the 1st meter of the trajectory



a) 5 J b) 10 J c) 15 J d) 2.5 J

365. The upper half of an inclined plane with inclination Ø is perfectly smooth, while the lower half is rough. A body starting from rest at the top will again come to rest at the bottom. If the coefficient of the friction for the lower half is given by

a) 2sin ϕ b) 2 cos ϕ c) 2 tan ϕ d) tan ϕ

366. A car of mass 1250 kg is moving at 30 m/s. Its engine delivers 30 kW while resistive force due to surface is 750 N. What max acceleration can be given in the car

a) $\frac{1}{3}\ m/s^2$ b) $\frac{1}{4}\ m/s^2$ c) $\frac{1}{5}\ m/s^2$ d) $\frac{1}{6}\ m/s^2$

367. When two bodies collide elastically, then

a) Kinetic energy of the system alone is conserved

b) Only momentum is conserved

c) Both energy and momentum are conserved

d) Neither energy nor momentum is conserved

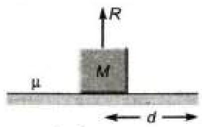
368. A chain of mass M is placed on a smooth table with 1/3 of its length L hanging over the edge. The work done in pulling the chain back to the table is

a) $\frac{MgL}{3}$ b) $\frac{MgL}{6}$ c) $\frac{MgL}{9}$ d) $\frac{MgL}{18}$

369. A spring, which is initially in its unstretched condition, is first stretched by a length$x$ and then again by a further length x.The work done in the first case is w_1, and in the second case is w_2. Then

a) $W_2 = W_1$ b) $W_2 = 2W_1$ c) $w_2 = 3w_1$ d) $w_2 = 4w_1$

370. If reaction is R and coefficient of friction is μ, what is work done against friction in moving a body by distance d?



a) $\frac{\mu Rd}{4}$ b) $2\mu Rd$ c) μRd d) $\frac{\mu Rd}{2}$

371. A 16 kg block moving on a frictionless horizontal surface with a velocity of 4 m/s compresses an ideal spring and comes to rest. If the force constant of the spring be 100 N/m, then the spring is compressed by

a) 1.6 m b) 4 m c) 6.1 m d) 3.2 m

372. A nucleus with mass number 220 initially at rest emits an α −particle.If the Q value of the reaction is 5.5 MeV, calculate the kinetic energy of the α −particle

a) 4.4MeV b) 5.4MeV c) 5.6MeV d) 6.5MeV

373. An electric pump is used to fill an overhead talk of capacity $9m^3$ kept at a height of $10m$ above the ground. If the pump takes 5 minutes to fill the tank by consuming $10kW$ power the efficiency of the pump should be (Take $g = 10ms^{-2}$)

a) 60% b) 40% c) 20% d) 30%

374. A body of mass 10 kg is dropped to the ground from a height of 10 $metres$. The work done by the gravitational force is ($g = 9.8\ m/s^2$)

a) −490 $joules$ b) +490 $joules$ c) −980 $joules$ d) +980 $joules$

375. A body of mass 3 kg acted upon by a constant force is displaced by S metre, given by relation $S = \frac{1}{3}t^2$, where t is in second. Work done by the force in 2 seconds is

a) $\frac{8}{3}$ J b) $\frac{19}{5}$ J c) $\frac{5}{19}$ J d) $\frac{3}{8}$ J

376. A body of mass m_1 collides elastically with another body of mass m_2 at rest .If the velocity of m_1 after collision becomes 2/3 times its initial velocity, the ratio of their masses, is

a) 1:5 b) 5:1 c) 5:2 d) 2:5

377. For a system to follow the law of conservation of linear momentum during a collision , the condition is

Total external force acting on the system is zero.

Total external force acting on the system finite and time of collision is negligible.

Total internal force acting on the system is zero.

a) (1)only b) (2)only c) (3)only d) (1)and (2)

378. A cubical vessel of height 1 m is full of water. what is the amount of work done in pumping water out of the vessel?(Take g=10ms^{-2})

a) 1250 J b) 5000 J c) 1000 J d) 2500 J

379. A bomb of mass 3.0 kg explodes in air into two pieces of masses 2.0 kg and 1.0 kg .The smaller mass goes at a speed of 80ms^{-1}.The total energy imparted to the two fragments is

a) 1.07 kJ b) 2.14 kJ c) 2.4 kJ d) 4.8 kJ

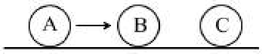
380. Stopping distance of a moving vehicle is directly proportional to

a) Square of the initial velocity b) Square of the initial acceleration
c) The initial velocity d) The initial acceleration

381. A particle moves along the x$-a$xis from x= x_1 to $x = x_2$ under the action of a force given by F=2x. Then the work done in the process is

a) Zero b) $x_2^2 - x_1^2$ c) $2x_2(x_2 - x_1)$ d) $2x_1(x_1 - x_2)$

382. Three identical spherical balls A, B and C are placed on a table as shown in the figure along a straight line. B and C are at rest initially



The ball A and B head on with a speed of 10ms^{-1}. Then after all collisions (assumed to be elastic) A and B are brought to rest and C takes off with a velocity of

a) 5 $m\,s^{-1}$ b) 10 $m\,s^{-1}$ c) 2.5 $m\,s^{-1}$ d) 7.5 $m\,s^{-1}$

383. The displacement x in metre of a particle of mass m kg moving in one dimension under the action of a force is related to the time t in second by the equation $t = \sqrt{x} + 3$, the work done by the force (in joule) in first six seconds is

a) 18 m b) Zero c) 9 $m/2$ d) 36 m

384. A body of mass 2 kg is projected at 20ms^{-1} at an angle 60° above the horizontal. Power Due to the gravitational force at its heights point is

a) 200 W b) $100\sqrt{3}W$ c) 50 W d) Zero

385. The energy which an e^- acquires when accelerated through a potential difference of 1 volt is called

a) 1 $Joule$ b) 1 eV c) 1 Erg d) 1 $Watt$

386. A spring gun of spring constant 90 $Ncm^{-1}$is compressed 12 cm by a ball of mass 16 g. If the trigger is pulled, the velocity of the ball is

a) 50 ms^{-1} b) 9 ms^{-1} c) 40 ms^{-1} d) 90ms^{-1}

387. A body of mass 0.1 kg moving with a velocity of 10 m/s hits a spring (fixed at the other end) of force constant 1000 N/m and comes to rest after compressing the spring. The compression of the spring is

a) 0.01 m b) 0.1 m c) 0.2 m d) 0.5 m

388. A body of mass 2 kg is projected at 20 m/s at an angle of 60° above the horizontal. Power on the block due to the gravitational force at its highest point is

a) 200 W b) $100\sqrt{3}$ W c) 50 W d) Zero

389. A body of mass m moving with a constant velocity v hits another body of the same mass moving with the same velocity v but in the opposite direction and sticks to it. The velocity of the compound body after collision is

a) v b) $2v$ c) Zero d) $v/2$

390. If the kinetic energy of a body becomes four times of its initial value, then new momentum will

a) Becomes twice its initial value
b) Become three times its initial value
c) Become four times its initial value
d) Remains constant

391. A body moving with a velocity v, breaks up into two equal parts. One of the part retraces back with velocity v.Then, the velocity of the other part is

a) v, in forward direction
b) 3 v in forward direction
c) v, in backward direction
d) 3 v in backward direction

392. A rubber ball is dropped from a height of 5 m on a planet, where the acceleration due to gravity is not known. On bouncing it rises to 1.8 m. The ball loses its velocity on bouncing by a factor of

a) $\frac{16}{25}$ b) $\frac{2}{5}$ c) $\frac{3}{5}$ d) $\frac{9}{25}$

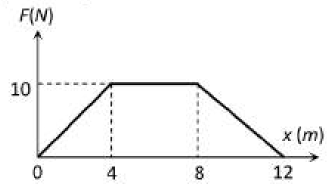
393. A uniform chain of length L and mass M is lying on a smooth table and one third of its length is hanging vertically down over the edge of the table. If g is acceleration due to gravity, the work required to pull the hanging part on to the table is

a) MgL b) $MgL/3$ c) $MgL/9$ d) $MgL/18$

394. Four smooth steel balls of equal mass at rest are free to move along a straight line without friction. The first ball is given a velocity of 0.4 m/s. It collides head on with the second elastically, the second one similarly with the third and so on. The velocity of the last ball is

a) 0.4 m/s b) 0.2 m/s c) 0.1m/s d) 0.05 m/s

395. A particle of a mass 0.1 kg is subjected to a force which varies with distance as shown in fig. If it starts its journey from rest at $x = 0$, its velocity at $x = 12\ m$ is



a) 0 m/s b) $20\sqrt{2}\ m/s$ c) $20\sqrt{3}\ m/s$ d) 40 m/s

396. The potential energy of a certain spring when stretched through a distance 'S' is 10 *joule*. The amount of work (in joule) that must be done on this spring to stretch it through an additional distance 'S' will be

a) 30 b) 40 c) 10 d) 20

397. A particle moves in a straight line with retardation proportional to its displacement. Its loss of kinetic energy for any displacement $x$is proportional to

a) x^2 b) e^x c) x d) $\log_e x$

398. A gun of mass 20 kg has bullet of mass 0.1 kg in it. The gun is free to recoil 804 J of recoil energy are released on firing the gun. The speed of bullet (ms^{-1}) is

a) $\sqrt{804 \times 2010}$ b) $\sqrt{\frac{2010}{804}}$ c) $\sqrt{\frac{804}{2010}}$ d) $\sqrt{804 \times 4 \times 10^3}$

399. A neutron having mass of $1.67 \times 10^{-27}\ kg$ and moving at $10^8 m/s$ collides with a deutron at rest and sticks to it. If the mass of the deutron is $3.34 \times 10^{-27}\ kg$ then the speed of the combination is

a) $2.56 \times 10^3\ m/s$ b) $2.98 \times 10^5\ m/s$ c) $3.33 \times 10^7\ m/s$ d) $5.01 \times 10^9\ m/s$

400. A body of mass 5 kg is thrown vertically up with a kinetic energy of 490 J. The height at which the kinetic energy of the body becomes half of the original value is

a) 12.5m b) 10m c) 2.5m d) 5m

401. A body of mass 4 kg is moving with momentum of 8 kg $-$ ms^{-1}. A force of 0.2 N acts on it in the direction of motion of the body for 10 s. The increase in KE in joule is

a) 10 b) 8.5 c) 4.5 d) 4

402. Two springs of spring constants 1500 Nm^{-1} and 3000 Nm^{-1} respectively are stretched with the same force. They will have potential energy into ratio

a) 1:2 b) 2:1 c) 1:4 d) 4:1

403. A nucleus at rest splits into two nuclear parts having same density and radii in the ratio 1:2. Their velocities are in the ratio

a) 2: 1 b) 4: 1 c) 6: 1 d) 8: 1

404. The potential energy of a 1 kg particle free to move along the x-axis is given by

$$V(x) = \left(\frac{x^4}{4} - \frac{x^2}{4}\right)J$$

The total mechanical energy of the particle is $2J$. Then, the maximum speed (in m/s) is

a) $\sqrt{2}$ b) $1/\sqrt{2}$ c) 2 d) $3/\sqrt{2}$

405. Choose the incorrect statement

a) No work is done if the displacement is perpendicular to the direction of the applied force

b) If the angle between the force and displacement vectors is obtuse, then the work done is negative

c) Frictional force in non-conservative

d) All the central forces are non-conservative

406. A force $F = Ay^2 + By + C$ acts on a body in the y-direction. The work done by this force during a displacement from $y = -a$ to $y = a$ is

a) $\frac{2Aa^3}{3}$ b) $\frac{2Aa^3}{3} + 2Ca$ c) $\frac{2Aa^3}{3} + \frac{Ba^2}{2} + Ca$ d) None of these

407. A particle of mass m moving eastward with a speed v collides with another particle of the same mass moving northward with the same speed v. The two particles coalesce on collision. The new particle of mass $2m$ will move in the north-easterly direction with a velocity

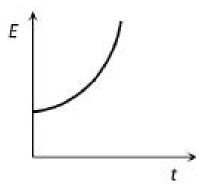
a) $v/2$ b) $2v$ c) $v/\sqrt{2}$ d) v

408. A bomb of mass 9 kg explodes into 2 pieces of mass $3kg$ and $6kg$. The velocity of mass $3kg$ is 1.6 m/s, the K.E. of mass $6kg$ is

a) 3.84 J b) 9.6 J c) 1.92 J d) 2.92 J

409. A particle is dropped from a height h. A constant horizontal velocity is given to the particle. Taking g to be constant every where, kinetic energy E of the particle $w.r.t.$ time t is correctly shown in

a)



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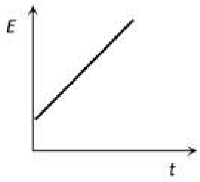

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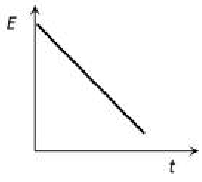

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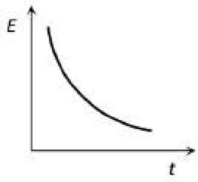


410. A quarter horse power motor runs at a speed of 600 $r.p.m.$ Assuming 40% efficiency the work done by the motor in one rotation will be

a) 7.46 J b) 7400 J c) 7.46 $ergs$ d) 74.6 J

411. A particle of mass m moving with a velocity $\vec{V}$ makes a head on elastic collision with another particle of same mass initially at rest. The velocity of first particle after the collision will be

a) $\vec{V}$ b) $-\vec{V}$ c) $-2\vec{V}$ d) Zero

412. A uniform chain of length $2m$ is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is $4kg$. What is the work done in pulling the entire chain on the table

a) 7.2 J b) 3.6 J c) 120 J d) 1200 J

413. A body of mass M is moving with a uniform speed of 10 m/s on frictionless surface under the influence of two forces F_1 and F_2. The net power of the system is

a) $10F_1F_2M$ b) $10(F_1 + F_2)M$ c) $(F_1 + F_2)M$ d) Zero

414. A cord is used to lower vertically a block of mass M by a distance d with constant downward acceleration $\frac{g}{4}$. Work done by the cord on the block is

a) $Mg\frac{d}{4}$ b) $3Mg\frac{d}{4}$ c) $-3\,Mg\frac{d}{4}$ d) Mgd

415. At high altitude, a body explodes at rest into two equal fragments with one fragment receiving horizontal velocity of 10 m/s. Time taken by the two radius vectors connecting point of explosion to fragments to make 90° is

a) 10 s b) 4 s c) 2 s d) 1 s

416. A spring of force constant 800 Nm^{-1} has an extension of 5 cm.The work done in extending it from 5 cm to 15 cm is

a) 16 J b) 8 J c) 32 J d) 24 J

417. Two particles having position vectors $\vec{r_1} = (3\hat{\imath} + 5\hat{\jmath})\ metres$ and $\vec{r_2} = (-5\hat{\imath} - 3\hat{\jmath})\ metres$ are moving with velocities $\vec{v}_1 = (4\hat{\imath} + 3\hat{\jmath})m/s$ and $\vec{v}_2 = (\alpha\hat{\imath} + 7\hat{\jmath})m/s$. If they collide after 2 seconds, the value of 'α' is

a) 2 b) 4 c) 6 d) 8

418. Two balls at same temperature collide. What is conserved

a) Temperature b) Velocity c) Kinetic energy d) Momentum

419. A body of mass 4 kg moving with velocity 12 m/s collides with another body of mass 6 kg at rest. If two bodies stick together after collision, then the loss of kinetic energy of system is

a) Zero b) 288 J c) 172.8 J d) 144 J

420. In which case does the potential energy decrease

a) On compressing a spring b) On stretching a spring

c) On moving a body against gravitational force d) On the rising of an air bubble in water

421. A ball is released from the top of a tower. The ratio of work done by force of gravity in first, second and third second of the motion of the ball is

a) 1: 2: 3 b) 1: 4: 9 c) 1: 3: 5 d) 1: 5: 3

422. A rod AB of mass M, length $L$is lying on a horizontal frictionless surface. A particle of mass m travelling along the surface hits the end A of the rod with a velocity $v_0$in a direction perpendicular to AB.The collision is completely elastic. After the collision ,the
Particle comes to rest. The ratio $\frac{m}{M}$ Is

a) $\frac{\omega^2 L^2}{9v_0^2}$ b) $\frac{9v_0^2}{\omega^2 L^2}$ c) $\frac{9v_0}{\omega L}$ d) $\frac{\omega L}{9v_0}$

423. Two masses of 1g and 4g are moving with equal kinetic energies. The ratio of the magnitudes of their linear momenta is

a) 4 : 1 b) $\sqrt{2}$: 1 c) 1 : 2 d) 1 : 16

424. Two bodies moving towards each other collide and move away in opposite directions. There is some rise in temperature of bodies because a part of the kinetic energy is converted into

a) Heat energy b) Electrical energy c) Nuclear energy d) Mechanical energy

425. Two identical cylindrical vessels with their bases at same level each contains a liquid of density ρ. The height of the liquid in vessel is $h_1$and that in the other vessel is h_2. The area of either base is A. The work done by gravity in equalizing the levels when the two vessels are connected, is

a) $(h_1 - h_2)g\rho$ b) $(h_1 - h_2)gA\rho$ c) $\frac{1}{2}(h_1 - h_2)^2 gA\rho$ d) $\frac{1}{4}(h_1 - h_2)^2 gA\rho$

426. A block of mass 10 kg slides down a rough slope which is inclined at 45° to the horizontal. The coefficient of sliding friction is 0.30. When the block has slide 5 m, the work done on the block by the force of friction is nearly

a) 115 J b) $75\sqrt{2}$ J c) 321.4 J d) −321.4 J

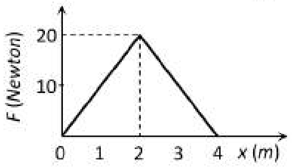
427. Two spheres A and B of masses m_1 and m_2 respectively collide. A is at rest initially and B is moving with velocity v along x-axis. After collision B has a velocity $\frac{v}{2}$ in a direction perpendicular to the original direction. The mass A moves after collision in the direction

a) Same as that of B
b) Opposite to that of B
c) $\theta = \tan^{-1}(1/2)$ to the x-axis
d) $\theta = \tan^{-1}(-1/2)$ to the x-axis

428. The momentum of a body increases by 20%. The percentage increase in its kinetic energy is

a) 20
b) 44
c) 66
d) 88

429. The graph between the resistive force F acting on a body and the distance covered by the body is shown in figure. The mass of the body is 25 kg and initial velocity is 2 m/s. When the distance covered by the body is $4m$, its kinetic energy would be



a) 50 J
b) 40 J
c) 20 J
d) 10 J

430. A body moving with velocity v has momentum and kinetic energy numerically equal. What is the value of v?

a) $2ms^{-1}$
b) $\sqrt{2}ms^{-1}$
c) $1ms^{-1}$
d) $0.2ms^{-1}$

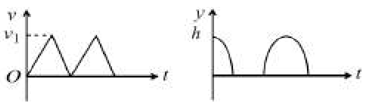
431. The potential energy of a conservative system is given by $V(x) = (x^2 - 3x)$ joule. Then its equilibrium position is at

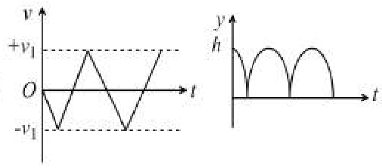
a) $x = 1.5$ m
b) $x = 2$m
c) $x = 2.5$ m
d) $x = 3$ m

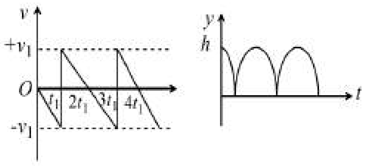
432. If the $K.E.$ of a body is increased by 300%, its momentum will increase by

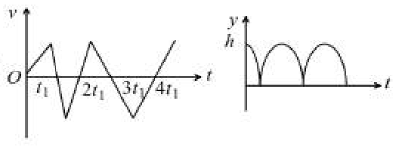
a) 100%
b) 150%
c) $\sqrt{300}$%
d) 175%

433. Consider a rubber ball freely falling from a height $h = 4.9$ m onto a horizontal elastic plate. Assume that the duration of collision is negligible and the collision with the plate is totally elastic.
Then the velocity as a function of time and the height as a function of time will be

a) 

b) 

c) 

d) 

434. A body projected vertically from the earth reaches a height equal to earth's radius before returning to the earth. The power exerted by the gravitational force is greatest

a) At the instant just after the body is projected
b) At the highest position of the body
c) At the instant just before the body hits the earth
d) It remains constant all through

435. A stationary bomb explodes into two parts of masses in the ratio of 1:3 .If the heavier mass moves with a velocity $4ms^{-1}$, what is the velocity of lighter part?

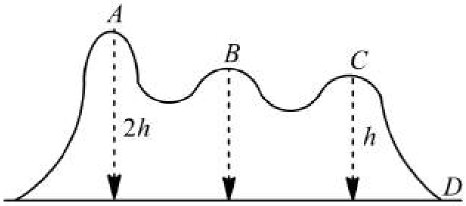
a) 12ms^{-1}opposite to heavier mass
b) 12ms^{-1}in the direction of heavier mass
c) $6\ \text{ms}^{-1}$opposite to heavier mass
d) 6ms^{-1}in the direction heavier mass

436. A ball of mass 2 kg and another of mass 4 kg are dropped together from a 60 ft tall building .After a fall of 30 ft each towards earth ,their respective kinetic energies will be in the ratio of

a) $\sqrt{2}$: 1
b) 1:4
c) 1:2
d) 1:$\sqrt{2}$

437. A small roller coaster starts at point A with a speed u on a curved track as shown in the figure.

The friction between the roller coaster and the track is negligible and it always remains in contact with the track. The speed of roller coaster at point D on the track will be



a) $(u^2 + gh)^{1/2}$ b) $(u^2 + 2gh)^{1/2}$ c) $(u^2 + 4\,gh)^{1/2}$ d) u

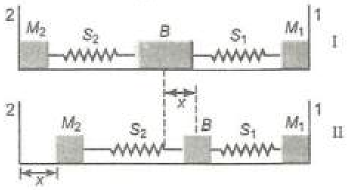
438. In which of the following cases, can the work done increase the potential energy?

a) Both conservative and non-conservative forces b) Conservative force only
c) Non- conservative force only d) Neither conservative nor conservative forces

439. A particle of mass 'm' and charge 'q' is accelerated through a potential difference of 'V' volt. Its energy is

a) qV b) $mq\,V$ c) $\left(\frac{q}{m}\right)V$ d) $\frac{q}{mV}$

440. A block(B) is attached to two unstretched springs $S_1$and S_2 with springs constants k and $4k$,representively (see Fig. I)The other ends are attached to identical supports M_1 and M_2 not attached to the walls. The springs and supports have negligible mass. There is no friction anywhere. The block B is displaced towards wall I by small distance x(Fig II) and released. The block returns and moves a maximum distance y towards wall 2.Displacements x and y are measured with respect to the equilibrium position of the block B The ratio $\frac{y}{x}$ is



a) 4 b) 2 c) $\frac{1}{2}$ d) $\frac{1}{4}$

441. In an inelastic collision, what is conserved

a) Kinetic energy b) Momentum c) Both (a) and (b) d) Neither (a) nor (b)

442. A bullet of mass 10 g is fired horizontally with a velocity 1000 ms^{-1} from a rifle situated at a height 50 m above the ground. If the bullet reaches the ground with a velocity 500 ms^{-1},the work done against air resistance in the trajectory of the bullet is (g=10ms^{-2})

a) 5005 J b) 3755 J c) 3750 J d) 17.5 J

443. A body of mass m moving with velocity v collides head on another body of mass $2m$ which is initially at rest. The ratio of KE of colliding body before and after collision body before and after collision will be

a) 1:1 b) 2:1 c) 4:1 d) 9:1

444. Two bodies A and B have masses 20 kg and 5 kg respectively .Each one is acted upon by a force of 4 kg-wt. If they acquire the same kinetic energy in times t_A and t_B, then the ration $\frac{t_A}{t_B} is$

a) $\frac{1}{2}$ b) 2 c) $\frac{2}{5}$ d) $\frac{5}{6}$

445. Two bodies with kinetic energies in the ratio of 4 : 1 are moving with equal linear momentum. The ratio of their masses is

a) 1 : 2 b) 1 : 1 c) 4 : 1 d) 1 : 4

446. Two springs p and Q of force constants k_p and k_Q $\left(k_Q = \frac{k_p}{2}\right)$ are stretched by applying forces of equal magnitude. If the energy stored in Q is E,then the energy stored in$P$ is

a) E b) 2E c) $\frac{E}{8}$ d) $\frac{E}{2}$

447. Which of the following is a scalar quantity

a) Displacement b) Electric field c) Acceleration d) Work

448. A spring with spring constant k when stretched through 1 cm the potential energy is U.If it is stretched by 4 cm ,the potential energy will be

a) 4U b) 8U c) 16U d) 2U

449. A body of mass M_1 collides elastically with another mass M_2 at rest. There is maximum transfer of energy when

a) $M_1 > M_2$ b) $M_1 < M_2$

c) $M_1 = M_2$ d) Same for all values of M_1 and M_2

450. What power must a sprinter, weighing 80 kg, develop from the start if he has to impart a velocity of $10\ ms^{-1}$ to his body in 4 s?

a) 1 kW b) 2 kW c) 3 kW d) 4 kW

451. To the free end of spring hanging from a rigid support, a block of mass m is hung and slowly allowed to come to its equilibrium position. Then stretching in the spring is d. if the same block is attached to the same spring and allowed to fall suddenly, the amount of stretching is (force constant ,k)

a) $\frac{mg}{k}$ b) $2d$ c) $\frac{mg}{3k}$ d) 4d

452. A machine, which is 75% efficient, uses 12 J of energy in lifting up a 1 kg mass through a certain distance. The mass is then allowed to fall through that distance. The velocity at the end of its fall is (in ms^{-1})

a) $\sqrt{24}$ b) $\sqrt{32}$ c) $\sqrt{18}$ d) $\sqrt{9}$

453. A ball is projected vertically down with an initial velocity from a height of 20 m onto a horizontal floor. During the impact it loses 50% of its energy and rebounds to the same height. The initial velocity of its projection is

a) $20\ ms^{-1}$ b) $15\ ms^{-1}$ c) $10\ ms^{-1}$ d) $5\ ms^{-1}$

454. A man throws a piece of stone to a height of 12 m where it reaches with a speed of $12\ ms^{-1}$. If he throws the same stone such that it just reaches this height, the percentage of energy saved is nearly

a) 19% b) 38% c) 57% d) 76%

455. A particle moves in a straight line with retardation proportional to its displacement. Its loss of kinetic energy for any displacement x is proportional to

a) x^2 b) e^x c) x d) $\log_e x$

456. A space craft of mass M and moving with velocity v suddenly breaks in two pieces of same mass m. After the explosion one of the mass m becomes stationary. What is the velocity of the other part of craft?

a) $\frac{Mv}{M-m}$ b) V c) $\frac{Mv}{m}$ d) $\frac{M-m}{m}v$

457. The coefficient of restitution e for a perfectly inelastic collision is

a) 1 b) 0 c) ∞ d) -1

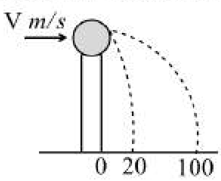
458. A force $(4\hat{\imath} + \hat{\jmath} - 2\hat{k})N$ acting on a body maintains its velocity at $(2\hat{\imath} + 2\hat{\jmath} + 3\hat{k})ms^{-1}$. The power exerted is

a) 4 W b) 5 W c) 2 W d) 8 W

459. Power applied to particle varies with time as $p = (3t^2 - 2t + 1)W$,where t is in second. Find the change in its kinetic energy between t=1s and t=4s

a) 32 J b) 46 J c) 61 J d) 102 J

460. A ball of mass 0.2 kg rests on a vertical post of height 5 m. A bullet of mass 0.01 kg, travelling with a velocity $V\ m/s$ in a horizontal direction, hits the centre of the ball. After the collision, the ball and bullet travel independently. The ball hits the ground at a distance of 20 m and the bullet at a distance of 100 m from the foot of the post. The initial velocity V of the bullet is



a) 250 m/s b) $250\sqrt{2}\ m/s$ c) 400 m/s d) 500 m/s

461. The power of a water jet flowing through an orifice of radius r with velocity v is

a) Zero b) $500\ \pi r^2\ v^2$ c) $500\ \pi r^2\ v^3$ d) $\pi r^4 v$

462. In an explosion a body breaks up into two pieces of unequal masses. In this

a) Both parts will have numerically equal momentum
b) Lighter part will have more momentum
c) Heavier part will have more momentum
d) Both parts will have equal kinetic energy

463. A 3 kg body is dropped from the top of a tower of height 135 m. If $g = 10\ ms^{-2}$, then the kinetic energy of the body after 3 s will be

a) 950 J b) 10 J c) 1150 J d) 1350 J

464. A 5 kg stone of relative density 3 is resting at the bed of a lake. It is lifted through a height of 5 m in the lake. If $g = 10 ms^2$, then the work done is

a) $\frac{500}{3}$J b) $\frac{350}{3}$J c) $\frac{750}{3}$J d) Zero

465. A gun fires a bullet of mass 50 g with a velocity of $30 msec^{-1}$. Because of this the gun is pushed back with a velocity of $1 msec^{-1}$. The mass of the gun is

a) 15 kg b) 30 kg c) 1.5 kg d) 20 kg

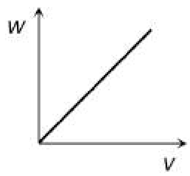
466. The work done in pulling up a block of wood weighing 2 kN for a length of 10 m on a smooth plane inclined at an angle of 15° with the horizontal is [$\sin 15° = 0.2588$]

a) 4.36 kJ b) 5.17 kJ c) 8.91 kJ d) 9.82 kJ

467. A ball is dropped from a height of 20 cm. Ball rebounds to a height of 10 cm. What is the loss of energy?

a) 25% b) 75% c) 50% d) 100%

468. A particle, initially at rest on a frictionless horizontal surface, is acted upon by a horizontal force which is constant in size and direction. A graph is plotted between the work done (W) on the particle, against the speed of the particle, (v). If there are no other horizontal forces acting on the particle the graph would look like

a)


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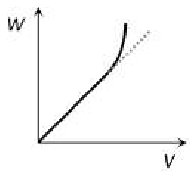

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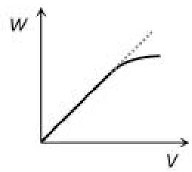

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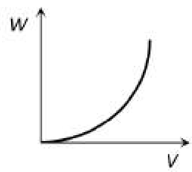
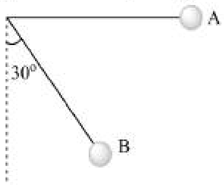


469. A simple pendulum is released from A as shown. If m and l represent the mass of the bob and length of the pendulum, the gain in kinetic energy at B is



a) $\frac{mgl}{2}$ b) $\frac{mgl}{\sqrt{2}}$ c) $\frac{\sqrt{3}}{2}mgl$ d) $\frac{\sqrt{2}}{3}mgl$

470. When a spring is extended by 2 cm energy stored is 100 J. When extended by further 2 cm, the energy increases by

a) 400 J b) 300 J c) 200 J d) 100 J

471. A wire is stretched under a force. If the wire suddenly snaps the temperature of the wire

a) Remains the same
b) Decreases
c) Increases
d) First decreases then increases

472. A 5 kg brick of 20 cm × 10 cm × 8 cm dimensionless lying on the largest base. It is now made to stand with length vertical. If $g = 10 ms^{-2}$, then the amount of work done is

a) 3 J b) 5 J c) 7 J d) 9 J

473. A body of mass m having an initial velocity v, makes head on collision with a stationary body of mass M. After the collision, the body of mass m comes to rest and only the body having mass M moves. This will happen only when

a) $m >> M$ b) $m << M$ c) $m = M$ d) $m = \frac{1}{2} M$

474. If a man increase his speed by 2 m/s, his K.E. is doubled, the original speed of the man is

a) $(1 + 2\sqrt{2})\ m/s$ b) $4\ m/s$ c) $(2 + 2\sqrt{2})\ m/s$ d) $(2 + \sqrt{2})\ m/s$

475. A sphere of mass m, moving with velocity V, enters a hanging bag of sand and stops. If the mass of the bag is M and it is raised by height h, then the velocity of the sphere was

a) $\frac{M+m}{m}\sqrt{2gh}$ b) $\frac{M}{m}\sqrt{2gh}$ c) $\frac{m}{M+m}\sqrt{2gh}$ d) $\frac{m}{M}\sqrt{2gh}$

476. An engineer claims to have made an engine delivering 10 KW power with fuel consumption of 1 gs^{-1}. The calorific value of fuel is $2kcalg^{-1}$. This claim is

a) Valid b) Invalid
c) Dependent o engine design d) Dependent on load

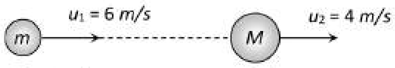
477. A body moves a distance of 10 m along a straight line under action of 5 N force. If work done is 25 J, then angle between the force and direction of motion of the body will be

a) 75^0 b) 60^0 c) 45^0 d) 30^0

478. A body of mass m_1 is moving with a velocity V. It collides with another stationary body of mass m_2. They get embedded. At the point of collision, the velocity of the system

a) Increases b) Decreases but does not become zero
c) Remains same d) Become zero

479. A particle of mass m moving with horizontal speed 6 m/sec as shown in figure. If $m << M$ than for one dimensional elastic collision, the speed of lighter particle after collision will be



a) $2m/sec$ in original direction b) $2m/sec$ opposite to the original direction
c) $4m/sec$ opposite to the original direction d) $4m/sec$ in original direction

480. Two identical blocks A and B, each of mass 'm' resting on smooth floor are connected by a light spring of natural length L and spring constant K, with the spring at its natural length. A third identical block 'C' (mass m) moving with a speed v along the line joining A and B collides with A. The maximum compression in the spring is

a) $v\sqrt{\frac{m}{2k}}$ b) $m\sqrt{\frac{v}{2k}}$ c) $\sqrt{\frac{mv}{k}}$ d) $\frac{mv}{2k}$

481. When a spring is stretched by 2 cm, it stores 100 J of energy. If it is stretched further by 2 cm, the stored energy will be increased by

a) 100 J b) 200 J c) 300 J d) 400 J

482. A body of mass 5 kg is placed at the origin, and can move only on the x-axis. A force of 10 N is acting on it in a direction making an angle of 60° with the x-axis and displaces it along the x-axis by 4 $metres$. The work done by the force is

a) 2.5 J b) 7.25 J c) 40 J d) 20 J

483. A spherical ball of mass 20 kg is stationary at the top of a hill of height 100 m. It slides down a smooth surface to the ground, then climbs up another hill of height 30 m and finally slides down to a horizontal base at a height of 20 m above the ground. The velocity attained by the ball is

a) 10 m/s b) $10\sqrt{30}\ m/s$ c) 40 m/s d) 20 m/s

484. A ball is dropped from height 10 m. Ball is embedded in sand 1 m and stops, then

a) Only momentum remains conserved b) Only kinetic energy remains conserved
c) Both momentum and K.E. are conserved d) Neither K.E. nor momentum is conserved

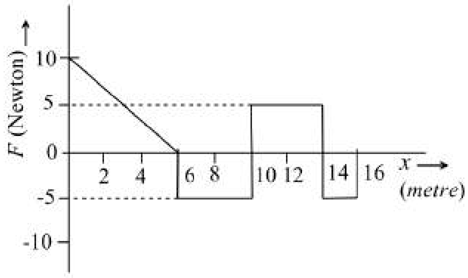
485. A bob of mass m accelerates uniformly from rest to v_1 in time t_1. As a function of t, the instantaneous power delivered to the body is

a) $\frac{mv_1 t}{t_2}$ b) $\frac{mv_1 t}{t_1}$ c) $\frac{mv_1 t^2}{t_1}$ d) $\frac{mv_1^2 t}{t_1^2}$

486. An engine accelerates a car of mass 800 kg to a speed of 72 kmh^{-1}. If the frictional force is 10 M per ton, the power developed by the engine is

a) 10 kW b) 15 kW c) 20 kW d) 5 kW

487. A particle is acted upon by a force F which varies with position x as shown in the figure. If the particle at $x = 0$ has kinetic energy of 25 J, then the kinetic energy of the particle at $x = 16\,m$ is



a) 45 J b) 30 J c) 70 J d) 135 J

488. A ball moves in a frictionless inclined table without slipping. The work done by the table surface on the ball is

a) Positive b) Negative c) Zero d) None of these

489. A spring of force constant 800 N/m has an extension of 5cm. The work done in extending it from 5 cm to 15 cm is

a) 16 J b) 8 J c) 32 J d) 24 J

490. A body of mass M is dropped from a height h on a sand floor. If the body penetrates x cm into the sand, the average resistance offered by the sand to the body is

a) $Mg\left(\frac{h}{x}\right)$ b) $Mg\left(1+\frac{h}{x}\right)$ c) $Mgh + Mgx$ d) $Mg\left(1-\frac{h}{x}\right)$

491. A body of mass 2 kg collides with a wall with speed 100 m/s and rebounds with same speed. If the time of contact was 1/50 second, the force exerted on the wall is

a) 8 N b) $2 \times 10^4\ N$ c) 4 N d) $10^4\ N$

492. A body of mass 3 kg is under a force, which causes a displacement in it given by $S = \frac{t^3}{3}$ (in m). Find the work done by the force in first 2 seconds

a) 2 J b) 3.8 J c) 5.2 J d) 24 J

493. If a long spring is stretched by 0.02 m, its potential energy is U. If the spring is stretched by 0.1 m, then its potential energy will be

a) $\frac{U}{5}$ b) U c) 5 U d) 25 U

494. A body of mass Mmoves with velocity v and collides elastically with another body of mass m ($M >> m$) at rest , then the velocity of body of mass m is

a) v b) 2v c) v/2 d) zero

495. The potential energy of a body is given by, $U = A - Bx^2$ (Where x is the displacement). The magnitude of force acting on the particle is

a) Constant b) Proportional to x
c) Proportional to x^2 d) Inversely proportional to x

496. A neutron moving with velocity v collides with a stationary $\alpha - particle$.The velocity of the neutron after the collision is

a) $-\frac{3v}{5}$ b) $\frac{3v}{5}$ c) $\frac{2v}{5}$ d) $-\frac{2v}{5}$

497. A man, by working a hand pump fixed to a well, pumps out 10 m^3 water in 1 s. If the water in the well is 10 m below the ground level, then the work done by the man is ($g = 10ms^{-2}$)

a) 10^3J b) 10^4J c) 10^5J d) 10^6J

498. A bomb is kept stationary at a point. It suddenly explodes into two fragments of masses 1g and 3g. The total KE of the fragments is 6.4×10^4J. What is the KE of the smaller fragment?

a) 2.5×10^4J b) 3.5×10^4J c) 4.8×10^4J d) 5.2×10^4J

499. A particle falls from a height h upon a fixed horizontal plane and rebounds. If e is the coefficient of restitution, the total distance travelled before rebounding has stopped is

a) $h\left(\frac{1+e^2}{1-e^2}\right)$ b) $h\left(\frac{1-e^2}{1+e^2}\right)$ c) $\frac{h}{2}\left(\frac{1-e^2}{1+e^2}\right)$ d) $\frac{h}{2}\left(\frac{1+e^2}{1-e^2}\right)$

500. A rod of mass m and length l is made to stand at an angle of 60^0 with the vertical. Potential energy of the rod in this position is

a) mgl b) $\frac{mgl}{2}$ c) $\frac{mgl}{3}$ d) $\frac{mgl}{4}$

501. A bullet hits and gets embedded in a solid block resting on a horizontal frictionless table. What is conserved

a) Momentum and kinetic energy b) Kinetic energy alone

c) Momentum alone d) Neither momentum nor kinetic energy

502. A lead ball strikes a wall and falls down, a tennis ball having the same mass and velocity strikes the wall and bounces back. Check the correct statement

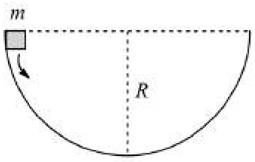
a) The momentum of the lead ball is greater than that of the tennis ball

b) The lead ball suffers a greater change in momentum compared with the tennis ball

c) The tennis ball suffers a greater change in momentum as compared with the lead ball

d) Both suffer an equal change in momentum

503. A mass m slips along the wall of a semispherical surface of radius R. The velocity at the bottom of the surface is

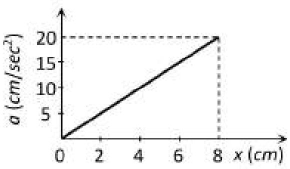


a) $\sqrt{Rg}$ b) $\sqrt{2Rg}$ c) $2\sqrt{\pi Rg}$ d) $\sqrt{\pi Rg}$

504. A body of mass m accelerates uniformly from rest to v_1 in time t_1. As a function of time t, the instantaneous power delivered to the body is

a) $\frac{mv_1t}{t_1}$ b) $\frac{mv_1^2t}{t_1}$ c) $\frac{mv_1t^2}{t_1}$ d) $\frac{mv_1^2t}{t_1^2}$

505. A $10kg$ mass moves along x-axis. Its acceleration as a function of its position is shown in the figure. What is the total work done on the mass by the force as the mass moves from $x = 0$ to $x = 8\ cm$



a) 8×10^{-2} *joules* b) 16×10^{-2} *joules* c) 4×10^{-4} *joules* d) 1.6×10^{-3} *joules*

506. A bullet when fired at a target with velocity of 100 ms^{-1} penetrates 1 m into it. If the bullet is fired at a similar target with a thickness 0.5m, then it will emerge from it with a velocity of

a) $50\sqrt{2}$ m/s b) $\frac{50}{\sqrt{2}}$ m/s c) 50 m/s d) 10 m/s

507. Two springs A and B are stretched by applying forces of equal magnitudes at the four ends. If spring constant of A is 2 times greater than that of spring B, and the energy stored in A is E, that in B is

a) $\frac{E}{2}$ b) $2E$ c) E d) $\frac{E}{4}$

508. If a shell fired from a cannon, explodes in mid air, then

a) Its total kinetic energy increases b) Its total momentum increases

c) Its total momentum decreases d) None of these

509. A force of(5+3x)N acting on a body of mass 20 kg along the x-axis displaces it from x=2m to x=6m.The

Work done by the force is

a) 20 J b) 48 J c) 68 J d) 86 J

510. A body falling from a height of $10m$ rebounds from hard floor. If it loses 20% energy in the impact, then coefficient of restitution is

a) 0.89 b) 0.56 c) 0.23 d) 0.18

511. One man takes 1 minute to raise a box to a height of 1 m and another man takes $\frac{1}{2}$ minute to do so. The energy of the two is

a) Different b) Same

c) Energy of the first is more d) Energy of the second is more

512. A body of mass 4 kg moving with velocity 12 ms^{-1} collides with another body of mass 6 kg at rest. If two bodies stick together after collision, then the loss of kinetic energy of system is

a) Zero b) 288 J c) 172.8 J d) 144 J

513. Water is drawn from a well in a 5 kg drum of capacity 55 L by two ropes connected to the top of the drum. The linear mass density of each rope is 0.5 kgm^{-1}. The work done in lifting water to the ground from the surface of water in the well 20 m below is [$g = 10ms^{-2}$]

a) 1.4×10^4 J b) 1.5×10^4 J c) $9.8 \times 10 \times 6$ J d) 18 J

514. A body falls on a surface of coefficient of restitution 0.6 from a height of 1 m. Then the body rebounds to a height of

a) 0.6 m b) 0.4 m c) 1 m d) 0.36 m

515. A ball is released from the top of a tower. The ratio of work done by force of gravity in 1st second,2nd second and 3rd second of the motion of ball is

a) 1 : 2 : 3 b) 1 : 4 : 16 c) 1 : 3 : 5 d) 1 : 9 : 25

516. A space craft of mass 'M' and moving with velocity 'v' suddenly breaks in two pieces of same mass m. After the explosion one of the mass 'm' becomes stationary. What is the velocity of the other part of craft

a) $\frac{Mv}{M-m}$ b) v c) $\frac{Mv}{m}$ d) $\frac{M-m}{m}v$

517. A ball is projected vertically upwards with a certain initial speed. Another ball of the same mass is projected at an angle of 60° with the vertical with the same initial speed. At highest points of their journey, the ratio of their potential energies will be

a) 1: 1 b) 2: 1 c) 3: 2 d) 4: 1

518. An object of mass m is attached to light string which passes through a hollow tube. The object is set into rotation in a horizontal circle of radius , r_1.If the string is pulled shortening the radius to r_2,the ratio of new kinetic energy to the original kinetic energy is

a) $\left(\frac{r_2}{r_1}\right)^2$ b) $\left(\frac{r_1}{r_2}\right)^2$ c) $\frac{r_1}{r_2}$ d) $\frac{r_2}{r_1}$

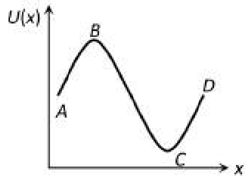
519. A neutron travelling with a velocity v and K.E. E collides perfectly elastically head on with the nucleus of an atom of mass number A at rest. The fraction of total energy retained by neutron is

a) $\left(\frac{A-1}{A+1}\right)^2$ b) $\left(\frac{A+1}{A-1}\right)^2$ c) $\left(\frac{A-1}{A}\right)^2$ d) $\left(\frac{A+1}{A}\right)^2$

520. A mass m is attached to the end of a rod of length l. The mass goes around a vertical circular path with the other end hinged at the centre. What should be the minimum velocity of mass at the bottom of the circle, so that the mass complete the circle?

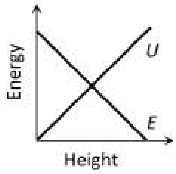
a) $\sqrt{4gl}$ b) $\sqrt{3gl}$ c) $\sqrt{5gl}$ d) $\sqrt{gl}$

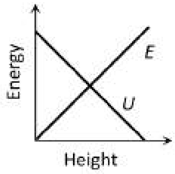
521. The potential energy of a particle varies with distance x as shown in the graph. The force acting on the particle is zero at

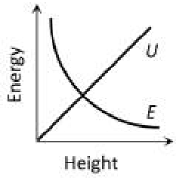


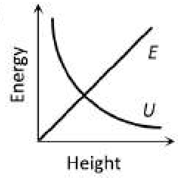
a) C b) B c) B and C d) A and D

522. Which of the following graphs is correct between kinetic energy (E), potential energy (U) and height (h) from the ground of the particle

a) 

b) 

c) 

d) 

523. Two trolleys of mass m and $3m$ are connected by a spring. They were compressed and released once, they move off in opposite direction and comes to rest after covering distances S_1 and S_2 respectively. Assuming the coefficient of friction to be uniform, the ratio of distances $S_1 : S_2$ is

a) 1 : 9 b) 1 : 3 c) 3 : 1 d) 9 : 1

524. A stone of mass 2 kg is projected upward with KE of 98 J. The height at which the KE of the body becomes half its original value, is given by (Take $g = 10 ms^{-2}$)

a) 5 m b) 2.5 m c) 1.5 m d) 0.5 m

525. Two bodies of masses 0.1 kg and 0.4 kg move towards each other with the velocities 1 m/s and 0.1 m/s respectively, After collision they stick together. In 10 sec the combined mass travels

a) 120 m b) 0.12 m c) 12 m d) 1.2 m

526. The kinetic energy of a body of mass $3kg$ and momentum 2 Ns is

a) 1 J b) $\frac{2}{3} J$ c) $\frac{3}{2} J$ d) 4 J

527. A body of mass m is at rest. Another body of same mass moving with velocity V makes head on elastic collision with the first body. After collision the first body starts to move with velocity

a) V b) $2V$ c) Remain at rest d) No predictable

528. Two bodies of masses m and $2m$ have same momentum. Their respective kinetic energies E_1 and E_2 are in the ratio

a) 1 : 2 b) 2 : 1 c) 1 : $\sqrt{2}$ d) 1 : 4

529. Two masses of 0.25 kg each moves towards each other with speed $3ms^{-1}$ and $1ms^{-1}$ collide and stick together. Find the final velocity

a) 0.5 ms^{-1} b) $2ms^{-1}$ c) $1ms^{-1}$ d) 0.25 ms^{-1}

530. Two equal masses m_1 and m_2 moving along the same straight line with velocities $+3$ m/s and -5 m/s respectively collide elastically. Their velocities after the collision will be respectively

a) $+4$ m/s for both b) -3 m/s and $+5$ m/s c) -4 m/s and $+4$ m/s d) -5 m/s and $+3$ m/s

531. A block of mass $5kg$ is resting on a smooth surface. At what angle a force of $20N$ be acted on the body so that it will acquired a kinetic energy of $40J$ after moving $4m$

a) 30° b) 45° c) 60° d) 120°

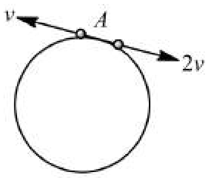
532. A particle of mass 100 g is thrown vertically upwards with a speed of $5ms^{-1}$.The work done by the force of gravity during the time, the particle goes up is

a) -0.5 J b) -1.25 J c) 1.25 J d) 0.5 J

533. A body of mass 5 kg moving with a velocity 10 m/s collides with another body of the mass 20 kg at, rest and comes to rest. The velocity of the second body due to collision is

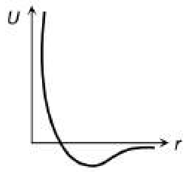
a) 2.5 m/s b) 5 m/s c) 7.5 m/s d) 10 m/s

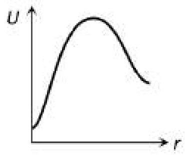
534. Two small particles of equal masses start moving in opposite directions from a point A in a horizontal circular orbit. Their tangential velocities are v and $2v$ respectively, as shown in the figure. Between collisions, the particles move with constant speeds. After making how many elastic collisions, other than that at A ,these two particles will again reach The point A?

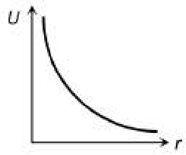


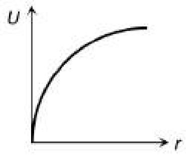
a) 4 b) 3 c) 2 d) 1

535. The diagrams represent the potential energy U of a function of the inter-atomic distance r. Which diagram corresponds to stable molecules found in nature

a) 

b) 

c) 

d) 

536. A ball whose kinetic energy is E, is projected at an angle 45° to the horizontal. The kinetic energy of the ball at the highest point of its flight will be

a) E b) $\frac{E}{\sqrt{2}}$ c) $\frac{E}{2}$ d) Zero

537. When a force is applied on a moving body, its motion is retarded. Then the work done is

a) Positive b) Negative c) Zero d) Positive and negative

538. A force applied by an engine of a train of mass 2.05×10^6 kg changes its velocity from 5 m/s to 25 m/s in 5 minutes. The power of the engine is

a) $1.025MW$ b) $2.05MW$ c) $5MW$ d) $6MW$

539. If the kinetic energy of a body increases by 0.1%, the percent increase of its momentum will be

a) 0.05 % b) 0.1 % c) 1.0 % d) 10 %

540. A canon ball is fired with a velocity 200 m/sec at an angle of 60° with the horizontal. At the highest point of its flight it explodes into 3 equal fragments, one going vertically upwards with a velocity 100 m/sec, the second one falling vertically downwards with a velocity 100 m/sec. The third fragment will be moving with a velocity

a) 100 m/s in the horizontal direction
b) 300 m/s in the horizontal direction
c) 300 m/s in a direction making an angle of 60° with the horizontal
d) 200 m/s in a direction making an angle of 60° with the horizontal

541. A sphere collides with another sphere of identical mass. After collision, the two spheres move. The collision is inelastic. Then the angle between the directions of the two spheres is

a) 90° b) 0° c) 45° d) Different from 90°

542. A 20 kg ball moving with a velocity 6 ms^{-1} collides with a 30 kg ball initially at rest .if both of them coalesce ,then final velocity of the combined mass is

a) 6 ms^{-1} b) 5 ms^{-1} c) 3.6 ms^{-1} d) $2.4ms^{-1}$

543. A body is acted upon by a force, which is inversely proportional to the distance covered (x). The work done will be proportional to

a) x b) $x^{1/2}$ c) x^2 d) None of these

544. A block of mass m at the end of the string is whirled round a vertical circle of radius r. The critical speed of the block at the top of the swing is

a) $\left(\frac{r}{g}\right)^{1/2}$ b) $\frac{g}{r}$ c) $\frac{m}{rg}$ d) $(rg)^{1/2}$

545. A particle of mass 2 kg starts moving in a straight line with an initial velocity of 2 ms^{-1} at a constant acceleration of 2 ms^{-2}. Then rate of change of kinetic energy
a) Is four times the velocity at any moment
b) Is two times the displacement at any moment
c) Is four times the rate of change of velocity at any moment
d) Is constant through out

546. The velocity of 2 kg body is changed from $(4\hat{\mathbf{i}} + 3\hat{\mathbf{j}})$ ms^{-1}. The work done on the body is
a) 9 J b) 11 J c) 1 J d) Zero

547. A force acts on a 30 g particle in such a way that the position of the particle as a function of time is given by $x = 3t - 4t^2 + t^3$, where x is in $metres$ and t is in seconds. The work done during the first 4 seconds is
a) 5.28 J b) 450 mJ c) 190 mJ d) 530 mJ

548. If a skater of weight 3 kg has initial speed 32 m/s and second one of weight 4 kg has 5 m/s. After collision, they have speed (couple) 5 m/s. Then the loss in K.E. is
a) 48 J b) 96 J c) Zero d) None of these

549. The potential energy of a certain spring when stretched through a distance s is 10 J .The amount of work done (in joule)that must be done on this spring to stretch it through an additional distance s, will be
a) 20 b) 10 c) 30 d) 40

550. A particle of mass m moving with velocity V_0 strikes a simple pendulum of mass m and strikes to it. The maximum height attained by the pendulum will be
a) $h = \frac{v_0^2}{8g}$ b) $\sqrt{V_0 g}$ c) $2\sqrt{\frac{V_0}{g}}$ d) $\frac{V_0^2}{4g}$

551. In a certain situation, $\vec{\mathbf{F}}$ and $\vec{\mathbf{s}}$ are not equal to zero but the work done is zero. From this, we conclude that
a) $\vec{\mathbf{F}}$ and $\vec{\mathbf{s}}$ are in same direction
b) $\vec{\mathbf{F}}$ and $\vec{\mathbf{s}}$ are in opposite direction
c) $\vec{\mathbf{F}}$ and $\vec{\mathbf{s}}$ are at right angles
d) $\vec{\mathbf{F}} > \vec{\mathbf{s}}$

552. A bomb of mass $3m$ kg explodes into two pieces of mass m kg and $2m$ kg. If the velocity of m kg mass is 16 m/s, the total kinetic energy released in the explosion is
a) 192 mJ b) 96 mJ c) 384 mJ d) 768 mJ

553. Identify the wrong statement
a) A body can have momentum without energy
b) A body can have energy without momentum
c) The momentum is conserved in an elastic collision
d) Kinetic energy is not conserved in an inelastic collision

554. A body constrained to move in the y-direction is subjected to force $\mathbf{F} = 2\hat{\imath} + 15\hat{\jmath} + 6\hat{\boldsymbol{k}}$ N. The work done by this force in moving the body through a distance of 10 m along y-axis is
a) 100 J b) 150 J c) 120 J d) 200 J

555. A bullet fired from a gun with a velocity of 10^4 ms^{-1} goes through a bag full of straw. If the bullet loses half of its kinetic energy in the bag, its velocity when it comes out of the bag will be
a) 7071.06 ms^{-1} b) 707 ms^{-1} c) 70.71 ms^{-1} d) 707.06 ms^{-1}

556. A block of mass 0.50 kg is moving with a speed of 2.00ms^{-1}on a smooth surface. It strikes another mass of 1.00 kg and then they move together as a single body .The energy loss during the collision is
a) 0.16 J b) 1.00 J c) 0.67 J d) 0.34 J

557. A river of salty water is flowing with a velocity 2 ms^{-1} If the density of the water is 1.2 g/cc, then the kinetic energy of each cubic metre of water is
a) 2.4 J b) 24 J c) 2.4 KJ d) 4.8 KJ

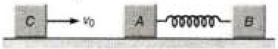
558. The slope of the kinetic energy versus position vector gives the rate of change of
a) Momentum b) Velocity c) Force d) Power

559. A bullet of mass 20 g and moving with 600 ms^{-1} collides with a block of mass 4 kg hanging with the string. What is velocity of bullet when it comes out of block if block rises to height 0.2 after collision?
a) 200 ms^{-1} b) 150 ms^{-1} c) 400 ms^{-1} d) 300 ms^{-1}

560. A mass of 50 kg is raised through a certain height by a machine whose efficiency is 90%, the energy is 5000 J. If the mass is now released, its KE on hitting the ground shall be

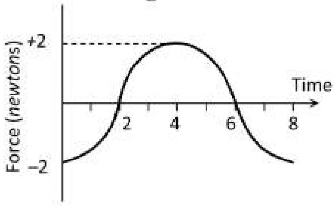
a) 5000 J
b) 4500 J
c) 4000 J
d) 5500 J

561. A block C of mass $m$is moving with velocity $v_0$and collides elastically with block $A$of mass m and connected to another block $B$of mass $2m$ through spring constant k.What is k if x_0 is compression of spring when velocity of A and B is same ?



a) $\frac{mv_0^2}{X_0^2}$
b) $\frac{mv_0^2}{2x_0^2}$
c) $\frac{3}{2}\frac{mv_0^2}{x_0^2}$
d) $\frac{2}{3}\frac{mv_0^2}{x_0^2}$

562. A force–time graph for a linear motion is shown in figure where the segments are circular. The linear momentum gained between zero and 8 *second* is



a) -2π *newton* $\times$ *second*
b) *Zero newton* $\times$ *second*
c) $+4\pi$ *newton* $\times$ *second*
d) -6π *newton* $\times$ *second*

563. A particle is released from a height S. At certain height its kinetic energy is three times its potential energy. The height and speed of the particle at that instant are respectively

a) $\frac{S}{4}, \frac{3gS}{2}$
b) $\frac{S}{4}, \frac{\sqrt{3gS}}{2}$
c) $\frac{S}{2}, \frac{\sqrt{3gS}}{2}$
d) $\frac{S}{4}. \frac{\sqrt{3gS}}{2}$

564. A mass M is lowered with the help of a string by a distance h at a constant acceleration g/2. The work done by the string will be

a) $\frac{Mgh}{2}$
b) $\frac{-Mgh}{2}$
c) $\frac{3Mgh}{2}$
d) $\frac{-3Mgh}{2}$

565. **Statement I** Two particles moving in the same direction do not lose all their energy in a completely inelastic collision.

Statement II Principle of conservation of momentum holds true for all kinds of collisions.

a) Statement I is true, statement II is true, statement II is the correct explanation of statement I.
b) Statement I is true Statement II is true, Statement II is not correct explanation of statement I.
c) Statement I is false, Statement II is true.
d) Statement I is true, Statement II is false.

566. A ball hits the floor and rebounds after inelastic collision. In this case

a) The momentum of the ball just after the collision is the same as that just before the collision
b) The mechanical energy of the ball remains the same in the collision
c) The total momentum of the ball and the earth is conserved
d) The total energy of the ball and the earth is conserved

567. Which of the following statements is wrong?

a) KE of a body is independent of the direction of motion
b) In an elastic collision of two bodies ,the momentum and energy of each body is conserved
c) If two protons are brought towards each other the PE of the system decreases.
d) A body cannot have energy without momentum.

568. An elastic string of unstretched length L and force constant k is stretched by a small length x. It is further stretched by another small length y. The work done in the second stretching is

a) $\frac{1}{2}ky^2$
b) $\frac{1}{2}k(x^2+y^2)$
c) $\frac{1}{2}k(x+y)^2$
d) $\frac{1}{2}ky(2x+y)$

569. A shell of mass m moving with velocity v suddenly breaks into 2 pieces. The part having mass $m/4$ remains stationary. The velocity of the other shell will be

a) v b) $2v$ c) $\frac{3}{4}v$ d) $\frac{4}{3}v$

570. A one kilowatt motor is used to pump water from a well 10 m deep. The quantity of water pumped out per second is nearly

a) 1 kg b) 10 kg c) 100 kg d) 1000 kg

571. The area under the displacement-force curve gives

a) Distance travelled b) Total force c) Momentum d) Work done

572. A billiard ball moving with a speed of 5 m/s collides with an identical ball originally at rest. If the first ball stops after collision, then the second ball will move forward with a speed of

a) 10 ms^{-1} b) 5 ms^{-1} c) 2.5 ms^{-1} d) 1.0 ms^{-1}

573. Two balls of masses 2 g and 6 g are moving with KE in the ratio of 3:1. What is the ratio of their linear momenta?

a) 1:1 b) 2:1 c) 1:2 d) None of these

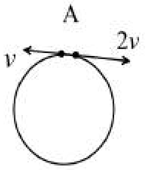
574. The energy required to accelerate a car from rest to 10 $\mathrm{ms^{-1}}$ is E. What energy will be required to accelerate the car from 10 $\mathrm{ms^{-1}}$ to 20 $\mathrm{ms^{-1}}$?

a) E b) $3E$ c) $5E$ d) $7E$

575. A shell of mass 200 gm is ejected from a gun of mass 4 kg by an explosion that generates 1.05 kg of energy. The initial velocity of the shell is

a) 40 ms^{-1} b) 120 m^{-1} c) 100 ms^{-1} d) 80 ms^{-1}

576. Two small particles of equal masses start moving in opposite directions from a point A in a horizontal circular orbit. Their tangential velocities are v and $2v$, respectively, as shown in the figure. Between collisions, the particles move with constant speeds. After making how many elastic collisions, other than that at A, these two particles will again reach the point A



a) 4 b) 3 c) 2 d) 1

577. The work done in dragging a stone of mass 100 kg up an inclined plane 1 in 100 through a distance of 10 m is (take g = 9.8 $\mathrm{ms^{-2}}$)

a) Zero b) 980 J c) 9800 J d) 98 J

578. A bullet of mass 0.05 kg moving with a speed of 80 ms^{-1} enters a wooden block and is stopped after a distance of 0.40 m. The average resistive force exerted by the block on the bullet is

a) 300 N b) 20 N c) 400 N d) 40 N

579. A spring with spring constant k is extended from $x = 0$ to $x = x_1$.The work done will be

a) κx_1^2 b) $\frac{1}{2}\kappa x_1^2$ c) $2\kappa x_1^2$ d) $2\kappa x_1$

580. Given that the position of the body in metre is a function of time as follows

$x = 2t^4 + 5t + 4$

The mass of the body is 2 kg. What is the increase in its kinetic energy one second after the start of motion?

a) 168 J b) 169 J c) 32 J d) 144 J

581. The kinetic energy of a body is increased by 300%. What is the percentage increase in the momentum of the body?

a) 50% b) 100% c) 150% d) 200%

582. Two bodies A and B have masses 2 kg and 5 kg respectively. Each one is acted upon by a force of 4 kg wt. If they acquire the same kinetic energy in times t_A and t_B, then the ratio $\frac{t_A}{t_B}$ is

a) $\frac{1}{2}$ b) 2 c) $\frac{2}{5}$ d) $\frac{5}{6}$

583. A lorry and a car moving with the same K.E. are brought to rest by applying the same retarding force, then

a) Lorry will come to rest in a shorter distance
b) Car will come to rest in a shorter distance
c) Both come to rest in a same distance
d) None of the above

584. A ball is allowed to fall from a height of $10\ m$. If there is 40% loss of energy due to impact, then after one impact ball will go up to

a) $10\ m$
b) $8\ m$
c) $4\ m$
d) $6\ m$

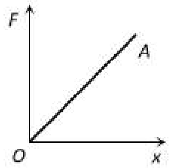
585. A body of mass $10\ kg$ at rest is acted upon simultaneously by two forces $4\ N$ and $3\ N$ at right angles to each other. The kinetic energy of the body at the end of $10\ sec$ is

a) $100\ J$
b) $300\ J$
c) $50\ J$
d) $125\ J$

586. The force constant of a weightless spring is $16\ N/m$. A body of mass $1.0\ kg$ suspended from it is pulled down through 5 cm and then released. The maximum kinetic energy of the system (spring + body) will be

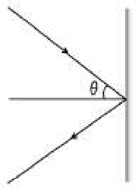
a) $2 \times 10^{-2}\ J$
b) $4 \times 10^{-2}\ J$
c) $8 \times 10^{-2}\ J$
d) $16 \times 10^{-2}\ J$

587. The force required to stretch a spring varies with the distance as shown in the figure. If the experiment is performed with above spring of half length, the line OA will



a) Shift towards F-axis
b) Shift towards X-axis
c) Remain as it is
d) Become double in length

588. An intense stream of water of cross-sectional area A strikes a wall at an angle θ with the normal to the wall and returns back elastically. If the density of water is ρ and its velocity is v, then the force exerted in the wall will be



a) $2Av\rho \cos\theta$
b) $2Av^2\rho \cos\theta$
c) $2Av^2\rho$
d) $2Av\rho$

589. Four particles given, have same momentum. Which has maximum kinetic energy

a) Proton
b) Electron
c) Deutron
d) α- particles

590. The energy associated with one gram of mass is

a) $9 \times 10^{-13}\ J$
b) $9 \times 10^{-16}\ J$
c) $9 \times 10^{13}\ J$
d) $9 \times 10^{16}\ J$

591. Natural length of a spring is $60\ cm$, and its spring constant is $4000\ N/m$. A mass of $20\ kg$ is hung from it. The extension produced in the spring is, (Take $g = 9.8\ m/s^2$)

a) $4.9\ cm$
b) $0.49\ cm$
c) $9.4\ cm$
d) $0.94\ cm$

592. An ice cream has a marked value of $700\ kcal$. How many kilowatt - hour of energy will it deliver to the body as it is digested

a) $0.81\ kWh$
b) $0.90\ kWh$
c) $1.11\ kWh$
d) $0.71\ kWh$

593. A 50g bullet moving with a velocity of $10\ \text{ms}^{-1}$ gets embeded into a 950g stationary body. The loss in KE of the system will be

a) 95%
b) 100%
c) 5%
d) 50%

594. Consider elastic collision of a particle of mass m moving with a velocity u with another particle of the same mass at rest. After the collision the projectile and the struck particle move in directions making angles θ_1 and θ_2 respectively with the initial direction of motion. The sum of the angles $\theta_1 + \theta_2$, is

a) 45°
b) 90°
c) 135°
d) 180°

595. A shell is fired from a cannon with velocity $v\ m/sec$ at an angle θ with the horizontal direction. At the highest point in its path it explodes into two pieces of equal mass. One of the pieces retraces its path to the cannon and the speed in m/sec of the other piece immediately after the explosion is

a) $3v\cos\theta$ b) $2v\cos\theta$ c) $\frac{3}{2}v\cos\theta$ d) $\frac{\sqrt{3}}{2}v\cos\theta$

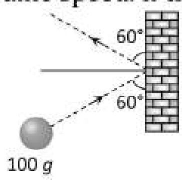
596. A force $\boldsymbol{F} = -K(y\boldsymbol{i} + x\boldsymbol{j})$ (where K is a positive constant) acts on a particle moving in the xy-plane. Starting from the origin, the particle is taken along the positive x-axis to the point $(a, 0)$ and then parallel to the y-axis to the point (a, a). The total work done by the force F on the particles is
a) $-2\,Ka^2$ b) $2Ka^2$ c) $-Ka^2$ d) Ka^2

597. A stationary particle explodes into two particle of masses m_1 and m_2 which move in opposite directions with velocities v_1 and v_2. The ratio of their kinetic energies E_1/E_2 is
a) m_1/m_2 b) 1 c) m_1v_2/m_2v_1 d) m_2/m_1

598. A bucket tied to a string is lowered at a constant acceleration of $\frac{g}{4}$. If the mass of the bucket is m and is lowered by a distance d, the work done by the string will be
a) $\frac{mgd}{4}$ b) $-\frac{3}{4}mgd$ c) $-\frac{4}{3}mgd$ d) $\frac{4}{3}mgd$

599. The potential energy of a 1 kg particle free to move along the x-axis is given by $V(x) = \left(\frac{x^4}{4} - \frac{x^2}{2}\right)$ J.The total mechanical energy of particle is 2 J. Then, the maximum speed (in $\mathrm{ms^{-1}}$) is
a) $3/\sqrt{2}$ b) $\sqrt{2}$ c) $1/\sqrt{2}$ d) 2

600. A mass of 100 g strikes the wall with speed 5 m/s at an angle as shown in figure and it rebounds with the same speed. If the contact time is 2×10^{-3} sec, what is the force applied on the mass by the wall



a) $250\sqrt{3}\ N$ to right b) 250 N to right c) $250\sqrt{3}\ N$ to left d) 250 N to left

601. Two masses m_A and m_B moving with velocities v_A and v_B in opposite directions collide elastically. After that the masses m_A and m_B move with velocity v_B and v_A respectively. The ratio (m_A/m_B) is
a) 1 b) $\frac{v_A - v_B}{v_A + v_B}$ c) $(m_A + m_B)/m_A$ d) v_A/v_B

602. An open knife edge of mass 'm' is dropped from a height 'h' on a wooden floor. If the blade penetrates upto the depth 'd' into the wood, the average resistance offered by the wood edge is
a) mg b) $mg\left(1 - \frac{h}{d}\right)$ c) $mg\left(1 + \frac{h}{d}\right)$ d) $mg\left(1 + \frac{h}{d}\right)^2$

603. A ball dropped from a height of $2m$ rebounds to a height of 1.5 m after hitting the ground. Then the percentage of energy lost is
a) 25 b) 30 c) 50 d) 100

604. A body of mass 50 kg is projected vertically upwards with velocity of 100 m/sec. 5 seconds after this body breaks into 20 kg and 30 kg. If 20 kg piece travels upwards with 150 m/sec, then the velocity of the block will be
a) 15 m/sec downwards b) 15 m/sec upwards
c) 51 m/sec downwards d) 51 m/sec upwards

605. The kinetic energy possessed by a body of mass m moving with a velocity v is equal to $1/2\ mv^2$, provided
a) The body moves with velocities comparable to that of light
b) The body moves with velocities negligible compared to the speed of light
c) The body moves with velocities greater than that of light
d) None of the above statement is corrects

WORK ENERGY AND POWER

: ANSWER KEY :

1)	b	2)	d	3)	b	4)	a	161)	a	162)	a	163)	a	164)	a
5)	b	6)	c	7)	c	8)	c	165)	d	166)	b	167)	c	168)	a
9)	a	10)	b	11)	c	12)	d	169)	b	170)	c	171)	b	172)	b
13)	a	14)	c	15)	b	16)	b	173)	c	174)	d	175)	b	176)	c
17)	b	18)	b	19)	c	20)	a	177)	a	178)	b	179)	c	180)	d
21)	d	22)	d	23)	c	24)	a	181)	d	182)	d	183)	d	184)	a
25)	a	26)	d	27)	b	28)	a	185)	a	186)	a	187)	d	188)	d
29)	d	30)	b	31)	a	32)	b	189)	a	190)	d	191)	c	192)	a
33)	d	34)	b	35)	d	36)	c	193)	b	194)	c	195)	a	196)	b
37)	d	38)	c	39)	c	40)	d	197)	a	198)	a	199)	d	200)	b
41)	c	42)	a	43)	a	44)	c	201)	b	202)	b	203)	d	204)	d
45)	d	46)	b	47)	c	48)	a	205)	b	206)	d	207)	b	208)	d
49)	c	50)	b	51)	b	52)	b	209)	a	210)	a	211)	a	212)	b
53)	b	54)	d	55)	c	56)	c	213)	c	214)	a	215)	a	216)	c
57)	c	58)	b	59)	b	60)	c	217)	a	218)	b	219)	a	220)	b
61)	c	62)	b	63)	b	64)	d	221)	a	222)	a	223)	b	224)	d
65)	d	66)	b	67)	b	68)	a	225)	c	226)	b	227)	c	228)	c
69)	a	70)	c	71)	c	72)	c	229)	d	230)	a	231)	b	232)	c
73)	b	74)	c	75)	d	76)	b	233)	b	234)	a	235)	c	236)	b
77)	d	78)	d	79)	c	80)	b	237)	c	238)	c	239)	b	240)	b
81)	a	82)	a	83)	a	84)	b	241)	c	242)	a	243)	d	244)	b
85)	a	86)	b	87)	d	88)	d	245)	d	246)	a	247)	b	248)	a
89)	c	90)	b	91)	c	92)	c	249)	b	250)	c	251)	a	252)	b
93)	d	94)	c	95)	b	96)	a	253)	a	254)	a	255)	c	256)	a
97)	d	98)	d	99)	d	100)	a	257)	d	258)	c	259)	b	260)	a
101)	a	102)	c	103)	b	104)	d	261)	c	262)	d	263)	c	264)	d
105)	a	106)	b	107)	d	108)	a	265)	b	266)	c	267)	c	268)	b
109)	c	110)	c	111)	c	112)	c	269)	b	270)	a	271)	b	272)	c
113)	d	114)	b	115)	c	116)	d	273)	c	274)	c	275)	a	276)	b
117)	b	118)	a	119)	c	120)	b	277)	a	278)	b	279)	c	280)	b
121)	d	122)	c	123)	b	124)	d	281)	b	282)	d	283)	a	284)	d
125)	a	126)	a	127)	b	128)	c	285)	d	286)	d	287)	b	288)	c
129)	a	130)	c	131)	b	132)	c	289)	a	290)	c	291)	b	292)	b
133)	b	134)	c	135)	a	136)	a	293)	c	294)	a	295)	a	296)	a
137)	c	138)	b	139)	a	140)	c	297)	b	298)	a	299)	b	300)	a
141)	a	142)	a	143)	c	144)	c	301)	b	302)	c	303)	a	304)	c
145)	d	146)	d	147)	d	148)	b	305)	c	306)	b	307)	d	308)	a
149)	c	150)	a	151)	d	152)	a	309)	b	310)	d	311)	b	312)	a
153)	a	154)	c	155)	a	156)	c	313)	b	314)	b	315)	a	316)	b
157)	b	158)	c	159)	d	160)	a	317)	b	318)	c	319)	b	320)	c

321)	b	322)	c	323)	d	324)	b
325)	d	326)	d	327)	c	328)	b
329)	c	330)	b	331)	c	332)	a
333)	c	334)	b	335)	c	336)	b
337)	c	338)	a	339)	c	340)	a
341)	c	342)	b	343)	a	344)	b
345)	c	346)	a	347)	a	348)	a
349)	d	350)	c	351)	b	352)	c
353)	b	354)	a	355)	d	356)	a
357)	c	358)	a	359)	c	360)	c
361)	a	362)	b	363)	a	364)	d
365)	c	366)	c	367)	c	368)	d
369)	c	370)	c	371)	a	372)	b
373)	d	374)	d	375)	a	376)	b
377)	a	378)	b	379)	d	380)	a
381)	d	382)	b	383)	b	384)	a
385)	b	386)	d	387)	b	388)	d
389)	c	390)	a	391)	b	392)	b
393)	d	394)	a	395)	d	396)	a
397)	a	398)	d	399)	c	400)	d
401)	c	402)	b	403)	d	404)	d
405)	d	406)	b	407)	c	408)	c
409)	a	410)	a	411)	d	412)	b
413)	d	414)	c	415)	c	416)	b
417)	d	418)	d	419)	c	420)	d
421)	c	422)	a	423)	c	424)	a
425)	d	426)	b	427)	d	428)	b
429)	d	430)	a	431)	a	432)	a
433)	c	434)	c	435)	a	436)	c
437)	d	438)	b	439)	a	440)	c
441)	b	442)	c	443)	d	444)	b
445)	d	446)	d	447)	d	448)	c
449)	c	450)	a	451)	b	452)	c
453)	a	454)	b	455)	a	456)	c
457)	b	458)	a	459)	b	460)	d
461)	c	462)	a	463)	d	464)	a
465)	c	466)	b	467)	c	468)	d

469)	c	470)	b	471)	c	472)	a
473)	c	474)	c	475)	a	476)	b
477)	b	478)	b	479)	a	480)	a
481)	c	482)	d	483)	c	484)	a
485)	d	486)	d	487)	a	488)	c
489)	b	490)	b	491)	b	492)	d
493)	d	494)	b	495)	b	496)	a
497)	d	498)	c	499)	a	500)	d
501)	c	502)	c	503)	b	504)	d
505)	a	506)	a	507)	b	508)	a
509)	c	510)	a	511)	b	512)	c
513)	a	514)	d	515)	c	516)	a
517)	d	518)	b	519)	a	520)	c
521)	c	522)	a	523)	d	524)	b
525)	d	526)	b	527)	a	528)	b
529)	c	530)	d	531)	c	532)	b
533)	a	534)	c	535)	a	536)	c
537)	b	538)	b	539)	a	540)	b
541)	d	542)	d	543)	d	544)	d
545)	a	546)	b	547)	a	548)	d
549)	d	550)	a	551)	c	552)	a
553)	a	554)	b	555)	a	556)	c
557)	c	558)	a	559)	a	560)	b
561)	d	562)	b	563)	d	564)	b
565)	d	566)	c	567)	c	568)	d
569)	d	570)	b	571)	d	572)	b
573)	a	574)	b	575)	c	576)	c
577)	d	578)	c	579)	b	580)	d
581)	b	582)	b	583)	c	584)	d
585)	d	586)	a	587)	a	588)	b
589)	b	590)	c	591)	a	592)	a
593)	a	594)	b	595)	a	596)	c
597)	d	598)	b	599)	a	600)	c
601)	a	602)	c	603)	a	604)	a
605)	b						

WORK ENERGY AND POWER

: HINTS AND SOLUTIONS :

1 **(b)**

$P = \frac{\text{total energy}}{t} = \frac{mgh + \frac{1}{2}mv^2}{t}$

$= \frac{10 \times 10 \times 20 + \frac{1}{2} \times 10 \times 10 \times 10}{1}$

$= 2000 + 500 = 2500\text{ W}$

$= 2.5\text{ kW}$

2 **(d)**

Clearly, 80% energy is retained after impact

$\therefore\ h' = \frac{80}{100} \times 10 = 8\text{ m}$

3 **(b)**

$v = \frac{dx}{dt} = \frac{d}{dt}\left(\frac{t^3}{3}\right) = t^2$

When $t = 0$, then $v = 0$, when $t = 2$, then $v = 4\text{ m/s}$

Work done in first two second = change in KE

$W = \frac{1}{2}m[(4)^2 - (0)^2] = \frac{1}{2} \times 2 \times 16 = 16\text{ J}$

4 **(a)**

As truck is moving on an incline plane therefore only component of weight ($mg\sin\theta$) will oppose the upward motion

Power = force × velocity = $mg\sin\theta \times v$

$= 30000 \times 10 \times \left(\frac{1}{100}\right) \times \frac{30 \times 5}{18} = 25\ kW$

5 **(b)**

$m_1 = 2\ kg$ and $v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 = \frac{u_1}{4}$ [Given]

By solving we get $m_2 = 1.2\ kg$

6 **(c)**

$p = \sqrt{2mE_k}$

or $p \propto \sqrt{m}$ [$\because E_k$ is given to be constant]

$\therefore\ \frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$

7 **(c)**

$t = \sqrt{\left(\frac{2h}{g}\right)}$

The second impact occurs after an additional times

$= 2\sqrt{2h_1 g}$

$= 2e\sqrt{\frac{2h}{g}}$

The third impact occurs after an additional time

$= 2\sqrt{2h_2 g}$

$= 2e^2\sqrt{\frac{2h}{g}}$

$= e^2\sqrt{\frac{8h}{g}}$

8 **(c)**

By definition

9 **(a)**

$P = \frac{\vec{F}.\vec{s}}{t} = \frac{(2\hat{\imath} + 3\hat{\jmath} + 4\hat{k}).(3\hat{\imath} + 4\hat{\jmath} + 5\hat{k})}{4} = \frac{38}{4}$

$= 9.5\ W$

10 **(b)**

$\Delta U = mgh = 20 \times 9.8 \times 0.5 = 98\ J$

11 **(c)**

Given ,$t_1 = 10s,\quad t_2 = 20,\quad w_1 = w_2$

power= $\frac{work\ done}{time}$

or $\frac{p_1}{p_2} = \frac{w_1/t_1}{w_2/t_2}$

$\therefore\quad \frac{p_1}{p_2} = \frac{t_2}{t_1} = \frac{2}{1}$

12 **(d)**

Coefficient of restitution is given by

$e = \frac{\text{relative velocity of seperation}}{\text{relative velocity of approach}}$

We have

$e_1 = \frac{1}{2}$

And $e_2 = \left(\frac{relative\text{ velocity of seperation}}{\text{relative velocity of approach}}\right)_2$

Given ,$\frac{e_1}{e_2} = \frac{3}{1} \Rightarrow \frac{e_2}{e_1} = \frac{1}{3}$

$\therefore \left(\frac{\text{relative velocity of seperation}}{\text{relative velocity of approach}}\right)_2 = \frac{1}{3} \times \frac{1}{2} = \frac{1}{6}$

Or $\left(\frac{\text{relative velocity of approach}}{\text{relative velocity of seperation}}\right)_2 = \frac{6}{1}$

13 **(a)**

$h = 500\ m, \frac{dm}{dt} = 2000\ \text{kgs}^{-1}$

power output $= \frac{80}{100} \times \frac{dm}{dt} gh$

$= \frac{4}{5} \times 2000 \times 10 \times 500\text{W}$

$= 8 \times 10^6\text{W} = 8\text{MW}$

14 **(c)**

$\int F dt = \Delta\rho$

$\Rightarrow \frac{1}{2} \times 4 \times 3 - \frac{1}{2} \times 1.5 \times 2 = p_f - 0 \Rightarrow p_f$

$= 6 - 1.5 = \frac{9}{2}$

$K.E. = \frac{p^2}{2m} = \frac{81}{4 \times 2 \times 2}; K.E. = 5.06\ J$

15 **(b)**

When ball falls vertically downward from height h_1 its velocity $\vec{v}_1 = \sqrt{2gh_1}$

And its velocity after collision $\vec{v}_2 = \sqrt{2gh_2}$

Change in momentum

$\Delta\vec{P} = m(\vec{v}_2 - \vec{v}_1) = m(\sqrt{2gh_1} + \sqrt{2gh_2})$

[Because $\vec{v}_1$ and $\vec{v}_2$ are opposite in direction]

17 **(b)**

Kinetic energy $E = \frac{P^2}{2m} = \frac{(Ft)^2}{2m} = \frac{F^2t^2}{2m}$ [As $P = Ft$]

18 **(b)**

Here $k = \frac{1}{2}mv^2 = as^2$

$\therefore\ mv^2 = 2as^2$

Differentiating w.r.t. time t

$2mv\frac{dv}{dt} = 4as\frac{ds}{dt} = 4asv, m\frac{dv}{dt} = 2as$

This is the tangential force, $F_t = 2as$

Centripetal force $F_c = \frac{mv^2}{R} = \frac{2as^2}{R}$

$\therefore$ Force acting on the particle

$F = \sqrt{F_t^2 + F_c^2} = \sqrt{(2as)^2 + \left(\frac{2as}{R}\right)^2}$

$= 2as\sqrt{1 + s^2/R^2}$

19 **(c)**

The relation between linear momentum and kinetic energy is

$p^2 = 2mk$ ....(i)

But linear momentum is increased by 50%, then

$p' = \frac{150}{100}p$

$p' = \frac{3}{2}p$

Hence, $p'^2 = 2mk'$

Or $\left(\frac{3}{2}p\right)^2 = 2mk'$

Or $\frac{9}{4}p^2 = 2mk'$ ....(ii)

On putting the value of p^2 from Eq. (i) in Eq. (ii)

$\frac{9}{4} \times 2mk = 2mk'$

Or $K' = \frac{9}{4}k$

So, the increase in kinetic energy is

$\Delta K = \frac{9}{4}k - k = \frac{5}{4}k$

Hence, percent increase in kinetic energy

$= \frac{(5/4)K}{K} \times 100\%$

$= \frac{5}{4} \times 100\% = 125\%$

20 **(a)**

$m = 0.3 \times 10^8$ kg, $F = 0.5 \times 10^5\text{N}, s = 3m, v = ?$

Work done= $F \times s$

This work becomes the kinetic energy of the ship

$\therefore \frac{1}{2}mv^2 = F \times s$

or $v^2 = \frac{2Fs}{m} = \frac{2\times0.5\times10^5\times3}{0.3\times10^8}$ or $v = 0.1\text{ms}^{-1}$

21 **(d)**

$P = \frac{mgh}{t}$

$m = \frac{Pt}{gh} = \frac{200 \times 60}{10 \times 10} = 1200\ \text{L}$

22 **(d)**

Question is somewhat based on approximations.

Let mass of athlete is 65 kg.

Approx velocity is 10 ms^{-1}

So, KE $= \frac{65\times100}{2} = 3750\ J$

So, option(d) is most probable answer.

23 **(c)**

$w = \frac{F^2}{2k}$

If both springs are stretched by same force then $w \propto \frac{1}{k}$.

As $k_1 > k_2$ therefore, $w_1 < w_2$

I.e., more work is done in case of second spring.

24 **(a)**

$a = \frac{\text{Net pulling force}}{\text{Total mass}}$

$= \dfrac{0.72g - 0.36g}{0.72 + 0.36} = \dfrac{g}{3}$

$s = \dfrac{1}{2}at^2 = \dfrac{1}{2}\left(\dfrac{g}{3}\right)(1)^2 = \dfrac{g}{6}$

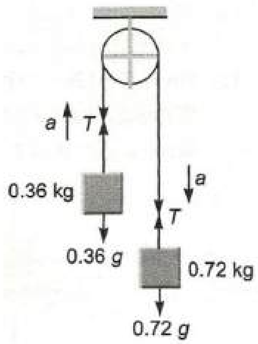
$\text{T} - 0.36g = 0.36a = 0.36\frac{g}{3}$

$\therefore T = 0.48g$

Now, $w_T = TS\ \cos 0° (on\ 0.36\ kg\ mass)$

$= (0.48\ g)\left(\dfrac{g}{6}\right)(1) = 0.08(g^2)$

$= 0.08(10)^2 = 8\text{J}$



25 **(a)**

Volume of water to raise $= 22380\ l = 22380 \times 10^{-3} m^3$

$P = \dfrac{mgh}{t} = \dfrac{V\rho gh}{t} \Rightarrow t = \dfrac{V\rho gh}{P}$

$t = \dfrac{22380 \times 10^{-3} \times 10^3 \times 10 \times 10}{10 \times 746} = 5\ min$

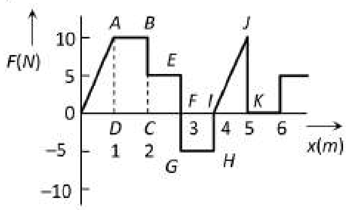
26 **(d)**

Change in momentum $= m\vec{v}_2 - m\vec{v}_1 = -mv - mv = -2mv$

27 **(b)**

Work done = area under F-x graph

= area of rectangle $ABCD$ + area of rectangle $LCEF$ + area of rectangle $GFIH$ + area of triangle IJK



$= (2-1) \times (10-0) + (3-2)(5-0)$

$+ (4-3)(-5-0) + \frac{1}{2}(5-4)(10-0) = 15\,J$

28 **(a)**

The relation between kinetic energy(K)and momentum p is given by

$K = \dfrac{p^2}{2m}$

Given , $m_1 = 1g = 1 \times 10^{-3}kg = 0.001kg$,

$m_2 = 4g = 4 \times 10^{-3}kg = 0.004\ kg$,

$\therefore K_1 = K_2$

ie , $\frac{p_1^2}{2m_1} = \frac{p_2^2}{2m_2}$

or $\frac{p_1}{p_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{0.001}{0.004}} = \frac{1}{2}$

29 **(d)**

Velocity at B when dropped from A

where $AC = s$

$v^2 = u^2 + 2\text{g}(s - x)$ ....(i)

$v^2 = 2\text{g}(s - x)$ ....(ii)

Potential energy at $B = mgx$

$\therefore$ Kinetic energy = $3 \times$ potential energy

$\dfrac{1}{2}m \times 2\text{g}(s - x) = 3 \times mgx$

or $(s - x) = 3x$

or $s = 4x$ or $x = \frac{s}{4}$

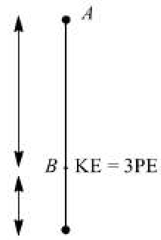
From Eq. (i)

$v^2 = 2\text{g}(s - x)$

$= 2\text{g}\left(s - \dfrac{s}{4}\right)$

$= \dfrac{2\text{g} \times 3s}{4} = \dfrac{3\text{g}s}{2}$

$\therefore x = \frac{s}{4}$ and $v = \sqrt{\frac{3\text{g}s}{2}}$



31 **(a)**

Impulse = change in momentum $= 2\ mv$

$= 2 \times 0.06 \times 4 = 0.48\ kg\ m/s$

32 **(b)**

Here : Energy of one apple $= 21\ KJ = 21 \times 10^3\ J$

Efficiency of the boy $= 28\% = 0.28$

Mass of the boy $m = 40\ kg$

Here the actual energy consumed by the boy is given by as

$0.28 \times 21000 = 5880\ J$ .....(i)

And the energy consumed by the boy in climbing h meter height is given by

$= m\ g\ h = 40 \times 9.8 \times h$ ...(ii)

Equating equations (i) and (ii) we get

$40 \times 9.8 \times h = 5880$

$h = \dfrac{5880}{40 \times 9.8} = 15\ m$

33 **(d)**

As the speed of mass is uniform hence, net power will be zero.

34 **(b)**

$W_1 = \frac{1}{2}k \times x_1^2$

$= \frac{1}{2} \times 5 \times 10^3 \times (5 \times 10^{-2})^2 = 6.25\text{J}$

$W_2 = \frac{1}{2}k(x_1 + x_2)^2$

$= \frac{1}{2} \times 5 \times 10^3 (5 \times 10^{-2} + 5 \times 10^{-2})^2 = 25\ \text{J}$

Net work done = $W_2 - W_1 = 25 - 6.25$

$= 18.75\text{J} = 18.75\text{N} - \text{m}$

35 **(d)**

$m = 10 \times 0.8\ \text{kg} = 8\ \text{kg}, h = 5\text{m}$

$P = \frac{mgh}{t}$

$= \frac{8 \times 10 \times 5}{10} = 40\ \text{W}$

36 **(c)**

Work done = Gain in potential energy

Area under curve $= mgh$

$\Rightarrow \frac{1}{2} \times 11 \times 100 = 5 \times 10 \times h \Rightarrow h = 11m$

37 **(d)**

$U = \frac{1}{2}kx^2$ If x becomes 5 times then energy will becomes 25 times $i.e.\ 4 \times 25 = 100\ J$

38 **(c)**

The momentum of the two-particle system, at $t = 0$ is

$\vec{P}_i = m_1\vec{v}_1 + m_2\vec{v}_2$

Collision between the two does not affect the total momentum of the system

A constant external force $(m_1 + m_2)g$ acts on the system

The impulse given by this force, in time $t = 0$ to $t = 2t_0$

is $(m_1 + m_2)g \times 2t_0$

∴ Change in momentum in this interval

$= |m_1\vec{v}'_1 + m_2\vec{v}'_2 - (m_1\vec{v}_1 + m_2\vec{v}_2)|$

$= 2(m_1 + m_2)gt_0$

39 **(c)**

Potential energy of a body = 75% of 12 J

$mgh = 9\ J \Rightarrow h = \frac{9}{1 \times 10} = 0.9\ m$

Now when this mass allow to fall then it acquire velocity

$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 0.9} = \sqrt{18}\ m/s$

40 **(d)**

By the conservation of momentum

$40 \times 10 + (40) \times (-7) = 80 \times v$

$\Rightarrow v = 1.5\ m/s$

41 **(c)**

$P = \frac{mgh}{t} = 10 \times 10^3 \Rightarrow t = \frac{200 \times 40 \times 10}{10 \times 10^3}$

$= 8\ sec$

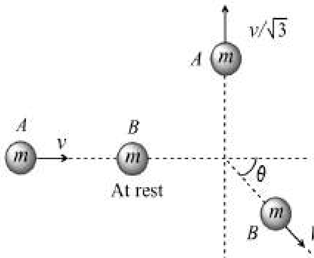
42 **(a)**

From the formulae $v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1$

We get $v = \left(\frac{M - m}{M + m}\right)u$

43 **(a)**

Let mass A moves with velocity v and collides inelastically with mass B, which is at rest



According to problem mass A moves in a perpendicular direction and let the mass B moves at angle θ with the horizontal with velocity v

Initial horizontal momentum of system (before collision) $= mv$ ....(i)

Final horizontal momentum of system (after collision) $= mV\cos\theta$ ....(ii)

From the conservation of horizontal linear momentum

$mv = mV\cos\theta \Rightarrow v = V\cos\theta$ ...(iii)

Initial vertical momentum of system (before collision) is zero

Final vertical momentum of system $\frac{mv}{\sqrt{3}} - mV\sin\theta$

From the conservation of vertical linear momentum

$\frac{mv}{\sqrt{3}} - mV\sin\theta = 0 \Rightarrow \frac{v}{\sqrt{3}} = V\sin\theta$ ...(iv)

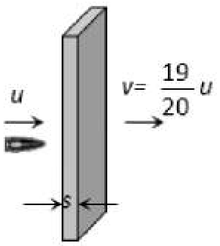
By solving (iii) and (iv)

$v^2 + \frac{v^2}{3} = V^2(\sin^2\theta + \cos^2\theta)$

$\Rightarrow \frac{4v^2}{3} = V^2 \Rightarrow V = \frac{2}{\sqrt{3}}v$

44 **(c)**

Let the thickness of one plank be s



If bullet enters with velocity u then it leaves with velocity

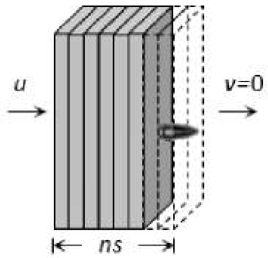
$v=\left(u-\frac{u}{20}\right)=\frac{19}{20}u$

From $v^2=u^2-2as$

$\Rightarrow\left(\frac{19}{20}u\right)^2=u^2-2as\Rightarrow\frac{400}{39}=\frac{u^2}{2as}$

Now if the n planks are arranged just to stop the bullet then again from

$v^2=u^2-2as$



$0=u^2-2ans$

$\Rightarrow n=\frac{u^2}{2as}=\frac{400}{39}$

$\Rightarrow n=10.25$

As the planks are more than 10 so we can consider $n=11$

45 **(d)**

$F=\frac{-dU}{dx}\Rightarrow dU=-F\,dx$

$\Rightarrow U=-\int_0^x(-Kx+ax^3)dx=\frac{kx^2}{2}-\frac{ax^4}{4}$

$\therefore$ We get $U=0$ at $x=0$ and $x=\sqrt{2k/a}$

And also $U=$ negative for $x>\sqrt{2k/a}$

So $F=0$ at $x=0$

$i.e.$ slope of $U-x$ graph is zero at $x=0$

46 **(b)**

Here $a_c=\frac{v^2}{r}=k^2rt\quad\because v=krt$

$\therefore\ v=krt$

The integral acceleration is $a_t=\frac{dv}{dt}=\frac{d(krt)}{dt}=kr$

The work done by centripetal force will be zero

So power is delivered to the particle by only tangential force which acts in the same direction of instantaneous velocity

$\therefore$ Power $=F_yv=ma_tkrt=m(kr)(krt)$

$=mk^2r^2t$

47 **(c)**

$F=\frac{3}{10}mg$

$W=-F\,s$ or $W=-\frac{3}{10}mgs$

or $W=-\frac{3}{10}\times200\times10\text{ J}=-600\text{ J}$

48 **(a)**

Work done by the net force = change in kinetic energy of the particle

49 **(c)**

$U=\frac{1}{2}K(x_2^2-x_1^2)\Rightarrow U=\frac{1}{2}K(3^2-0)\Rightarrow U$

$=4.5\,K$

50 **(b)**

Work done is given by

$F\cdot s=(2\hat{\imath}+4\hat{\jmath})\cdot(3\hat{\jmath}+5\hat{k})$

=12j

Now, power=$\frac{work}{time}=\frac{12}{2}=6w$

51 **(b)**

Kinetic energy acquired by the body

= Force applied on it × distance covered by the body

K.E. $=F\times d$

If F and d both are same then K. E. acquired by the body will be same

52 **(b)**

$W_1=\frac{1}{2}kx_1^2=\frac{1\times5}{2}\times10^3\times(5\times10^{-2})^2=6.25\text{ J}$

$W_2=\frac{1}{2}k(x_1+x_2)^2$

$=\frac{1}{2}\times5\times10^3(5\times10^{-2}+5\times10^{-2})^2=25\text{ J}$

Net work done $=W_2-W_1$

$=25-6.25=18.75\text{ J}=18.75\text{ N}-\text{m}$

53 **(b)**

Minimum force $mg\sin\theta$, so, minimum power is given by

$P=mg\sin\theta\,v$ or $v=\frac{P}{mg\sin\theta}$

or $v=\frac{9000\times2}{1200\times10\times1}\text{ms}^{-1}=15\text{ms}^{-1}$

$=15\times\frac{18}{5}=54\text{ kmh}^{-1}$

54 **(d)**

From law of conservation of linear momentum

Total final momentum =Total initial momentum

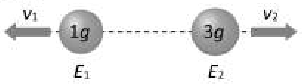
$m_1v_1+m_2v_2=0$

Here, $m_1=m_2$

So, $v_1=-v_2$

So, both parts will move with same speed in opposite directions.

55 **(c)**



As the momentum of both fragments are equal therefore

$\frac{E_1}{E_2} = \frac{m_2}{m_1} = \frac{3}{1}$ *i.e.*, $E_1 = 3E_2$ ...(i)

According to problem $E_1 + E_2 = 6.4 \times 10^4\, J$ ...(ii)

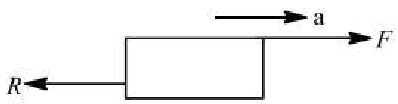
By solving equation (i) and (ii), we get

$E_1 = 4.8 \times 10^4\, J$ and $E_2 = 1.6\, \times 10^4\, J$

56 **(c)**

From the diagram

$F - R = ma$



or $F = R + ma$

Or Rate of doing work=power

$=F\cdot v$

$=(R+ma)\cdot v$

57 **(c)**

$P = \frac{mgh}{t} \Rightarrow \frac{P_1}{P_2} = \frac{m_1}{m_2} \times \frac{t_2}{t_1}$ [As h = constant]

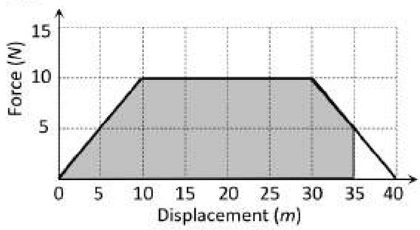
$\therefore \frac{P_1}{P_2} = \frac{60}{50} \times \frac{11}{12} = \frac{11}{10}$

58 **(b)**

$\text{Power} = \frac{\text{Work done}}{\text{time}} = \frac{\text{Increase in K.E.}}{\text{time}}$

$P = \frac{\frac{1}{2}mv^2}{t} = \frac{\frac{1}{2} \times 10^3 \times (15)^2}{5} = 22500\, W$

60 **(c)**



Work done = (Shaded area under the graph between

$x = 0$ to $x = 35\, m$) $= 287.5\, J$

61 **(c)**

From work-energy theorem

Δ KE $= W_{\text{net}}$

or $K_f - K_i = \int Pd$

or $\frac{1}{2}mv^2 = \int_0^2 \left(\frac{3}{2}t^2\right) dt$

$v^2 = \left[\frac{t^3}{2}\right]_0^2$

$v = 2\ \text{ms}^{-1}$

62 **(b)**

$P = \sqrt{2mE}$ if E are equal then $P \propto \sqrt{m}$

i.e., heavier body will possess greater momentum

63 **(b)**

$v = 36\, km/h = 10\, m/s$

By law of conservation of momentum

$2 \times 10 = (2+3)V \Rightarrow V = 4\, m/s$

Loss on K.E. $= \frac{1}{2} \times 2 \times (10)^2 - \frac{1}{2} \times 5 \times (4)^2 = 60\, J$

64 **(d)**

$E = \frac{P^2}{2m} \Rightarrow E_2 = E_1 \left(\frac{P_2}{P_1}\right)^2 = E_1 \left(\frac{2P}{P}\right)^2$

$\Rightarrow E_2 = 4E_1 = E_1 + 3E_1 = E + 300\%$ of E

65 **(d)**

Here $k = \frac{F}{x} = \frac{10}{1 \times 10^{-3}} = 10^4\, N/m$

$W = \frac{1}{2}kx^2 = \frac{1}{2} \times 10^4 \times (40 \times 10^{-3})^2 = 8J$

66 **(b)**

Given m= 5g = 0.005kg, h=19.5m,

$x = 50cm = 0.5m,\ \ v = 10ms^{-1}, g = 10ms^{-2}$

The change in mechanical energy

$\Delta U = mg(h + x) + \frac{1}{2}mv^2$

$= 0.005 \times 10(19.5 + 0.5) + \frac{1}{2} \times 0.005 \times (10)^2$

$=0.005 \times 10 \times 20 + \frac{1}{2} \times 0.005 \times 100$

$= 1 + 0.25 = 1.25j$

67 **(b)**

$m_1v_1 + m_2v_2 = (m_1 + m_2)v_{\text{sys.}}$

$20 \times 10 + 5 \times 0 = (20 + 5)v_{\text{sys.}} \Rightarrow v_{\text{sys.}} = 8\, m/s$

K. E. of composite mass $= \frac{1}{2}\ (20 + 5) \times (8)^2 =$ $800\, J$

68 **(a)**

$P = \left(\frac{m}{t}\right) gh = 100 \times 10 \times 100 = 10^5 W$

$= 100\, kW$

69 **(a)**

Momentum would be maximum when KE would be maximum and this is the case when total elastic PE is converted KE.

According to conservation of energy

$\frac{1}{2}kL^2 = \frac{1}{2}Mv^2$

Or $kL^2 = \frac{(Mv)^2}{M}$

$MKL^2 = p^2$ $(p = Mv)$

$\therefore p = L\sqrt{MK}$

70 **(c)**

Initially potential energy $= \frac{1}{2}kx^2$

$\Rightarrow\ U = \frac{1}{2}kx^2$

or $2U = kx^2 \Rightarrow k = \frac{2U}{x^2}$

When it is stretched to nx cm, then

$$PE = \frac{1}{2}kx_1^2 = \frac{1}{2} \times \frac{2U}{x^2} \times n^2x^2 = n^2U$$

$\therefore$ Potential energy stored in the spring $= n^2U$

71 **(c)**

$\vec{F} = 3x^2\hat{\imath} + 4\hat{\jmath}, \vec{r} = x\hat{\imath} + y\hat{\jmath}$

$\therefore d\vec{r} = dx\hat{\imath} + dy\hat{\jmath}$

Work done, $W = \int \vec{F}.d\vec{r} = \int_{(2,3)}^{(3,0)}(3x^2\hat{\imath} + 4\hat{\jmath}).(dx\hat{\imath} + dy\hat{\jmath})$

$$= \int_{(2,3)}^{(3,0)}(3x^2dx + 4dy) = [x^3 + 4y]_{(2,3)}^{(3,0)}$$

$= 3^3 + 4 \times 0 - (2^3 + 4 \times 3)$

$= 27 + 0 - (8 + 12) = 27 - 20 = +7J$

According to work energy theorem

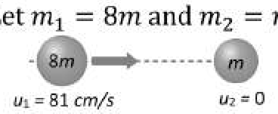
Change in the kinetic energy = Work done, $W = +7J$

72 **(c)**

Radio in radius of steel balls = 1/2

So, ratio in the masses $= \frac{1}{8}$ [As $M \propto V \propto r^3$]

Let $m_1 = 8m$ and $m_2 = m$



$$v_2 = \frac{2m_1u_1}{m_1 + m_2} = \frac{2 \times 8m \times 81}{8m + m} = 144\ cm/s$$

73 **(b)**

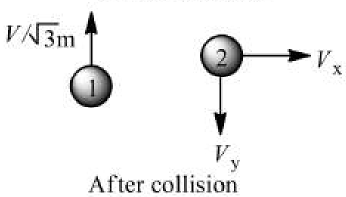
Work done does not depend on time

74 **(c)**

In x-direction

$mu_1 + 0 = 0 + mv_x$

Before collision



After collision

Or $mv = mv_x$

Or $v_x = v$

In y-direction

$$0 + 0 = m\left(\frac{v}{\sqrt{3}}\right) - mv_y$$

Or $v_y = \frac{v}{\sqrt{3}}$

$\therefore$velocity of second mass after collision

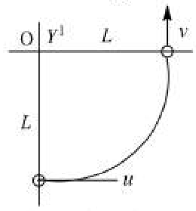
$$v' = \sqrt{\left(\frac{v}{\sqrt{3}}\right)^2 + v^2} = \sqrt{\frac{4}{3}v^2}$$

$$\therefore \quad v' = \frac{2}{\sqrt{3}}v$$

75 **(d)**

In this case motion of stone is in vertical circle of radius L and centre at O

The change in velocity is



$\Delta\vec{\mathbf{v}} = \vec{\mathbf{v}} - \vec{\mathbf{u}} = v\hat{\mathbf{j}} - u\hat{\mathbf{i}}$

$|\Delta\vec{\mathbf{v}}| = \sqrt{(v)^2 + (-u)^2}$

$\therefore = \sqrt{v^2 + u^2}$

According to work-energy theorem,

$W = \Delta K$

or $W_T + W_g = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$ ...(i)

W_T = work done by the force of tension = 0

W_g = work done by the fore of gravity

$= mgL$ (path independent)

From Eq. (i), $0 - mgL = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

$\because \quad v^2 = u^2 - 2gL$

$\therefore \quad |\Delta\vec{\mathbf{v}}| = \sqrt{v^2 + u^2} = \sqrt{2(u^2 - gL)}$

76 **(b)**

Gravitational force is a conservative force and work done against it is a point function *i.e.* does not depend on the path

77 **(d)**

As the speed of mass is uniform hence, net power will be zero.

78 **(d)**

If there is no air drag then maximum height

$$H = \frac{u^2}{2g} = \frac{14 \times 14}{2 \times 9.8} = 10\ m$$

But due to air drag ball reaches up to height $8m$ only. So loss in energy

$= mg(10 - 8) = 0.5 \times 9.8 \times 2 = 9.8\ J$

79 **(c)**

Power $= \frac{W}{t}$ If W is constant then $P \propto \frac{1}{t}$

$i.e. \frac{P_1}{P_2} = \frac{t_2}{t_1} = \frac{20}{10} = \frac{2}{1}$

80 **(b)**

Given ,m=2kg,v=$3ms^{-1}$, $K = 144Nm^{-1}$

Let spring is compressed by a length x.

$$ie \frac{1}{2}mv^2 = \frac{1}{2}kx^2$$

$\therefore \quad \frac{1}{2} \times 2 \times (3)^2 = \frac{1}{2} \times 144 \times x^2$

Or $\quad 9 = 72x^2$

Or $\quad x = \sqrt{\frac{9}{72}} = \frac{1}{2\sqrt{2}} m$

Hence, length of compressed spring

$= 2 - \frac{1}{2\sqrt{2}}$

$= \frac{4\sqrt{2} - 1}{2\sqrt{2}} = 1.5\text{m}$

81 **(a)**

$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) u_1 + \left(\frac{2m_2}{m_1 + m_2}\right) u_2$ and

$v_2 = \left(\frac{2m_1}{m_1 + m_2}\right) u_1 + \left(\frac{m_2 - m_1}{m_1 + m_2}\right) u_2$

On putting the values $v_1 = 6\ m/s$ and $v_2 = 12\ m/s$

82 **(a)**

The heat required for producing $1g$ of steam = $540\ cal$

$= 540 \times 4.2\ J = 2268\ J$

Energy given by immersion heater is

$= 1.08\ kW = 1080W$

Now time taken to produce $100g$ of steam

$= \frac{2268 \times 100}{1080} = 210\ sec$

83 **(a)**

Given, pressure=$20000 Nm^{-2}$

Volume=$1cc = 10^{-6}\ m^3$

∵Power=pressure×volume per second

$\therefore\ Power = 20000 \times 10^{-6}$

$p = 0.02\ w$

84 **(b)**

$v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 0.1} = \sqrt{1.96} = 1.4\ m/s$

85 **(a)**

Initial KE of the system is zero, as both bullet and solid block are at rest .Final KE of the system increases.

Hence, in this process only momentum is conserved.

86 **(b)**

$P = 3t^2 - 2t + 1 = \frac{dE}{dt}$

$\therefore\ dE = (3t^2 - 2t + 1)dt$

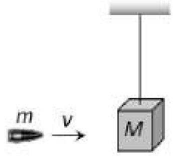
$E = \int_{t=2s}^{t=4s} (3t^2 - 2t + 1)dt$

$= \left[\frac{3t^3}{3} - \frac{2t^2}{2} + t\right]_{t=2s}^{t=4s}$

$= [(4^3 - 2^3) - (4^2 - 2^2) + (4 - 2)]$

$E = 56 - 12 + 2 = 46\ \text{J}$

87 **(d)**



Initial momentum = mv

Final momentum = $(m + M)V$

By conservation of momentum $mv = (m + M)V$

$\therefore$ Velocity of (bag + bullet) system $V = \frac{mv}{M+m}$

$\therefore$ Kinetic energy = $\frac{1}{2}\ (m + M)V^2$

$= \frac{1}{2}(m + M)\left(\frac{mv}{M + m}\right)^2 = \frac{1}{2}\frac{m^2v^2}{M + m}$

88 **(d)**

Watt and *Horsepower* are the units of power

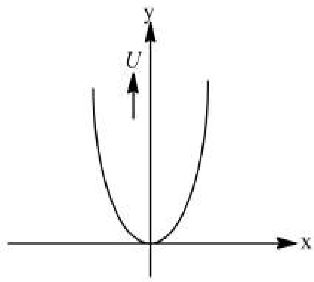
89 **(c)**

The variation of potential energy(U)

With distance(x)is

$U = \frac{1}{2}kx^2$

Hence, parabolic graph is obtained.



90 **(b)**

Work done = Area enclosed by $F - x$ graph

$= \frac{1}{2} \times (3 + 6) \times 3 = 13.5\ J$

93 **(d)**

Work done = $F \times s = ma \times \frac{1}{2}at^2$ $\left[\text{from } s = ut + \frac{1}{2}at^2\right]$

$\therefore W = \frac{1}{2}ma^2t^2 = \frac{1}{2}m\left(\frac{v}{t_1}\right)^2 t^2 \left[\text{As } a = \frac{v}{t_1}\right]$

94 **(c)**

Potential energy $U = \frac{1}{2}kx^2$

$\therefore U \propto x^2$ [If k = constant]

If elongation made 4 times then potential energy will become 16 times

95 **(b)**

If target is at rest then final velocity of bodies are

$v_1 = \left(\frac{m_1-m_2}{m_1+m_2}\right) u_1$ ...(i) and $v_2 = \frac{2m_1u_1}{m_1+m_2}$ ...(ii)

From (i) and (ii) $\frac{v_1}{v_2} = \frac{m_1-m_2}{2m_1} = \frac{2}{5} \Rightarrow \frac{m_1}{m_2} = 5$

97 **(d)**

Given, $\frac{dK}{dt} = constant$

$K \propto t$

$v \propto \sqrt{t}$

$P = Fv = \frac{dK}{dt} = constant$

$F \propto \frac{1}{v}$

$F \propto \frac{1}{\sqrt{t}}$

99 **(d)**

$h_n = he^{2n}$, if $n = 2$ then $h_2 = he^4$

100 **(a)**

$U = \frac{F^2}{2k} = \frac{T^2}{2k}$

101 **(a)**

Energy supplied to liquid per second by the pump

$= \frac{1}{2}\frac{mv^2}{t} = \frac{1}{2}\frac{V\rho v^2}{t} = \frac{1}{2}A \times \left(\frac{l}{t}\right) \times \rho \times v^2 \left[\frac{l}{t} = v\right]$

$= \frac{1}{2}A \times v \times \rho \times v^2 = \frac{1}{2}\ A\rho v^3$

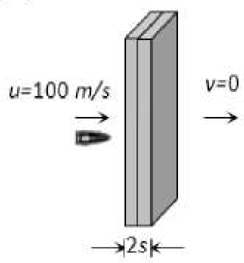
102 **(c)**

$P = \sqrt{2mE}$ it is clear that $P \propto \sqrt{E}$

So the graph between P and $\sqrt{E}$ will be straight line

But graph between $\frac{1}{P}$ and $\sqrt{E}$ will be hyperbola

103 **(b)**



Let the thickness of each plank is s. If the initial speed of bullet is 100 m/s then it stops by covering a distance $2s$

By applying $v^2 = u^2 - 2as \Rightarrow 0 = u^2 - 2as$

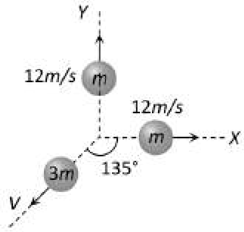
$s = \frac{u^2}{2a}$ $s \propto u^2$ [If retardation is constant]

If the speed of the bullet is doubled then bullet will cover four times distance before coming to rest

$i.e.\ s_2 = 4(s_1) = 4(2s) \Rightarrow s_2 = 8s$

So number of planks required = 8

104 **(d)**



The momentum of third part will be equal and opposite to the resultant of momentum of rest two equal parts let V is the velocity of third part

By the conservation of linear momentum

$3m \times V = m \times 12\sqrt{2}$

$\Rightarrow V = 4\sqrt{2}\ m/s$

105 **(a)**

Given, $K = as^2$ or $\frac{1}{2}mv^2 = as^2$

or $mv^2 = 2as$

Differentiating w.r.t. time t,

$m.(2v).\left(\frac{dv}{dt}\right) = (2a)(2s)\left(\frac{ds}{dt}\right)$

$\therefore \frac{ds}{dt} = v$

$\therefore\ 2m\frac{dv}{dt} = 4as \Rightarrow m\frac{dv}{dt} = 2as$

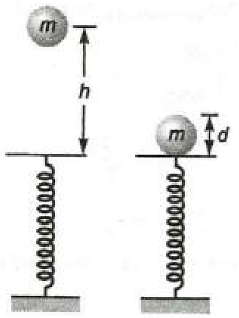
or $F_t = 2as$

$F = \sqrt{F_t^2 + F_r^2}$ $(\because F_r = 0)$

$F = F_t = 2as$

106 **(b)**

Situation is shown in figure. When mass m falls vertically on spring, then spring is compressed by distance d.



Hence, net work done in the process is

W=Potential energy stored in the spring

+Loss of potential energy of mass

$= mg(h+d) - \frac{1}{2}kd^2$

107 **(d)**

Kinetic energy for first condition

$= \frac{1}{2}m(v_2^2 - v_1^2) = \frac{1}{2}m(20^2 - 10^2) = 150\ mJ$

K.E. for second condition $= \frac{1}{2}m(10^2 - 0^2) =$
$50mJ$

$$\therefore \frac{(K.E.)I}{(K.E.)II} = \frac{150m}{50m} = 3$$

108 **(a)**

For first condition

Initial velocity $= u$, final velocity $= u/2, s = 3\ cm$

From $v^2 = u^2 - 2as \Rightarrow \left(\frac{u}{2}\right)^2 = u^2 - 2as \Rightarrow a = \frac{3u^2}{8s}$

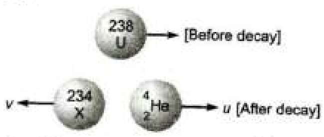
Second condition

Initial velocity $= u/2$, Final velocity $= 0$

From $v^2 = u^2 - 2ax \Rightarrow 0 = \frac{u^2}{4} - 2ax$

$$\therefore x = \frac{u^2}{4 \times 2a} = \frac{u^2 \times 8s}{4 \times 2 \times 3u^2} = s/3 = 1cm$$

109 **(c)**



Apply conservation of linear momentum.

$0 = 4u - 234v$

$$\Rightarrow v = \frac{4u}{234}$$

The residual nucleus will recoil with a velocity of $\frac{4u}{234}$ unit.

Recoil speed of residual nucleus is $\frac{4u}{234}$

110 **(c)**

Initial momentum of the system $= m_1 \times 40 + m_2 \times 0$

Final momentum of the system $= (m_1 + m_2) \times 30$

By the law of conservation of momentum

$m_1 \times 40 + m_2 \times 0 = (m_1 + m_2) \times 30$

$$\Rightarrow 40m_1 = 30m_1 + 30m_2 \Rightarrow 10m_1 = 30m_2 = \frac{m_1}{m_2} = 3$$

111 **(c)**

Let mass of boy be m. Therefore, mass of man $= 2\ m$, as

KE of man $= \frac{1}{2}$ KE of boy

$$\therefore \frac{1}{2}(2m)u^2 = \frac{1}{2} \times \frac{1}{2}mu'^2$$

$$u^2 = \frac{u'^2}{4}, u = \frac{u'}{2}$$

When man speeds up to $1\ \text{ms}^{-1}$,

KE of man = KE of boy

$$\frac{1}{2}(2m)(u+1)^2 = \frac{1}{2}mu'^2 = \frac{1}{2}m(2u)^2$$

$(u+1)^2 = 2u^2$

$u + 1 = \sqrt{2}u$

$$u = \frac{1}{\sqrt{2}-1} = \frac{\sqrt{2}+1}{(\sqrt{2}-1)(\sqrt{2}+1)}$$

$u = (\sqrt{2}+1)\text{ms}^{-1}$

$u' = 2u = 2(\sqrt{2}+1)\text{ms}^{-1}$

112 **(c)**

Initial height of CG$= \frac{a}{2}$

Final height of CG $= \frac{b}{2}$

Work done$= mg\left[\frac{b}{2} - \frac{a}{2}\right] = mg\left(\frac{b-a}{2}\right)$

113 **(d)**

Friction is a non-conservative force

114 **(b)**

Work done $= mgh = 10 \times 9.8 \times 1 = 98\ J$

115 **(c)**

Average velocity $= \frac{100}{10} = 10\ m/s$

$$\text{K.E.} = \frac{1}{2}m \times v^2 = \frac{1}{2}m \times (10)^2$$

If $m = 40\ kg$, then $K.E. = 2000\ J$. If $m = 100kg$, then $K.E. = 5000\ J$

So range will be $2000J - 5000J$

117 **(b)**

$$W \int_0^{x_1} F.dx = \int_0^{x_1} Cx\ dx = C\left[\frac{x^2}{2}\right]_0^{x_1} = \frac{1}{2}Cx_1^2$$

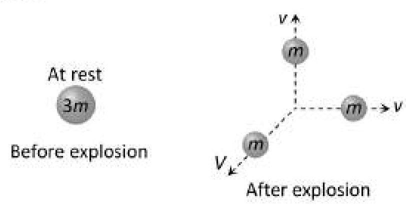
118 **(a)**

The kinetic energy of mass is converted into potential energy of a spring

$$\frac{1}{2}mv^2 = \frac{1}{2}kx^2 \Rightarrow x = \sqrt{\frac{mv^2}{k}} = \sqrt{\frac{0.5 \times (1.5)^2}{50}}$$

$$= 0.15\ m$$

119 **(c)**



Initial momentum of $3m$ mass $= 0$ ...(i)

Due to explosion this mass splits into three fragments of equal masses

Final momentum of system $= m\vec{V} + mv\hat{i} + mv\hat{j}$ ...(ii)

By the law of conservation of linear momentum

$m\vec{V} + mv\hat{\imath} + mv\hat{\jmath} = 0 \Rightarrow \vec{V} = -v(\hat{\imath} + \hat{\jmath})$

120 **(b)**

The work is stored as the PE of the body and is given by,

$$U = \int_{x_1}^{x_2} F_{ext}\, dx$$

or $U = \int_{x_1}^{x_2} kx\, dx$

$= \frac{1}{2}k(x_2^2 - x_1^2)$

$= \frac{800}{2}[(0.15)^2 - (0.05)^2]$

$[0.02 - 0.002][\because k = 800\text{Ns}^{-1}]$

$= 400 \times [0.2 \times 0.1]$

$= 8\text{ J}$

121 **(d)**

Total mass $= (50 + 20) = 70\ kg$

Total height $= 20 \times 0.25 = 5m$

$\therefore$ Work done $= mgh = 70 \times 9.8 \times 5 = 3430\ J$

122 **(c)**

$W = Fs\cos\theta$

or $\cos\theta = \frac{W}{Fs} = \frac{25}{10\times5} = \frac{1}{2}$ or $\theta = 60°$

123 **(b)**

Momentum and kinetic energy is conserved only in this case

124 **(d)**

$$P = \frac{mgh}{t} \Rightarrow m = \frac{p \times t}{gh} = \frac{2 \times 10^3 \times 60}{10 \times 10}$$

$= 1200\ kg$

As volume $= \frac{\text{mass}}{\text{density}} \Rightarrow v = \frac{1200kg}{10^3 kg/m^3} = 1.2m^3$

Volume $= 1.2m^3 = 1.2 \times 10^3\ litre = 1200 litre$

125 **(a)**

$E = \frac{P^2}{2m}$ if $P =$ constant then $E \propto \frac{1}{m}$

126 **(a)**

The bomb of mass $12kg$ divides into two masses m_1 and m_2 then $m_1 + m_2 = 12$ ...(i)

And $\frac{m_1}{m_2} = \frac{1}{3}$ ...(ii)

By solving we get $m_1 = 3kg$ and $m_2 = 9kg$

Kinetic energy of smaller part $= \frac{1}{2}m_1 v_1^2 = 216\ J$

$\therefore\ v_1^2 = \frac{216 \times 2}{3} \Rightarrow v_1 = 12\ m/s$

So its momentum $= m_1 v_1 = 3 \times 12 = 36\ kg - m/s$

As both parts possess same momentum therefore momentum of each part is $36\ kg - m/s$

127 **(b)**

$m_1u_1 + m_2u_2 = (m_1 + m_2)v$

$\therefore\quad 10 \times u_1 + 5 \times 0 = (10 + 5) \times 4$

Or $\quad u_1 = \frac{15\times4}{10} = 6ms^{-1}$

128 **(c)**

When block of mass M collides with the spring its kinetic energy gets converted into elastic potential energy of the spring

From the law of conservation of energy

$$\frac{1}{2}Mv^2 = \frac{1}{2}KL^2 \ \therefore v = \sqrt{\frac{K}{M}}L$$

Where v is the velocity of block by which it collides with spring. So, its maximum momentum

$$P = Mv = M\sqrt{\frac{K}{M}}L = \sqrt{MK}L$$

After collision the block will rebound with same linear momentum

129 **(a)**

We know that $P = F \times v = F \times \frac{L}{T}$

As $F = [\text{MLT}^{-2}] =$ constant

$\therefore\ L \propto T^2$

$\therefore\ P = F \times \frac{L}{T} = F \times \frac{T^2}{T} = F \times T$

or $P \propto T$

Choice (a) is correct

130 **(c)**

$$1400 \times 10 \times 10 + W = \frac{1}{2} \times 15 \times 15$$

or $W = 700 \times 15 \times 15 - 1400 \times 10 \times 10$

or $W = 700(225 - 200)$ J

or $W = 700 \times 25$ J $= 75.5$ kJ

131 **(b)**

Potential energy of spring $= \frac{1}{2}Kx^2$

$\therefore PE \propto x^2 \Rightarrow PE \propto a^2$

132 **(c)**

KE$= \frac{1}{2}mv^2 = \frac{1}{2}m(at)^2 = \frac{1}{2}ma^2t^2$

Rate of change of KE,

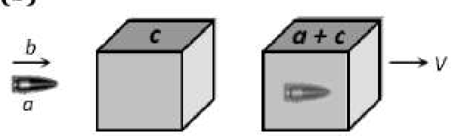
$$\frac{dk}{dt} = \frac{d}{dt}\left(\frac{1}{2}ma^2t^2\right) = ma^2t$$

$\because\ \frac{dk}{dt} \propto t$

So, statement A is correct.

When the body is at rest then it may be or may not be in equilibrium, so statement B is wrong.

133 **(b)**



Initially bullet moves with velocity b and after collision bullet get embedded in block and both move together with common velocity

By the conservation of momentum

$\Rightarrow a \times b + 0 = (a + c)V \Rightarrow V = \dfrac{ab}{a + c}$

134 **(c)**

$P = Fv$ and $F \propto v$

$\therefore\ P \propto v^2; \dfrac{P_2}{P_1} = \dfrac{v_2^2}{v_1^2}$

or $\frac{P_2}{16} = \frac{3\times3}{2\times2} = \frac{9}{4}$

or $P_2 = 16\frac{9}{4}$ HP $=$ 36 HP

135 **(a)**

$P = E \Rightarrow mv = \dfrac{1}{2}\ mv^2 \Rightarrow v = 2\ m/s$

136 **(a)**

Work done $W = \int_0^x F.dx$

$= \int_0^x Cx\ dx = C\left(\dfrac{x^2}{2}\right)_0^x$

$= \dfrac{1}{2}Cx^2$

137 **(c)**

Friction is a non-conservative external force to the system, it decreases momentum and kinetic energy both

138 **(b)**

Let $v_M$is velocity of man,$v_B$of boy, then kinetic energy according to question ,

$ie\ K = \dfrac{1}{2}Mv_M^2 = \dfrac{1}{2}.\dfrac{M}{2}.v_B^2$

Or $v_M^2 = \frac{V_B^2}{2}$

Or $\sqrt{2}v_M = v_B$

When man speeds up 2 $ms^{-1}$and boy changes his speed by $x\ ms^{-1}$.Then ,

$\dfrac{1}{2}M(v_M + 2)^2 = \dfrac{1}{2}\cdot\dfrac{M}{2}\cdot(v_B + x)^2$

Or $(v_M + 2)^2 = \frac{(v_B+x)^2}{2}$

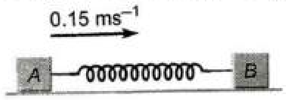
$2(v_M + 2)^2 = \left(\sqrt{2}v_M + x\right)^2 \quad (\because v_B = \sqrt{2}v_m)$

Or $\sqrt{2}(v_M + 2) = \sqrt{2}v_M + x$

Or $+2\sqrt{2} = x$

140 **(c)**

As the block A moves with velocity with velocity $0.15\ ms^{-1}$, it compresses the spring Which pushes B towards right. A goes on compressing the spring till the velocity acquired by B becomes equal to the velocity of A, i.e. $0.15\ \mathrm{ms}^{-1}$. Let this velocity be v. Now, spring is in a state of maximum compression. Let x be the maximum compression at this stage.



According to the law of conservation of linear momentum, we get

$m_A u = (m_A + m_B)v$

Or $v = \frac{m_A u}{m_A + m_B}$

$\dfrac{2 \times 0.15}{2 + 3} = 0.06ms^{-1}$

According to the law of conservation of energy

$\dfrac{1}{2}m_A u^2 = \dfrac{1}{2}(m_A + m_B)V^2 + \dfrac{1}{2}kx^2$

$\dfrac{1}{2}m_A u^2 - \dfrac{1}{2}(m_A + m_B)v^2 = \dfrac{1}{2}kx^2$

$\dfrac{1}{2}\times 2 \times (0.15)^2 - \dfrac{1}{2}(2 + 3)(0.06)^2 = \dfrac{1}{2}kx^2$

$0.0225 - 0.009 = \dfrac{1}{2}kx^2$

$or\ 0.0135 = \dfrac{1}{2}kx^2$

Or $x = \sqrt{\frac{0.0027}{k}} = \sqrt{\frac{0.0027}{10.8}} = 0.05m$

141 **(a)**

Percentage of energy loss

$= \frac{mg(2-1.5)}{mgh} \times 100$

$= \dfrac{mg(0.5)}{mg \times 2} \times 100$

=25%

142 **(a)**

$P = \dfrac{W}{t} = \dfrac{mgh}{t} = \dfrac{200 \times 10 \times 50}{10} = 10 \times 10^3 W$

143 **(c)**

Momentum of the third part will be equal to the resultant of momentum of two parts.

$p_3 = \sqrt{p_1^2 + p_2^2}$

$p_3 = \sqrt{(-2p)^2 + p^2}$

$p_3 = p\sqrt{5}$

144 **(c)**

Work done $W = mgh + \Delta pV$

$= Vpgh + \Delta pV$

Given $\quad V = 4\mathrm{m}^3, \mathrm{p} = 10^3\mathrm{kg}^{-2}, \mathrm{g} = 10\mathrm{ms}^{-2}$,

$\mathrm{h} = 20\mathrm{m}, \Delta\mathrm{p} = (2 \times 10^5 - 1 \times 10^5)\mathrm{Nm}^{-2}$

$W = 4 \times 10^3 \times 10 \times 20 + (2 \times 10^5 - 1 \times 10^5) \times 4$

$8 \times 10^5 + 4 \times 10^5 = 12 \times 10^5\mathrm{J}$

145 **(d)**

$P = \sqrt{2ME}$. If kinetic energy are equal then $P \propto \sqrt{m}$

i.e., heavier body posses large momentum

As $M_1 < M_2$ therefore $M_1V_1 < M_2V_2$

146 **(d)**

At a given height the half of the kinetic energy of the body is equal to its potential energy.

Initial kinetic energy of the body

$= \frac{1}{2}mv^2 = \frac{1}{2}m(4)^2 = 8m$

Let at height h, the kinetic energy reduces to half, *i.e.*, it becomes 4 m. It is also equal to potential energy.

Hence, $mgh = 4m$ or $h = \frac{4}{g} = \frac{4}{10} = 0.4\ m$

147 **(d)**

Due to elastic collision of bodies having equal mass, their velocities get interchanged

148 **(b)**

If W_1 = work done by applied force

W_2 = work done against friction then applying work energy theorem

$W_1 - W_2$ = PE +KE (at the top)

$F \times s - W_2 = mgh + \frac{1}{2}mv^2$

$100 \times 12 - W_2 = 50 \times 10 \times 2 + \frac{1}{2} \times 50 \times 2^2$

$1200 - W_2 = 1100$

$W_2 = 100$ J

149 **(c)**

$W = Fs\cos\theta \Rightarrow \cos\theta = \frac{W}{F_s} = \frac{25}{50} = \frac{1}{2} \Rightarrow \theta = 60°$

150 **(a)**

Kinetic energy, $= \frac{1}{2} \times 950 \times \left(100 \times \frac{5}{18}\right)^2$ J

$= 0.3665 \times 10^6$ J $= 0.367$ MJ

152 **(a)**

This is the case of work done by a variable force

$W = \int_0^5 (3x^2 - 2x + 7)dx$

$W = |x^3 + x^2 + 7x|_0^5$

or $W = (5 \times 5 \times 5 - 5 \times 5 + 7 \times 5)$

or $W = (125 - 25 + 35) = 135$ J

153 **(a)**

Both statements $A$and Bgiven in the system are true.

154 **(c)**

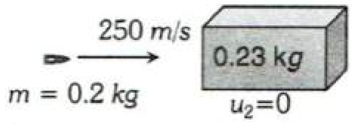
After impact the mass and block move together and come to rest after a distance of 40 m

By conservation of momentum,

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$0.02 \times 250 + 0.23 \times 0 = 0.02v + 0.23v$

$5 + 0 = v(0.25)$



$\frac{500}{25} = v = 20ms^{-1}$

Now, by conservation of energy,

$\frac{1}{2}Mv^2 = \mu R.d$

$\frac{1}{2} \times 0.25 \times 400 = \mu \times 0.25 \times 9.8 \times 40 \Rightarrow \mu = 0.51$

155 **(a)**

$\frac{1}{2}mv^2 - f_kx = \frac{1}{2}kx^2$

$\frac{1}{2} \times 2 \times 16 - 15x = \frac{1}{2} \times 10^4 \times x^2$

$\therefore x = 5.5\ cm$

156 **(c)**

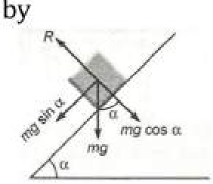
The explanation are given below

(i)If a body is moved up in inclined plane, then the work done against friction force is zero as there is no friction. But a work has to be done against the gravity. So, this statement is incorrect.

(ii)If there were no friction, moving vehicles could not be stopped by locking the brakes. Vehicles are stopped by air friction only.

So , This Statement is correct.

(iii) In this situation the normal reaction is given by

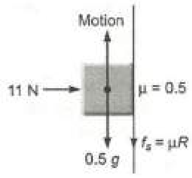


$R = mg\cos\alpha$ ... (i)

If α increase then the value of $\cos\alpha$ also decreases.

So, this Statement is incorrect.

(iv)When the duster is rubbing upward then an external force is applied and its value is



$F' = 0.5g + \mu R$

$\therefore\ F' = 0.5g + 0.5 \times 11$

Or $F' = (0.5 \times 10 + 5.5)$N (Here R=11 N)

Or $F' = 10.5$N

Hence, work done in rubbing the duster through a distance of 10 cm.

$W = F' \times d$

$\Rightarrow \quad W = 10.5 \times \frac{10}{100}\text{J}$

Or $F' = 10.5\text{J}$

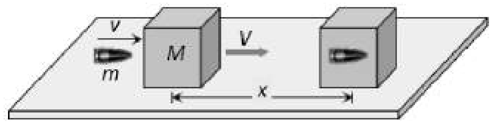
157 **(b)**

$W = Fs = F \times \frac{1}{2}at^2 \left[\text{from } s = ut + \frac{1}{2}at^2\right]$

$\Rightarrow W = F\left[\frac{1}{2}\left(\frac{F}{m}\right)t^2\right] = \frac{F^2t^2}{2m} = \frac{25 \times (1)^2}{2 \times 15} = \frac{25}{30}$

$= \frac{5}{6}J$

158 **(c)**



Let speed of the bullet $= v$

Speed of the system after the collision $= V$

By conservation of momentum $mv = (m + M)V$

$\Rightarrow V = \frac{mv}{M + m}$

So the initial K.E. acquired by the system

$= \frac{1}{2}(M + m)V^2 = \frac{1}{2}(m + M)\left(\frac{mv}{M + m}\right)^2$

$= \frac{1}{2}\frac{m^2v^2}{(m + M)}$

This kinetic energy goes against friction work done by friction $= \mu R \times x = \mu(m + M)g \times x$

By the law of conservation of energy

$\frac{1}{2}\frac{m^2v^2}{(m + M)} = \mu(m + M)g \times x \Rightarrow v^2$

$= 2\mu gx\left(\frac{m + M}{m}\right)^2$

$\therefore v = \sqrt{2\mu gx}\left(\frac{m + m}{m}\right)$

159 **(d)**

Here, the constant horizontal force required to take the body from position 1 to position 2 can be calculated by using work energy theorem. Let us assume that body taken slowly so that its speed doesn't change, then $\Delta K = 0$

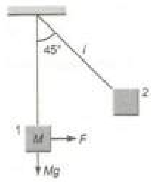
$= W_F + W_{Mg} + W_{\text{tension}}$

(symbols have their usual meanings)

$W_F = F \times l \sin 45°$,

$W_{Mg} = Mg(l - l\cos 45°), W_{\text{tension}} = 0$

$\therefore \ F = Mg(\sqrt{2} - 1)$



160 **(a)**

Kinetic energy$\left(\frac{1}{2}mv^2\right)$ will be maximum when rock reaches the ground. A heavy and light body when released from the same height reach the ground simultaneously and with same velocity

$v = \sqrt{2gh}$

$\therefore$ KE $\propto$ m

Therefore, kinetic energy will be twice that of the first rock.

162 **(a)**

Initial momentum $= mv$

Final momentum $= 2mV$

By the conservation of momentum, $mv = 2mV$

$\Rightarrow V = \frac{v}{2}$

K.E. of the system after the collision $= \frac{1}{2}(2m)\left(\frac{v}{2}\right)^2$

$\therefore$ loss in K.E. $= \frac{1}{2}mv^2 - \frac{1}{4}mv^2 = \frac{1}{4}mv^2$

This loss in K.E. will increase the temperature

$\therefore 2m \times s \times \Delta t = \frac{1}{4}mv^2 \Rightarrow \Delta t = \frac{v^2}{8s}$

163 **(a)**

Given, $r_1 = 2\hat{i} - 3\hat{j} - 4\hat{k}$

And $r_2 = 3\hat{i} - 4\hat{j} + 5\hat{k}$

Now, $r_2 - r_1 = \hat{i} - \hat{j} + 9\hat{k}$

And $F = 4\hat{i} + \hat{j} + 6\hat{k}$

$\therefore$ work done = F.r

$W = (4\hat{i} + \hat{j} + 6\hat{k}).(\hat{i} - \hat{j} + 9\hat{k})$

$= 4 - 1 + 54 = 57$ J

164 **(a)**

As surface is smooth so work done against friction is zero. Also the displacement and force of gravity are perpendicular so work done against gravity is zero

165 **(d)**

Power, $p = \frac{mgh}{t}$

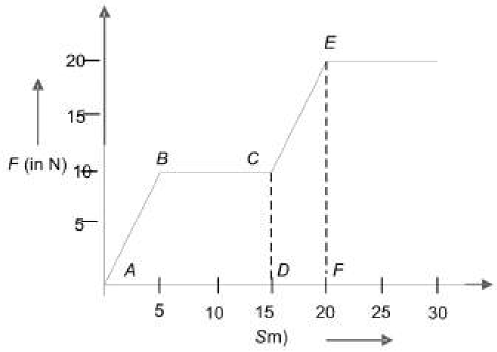
Or $\frac{m}{t}$ =mass of water fall per second

$= \frac{p}{gh} = \frac{1 \times 10^6}{10 \times 10} = 10^4 kgs^{-1}$

166 **(b)**

Work done W = Area $ABCEFDA$

= Area $ABCD$+Area $CEFD$



$=\frac{1}{2}\times(15+10)\times10+\frac{1}{2}\times(10+20)\times5$

$=125+75=200$J

167 **(c)**

As slope of problem graph is positive and constant upto certain distance and then it becomes zero

So from $F=\frac{-dU}{dx}$, up to distance a,

F = constant (negative) and becomes zero suddenly

169 **(b)**

The mass of the water flowing out per second

$m=Avp$ ...(i)

Where p=density of water

A=area of cross-section of pipe.

V= velocity of water

Rate of increase of kinetic energy

$=\frac{1}{2}mv^2=\frac{1}{2}(Avp)v^2$ ...(ii)

Mass m, flowing out per second, can be increasing to m' by increasing v to v', then power increase from P to P'.

$\frac{P'}{P}=\frac{\frac{1}{2}A'pV'^3}{\frac{1}{2}Apv^3}$ or $\frac{P'}{P}=\left(\frac{v'}{v}\right)^3$

Now, $\frac{m'}{m}=\frac{Apv'}{Apv}=\frac{v'}{v}$

As, $m'=nm, v'=nv$

$\therefore$ $\frac{P'}{P}=n^3 \Rightarrow P'=n^3P$

170 **(c)**

Initial momentum $=mv$

Final momentum $=3mV$

By the law of conservation of momentum $mv=3mV$

$\therefore V=v/3$

171 **(b)**

$P=\frac{dW}{dt}=P\frac{dv}{dt}$

$P=h\,d\,g=10\times13.6\times980$

$=1.3328\times10^5$ dyne/cm^2

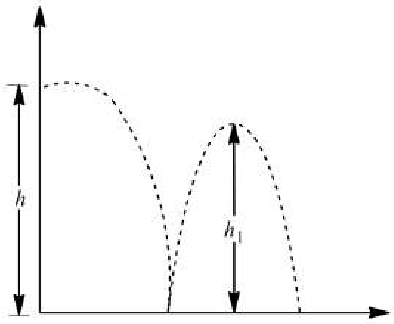
$\frac{dv}{dt}$ = Pulse frequency × blood discharged per pulse

$\frac{dv}{dt}=\frac{72}{60}\times75=90$ cc/sec

$\therefore$ Power of heart $=1.3328\times10^5\times90$ erg/sec

$=1.19$ W

172 **(b)**



Total distance travelled by the ball before its second hit is

$H=h+2h_1$

$=h[1+2e^2]$ $(\because h_1=he^2)$

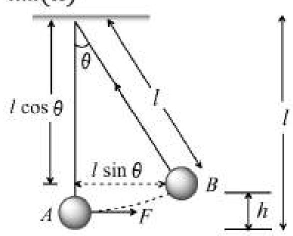
173 **(c)**

Work done by horizontal force

$W=F\times S=F\times l\sin\theta$ ....(i)

Increment in potential energy of mass M is

$U=Mgh=Mg(l-l\cos\theta)=Mgl(1-\cos\theta)$ .....(ii)



From equation (i) and (ii)

$Fl\sin\theta=Mgl(1-\cos\theta)$

$\Rightarrow Fl\frac{1}{\sqrt{2}}=Mgl\left(1-\frac{1}{\sqrt{2}}\right)$ [As $\theta=45°$]

$\therefore F=Mg(\sqrt{2}-1)$

174 **(d)**

$P=F\,v=(ma)v=m\left(\frac{d^2x}{dt^2}\right)\left(\frac{dx}{dt}\right)$

Since, power is constant

$\left(\frac{d^2x}{dt^2}\right)\left(\frac{dx}{dt}\right)=k$

or $\frac{d}{dt}\left(\frac{dx}{dt}\right)^2 = k$

$\left(\frac{dx}{dt}\right)^2 = k_1 t$

$\frac{dx}{dt} = \sqrt{k_1 t}$

$\frac{dx}{dt} = k_2(t)^{1/2} \quad (\therefore k_1^{1/2} = k_2)$

$x = k_3 t^{3/2} \ \left(\because k_3 = \frac{2}{3}k_2\right)$

Hence $\frac{dx}{dt} \propto t^{1/2} \propto x^{1/3}$

175 **(b)**

When target is very light and at rest then after head on elastic collision it moves with double speed of projectile *i. e.* the velocity of body of mass m will be $2v$

176 **(c)**

From work energy theorem, Δ KE $= W_{\text{net}}$

$K_f - K_i = \int P\, dt$

$\frac{1}{2}mv^2 - 0 = \int_0^2 \left(\frac{3}{2}t^2\right) dt$ or $\frac{1}{2}(2)v^2 = \frac{3}{2}\left[\frac{t^3}{3}\right]_0^2 = 4$

$v = 2\ \text{ms}^{-1}$

177 **(a)**

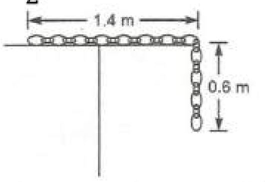
Work done = area between the graph and position axis

$W = 10 \times 1 + 20 \times 1 - 20 \times 1 + 10 \times 1 = 20\ erg$

178 **(b)**

Mass per unit length=$\frac{\text{M}}{\text{L}}$

$= \frac{4}{2} = 2\text{kgm}^{-1}$



The mass of 0.6 m of chain

$= 0.6 \times 2 = 1.2\text{kg}$

∴Center of mass of hanging part

$h = \frac{0.6 + 0}{2} = 0.3\text{m}$

Hence, work done in pulling the chain on the table =work done against gravity force

$W = mgh = 1.2 \times 10 \times 0.3 = 3.6\ \text{J}$

179 **(c)**

Opposing force in vertical pulling $= mg$

But opposing force on an inclined plane is $mg \sin\theta$, which is less than mg

180 **(d)**

Velocity of system $= \frac{mv}{m+M}$

KE of system $= \frac{1}{2}(M + m)\left(\frac{mv}{M+m}\right)^2$

$= \frac{m^2v^2}{2(M + m)}$

181 **(d)**

Because linear momentum is vector quantity where as kinetic energy is a scalar quantity

182 **(d)**

The rate of doing work by a train is called power.

Power=$\frac{work}{time}$

And work=force(F)×displacement(s)

Power=$F \times \frac{F\times s}{t}$

Or $P = F \times \frac{s}{t}$

Or $P = F \times v \qquad \left[\therefore v = \frac{s}{t}\right]$

183 **(d)**

In an inelastic collision, the particles do not regain their shape and size completely after collision. Some fraction of mechanical energy is retained by the colliding particles in the form of deformation potential energy .Thus the kinetic energy of particles no longer remains conserved .However, in the absence of external forces, law of conservation of linear momentum still holds good.

184 **(a)**

$W = \int_A^B F_x\ dx \Rightarrow W = \int_{x=4}^{k=-2} (-6x^3)\, dx$

$= -6\left[\frac{x^4}{4}\right]_{x=4}^{x=-2} = \left(\frac{-3}{2}\right)(-240) = 360\ J$

186 **(a)**

According t work-energy theorem,

Work done=change in rotational kinetic energy

$W = (\Delta\text{KE}_\text{r})_1 - (\Delta\text{KE}_\text{r})_2 \qquad$ ...(i)

But rotational Kinetic energy

$\text{K}=\frac{1}{2}I\omega^2$

From Eq.(i),We get

$W = \frac{1}{2}I\omega_1^2 - \frac{1}{2}I\omega_2^2$

$= \frac{1}{2}I(\omega_I^2 - \omega_2^2)$

As, $\omega = 2\pi\eta$

Hence, We get

$W = \frac{1}{2}I\ [\ (2\pi n_1)^2 - (2\pi n_2)^2\ ]$

$= \frac{1}{2} I \times 4\pi^2(n_1^2 - n_2^2)$ ……………..(ii)

Given $I = \frac{9.8}{\pi^2}$ kg − m²

$n_1 = 600\text{rpm} = 10\text{rps}$

$n_2 = 300\text{rpm} = 5\text{rps}$

From Eq.(ii),We get

$W = \frac{1}{2} \times \frac{9.8}{\pi^2} \times 4\pi^2(10^2 - 5^2) = 1467$ J

187 **(d)**

Centripetal acceleration

$\frac{v^2}{r} \propto r^{-2}$

Or $\frac{v^2}{r} = \frac{k}{r^2}$

Or $v^2 = \frac{k}{r}$

$\therefore \; KE = \frac{1}{2} mv^2$

$= \frac{1}{2} \frac{mk}{r}$

Or $KE \propto r^{-1}$

188 **(d)**

Both fragments will possess the equal linear momentum

$m_1v_1 = m_2v_2 \Rightarrow 1 \times 80 = 2 \times v_2 \Rightarrow v_2 = 40\ m/s$

$\therefore$ Total energy of system $= \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$

$= \frac{1}{2} \times 1 \times (80)^2 + \frac{1}{2} \times 2 \times (40)^2 = 4800\ J$

$= 4.8\ kJ$

189 **(a)**

Work = Area under $(F - d)$ graph

$= 8 + 5 = 13\ J$

190 **(d)**

$m = 6\text{kg}, \chi = \frac{t^2}{4}$

$\frac{dx}{dt} = v = \frac{t}{2}$

$v(0) = 0\ and\ v(2) = \frac{2}{2} = 1$

$\therefore k_i = \frac{1}{2} m(0)^2$

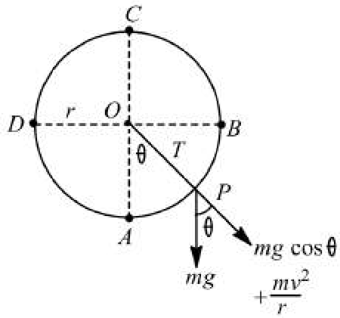
$and\ k_f = \frac{1}{2} m(1)^2 = \frac{1}{2} = \times 6 \times 1 = 3$

According to work-energy theorem

Work W= $K_f - k_i = 3 - 0 = 3$J

191 **(c)**

Net force towards centre=centripetal force



$T - mg\ cos\theta = \frac{mv^2}{r}$

At point C, θ = 180°

$T + mg = \frac{mv^2}{r}$

$\Rightarrow \qquad mg < \frac{mv^2}{r}$

192 **(a)**

$P = (mg \sin\theta + F)v$

$= \left(1000 \times 10 \times \frac{1}{20} + 200\right) \times 20$

$= 1400$ W $= 14$ kW

193 **(b)**

Work done,$W = \text{F} \cdot ds = (\text{F}_1 + \text{F}_2) \cdot (\text{s}_2 - \text{s}_1)$

$= \{(4\hat{i} + \hat{j} - 3\hat{k}) + (3\hat{i} + \hat{j} - \hat{k})\}$

$\{(5\hat{i} + 4\hat{j} + \hat{k}) - (\hat{i} + 2\hat{j} + 3\hat{k})\}$

$= (7\hat{i} + 2\hat{j} - 4\hat{k}).(4\hat{i} + 2\hat{j} - 2\hat{k})$

$= 28 + 4 + 8 = 40$ J

194 **(c)**

$v = \sqrt{(8)^2 + (6)^2} = 10\text{ms}^{-1}$

KE $= \frac{1}{2} mv^2$

$= \frac{1}{2} \times 0.4 \times 10 \times 10 = 20$ J

195 **(a)**

Initial K.E. of block when bullet strikes to it

$= \frac{1}{2}(m + M)V^2$

Due to this K.E. block will rise to a height h

Its potential energy $= (m + M)gh$

By the law of conservation of energy

$\frac{1}{2}(m + M)V^2 = (m + M)gh \;\; \therefore V = \sqrt{2gh}$

196 **(b)**

Power ,p= $\frac{\text{Total Energy}}{t} = \frac{\text{mgh} + \frac{1}{2}\text{mv}^2}{\text{t}}$

$\frac{10 \times 10 \times 20 + \frac{1}{2} + 10 \times 10 \times 10}{1}$

=2000+500=2500 W=2.5 KW

197 **(a)**

KE lost is $\frac{3}{4}$th, therefore, KE left is $\frac{1}{4}$ th. Hence, velocity of particle reduces from v_0 to $\frac{v_0}{2} = v_0 - \mu g t_0$

or $\mu = \frac{v_0}{2gt_0}$

198 **(a)**

Power = 7500, W = 7500 Js^{-1}, velocity $v = 20\ ms^{-1}$

$P = Fv$ or $F = \frac{P}{v} = \frac{7500\ Js^{-1}}{20\ ms^{-1}} = 375$ N

199 **(d)**

$u = 10ms^{-1}, v = 20ms^{-1}$

Work done = increase in kinetic energy

$= \frac{1}{2} \times 500[20^2 - 10^2] = \frac{500 \times 30 \times 10}{2}$

Power $= \frac{500 \times 30 \times 10}{2 \times 60}$W = 1250 W

200 **(b)**

For equilibrium

$\frac{dU}{dr} = 0 \Rightarrow \frac{-2A}{r^3} + \frac{B}{r^2} = 0$

$r = \frac{2A}{B}$

For stable equilibrium

$\frac{d^2U}{dr^2}$ should be positive for the value of r

Here $\frac{d^2U}{dr^2} = \frac{6A}{r^4} - \frac{2B}{r^3}$ is +ve value for $r = \frac{2A}{B}$

201 **(b)**

Kinetic energy of a body

$K = \frac{P^2}{2M}$

Or $K \propto P^2$

Or $\frac{p_2}{p_1} = \sqrt{\frac{K_2}{K_1}} = \sqrt{4}$

or $P_2 = 2P_1$

202 **(b)**

Work = Force × Displacement

If force and displacement both are doubled then work would be four times

203 **(d)**

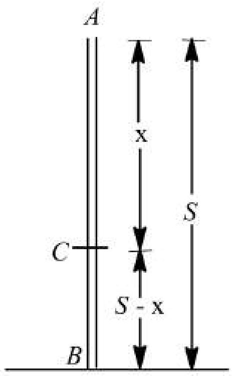
We can realize the situation as shown .Let at point C distance x from highest point A, the particle's kinetic energy is three times its potential energy.

Velocity at C,

$v^2 = 0 + 2gx$

Or $v^2 = 2gx$ .....(i)

Potential energy at C,= $mg\ (S - x)$ .....(ii)



At Point C,

Kinetic energy=3× *potential energy*

ie, $\frac{1}{2}m \times 2gx = 3 \times mg(S - x)$

or $x = 3S - 3x$

or $4x = 3S$

or $S = \frac{4}{3}x$

or $x = \frac{3}{4}S$

Therefore, from Eq.(i)

$v^2 = 2g \times \frac{3}{4}S$

Or $v^2 = \frac{3}{2}gS$ *or* $v = \sqrt{\frac{3}{2}gS}$

Height of the particle from the ground

$= S - x = S - \frac{3}{4}S = \frac{S}{4}$

204 **(d)**

$W = \int_0^5 F dx = \int_0^5 (7 - 2x + 3x^2)dx$

$= [7x - x^2 + x^3]_0^5$

$= 35 - 25 + 125 = 135\ J$

205 **(b)**

According to the graph the acceleration a varies linearly with the coordinate x. We may write $a = \alpha x$, where α is the slope of the graph.

From the graph

$\alpha = \frac{20}{8} mg_0 = 2.5\ s^{-2}$

The force on the brick is in the positive x-direction and according to Newton's second law, its magnitude is given by

$F = \frac{a}{m} = \frac{\alpha}{m}x$

If x_f is the final coordinate, the work done by the force is

$W = \int_0^{x_f} F\ dx = \frac{a}{m}\int_0^{x_f} x\ dx$

$= \frac{\alpha}{2m} x_f^2 = \frac{2.5}{2 \times 10} \times (8)^2$
$= 8$ J

206 **(d)**

The potential energy of a stretched spring is

$U = \frac{1}{2} kx^2$

Here, k=spring constant, x=elongation in spring.
But given that, the elongation is 2 cm.

So $U = \frac{1}{2} K(2)^2$

Or $U = \frac{1}{2} k \times 4$ ...(i)

If elongation is 10 cm then potential energy

$U' = \frac{1}{2} k(10)^2$

Or $U' = \frac{1}{2} k \times 100$ ...(ii)

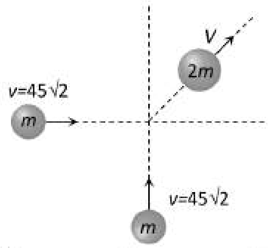
On dividing Eq. (ii) by Eq. (i), We have

$\frac{U'}{U} = \frac{\frac{1}{2} k \times 100}{\frac{1}{2} k \times 4}$

Or $\frac{U'}{U} = 25 \Rightarrow U' = 25U$

207 **(b)**

Initial momentum



$\vec{P} = m45\sqrt{2}\,\hat{\imath} + m45\sqrt{2}\,\hat{\jmath}$

$\Rightarrow |\vec{P}| = m \times 90$

Final momentum $2m \times V$

By conservation of momentum

$2m \times V = m \times 90$

$\therefore V = 45\ m/s$

208 **(d)**

Potential energy of the particle $U = k(1 - e^{-x^2})$

Force on particle $F = \frac{-dU}{dx} = -k[-e^{-x^2} \times (-2x)]$

$F = -2kxe^{-x^2} = -2kx \left[1 - x^2 + \frac{x^4}{2!} - \cdots\right]$

For small displacement $F = -2kx$

$\Rightarrow F \propto -x$ *i.e.* motion is simple harmonic motion

209 **(a)**

Given $F = -5x - 16x^3 = -(5 + 16x^2)x = -kx$ where $k(= 5 + 16x^2)$is force constant of spring ,Therefore , work done in stretching the spring from position x_1 to position x_2 *is*

$w = \frac{1}{2} k_2 x_2^2 - \frac{1}{2} k_1 x_1^2$

We have,$x_1 = 0.1$ m and$x_2 = 0.2$m.

$\therefore W = \frac{1}{2}[5 + 16(0.2)^2](0.2)^2$

$- \frac{1}{2}[5 + 16(0.1)^2](0.1)^2$

$= 2.82 \times 4 \times 10^{-2} - 2.58 \times 10^{-2} = 8.7 \times 10^{-2}$J

210 **(a)**

In a perfectly elastic collision the relative velocity remains unchanged in magnitude but reserved in direction. Therefore , velocity of heavy body after collision is v.

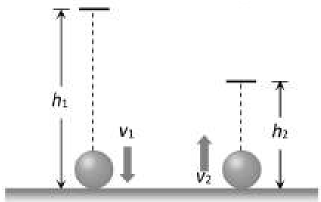
211 **(a)**

$E = \frac{p^2}{2m}$. If $P =$ constant then $E \propto \frac{1}{m}$

i.e., kinetic energy of heavier body will be less. As the mass of gun is more than bullet therefore it possess less kinetic energy

212 **(b)**

If ball falls from height h_1 and bounces back up to height h_2 then $e = \sqrt{\frac{h_2}{h_1}}$



Similarly if the velocity of ball before and after collision are v_1 and v_2 respectively then $e = \frac{v_2}{v_1}$

So $\frac{v_2}{v_1} = \sqrt{\frac{h_2}{h_1}} = \sqrt{\frac{1.8}{5}} = \sqrt{\frac{9}{25}} = \frac{3}{5}$

i.e. fractional loss in velocity $= 1 - \frac{v_2}{v_1} = 1 - \frac{3}{5} = \frac{2}{5}$

213 **(c)**

Let $m =$ mass of boy, $M =$ Mass of man

$v =$ velocity of boy, $V =$ velocity of man

$\frac{1}{2} MV^2 = \frac{1}{2}\left[\frac{1}{2} mv^2\right]$ ...(i)

$\frac{1}{2} M(V + 1)^2 = 1\left[\frac{1}{2} mv^2\right]$ ...(ii)

Putting $m = \frac{M}{2}$ and solving $V = \frac{1}{\sqrt{2} - 1}$

214 **(a)**

Since body moves with constant velocity, so. Net force on the body is zero.

Here, $N = mg, F = f$

$\therefore W = \vec{\mathbf{F}}.\vec{\mathbf{s}} = fs \cos 180''$

$= fs = -10 \times 2 = -20$ J

215 **(a)**

Given,

$m = 100$kg, h = 10m, t = 5s,

g $= 10ms^{-2}$ and $\eta = 60\%$

Power$=\frac{\text{work/time}}{\eta}=\frac{100}{60}\times\frac{\text{mgh}}{\text{t}}$
$=\frac{100}{60}\times\frac{100\times10\times10}{5}$
$=3.3\times10^3\text{W}$
$=3.3\text{kW}$

216 **(c)**

Height of CG of mass $m_1=\frac{a}{2}$

Height of CG of mass $m_2=a+\frac{b}{2}$

∴ Gravitational potential energy of system

$=m_1 g\frac{a}{2}+m_2 g\left(a+\frac{b}{2}\right)=\left[\frac{m_1}{2}+m_2\right]ga+m_2 g\frac{b}{2}$

$=\left[\left(\frac{m_1}{2}+m_2\right)a+m_2\frac{b}{2}\right]g$

217 **(a)**

The ball rebounds with the same speed. So change in it's Kinetic energy will be zero $i.e.$ work done by the ball on the wall is zero

218 **(b)**

To leave the block, it oscillates in vertical plane. If maximum extension in spring in extreme position of block is x_1 , then

Work done by weight of the block

=Potential energy stored in spring

$mg\,x=\frac{1}{2}kx^2$

$\therefore x=2\frac{mg}{k}\;2d \qquad \left(\because d=\frac{mg}{k}\right)$

219 **(a)**

The weight of bucket when it has been pulled up a distance x is (5-0.2x).

Hence, the required work is

$W=\int_{x=20}^{x=0}-(5-0.2x)\times10\times dx$

$=[50x]_{x=0}^{x=20}-\left[2\frac{x^2}{2}\right]_{x=0}^{x=20}$

$W=50\times20-(20)^2=600\text{J}$

220 **(b)**

$\Delta U=mgh=0.2\times10\times200=400J$

∴ Gain in K.E. = decrease in P.E. = 400 J

221 **(a)**

$P=Fv$

$=9000\text{N}\times2\text{ ms}^{-1}=18000\text{Js}^{-1}$

$=18000\text{ W}=18\text{ kW}$

222 **(a)**

$\vec{\mathbf{F}}=\frac{\partial U}{\partial x}\hat{\mathbf{i}}-\frac{\partial U}{\partial y}\hat{\mathbf{j}}=7\hat{\mathbf{i}}-24\hat{\mathbf{j}}$

$|\vec{\mathbf{F}}|=\sqrt{(7)^2+(-24)^2}=25$ unit

223 **(b)**

In case of elastic collision ,coefficient of restitution e=1

or

Relative speed of approach =relative speed of separation.

∴ Option (b)is correct.

224 **(d)**

Initial momentum $=\vec{P}=mv\hat{\imath}+mv\hat{\jmath}$

$|\vec{P}|=\sqrt{2}mv$

Final momentum $=2m\times V$

By the law of conservation of momentum

$2m\times V=\sqrt{2}\,mv\Rightarrow V=\frac{v}{\sqrt{2}}$

In the problem $v=10\;m/s$ [Given] $\therefore V=\frac{10}{\sqrt{2}}=5\sqrt{2}\;m/s$

225 **(c)**

$p=\sqrt{2ME}\;\therefore\frac{p_1}{p_2}=\sqrt{\frac{m_1}{m_2}\frac{E_1}{E_2}}=\sqrt{\frac{2}{1}\times\frac{8}{1}}=\frac{4}{1}$

227 **(c)**

$W=\frac{1}{2}k(x_2^2-x_1^2)$

$=\frac{1}{2}\times5\times10^3(10^2-5^2)\times10^{-4}$

$=18.75\,J$

228 **(c)**

Work done = force × distance = 4 N × 2 m = 8 J

229 **(d)**

$U=\frac{a}{x^{12}}-\frac{b}{x^6}$

$F=-\frac{dU}{dx}=+12\frac{a}{x^{13}}-\frac{6b}{x^7}=0\Rightarrow x=\left(\frac{2a}{b}\right)^{1/6}$

$U(x=\infty)=0$

$U_{\text{equilibrium}}=\frac{a}{\left(\frac{2a}{b}\right)^2}-\frac{b}{\left(\frac{2a}{b}\right)}=\frac{b^2}{4a}$

$\therefore U(x=\infty)-U_{\text{equilibrium}}=0-\left(-\frac{b^2}{4a}\right)=\frac{b^2}{4a}$

230 **(a)**

By conservation of energy, $mgh=\frac{1}{2}mv^2$

$\Rightarrow v=\sqrt{2gh}=\sqrt{2\times9.8\times1}=\sqrt{19.6}=4.43\;m/s$

231 **(b)**

If a body falls from height h, then from equation of motion we know that it will hit the ground with a velocity say u=$\sqrt{2gh}$ which is also the velocity of approach here. Now, if after collision it gains a height h_1 then again by equation of motion $v=$

$\sqrt{2gh}$, which is also the velocity of separation .so, by definition of e,

$$e = \sqrt{\frac{2gh_1}{2gh}}\ or\ \ h_1 = e^2 h$$

Given ,h=20 m, e=0.9

∴ height attained after first bounce

$h_1 = (0.9)^2 \times 20$

$= 0.9 \times 0.9 \times 20$

$= 16.2$

232 **(c)**

Velocity of fall is independent of the mass of the falling body

233 **(b)**

Work done = Force × displacement

= Weight of the book × Height of the book shelf

235 **(c)**

$$P = Fv = m.\frac{dv}{dt} \cdot v$$

$$\int v\,dv = \int \frac{p}{mdt};\ \frac{v^2}{2} = \frac{pt}{m}$$

$$v = \sqrt{\frac{2p}{m}}t^{1/2};\frac{dx}{dt} = \sqrt{\frac{2p}{m}}t^{1/2}$$

$$\int dx = \sqrt{\frac{2p}{m}}\int t^{1/2}dt;$$

$$x = \sqrt{\frac{2p}{3}}\frac{t^{3/2}}{3/2} = \frac{2}{3}\sqrt{\frac{2p}{3}}t^{3/2}$$

$x \propto t^{3/2}$

236 **(b)**

$$K = \frac{\text{mass}}{\text{length}} = \frac{dm}{dt}$$

$$\text{KE} = \frac{1}{2}mv^2 \Rightarrow \frac{d}{dt}(\text{KE}) = \frac{1}{2}\left(\frac{dm}{dt}\right)v^2$$

$$= \frac{1}{2}\left(\frac{dm}{dx} \times \frac{dx}{dt}\right)v^2$$

$$= \frac{1}{2}kvv^2 = \frac{1}{2}kv^3$$

237 **(c)**

Area of acceleration–displacement curve gives change in KE per unit mass

$\frac{1}{2}m(v^2 - u^2) = F.S = \frac{mdv}{dt} \times s$

$$\therefore \frac{\text{change in } KE}{\text{Mass}} = \frac{dv}{dt} \times s$$

238 **(c)**

Force required to move with constant velocity

∴ Power $= FV$

Force is required to oppose the resistive force R and also to accelerate the body of mass m with acceleration a

∴ Power $= (R + ma)V$

239 **(b)**

1. If the surface is smooth then the kinetic energy at B never be zero

2. If the surface is rough, the kinetic energy at B be zero. Because, work done by force of friction is negative. If work done by friction is equal to mgh then, net work done on body will be zero. Hence, net change in kinetic energy is zero. Hence, (b) is correct

3. If the surface is rough, the kinetic energy at B must be lesser than mgh. If surface is smooth, the kinetic energy at B is equal to mgh

4. The reason is same as in (a) and (b)

240 **(b)**

$k_A > k_B, x$ is the same

$\therefore \frac{1}{2}k_A x^2 > \frac{1}{2}k_B x^2 \Rightarrow W_A > W_B$

Forces are the same

$k_A x_A = k_B x_B$, As $k_A > k_B, x_A < x_B$

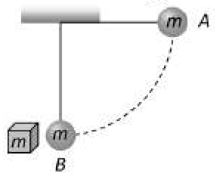
$W'_A = \frac{1}{2}(k_A x_A)x_A$ and $W'_B = \frac{1}{2}(k_B x_B)x_B$

$\therefore W'_A < W'_B; \therefore W_A > W_B$ but $W'_A < W'_B$

241 **(c)**

P.E. of bob at point $A = mgl$

This amount of energy will be converted into kinetic energy



∴ K.E. of bob at point $B = mgl$

And as the collision between bob and block (of same mass) is elastic so after collision bob will come to rest and total Kinetic energy will be transferred to block. So kinetic energy of block = mgl

242 **(a)**

Work done = Area under curve and displacement axis

= Area of trapezium

$= \frac{1}{2} \times$ (sum of two parallel lines) × distance between them

$$= \frac{1}{2}\ (10 + 4) \times (2.5 - 0.5) = \frac{1}{2}14 \times 2 = 14\,J$$

As the area actually is not trapezium so work done will be more than 14 J $i.e.$ approximately 16 J

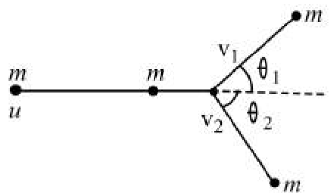
243 **(d)**

$U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$ at the stable equilibrium $\frac{du}{dx} = 0$

$\therefore \ -\frac{12}{x^{13}} + \frac{6b}{x^7} = 0 \Rightarrow x = \left(\frac{2a}{b}\right)^{1/6}$

244 **(b)**

Let particle with mass m, move with velocity u,and $v_1$and $v_2$be velocity after collision. Since , elastic collision is one in which the momentum is conserved , we have



$\therefore mu = mv_1 \cos\theta_1 + mv_2 \cos\theta_2$ .....(i)

In perpendicular direction

$0 = mv_1 \sin\theta_2 - mv_2 \sin\theta_2$ .....(ii)

Also elastic collision occurs only if there is no conversion of kinetic energy into other from,

Hence

$\frac{1}{2}mu^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2$

$u_2 = v_1^2 + v_2^2$ ....(iii)

Squaring Esq.(i)and (ii)and adding we get

$m^2u^2 = m^2(v_1 \cos\theta_1 + v_2 \cos\theta_2)^2 + m^2(v_1 \sin\theta_1 - v_2 \sin\theta_2)^2$

$u^2 = v_1^2 + v_2^2 + 2v_1v_2 \cos\theta_1 \cos\theta_2 - 2v_1v_2 \sin\theta_1 \sin\theta_2$

$u^2 = v_1^2 + v_2^2 + 2v_1v_2 \cos(\theta_1 + \theta_2)$

Using Eq.(iii),we get

$2v_1v_2 \cos(\theta_1 + \theta_2) = 0$

since $v_1v_2 \neq 0$

Hence $\cos(\theta_1 + \theta_2) = 0$

Or $\theta_1 + \theta_2 = 90°$

When two identical particles collide elastically and obliquely,

One being at rest, then they fly off in mutually perpendicular directions.

245 **(d)**

$P = \sqrt{2mE} \therefore \ P \propto \sqrt{E}$

$i.e.$, if kinetic energy of a particle is doubled then its momentum will becomes $\sqrt{2}$ times

246 **(a)**

$E = \frac{1}{2}kx^2$

$\therefore \ E \propto k$

$\therefore \ \frac{E_1}{E_2} = \frac{k_1}{k_2}$

247 **(b)**

$dW = -\mu\left[\frac{M}{L}\right] \text{g}l \, dl$

$W = \int_0^{\frac{2L}{3}} -\frac{\mu M\text{g}}{L} l \, dl$

or $W = -\frac{\mu M\text{g}}{L}\left|\frac{l^2}{2}\right|_0^{\frac{2L}{3}}$

or $W = -\frac{\mu M\text{g}}{L}\left|\frac{4L^2}{9} - 0\right|$

or $W = -\frac{2}{9}\mu M\text{g}L$

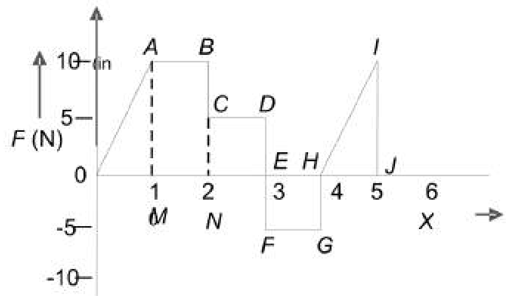
248 **(a)**

When a shell fired from cannon explodes in mid air then is kinetic energy increases.

249 **(b)**

Work done=area enclosed by $F - x$graph

=area of $ABNM$+ area of CDEN - area of $EFGH$+ area of HIJ



$=1 \times 10 + 1 \times 5 - 1 \times 5 + \frac{1}{2} \times 1 \times 10$

$= 10 + 5 - 5 + 5 = 15$ J

250 **(c)**

The energy gained by the particle

$U = \frac{1}{2}k(x_2^2 - x_1^2)$

$= \frac{1}{2}k(3^2 - 0^2) = \frac{9}{2}k4.5k$

251 **(a)**

$W = F \times s = F \times v \times t = 5 \times 2 \times 60 = 600 \, J$

252 **(b)**

Work done on the body = K.E. gained by the body

$Fs \cos\theta = 1 \Rightarrow F \cos\theta = \frac{1}{s} = \frac{1}{0.4} = 2.5N$

253 **(a)**

When block strikes the spring, the kinetic energy of block converts into potential energy of spring ie,

$$\frac{1}{2}mv^2 = \frac{1}{2}kx^2$$

Or $x = \sqrt{\frac{mv^2}{k}}$

$$= \sqrt{\frac{25 \times 3^2}{100}} \quad \sqrt{\frac{9}{4}} = \frac{3}{2} = 1.5\, m$$

When block returns to the original position, again potential energy converts into kinetic energy of the blocks, so velocity of the block is same as before but its sign changes as it goes to mean position.

Hence $v = -3ms^{-1}$

254 **(a)**

Because in perfectly inelastic collision the colliding bodies stick together and move with common velocity

255 **(c)**

Power of a pump $= \frac{1}{2}\rho A v^3$

To get twice amount of water from same pipe v has to be made twice. So power is to be made 8 times

256 **(a)**

Initial energy of body $= \frac{1}{2}mv^2 = \frac{1}{2} \times 1 \times (20)^2 = 200\, J$

A part of this energy consumes in doing work against gravitational force and remaining part consumes in doing work against air friction

i.e., $W_T = W_{grav.} + W_{air\ friction}$

$\Rightarrow 200 = 1 \times 10 \times 18 + W_{air} \Rightarrow W_{air} = 20\, J$

257 **(d)**

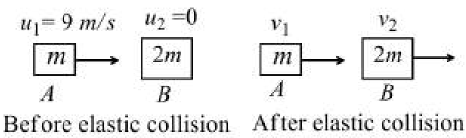
$$s = \frac{u^2}{2\mu g} = \frac{10 \times 10}{2 \times 0.5 \times 10} = 10m$$

258 **(c)**

$U = \frac{F^2}{2k} \Rightarrow \frac{U_1}{U_2} = \frac{k_2}{k_1}$ [If force are same]

$$\therefore \frac{U_1}{U_2} = \frac{3000}{1500} = \frac{2}{1}$$

259 **(b)**



$$v_2 = \frac{2m_1 v_1}{m_1 + m_2} = \frac{2 \times m \times 9}{m + 2m} = 6\, m/s$$

i.e. After elastic collision B strikes to C with velocity of $6\, m/s$. Now collision between B and C is perfectly inelastic

By the law of conservation of momentum

$2m \times 6 + 0 = 3m \times v_{sys}$

$\Rightarrow v_{sys} = 4\, m/s$

260 **(a)**

If after the collision of two bodies, the total kinetic energy of the bodies remains the same as it was before the collision, and also momentum remains same, then it is a case of perfectly elastic collision.

Momentum before collision= Momentum after collision

Kinetic energy before collision

=Kinetic energy after collision

Also, $u_1 - u_2 = -(v_1 - v_2)$

Where $(u_1 - u_2)$ is the relative velocity before the collision and $(v_1 - v_2)$is the relative velocity after the collision. Thus, in a perfectly elastic collision the relative velocity remains unchanged in magnitude, but is reserved in direction. Hence, velocity of the last ball is $-0.4\, ms^{-1}$.

261 **(c)**

Power,

$p = m \times a \times v$

$$p = m \times \frac{v^2}{t}$$

If p is constant, then for a given body $v^2 \propto \sqrt{t}$

Or $v \propto \sqrt{t}$

262 **(d)**

$$W = \int_0^2 F\, ds = \int_0^2 Ma\, ds = \int_0^2 M\frac{d^2s}{dt^2} ds$$

$$= \int_0^2 M\frac{d^2s}{dt^2} \cdot \frac{ds}{dt} dt$$

$$= \int_0^2 3\left(\frac{2}{3}\right) \cdot \left(\frac{2}{3}t\right) dt$$

$$= \frac{4}{3}\left[\frac{t^2}{2}\right]_0^2$$

$$W = \frac{4}{3} \times \frac{4}{2} = \frac{8}{3} = 2.6\, \text{J}$$

263 **(c)**

From the law of conservation of momentum

$3 \times 16 + 6 \times v = 9 \times 0$

Or $v = -8\, ms^{-1}$

$\Rightarrow$ $v = 8ms^{-1}$ (numerically)

Therefore, its kinetic energy

$k = \frac{1}{2} \times 6 \times (8)^2 = 192\text{J}$

264 **(d)**

Loss in PE in spring = gain in KE of ball

$\frac{1}{2}Kx^2 = \frac{1}{2}mv^2$

$\frac{90}{10^{-2}} \times (12 \times 10^{-2})^2 = 16 \times 10^{-3} v^2 \Rightarrow v$

$= 90\ m/s$

265 **(b)**

Power delivered to the body

$P = F.v = mav$

Since, body undergoes one dimensional motion and is initially at rest, so

$v = 0 + at$

$\therefore P = ma^2 t$ or $P \propto t$

266 **(c)**

According to law of conservation of linear momentum both pieces should possess equal momentum after explosion. As their masses are equal therefore they will possess equal speed in opposite direction

267 **(c)**

$E = \frac{1}{2}mv^2$. Differentiating $w.r.t.x$, we get

$\frac{dE}{dx} = \frac{1}{2}m \times 2v\frac{dv}{dx} = mv \times \frac{dv}{dt} \times \frac{dt}{dx} = mv \times \frac{a}{v}$

$= ma$

268 **(b)**

From conservation of energy,

Potential energy at height h = kinetic energy at ground

Therefore, at height h, potential energy of ball A

$\text{PE} = m_A gh$

KE at ground $= \frac{1}{2}m_A v_A^2$

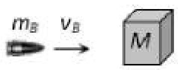
So, $m_A gh = \frac{1}{2}m_A v_A^2$

$v_A = \sqrt{2gh}$

Similarly, $v_B = \sqrt{2gh}$

Therefore, $v_A = v_B$

269 **(b)**



Initial K.E. of system = K.E. of the bullet $= \frac{1}{2}m_B v_B^2$

By the law of conservation of linear momentum

$m_B v_B + 0 = m_{\text{sys.}} \times v_{\text{sys.}}$

$\Rightarrow v_{\text{sys.}} = \frac{m_B v_B}{m_{\text{sys.}}} = \frac{50 \times 10}{50 + 950} = 0.5\ m/s$

Fractional loss in K.E. $= \frac{\frac{1}{2}m_B v_B^2 - \frac{1}{2}m_{\text{sys.}} v_{\text{sys.}}^2}{\frac{1}{2}m_B v_B^2}$

By substituting $m_B = 50 \times 10^{-3} kg, v_B = 10\ m/s$

$m_{\text{sys.}} = 1kg, v_s = 0.5\ m/s$ we get

Fractional loss $= \frac{95}{100}$ $\therefore$ Percentage loss = 95%

270 **(a)**

Power $= \frac{\text{workdone}}{\text{time}} = \frac{\text{pressure} \times \text{cnahge in volume}}{\text{time}}$

$= \frac{20000 \times 1 \times 10^{-6}}{1} = 2 \times 10^{-2} = 0.02\ W$

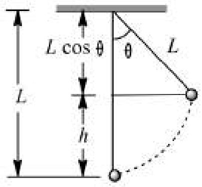
271 **(b)**

Because 50% loss in kinetic energy will affect its potential energy and due to this ball will attain only half of the initial height

272 **(c)**

$W = \Delta K$ or $W_T + W_g + W_F = 0$

(Since, change in kinetic energy is zero)



Here, W_T = work done by tension = 0

W_g = work done by fore of gravity

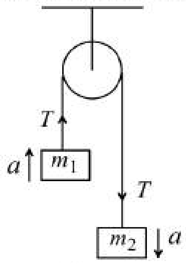
$= -mgh$

$= -mgL(1 - \cos\theta)$

$\therefore\ W_F = -W_g = mgL(1 - \cos\theta)$

273 **(c)**

In the given condition tension in the string



$T = \frac{2m_1 m_2}{m_1 + m_2}g = \frac{2 \times 0.36 \times 0.72}{1.08} \times 10$

$T = 4.8\ N$

And acceleration of each block

$a = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)g = \left(\frac{0.72 - 0.36}{0.72 + 0.36}\right)g = \frac{10}{3}\ m/s^2$

Let 'S' is the distance covered by block of mass $0.36\ kg$ in first sec

$S = ut + \frac{1}{2}at^2 \Rightarrow S = 0 + \frac{1}{2}\left(\frac{10}{3}\right) \times 1^2$

$= \frac{10}{6}\ meter$

$\therefore$ Work done by the string $W = TS = 4.8 \times \frac{10}{6}$

$\Rightarrow W = 8\ Joule$

274 **(c)**

$m_1 v_1 - m_2 v_2 = (m_1 + m_2)v$

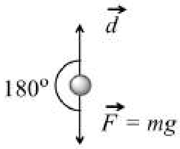
$\Rightarrow 2 \times 3 - 1 \times 4 = (2+1)v$

$\Rightarrow v = \frac{2}{3}\ m/s$

275 **(a)**

Maximum height reached by the particle

$H_{\max} = \frac{u^2}{2g} = \frac{(5)^2}{2 \times 10} = 1.25\ m$



Work done $= \vec{F}.\vec{d} = F\ d \cos\theta$

$= mg \times (H_{\max}) \times \cos(180°)$

$= 0.1 \times 10 \times 1.25 \times (-1) = -1.25\ J$

276 **(b)**

Fractional decrease in kinetic energy of neutron

$= -\left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2$ [As $m_1 = 1$ and $m_2 = 2$]

$= 1 - \left(\frac{1-2}{1+2}\right)^2 = 1 - \left(\frac{1}{3}\right)^2 = 1 - \frac{1}{9} = \frac{8}{9}$

278 **(b)**

Loss of KE = force × distance = $(ma)x$

As $a \propto x$

∴ Loss of KE $\propto x^2$

279 **(c)**

$v_2 = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)u_2 + \frac{2m_1 u_1}{m_1 + m_2} = \frac{2mu}{M+m} = \frac{2u}{1 + \frac{m}{M}}$

280 **(b)**

Potential energy at the required height

$= \frac{490}{2} = 245$ J

Again, 245=2× 10 × h or $h = \frac{245}{20}$m = 12.25 m

281 **(b)**

P = constant

$\Rightarrow\ Fv = P$ [$\because P$ = force × velocity]

$\Rightarrow\ Ma \times v = P$ [$\because F = Ma$]

$\Rightarrow\ va = \frac{P}{M}$

$\Rightarrow\ v \times \frac{vdv}{ds} = \frac{P}{M}$ $\left[\because a = \frac{vdv}{ds}\right]$

$\Rightarrow\ \int_0^v v^2 dv = \int_0^s \frac{P}{M} ds$

[Assuming at $t = 0$ it starts from rest, *ie*, from $s =$ 0]

$\Rightarrow\ \frac{v^3}{3} = \frac{P}{M}s$

$\Rightarrow\ v = \left(\frac{3P}{M}\right)^{1/3} \times s^{1/3}$

$\Rightarrow\ \frac{ds}{dt} = ks^{1/3} \left[k = \left(\frac{3P}{M}\right)^{1/3}\right]$

$\Rightarrow\ \int_0^s \frac{ds}{s^{1/3}} = \int_0^t kdt$

$\Rightarrow\ \frac{s^{2/3}}{2/3} = kt$

$\therefore\ s = \left(\frac{2}{3}k\right)^{3/2} \times t^{3/2}$

$\Rightarrow\ s \propto t^{3/2}$

282 **(d)**

Let m be the mass of the block, h the height from which it is dropped, and x the compression o the spring. Since, energy is conserved, so

Final gravitational potential energy

= final spring potential energy

or $mg(h+x) = \frac{1}{2}kx^2$

or $mg(h+x) + \frac{1}{2}kx^2 = 0$

or $kx^2 - 2mg(h+x) = 0$

$kx^2 - 2mgx - 2mgh = 0$

This is a quadratic equation for x. Its solution is

$x = \frac{mg \pm \sqrt{(mg)^2 + 2mghk}}{k}$

Now, $mg = 2 \times 9.8 = 19.6$ N

and $hk = 0.40 \times 1960 = 784$ N

$\therefore\quad x = \frac{19.6 \pm \sqrt{(19.6)^2 + 2(19.6)(784)}}{1960}$

$= 0.10$ m or -0.080 m

Since, x must be positive (a compression) we accept the positive solution and reject the negative solution. Hence, $x = 0.10$ m

283 **(a)**

When two bodies of same mass makes head on elastic collision, and then they interchange their velocities.

So, after collision first body starts to move with velocity v.

284 **(d)**

Energy supplied $= \frac{1}{2}mv^2 = \frac{1}{2}(0.5)14^2 = 49$ J

Energy stored $= mgh = 0.5 \times 9.8 \times 8 = 39.2$ J

∴ Energy dissipated = 49 − 39.2 = 9.8 J

285 **(d)**

$P = \frac{mgh}{t}$

$\frac{M}{t}$ = mass of water fall per second

$= \frac{P}{gh} = \frac{1 \times 10^6}{10 \times 10} = 10^4 \text{ kg s}^{-1}$

286 **(d)**

$F = -\frac{\partial U}{\partial x}\hat{\mathbf{i}} - \frac{\partial U}{\partial y}\hat{\mathbf{j}} = 7\hat{\mathbf{i}} - 24\hat{\mathbf{j}}$

$\therefore \quad a_x = \frac{F_x}{m} = \frac{7}{5} = 1.4 \text{ ms}^{-2}$ along positive x-axis

$a_y = \frac{F_y}{m} = -\frac{24}{5}$

$= 4.8\text{ms}^{-2}$ along negative y-axis

$\therefore v_x = a_x t = 1.4 \times 2$

$= 2.8 \text{ ms}^{-2}$

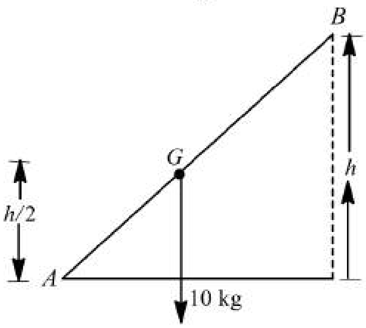
and $v_y = 4.8 \times 2 = 9.6 \text{ ms}^{-1}$

$\therefore v = \sqrt{v_x^2 + v_y^2} = 10 \text{ ms}^{-1}$

287 **(b)**

Work done$=\frac{mgh}{2}$

$\therefore \quad 100 = \frac{10 \times 10 \times h}{2}$



Or $\quad h = 2.0m$

288 **(c)**

$E = \frac{p^2}{2m}$ or $E \propto p^2$

or $\frac{E_1}{E_2} = \left(\frac{p_1}{p_2}\right)^2 = \left(\frac{p_1}{2p_2}\right)^2 = \frac{1}{2}$ or $E_2 = 4E_1$

So, increase is 300%

289 **(a)**

Mass of fragments are as 2 : 3

Total mass $= 20kg$

$\therefore$ Larger fragment $= 12kg$

$\therefore$ Smaller fragment $= 8\ kg$

Momentum is conserved

$\therefore 8 \times 6 = 12 \times v \Rightarrow v = 4 =$ velocity of larger fragment

$\therefore$ Kinetic energy $= \frac{1}{2}\ mv^2 = \frac{1}{2} \times 12 \times (4)^2 = 96\ J$

290 **(c)**

$\frac{1}{2}m_1u_1^2 - \frac{1}{2}m_1v_1^2 = \frac{75}{100} \times \frac{1}{2}m_1u_1^2$

Or $\qquad u_1^2 - v_1^2 = \frac{3}{4}u_1^2$

or $\qquad v_1 = \frac{1}{2}u_1 \quad$ ....(i)

Now $\qquad v_1 = \frac{(m_2 - m_1)u_1}{(m_1 + m_2)} \ldots .(ii)$

Thus, $\qquad \frac{1}{2}u_1 = \frac{(m_2 - m_1)u_1}{(m_1 + m_2)}$

or $\qquad m_2 = 3m_1 = 3m$

291 **(b)**

The linear momentum of exploding part will remain conserved.

Applying conservation of linear momentum, We write,

$m_1u_1 = m_2u_2$

Here,$m_1 = 18\text{kg}, m_2 = 12\text{kg}$

$u_1 = 6ms^{-1}, u_2 = ?$

$\therefore 18 \times 6 = 12\ u_2$

$\Rightarrow\ u_2 = \frac{18 \times 6}{12}\ \ 9ms^{-1}$

Thus, kinetic energy of 12 kg mass

$k_2 = \frac{1}{2}m_2u_2^2$

$= \frac{1}{2} \times 12 \times (9)^2$

$=6 \times 81$

$=486$ J

292 **(b)**

Force constant of a spring

$k = \frac{F}{x} = \frac{mg}{x} = \frac{1 \times 10}{2 \times 10^{-2}} \Rightarrow k = 500\ N/m$

Increment in the length $= 60 - 50 = 10\ cm$

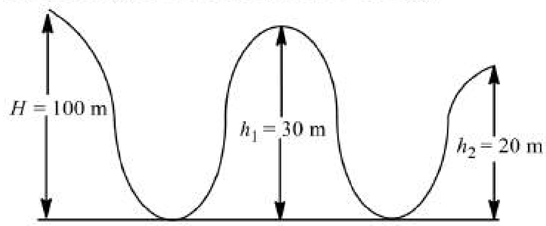
$U = \frac{1}{2}kx^2 = \frac{1}{2}500(10 \times 10^{-2})^2 = 2.5\ J$

293 **(c)**

There is no displacement

294 **(a)**

According to conservation of energy,



$mgH = \frac{1}{2}mv^2 + mgh_2$

Or $\quad mg(H - h_2) = \frac{1}{2}mv^2$

Or $v = \sqrt{2g(100 - 20)}$

Or v$=\sqrt{2 \times 10 \times 80} = 40ms^{-1}$

295 **(a)**

$U = \frac{1}{2}ks^2 = 10$ J

$U' = \frac{1}{2}k(s+s)^2 = 4\left(\frac{1}{2}ks^2\right) = 40$ J

$W = U' - U = 40 - 10 = 30$ J

296 **(a)**

$s = \frac{1}{3}t^2$

$v = \frac{ds}{dt} = \frac{2}{3}t, a = \frac{d^2s}{dt^2} = \frac{2}{3}$

$F = ma = 3 \times \frac{2}{3} = 2$ N

$W = 2 \times \frac{1}{3}t^2$

At $t = 2$ s,

$W = 2 \times \frac{1}{3} \times 2 \times 2 = \frac{8}{3}$ J

297 **(b)**

$W = \frac{1}{2}kx^2$

If both wires are stretched through same distance then

$W \propto k$. As $k_2 = 2k_1$ so $W_2 = 2W_1$

298 **(a)**

Work done = area under curve and displacement axis

$= 1 \times 10 - 1 \times 10 + 1 \times 10 = 10\, J$

299 **(b)**

Total mechanical energy= mgh

As, $\frac{\text{KE}}{\text{PE}} = \frac{2}{1}$

$\text{KE} = \frac{2}{3}\text{mgh}$

and $\text{PE} = \frac{1}{3}mgh$

Height from the ground at this instant,

$h' = \frac{h}{3}$ *and speed of particle at this instant,*

$v = \sqrt{2g(h-h')}$

$= \sqrt{2g\left(\frac{2h}{3}\right)}$

$= 2\sqrt{\frac{gh}{3}}$

300 **(a)**

$U = -\int F dx = -\int kx\, dx = -k\frac{x^2}{2}$

This is the equation of parabola symmetric to U axis in negative direction

301 **(b)**

Kinetic energy, $K = \frac{P^2}{2m}$

Where P is the momentum and m is the mass.

When momentum is increased by 20%, then

$\rho' = P + \frac{20}{100}P = 1.2P$

$\therefore K' = \frac{(1.2P)^2}{2m} = \frac{1.44P^2}{2m} = 1.44K$

$K' = K + 0.44K \Rightarrow \frac{K'-K}{K} = 0.44$

Percentage increase in kinetic energy is

$\frac{K'-K}{K} \times 100 = 0.44 \times 100 = 44\%$

302 **(c)**

Loss of kinetic energy $= \frac{1}{2}\frac{m_1m_2}{m_1+m_2}(v_1-v_2)^2$

$= \frac{1}{2} \times \frac{M \times M}{M+M}(V_1-V_2)^2$

$= \frac{M \cdot M}{2(2M)}(V_1-V_2)^2$

$= \frac{M}{4}(V_1-V_2)$

303 **(a)**

No work is done while covering the horizontal distance because $\vec{\mathbf{F}}.\vec{\mathbf{s}} = 0(\because\ \theta = 90°)$

But work is done during vertical displacement which is given by

$Fh = 60 \times 5 = 300$ J

304 **(c)**

$P = \frac{mgh}{t} = \frac{80 \times 10 \times 1.5}{2}$

$= 600$ W $= 0.6$ kW

305 **(c)**

The displacement of body is

$\overrightarrow{\mathbf{AB}} = \vec{\mathbf{r}}_B - \vec{\mathbf{r}}_A$

$= (3\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + 5\hat{\mathbf{k}}) - (2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 4\hat{\mathbf{k}})$

$= \hat{\mathbf{i}} + \hat{\mathbf{j}} + \hat{\mathbf{k}}$

$\therefore\ W = \vec{\mathbf{F}}.\overrightarrow{\mathbf{AB}} = (2\hat{\mathbf{i}} - 4\hat{\mathbf{j}}).(\hat{\mathbf{i}} - \hat{\mathbf{j}} + \hat{\mathbf{k}})$

$= 2 - 4 = -2$ J

306 **(b)**

Let the constant acceleration of body of mass m is a,

From equation of motion

$v_1 = 0 + at_1$

Or $a = \frac{v_1}{t_1}$ ...(i)

At an instant t, the velocity v of the body

$v = 0 + at$

$v = \frac{v_1}{t_1}t$ ...(ii)

Therefore, instantaneous power

$p = Fv = mav$

$= m\left(\frac{v_1}{t_1}\right) \times \left(\frac{v_1}{t_1}.t\right)$ [From Eqs.(i)and (ii)]

$= \frac{mv_1^2t}{t_1^2}$

307 **(d)**

Due to the same mass of A and B as well as due to elastic collision velocities of spheres get interchanged after the colision

308 **(a)**

Power $= Fv = v\left(\frac{m}{t}\right)v = v^2(\rho Av)$

$= \rho Av^3 = (100)(2)^3 = 800\ W$

309 **(b)**

Impulse = change in momentum

$mv_2 - mv_1 = 0.1 \times 40 - 0.1 \times (-30)$

310 **(d)**

Kinetic energy of particle ,$k = \frac{p_1^2}{2m}$

$p_1^2 = 2mk'$

When kinetic energy =2k

$p_2^2 = 2m \times 2k, p_2^2 = 2p_1^2, p_2 = \sqrt{2p_1}$

311 **(b)**

Gravitational potential energy of ball gets converted into elastic potential energy of the spring $mg(h+d) = \frac{1}{2}Kd^2$

Net work done $= mg(h+d) - \frac{1}{2}Kd^2 = 0$

312 **(a)**

$dW = Fdl$

$W = \int_0^l F\ dl \quad Y = \frac{FL}{dl}$

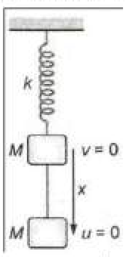
or $W = \int_0^l \frac{Y\,al}{L} dl$ or $F = \frac{Y\,al}{L}$

or $W = \frac{Ya}{L}\int_0^l dl$ or $W = \frac{Ya}{L}\left(\frac{l^2}{2}\right)$

or $W = \frac{1}{2}\frac{Y\,al}{L} l = \frac{1}{2}Fl$

313 **(b)**

Let x be the maximum extension of the spring, figure. From conservation of mechanical energy; decreases in gravitational potential energy = increase in elastic potential energy



$Mg\,x = \frac{1}{2}k\,x^2$

$x = \frac{2\,Mg}{k}$

314 **(b)**

$a = \frac{10-0}{5}\text{ms}^{-2} = 2\text{ms}^{-2}$;

$F = ma$ or $F = 1000 \times 2\text{ N} = 2000\text{ N}$

Average velocity $= \frac{0+10}{2}\text{ms}^{-1} = 5\text{ms}^{-1}$

Average power $= 2000 \times 5\text{ W} = 10^4\text{ W}$

Required horse power is $\frac{10^4}{746}$

315 **(a)**

Work done=area between the graph force displacement curve and displacement

$W = \frac{1}{2} \times 6 \times 10 - 5 \times 4 + 5 \times 4 - 5 \times 2$

$W = 20\ J$

According to work energy theorem

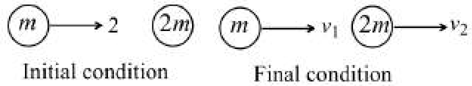
$\Delta = K_E = W$

$K_{E_f} = W + \Delta K$

=20+25

=45J

316 **(b)**



By conservation of linear momentum

$2m = mv_1 + 2mv_2 \Rightarrow v_1 + 2v_2 = 2$

By definition of $e, e = \frac{1}{2} = \frac{v_2 - v_1}{2-0}$

$\Rightarrow v_2 - v_1 = 1 \Rightarrow v_1 = 0$ and $v_2 = 1ms^{-1}$

317 **(b)**

Potential energy of water = kinetic energy at turbine

$mgh = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 19.6}$

$= 19.6\ m/s$

318 **(c)**

$U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$

$U(x = \infty) = 0$

As $\quad F = -\frac{dU}{dx} = -\left[\frac{12a}{x^{13}} + \frac{6b}{x^7}\right]$

At equilibrium, $F = 0$

$X^6 = \frac{2a}{b}$

$\therefore U_{at\ equilibrium} = \frac{a}{\left(\frac{2a}{b}\right)^2} - \frac{b}{\left(\frac{2a}{b}\right)} = -\frac{b^2}{4a}$

$\therefore D = \left[U(x - \infty) - U_{at\ equilibrium}\right] = \frac{b^2}{4a}$

320 **(c)**

$m_1v_1 - m_2v_2 = (m_1 + m_2)v$

$\therefore 2 \times 3 - 1 \times 4 = (2+1)v$

Or $v = \frac{2}{3}ms^{-1}$

321 **(b)**

KE $= \frac{1}{2}mv^2$

Given, $v_2 = (v_1 + 2)$

$$\frac{K_1}{K_2}=\left(\frac{v_1}{v_2}\right)^2$$
$$\frac{1}{2}=\frac{v_1^2}{(v_1+2)^2} \qquad (\because k_2=2k_1)$$
$$v_1^2+4v_1+4=2v_1^2$$
$$v_1^2-4v_1-4=0$$
$$v_1=\frac{4\pm\sqrt{16+16}}{2}$$
$$v_1=\frac{4+\sqrt{32}}{2}=2(\sqrt{2}+1)\text{ms}^{-1}$$

322 **(c)**

$$E=\frac{1}{2}mg^2t^2$$
$$\frac{E_1}{E_2}=\frac{\frac{1}{2}mg^2\times 3^2}{\frac{1}{2}mg^2(6^2-3^2)}=\frac{9}{9\times 3}=\frac{1}{3}$$

323 **(d)**

Initially mass 10 gm moves with velocity 100 cm/s

$\therefore$ Initial momentum $=10\times 100=1000\frac{gm\times cm}{sec}$

After collision system moves with velocity v_{sys}. then

Final momentum $=(10+10)\times v_{\text{sys.}}$

By applying in conservation of momentum

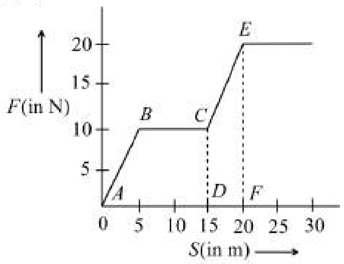
$1000=20\times v_{\text{sys.}}$

$\Rightarrow v_{\text{sys.}}=50\ cm/s$

If system rises upto height h then

$$h=\frac{v_{\text{sys.}}^2}{2g}=\frac{50\times 50}{2\times 1000}=\frac{2.5}{2}=1.25\ cm$$

324 **(b)**



Work done W = area under $F-S$ graph

= area of trapezium $ABCD$ + area of trapezium $CEFD$

$$=\frac{1}{2}\times(10+15)\times 10+\frac{1}{2}\times(10+20)\times 5$$
$$=125+75=200\ J$$

325 **(d)**

$s=10\text{m}, F=5\text{ N}, W=25\text{ J}, \theta=?$

$$\cos\theta=\frac{W}{Fs}=\frac{25}{5\times 10}=\frac{1}{2} \quad \therefore \theta=60°$$

326 **(d)**

Work done in raising water=mgh

or $W=(\text{volume}\times\text{density})gh$

$=(9\times 1000)\times 10\times 10$

Or $W=9\times 10^5\text{J}$

$$\therefore \text{ Useful power}=\frac{\text{work}}{\text{t}}=\frac{9\times 10^5}{5\times 60}=3\text{kW}$$

Hence, efficiency$=\frac{\text{useful power}}{\text{consuming power}}$

$$=\frac{3}{10}=30\%$$

327 **(c)**

Kinetic energy at highest point

$$(\text{KE})_H=\frac{1}{2}mv^2\cos 2\theta$$
$$=K\cos^2\theta$$
$$=K(\cos 60°)^2$$
$$=\frac{K}{4}$$

328 **(b)**

Loss in kinetic energy

$$=\frac{1}{2}\frac{m_1m_2(u_1-u_2)^2}{(m_1+m_2)}$$

$$=\frac{1}{2}\frac{m.m(u_1-u_2)^2}{(m+m)}$$
$$=\frac{m}{4}(u_1-u_2)^2$$

329 **(c)**

Change in momentum = Impulse

= Area under force-time graph

$\therefore mv$ = Area of trapezium

$$\Rightarrow mv=\frac{1}{2}\left(T+\frac{T}{2}\right)F_0\Rightarrow mv=\frac{3T}{4}F_0\Rightarrow F_0=\frac{4mu}{3T}$$

331 **(c)**

Kinetic energy $=\frac{1}{2}mv^2$

$\therefore$ K.E. $\propto v^2$

If velocity is doubled then kinetic energy will become four times

332 **(a)**

$$p=\frac{mgh}{t}=\frac{200\times 10\times 200}{10}=40\ kW$$

333 **(c)**

$$E_1=\frac{1}{2}mv^2$$
$$E_2=\frac{1}{2}m(v+1)^2$$
$$\frac{(E_2-E_1)}{E_1}=\frac{\frac{1}{2}m[(v+1)^2-v^2]}{\frac{1}{2}mv^2}=\frac{44}{100}$$

On solving, we get $v=5\text{ms}^{-1}$

334 **(b)**

Gravitational field is a conservative force field. In a conservative force field work done is path independent.

$\therefore \quad W_1 = W_2 = W_3$

335 **(c)**

Useful work $= \frac{75}{100} \times 12\text{ J} = 9\text{J}$

Now, $\frac{1}{2} \times 1 \times v^2 = 9$ or $v = \sqrt{18}\text{ ms}^{-1}$

336 **(b)**

Momentum of third part will be equal to the resultant of momenta of two part

$P_3^2 = P_1^2 + P_2^2$

Or $p_3 = \sqrt{P_1^2 + P_2^2}$

Or $3mv_3 = \sqrt{(m \times 30)^2 + (m \times 30)^2}$

Or $v_3 = \frac{30\sqrt{2}}{3} 10\sqrt{2} ms^{-1}$

337 **(c)**

Power given to turbine $= \frac{mgh}{t}$

$P_{in} = \left(\frac{m}{t}\right) \times g \times h \Rightarrow P_{in} = 15 \times 10 \times 60$

$\Rightarrow P_{in} = 9000\ W \Rightarrow P_{in} = 9\ kW$

As efficiency of turbine is 90% therefore power generated = 90% of 9 kW

$P_{out} = 9 \times \frac{90}{100} \Rightarrow P_{out} = 8.1\ kW$

338 **(a)**

In an inelastic collision, only momentum is conserved whereas in elastic collision both momentum and kinetic energy are conserved

339 **(c)**

When the ball is released from the top of tower then ratio of distances covered by the ball in first, second and third second

$h_I : h_{II} : h_{III} = 1:2:3$[Because $h_n \propto (2_n - 1)$]

$\therefore$ *Ratio of work done*

$mgh_I : mgh_{II} : mgh_{III} = 1:3:5$

340 **(a)**

$\vec{\mathbf{F}}.d\vec{\mathbf{F}} = (x\hat{\mathbf{i}} + y\hat{\mathbf{j}}).(dx\hat{\mathbf{i}} + dy\hat{\mathbf{j}})$

$= xdx + ydy$

341 **(c)**

Friction is a non-conservative force. Work done by a non-conservative force over a closed path is not zero. Hence, option (c) is a false statement

342 **(b)**

Initial velocity of particle, $v_i = 20\text{ ms}^{-1}$

Final velocity of the particle, $v_f = 0$

According to work-energy theorem,

$W_{\text{net}} = \Delta\text{KE} = K_f - K_i$

$= \frac{1}{2}m(v_f^2 - v_i^2)$

$= \frac{1}{2} \times 2(0^2 - 20^2)$

$= -400\text{ J}$

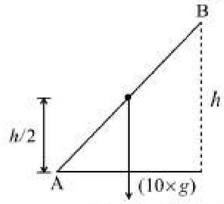
343 **(a)**

Work = Force × Displacement (length)

If unit of force and length be increased by four times then the unit of energy will increase by 16 times

344 **(b)**

Work done $= mg(h/2)$



$100 = \frac{10 \times 10 \times h}{2}$

$\Rightarrow h = 2.0\ m$

345 **(c)**

When a force of constant magnitude which is perpendicular to the velocity of particle acts on a particle, work done is zero and hence change in kinetic energy is zero

346 **(a)**

Power of gun $= \frac{\text{Total K.E.of fired bullet}}{\text{time}}$

$= \frac{n \times \frac{1}{2}mv^2}{t} = \frac{360}{60} \times \frac{1}{2} \times 2 \times 10^{-2} \times (100)^2$

$= 600\ W$

347 **(a)**

Power of motor initially $= p_0$

Let, rate of flow of motor $= (x)$

Since, power, $p_0 = \frac{work}{time} = \frac{mgy}{t} = mg\left(\frac{y}{t}\right)$,

$\frac{y}{t} = x =$ rate of flow of water

$= mgx$ ....(i)

If rate of flow of water is increased by n times, $i.e., (nx)$

Increased power, $p_1 = \frac{mgy\prime}{t} = mg\left(\frac{y'}{t}\right)$,

$= nmgx$ ....(ii)

The ratio of power

$\frac{p_1}{p_0} = \frac{n\ mgx}{mgx} = \frac{n}{1} \Rightarrow p_1 : p_0 \Rightarrow n:1$

348 **(a)**

Initially ^{238}U nucleus was at rest and after decay its part moves in opposite direction

According to conservation of momentum

$4v + 234V = 238 \times 0 \Rightarrow V = -\frac{4v}{234}$

349 **(d)**

Condition for vertical looping

$h = \frac{5}{2}r = 5cm \;\therefore r = 2\ cm$

350 **(c)**

Kinetic energy $= \frac{1}{2}mv^2$

As both balls are falling through same height therefore the possess same velocity

But $KE \propto m$ [If v = constant]

$\therefore \frac{(KE)_1}{(KE)_2} = \frac{m_1}{m_2} = \frac{2}{4} = \frac{1}{2}$

351 **(b)**

Power delivered to body

P=F$\cdot v$

$=mav$

$=ma(0+gt)$ $(\because u = o)$

$= magt$

Or $P \propto t$

353 **(b)**

When particle moves away from the origin then at position $x = x_1$ force is zero and at $x > x_1$, force is positive (repulsive in nature) so particle moves further and does not return back to original position

$i.e.$ the equilibrium is not stable

Similarly at position $x = x_2$ force is zero and at $x > x_2$, force is negative (attractive in nature)

So particle return back to original position $i.e.$ the equilibrium is stable

354 **(a)**

By conservation of momentum, $mv + M \times 0 = (m+M)V$

Velocity of composite block $V = \left(\frac{m}{m+M}\right)v$

K.E. of composite block $= \frac{1}{2}\ (M+m)V^2$

$= \frac{1}{2}\ (M+m)\left(\frac{m}{M+m}\right)^2 v^2 = \frac{1}{2}\ mv^2\left(\frac{m}{m+M}\right)$

355 **(d)**

Work done by the gun

=Total kinetic energy of the bullets

$= n = \frac{1}{2}mv^2$

$= 240 \times \frac{1}{2} \times 10 \times 10^{-3}(600)^2$

$= 120 \times \frac{1}{2} \times 10 \times 10^{-3} \times 600 \times 600$

$\therefore \quad Power\ of\ gun = \frac{work\ done}{time\ taken}$

$= \frac{120 \times 10 \times 10^{-3} \times 600 \times 600}{1min}$

$= \frac{120 \times 10 \times 360}{60} = 120 \times 10 \times 6w$

$\frac{120 \times 10 \times 6}{1000}kW = 7.2kW$

356 **(a)**

K.E. acquired by the body = work done on the body

$K.E. = \frac{1}{2}mv^2 = Fs$ $i.e.$ it does not depend upon the mass of the body although velocity depends upon the mass

$v^2 \propto \frac{1}{m}$ [If F and s are constant]

357 **(c)**

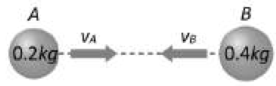
$P = \sqrt{2mE}\ \therefore P \propto \sqrt{m}$ (if E = const) $\therefore \frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}}$

358 **(a)**

$\frac{1}{2}kx^2 = \frac{1}{2}mv^2 + \frac{1}{2}mv^2 = mv^2$

$x = \sqrt{\frac{2mv^2}{k}}$

359 **(c)**



Initial linear momentum of system $= m_A\vec{v}_A + m_B\vec{v}_B$

$= 0.2 \times 0.3 + 0.4 \times v_B$

Finally both balls come to rest

$\therefore$ final linear momentum = 0

By the law of conservation of linear momentum

$0.2 \times 0.3 + 0.4 \times v_B = 0$

$\therefore v_B = -\frac{0.2 \times 0.3}{0.4} = -0.15\ m/s$

360 **(c)**

As the ball bounces back with same speed so change in momentum = 2 mv

And we know that force = rate of change of momentum

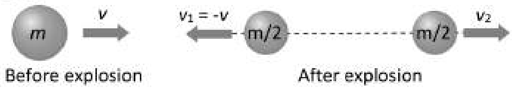
$i.e.$ force will act on the ball so there is an acceleration

361 **(a)**

Spring constant $k = \frac{F}{x}$ = Slope of curve

$\therefore k = \frac{4-1}{30} = \frac{3}{30} = 0.1\ kg/cm$

362 **(b)**



Let the initial mass of body = m

Initial linear momentum = mv ...(i)

When it breaks into equal masses then one of the fragment retrace back with same velocity

$\therefore$ Final linear momentum $= \frac{m}{2}(-v) + \frac{m}{2}(v_2)$ ...(ii)

By the conservation of linear momentum

$\Rightarrow mv = \frac{-mv}{2} + \frac{mv_2}{2}$

$\Rightarrow v_2 = 3v$

i.e., other fragment moves with velocity $3v$ in forward direction

363 **(a)**

Effective height through which man moves up $= 1 - h$

364 **(d)**

Work done (W) = Area under curve of F-x graph = Area of triangle $OAB = \frac{1}{2} \times 5 \times 1 = 2.5$ J

365 **(c)**

According to work-energy theorem,

$W = \Delta K = 0$

($\because$ Initial and final speeds are zero)

$\therefore$ work done by friction +work done by gravity=0

$-(\mu\, mg\, \cos\emptyset)\,\frac{l}{2} + mgl\, \sin\emptyset = 0$

$or\ \frac{\mu}{2}\cos\emptyset = \sin\emptyset$

$\therefore\ \mu = 2\tan\emptyset$

366 **(c)**

Force produced by the engine $F = \frac{P}{v} = \frac{30\times10^3}{30} = 10^3 N$

Acceleration $= \frac{\text{Forward force by engine} - \text{resistive force}}{\text{mas of car}}$

$= \frac{1000-750}{1250} = \frac{250}{1250} = \frac{1}{5}\ m/s^2$

369 **(c)**

The work done in stretching a sprig by a length x,

$W_1 = \frac{1}{2}kx^2$ ...(i)

The work done in stretching the spring by a further length$x$.

$W_2 = \frac{1}{2}k(2x)^2 - \frac{1}{2}kx^2$

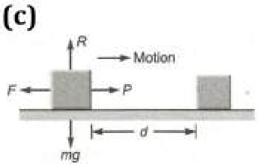
Or $W_2 = \frac{1}{2}k \times 4x^2 - \frac{1}{2}kx^2$

Or $W_2 = 3 \times \frac{1}{2}kx^2$ ...(ii)

From Esq. (i) and (ii)we have

$W_2 = 3W_1$

370 **(c)**



As shown a block of mass M is lying over rough horizontal surface. Let μ be the coeeficient of kinetic friction between the two surfaces in contact. The force Of friction between the block and horizontal surface is given by

$F = \mu R = \mu Mg \quad (\because R = Mg)$

To move the block without acceleration, the force (P)required will be just equal to the force of friction , ie ,

$P = F = \mu R$

If d is the distance moved , then work done is given by

$W = P \times d = \mu Rd$

371 **(a)**

Kinetic energy of the block is

$K = \frac{1}{2}mv^2$

This kinetic energy is equal to the work done by the block before coming to rest. The work done in compressing the spring through a distance x from its normal length is

$W = \frac{1}{2}kx^2$

$\therefore \quad \frac{1}{2}mv^2 = \frac{1}{2}kx^2$

$\Rightarrow \quad x = v\sqrt{\frac{m}{k}}$

Given,$v = 4m/s, m = 16kg, k = 100$ N/m

$\therefore x = 4 \times \sqrt{\frac{16}{100}} = 1.6\ m$

372 **(b)**

Given that,

$K_1 + K_2 = 5.5\ MeV \quad ...(i)$

From conservation of linear Momentum

Or $\sqrt{2K_1(216m)} = \sqrt{2k_2(4m)}$

Or $k_2 = 54\,K_1 \quad ...(ii)$

Solving Eq.(i)& (ii),we get

$k_2 = KE$ of $\alpha - particle = 5.4 Me\ V$.

373 **(d)**

Work done in raising water $= mgh$

$\therefore W =$ (volume $\times$ density) $gh = (9 \times 1000) \times 10 \times 10$

$\Rightarrow W = 9 \times 10^5\ J$

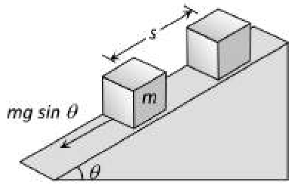
$\therefore$ Useful power $= \frac{\text{work}}{\text{time}} = \frac{9\times10^5}{5\times60} = 3kW$

$\therefore$ Efficiency $= \frac{3}{10} = 30\%$

374 **(d)**

As the body moves in the direction of force therefore work done by gravitational force will be positive

$W = Fs = mgh = 10 \times 9.8 \times 10 = 980\ J$



375 **(a)**

Given that, $S = \frac{1}{3}t^2$

$v = \frac{dS}{dt} = \frac{2}{3}t;\ a = \frac{d^2S}{dt^2} = \frac{2}{3}$

$F = ma = 3 \times \frac{2}{3} = 2\text{N};\quad \text{Work} = 2 \times \frac{1}{3}t^2$

At t=2

$\text{Work} = 2 \times \frac{1}{3} \times 2 \times 2 = \frac{8}{3}\text{J}$

376 **(b)**

In elastic collision

$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 + \left(\frac{2m_2}{m_1 + m_2}\right)u_2$

If the second ball is at rest ,ie $u_2 = 0$,then

$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1$

$\frac{2}{3}u_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 \quad \left[\because v_1 = \frac{2}{3}u_1\right]$

Or $2m_1 + 2m_2 = 3m_1 - 3m_2$

Or $m_1 = 5m_2$

Or $\frac{m_1}{m_2} = \frac{5}{1}$

377 **(a)**

From Newton's second law,

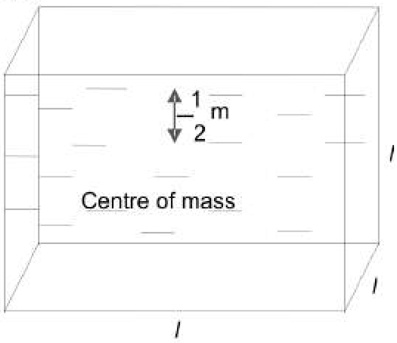
$F = \frac{dp}{dt}$

If F=0,then $\frac{dp}{dt} = 0$

$\Rightarrow \quad p = constant$

Thus, if total external force acting on the system is zero, then linear momentum of the system remains conserved.

378 **(b)**



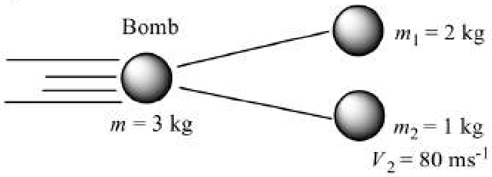
$V = l^3 = 1m^3$

$m = 1 \times 1000 = 1000\text{kg}$

$W = mgh = 1000 \times 10 \times \frac{1}{2} = 5000\ \text{J}$

379 **(d)**

From law of conservation of momentum, when no external force acts upon a system of two (or more) bodies, then the total momentum of the system remains constant.



Momentum before explosion =momentum after explosion.

since bomb v at rest, its velocity is zero, hence,

$mv = m_1v_1 + m_2v_2$

$3 \times 0 = 2v_1 + 1 \times 80$

$or\ v_1 = -\frac{80}{2} = -40ms^{-1}$

Total energy imparted is

$\text{KE} = \frac{1}{2}\text{m}_1\text{v}_1^2 + \frac{1}{2}\text{m}_2\text{v}_2^2$

$= \frac{1}{2} \times 2 \times (-40)^2 + \frac{1}{2} \times 1 \times (80)^2$

=1600+3200=4800J

=4.8kJ

380 **(a)**

Let d_s be the distance travelled by the vehicle before it stops

Here, final velocity $v = 0$, initial velocity $= u$

Using equation of motion $v^2 = u^2 + 2aS$

$\therefore 0^2 = u^2 + 2ad_s$

Or Stopping distance, $d_s = -\frac{u^2}{2a}$

381 **(d)**

Given $F = 2x$,

Work done $W = \int F\,dx$

$\therefore W = \int_{x_1}^{x_2} 2x\,dx = 2\left[\frac{x^2}{2}\right]_{x1}^{x2}$

$=(x_2^2 - x_1^2)$

383 **(b)**

Here $t = \sqrt{x} + 3$

or $x = (t-3)^2 = t^2 - 6t + 9$

$v = \frac{dx}{dt} = 2t - 6$

At $t = 0$ s, $v = 2 \times 0 - 6 = -6$

At $t = 6$ s, $v = 2 \times 6 - 6 = +6$

Initial and final KE are same hence no work is done

$$W = \frac{1}{2}m(v_1^2 - v_2^2) = 0$$

384 **(a)**

Given, m=2kg, v=20ms^{-1}, $\theta = 60°$

Power(P)is given as

$P = F \cdot v = Fv\cos\theta$

$P = mgv \cos\theta$

$\therefore\ P = 2 \times 20 \times 10 \times \cos 60°$

$P = 2 \times 20 \times 10 \times \frac{1}{2}$

$\Rightarrow\ P = 200$ W

386 **(d)**

Kinetic energy of ball=potential energy of spring

i.e., B $\frac{1}{2}mv^2 = \frac{1}{2}kx^2$

$\therefore\ 16 \times 10^{-3} \times v^2 = \frac{90}{10^{-2}} \times (12 \times 10^{-2})^2$

Or $v^2 = \frac{90\times144\times10^{-4}}{10^{-2}\times16\times10^{-3}}$

Or $v = 90ms^{-1}$

387 **(b)**

$$\frac{1}{2}mv^2 = \frac{1}{2}kx^2 \Rightarrow x = v\sqrt{\frac{m}{k}} = 10\sqrt{\frac{0.1}{1000}} = 0.1\ m$$

388 **(d)**

$P = v\cos\theta = mg\ v\cos 90° = 0$

389 **(c)**

Initial momentum of the system $= mv - mv = 0$

As body sticks together ∴ final momentum $= 2mV$

By conservation of momentum $2mV = 0 \therefore V = 0$

390 **(a)**

$P = \sqrt{2mE}\ \therefore P \propto \sqrt{E}$ *i.e.*, if kinetic energy becomes four times then new momentum will become twice

391 **(b)**

Let Mbe the mass of body moving with velocity v and m be mass of each broken part, velocity of one part which retraces back is v and that of second part is v'.

Momentum before breaking=momentum after breaking

$Mv = m(-v) + mv'$

Or $v' = \frac{Mv+mv}{m}$

Since, M=2m,therefore

$$v' = \frac{(2m+m)v}{m} = 3v$$

392 **(b)**

Potential energy=Kinetic energy

Ie, $mgh = \frac{1}{2}mv^2$

Or $v = \sqrt{2gh}$

If h_1 and h_2 are initial and final heights, then

$v_1 = \sqrt{2gh_1},\ \ v_2 = \sqrt{2gh_2}$

Loss in velocity

$\Delta v = v_1 - v_2 = \sqrt{2gh_1} - \sqrt{2gh_2}$

∴Fractional loss in velocity $=\frac{\Delta v}{v_1}$

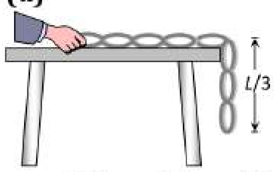
$$= \frac{\sqrt{2gh_1} - \sqrt{2gh_2}}{\sqrt{2gh_1}}$$

$$\frac{\Delta v}{v_1} = 1 - \sqrt{\frac{h_2}{h_1}}$$

$$= 1 - \sqrt{\frac{1.8}{5}}$$

$$= 1 - \sqrt{0.36} = 1 - 0.6 = 0.4 = \frac{2}{5}$$

393 **(d)**



$W = \frac{MgL}{2n^2} = \frac{MgL}{2(3)^2} = \frac{MgL}{18}$ [$n = 3$ Given]

394 **(a)**

In head on elastic collision velocity get interchanged (if masses of particle are equal) *i.e.* the last ball will move with the velocity of first ball *i.e.* 0.4 m/s

395 **(d)**

Area between curve and displacement axis

$= \frac{1}{2} \times (12 + 4) \times 10 = 80\ J$

In this time body acquire kinetic energy $= \frac{1}{2}\ mv^2$

By the law of conservation of energy

$\frac{1}{2}mv^2 = 80\ J$

$\Rightarrow \frac{1}{2} \times 0.1 \times v^2 = 80 \Rightarrow v^2 = 1600 \Rightarrow v$

$= 40\ m/s$

396 **(a)**

$\frac{1}{2}kS^2 = 10\ J$ [Given in the problem]

$\frac{1}{2}k[(2S)^2 - (S)^2] = 3 \times \frac{1}{2}kS^2 = 3 \times 10 = 30\ J$

397 **(a)**

Given a=-kx

$a = \frac{dv}{dt} = \frac{dv}{dx}.\frac{dx}{dt} = -kx$

Or $\frac{vdv}{dx} = -kx$

Or $v\ dv = -kx\ dx$

Let for any displacement from 0 to x,the velocity changes from $v_0 to\ v$.

$$\Rightarrow \int_{v0}^{v} vdv = -\int_{0}^{x} k\ \ x\,dx$$

Or $\frac{v^2-v_0^2}{2} = -\frac{kx^2}{2}$

$$or\ \ m\left(\frac{v^2-v_0^2}{2}\right) = -\frac{mkx^2}{2}$$

Or $\Delta K \propto x^2$ $\quad (\Delta K\ is\ loss\ in\ KE)$

398 **(d)**

Here, $m_1 = 20$ kg,

$m_2 = 0.1$ kg,

$v_1 =$ velocity of recoil of gun,

$v_2\ =$ velocity of bullet

As $\ m_1 v_1 = m_2 v_2$

$$v_1 = \frac{m_2}{m_1} v_2 = \frac{0.1}{20} v_2 = \frac{v_2}{200}$$

Recoil energy of gun= $\frac{1}{2} m_1 v_1^2$

$$= \frac{1}{2} \times 20 \left(\frac{v_2}{200}\right)^2$$

$$804 = \frac{10 v_2^2}{4 \times 10^4} = \frac{v_2^2}{4 \times 10^3}$$

$$v_2 = \sqrt{804 \times 4 \times 10^3} \text{ms}^{-1}$$

399 **(c)**

According to law of conservation of momentum

Momentum of neutron = Momentum of combination

$$\Rightarrow 1.67 \times 10^{-27} \times 10^8 = (1.67\ \times 10^{-27} + 3.34 \times 10^{-27}) v$$

$$\therefore v = 3.33 \times 10^7\ m/s$$

400 **(d)**

According to law of conservation of energy

$$\frac{1}{2} mu^2 = \frac{1}{2} mv^2 + mgh$$

$$490 = 245 + 5 \times 9.8 \times h$$

$$h = \frac{245}{49} = 5m$$

401 **(c)**

Initially, $4u = 8 \Rightarrow u = 2\text{m/s}$

Now, $\ \ mv - mu = Ft$

$mv - 8 = 0.2 \times 10$

or $\ v = 5/2\ \text{ms}^{-1}$

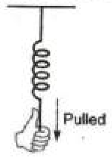
Increase in KE = $\frac{1}{2} m(v^2 - u^2)$

$$= \frac{1}{2} \times 4 \left[\left(\frac{5}{2}\right)^2 - (2)^2\right]$$

$= 4.5$ J

402 **(b)**

The work done in pulling the string is stored as potential energy in the spring



$U = \frac{1}{2} kx^2$ $\qquad$ ...(i)

Where k is spring constant and $x$is distance through which it is pulled.

Also in SHM

Force $\propto$ displacement

$F = kx$ $\qquad$ ....(ii)

Putting $x = \frac{F}{k}$in Eq. (i),we get

$$\text{U}= \frac{1}{2} k \left(\frac{F}{k}\right)^2 = \frac{F^2}{2k}$$

$$\therefore \frac{U_1}{U_2} = \frac{K_2}{K_1} = \frac{3000}{1500} = \frac{2}{1}$$

$$\therefore\ U_1 : U_2 = 2:1$$

403 **(d)**

Let a nucleus of mass M splits into two nuclear parts having masses M_1 and M_2 and radii R_1 and R_2 and densities ρ_1 and ρ_2

$\therefore M_1 = \rho_1 \frac{4}{3} \pi R_1^3$ and $M_2 = \rho_2 \frac{4}{3} \pi R_2^3$

Given: $\rho_1 = \rho_2$

$$\therefore \frac{M_1}{M_2} = \left(\frac{R_1}{R_2}\right)^3$$

According to law conservation of linear momentum,

$M \times 0 = M_1 v_1 + M_2 v_2$ or $\frac{M_1}{M_2} = -\frac{v_2}{v_1}$

$-ve$ sign show that both the parts are move in opposite direction in order to conserve the linear momentum

$$\therefore \frac{v_1}{v_2} = \frac{M_2}{M_1} \text{ or } \frac{v_1}{v_2} = \left(\frac{R_2}{R_1}\right)^3$$

$\frac{v_1}{v_2} = \left(\frac{2}{1}\right)^3 = \frac{8}{1}$ $\left[\text{Given} \frac{R_1}{R_2} = \frac{1}{2}\right]$

404 **(d)**

Potential energy $V = \frac{x^4}{4} - \frac{x^2}{2}$

For maximum kinetic energy, potential energy of a particle should be minimum

For minimum value of $V, \frac{dV}{dx} = 0$ and $\frac{d^2V}{dx^2} > 0$

Force $F = -\left(\frac{dV}{dx}\right) = \frac{4x^3}{4} - \frac{2x}{2} = 0 \Rightarrow x^3 - x = 0$

$\Rightarrow x(x^2 - 1) = 0$

$i.e.$ at $x = 0, x = +1$ and $x = -1$ for on the particle will be zero

Now $\frac{d^2V}{dx^2} = 3x^2 - 1$

For $x = +1$ and $x = -1 \frac{d^2V}{dx^2} > 1$

It means the potential energy of the particle will be minimum at $x = 1$ and $x = -1$

Now substituting these values in expression of potential energy

Energy $V_{\min} = \left[\frac{(1)^4}{4} - \frac{(1)^2}{2}\right] J = \left[\frac{1}{4} - \frac{1}{2}\right] J = -\frac{1}{4} J$

$$(\text{Kinetic energy})_{\max} = \text{Total energy} - (\text{potential energy})_{\min} = 2 - \left(-\frac{1}{4}\right)$$

$$\frac{1}{2} mv_{\max}^2 = \frac{9}{4} \Rightarrow v_{\max}^2 = \frac{9}{2} \Rightarrow v_{\max} = \frac{3}{\sqrt{2}}\ m/sec$$

405 **(d)**

All the central forces are conservative

406 **(b)**

$$W = \int F dy$$

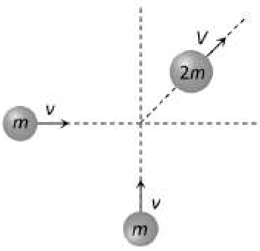
$$= \int_{-a}^{+a} (Ay^2 + By + C) dy$$

$$= \left[\frac{Ay^3}{3} + \frac{By^2}{2} + Cy\right]_{-a}^{+a}$$

$$= \left[\frac{Aa^3}{3} + \frac{Ba^2}{2} + Ca\right] - \left[-\frac{Aa^3}{3} + \frac{Ba^2}{2} - Ca\right]$$

$$= \frac{2Aa^3}{3} + 2Ca$$

407 **(c)**



Initial momentum of the system

$\vec{p}_1 = mv\hat{\imath} + mv\hat{\jmath} \Rightarrow |\vec{P}_i| = \sqrt{2}mv$

Final momentum of the system $= 2mV$

By the law of conservation of momentum

$\sqrt{2}mv = 2mV \Rightarrow V = \frac{v}{\sqrt{2}}$

408 **(c)**

As the bomb initially was at rest therefore

Initial momentum of bomb = 0

Final momentum of system $= m_1v_1 + m_2v_2$

As there is no external force

$\therefore m_1v_1 + m_2v_2 = 0 \Rightarrow 3 \times 1.6 + 6 \times v_2 = 0$

Velocity of 6 kg mass $v_2 = 0.8\ m/s$ (numerically)

Its kinetic energy $= \frac{1}{2} m_2 v_2^2 = \frac{1}{2} \times 6 \times (0.8)^2 = 1.92\ J$

409 **(a)**

As particle is projected with some velocity therefore its initial kinetic energy will not be zero

As it moves downward under gravity then its velocity increases with time K. E. $\propto v^2 \propto t^2$ [As $v \propto t$]

So the graph between kinetic energy and time will be parabolic in nature

410 **(a)**

Motor makes 600 revolution per minute

$\therefore n = 600 \frac{\text{revolution}}{\text{minute}} = 10 \frac{rev}{sec}$

$\therefore$ Time required for one revolution $= \frac{1}{10}\ sec$

Energy required for one revolution = power × time

$= \frac{1}{4} \times 746 \times \frac{1}{10} = \frac{746}{40}\ J$

But work done = 40% of input

$= 40\% \times \frac{746}{40} = \frac{40}{100} \times \frac{746}{40} = 7.46\ J$

411 **(d)**

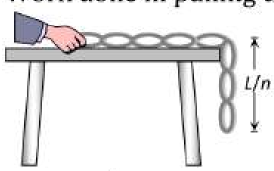
In perfectly elastic lead on collision of equal masses velocities gets interchanged

412 **(b)**

Fraction of length of the chain hanging from the table

$= \frac{1}{n} = \frac{60\ cm}{200\ cm} = \frac{3}{10} \Rightarrow n = \frac{10}{3}$

Work done in pulling the chain on the table



$$W = \frac{mgL}{2n^2}$$

$$= \frac{4 \times 10 \times 2}{2 \times (10/3)^2} = 3.6\ J$$

413 **(d)**

$\because$ Speed is constant

$\therefore$ Work done by forces = 0

$\therefore$ Power $= \frac{\text{Work}}{\text{Time}} = 0$

414 **(c)**

When the block moves vertically downward with acceleration $\frac{g}{4}$ then tension in the cord

$T = M\left(g - \frac{g}{4}\right) = \frac{3}{4}Mg$

Work done by the cord $\vec{F}.\vec{S} = FS\cos\theta$

$= Td\cos 180°$

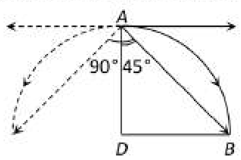
$= \left(-\frac{3}{4}Mg\right) \times d = -3Mg\frac{d}{4}$

415 **(c)**

As the body at rest explodes into two equal parts, they acquire equal velocities in opposite directions according to conservation of momentum

When the angle between the radius vectors connecting the point of explosion to the fragments is 90°, each radius vector makes an angle 45° with the vertical.

To satisfy this condition, the distance of free fall AD should be equal to the horizontal range in same interval of time



$AD = DB$

$AD = 0 + \frac{1}{2} \times 10t^2 = 5t^2$

$DB = ut = 10t$

$\therefore 5t^2 = 10t \Rightarrow t = 2\ sec$

416 **(b)**

The work is stored as the PE of the body and is given by,

$U = \int_{x_1}^{x_2} F_{\text{external}} dx$

Or $U = \int_{x_1}^{x_2} kx\,dx$

$= \frac{1}{2}k(x_2^2 - x_1^2)$

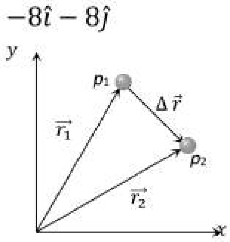
$= \frac{800}{2}[(0.15)^2 - (0.05)^2][K = 800\ (\text{given})]$

$= 400[0.2 \times 0.1]$

$= 8$ J

417 **(d)**

It is clear from figure that the displacement vector $\Delta\vec{r}$ between particles p_1 and p_2 is $\Delta\vec{r} = \vec{r_2} - \vec{r_1} = -8\hat{\imath} - 8\hat{\jmath}$



$|\Delta\vec{r}| = \sqrt{(-8)^2 + (-8)^2} = 8\sqrt{2}$ ....(i)

Now, as the particles are moving in same direction

($\because \vec{v_1}$ and $\vec{v_2}$ are $+ve$), the relative velocity is given by

$\vec{v}_{rel} = \vec{v_2} - \vec{v_1} = (\alpha - 4)\hat{\imath} + 4\hat{\jmath}$

$|\vec{v}_{rel}| = \sqrt{(\alpha-4)^2 + 16}$ ...(ii)

Now, we know $|\vec{v}_{rel}| = \frac{|\Delta\vec{r}|}{t}$

Substituting the values of $\vec{v}_{rel}$ and $|\Delta\vec{r}|$ from equation (i) and (ii) and $t = 2s$, then on solving we get $\alpha = 8$

419 **(c)**

Loss in K.E. $= \frac{m_1 m_2}{2(m_1+m_2)}(u_1 - u_2)^2$

$= \frac{4 \times 6}{2 \times 10} \times (12 - 0)^2 = 172.8\,J$

420 **(d)**

In compression or extension of a spring work is done against restoring force

In moving a body against gravity work is done against gravitational force of attraction

It means in all three cases potential energy of the system increases

But when the bubble rises in the direction of upthrust force then system works so the potential energy of the system decreases

421 **(c)**

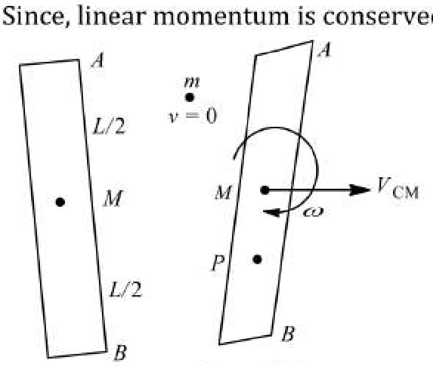
When the ball is released from the top of tower then ratio of distances covered by the ball in first, second and third second

$h_I : h_{II} : h_{III} = 1:3:5$: [Because $h_n \propto (2n-1)$]

$\therefore$ Ratio of work done $mgh_I : mgh_{II} : mgh_{III} = 1:3:5$

422 **(a)**

Since, linear momentum is conserved



Before collision After collision

$mv_0 = Mv_{CM}$ .... (i)

Angular momentum is also conserved

$mv_0\frac{L}{2} = \frac{ML^2}{12}\omega$ ..... (ii)

Where $\frac{ML^2}{12}$ is the moment of inertia of the rod about the axis of rotation

Since, collision is completely elastic , kinetic energy is also conserved .Thus,

$$\frac{1}{2}mv_0^2 = \frac{1}{2}M_{v_{CM}} + \frac{1}{2}\left(\frac{ML^2}{12}\right)^2 \omega^2$$

From Eqs. (i)and (ii),We get

$$v_{CM} = \frac{1}{6}\omega L$$

Putting this value in Eq. (iii),we get

$$\frac{1}{2}mv_0^2 = \frac{1}{2}M\left(\frac{1}{36}\omega^2 L^2\right) + \frac{1}{2}M\left(\frac{1}{12}\omega^2 L^2\right)$$

$$\frac{1}{18}M\omega^2 L^2$$

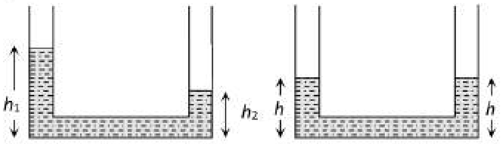
OR $\frac{m}{M} = \frac{\omega^2 L^2}{9V_O^2}$

423 **(c)**

$P = \sqrt{2mE}$. If E are same then $P \propto \sqrt{m}$

$$\Rightarrow \frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$$

425 **(d)**



If h is the common height when they are connected, by conservation of mass

$\rho A_1 h_1 + \rho A_2 h_2 = \rho h(A_1 + A_2)$

$h = (h_1 + h_2)/2$ [As $A_1 = A_2 = A$ given]

As $(h_1/2)$ and $(h_2/2)$ are heights of initial centre of gravity of liquid in two vessels, the initial potential energy of the system

$U_i = (h_1 A\rho)g\frac{h_1}{2} + (h_2 A\rho)g\frac{h_2}{2} = \rho g A\frac{(h_1^2+h_2^2)}{2}$ ...(i)

When vessels are connected the height of centre of gravity of liquid in each vessel will be $h/2$

$i.e. \left(\frac{(h_1+h_2)}{4}\right)$ [as $h = (h_1 + h_2)/2$]

Final potential energy of the system

$$U_F = \left[\frac{(h_1 + h_2)}{2}A\rho\right]g\left(\frac{h_1 + h_2}{4}\right)$$

$= A\rho g\left[\frac{(h_1+h_2)^2}{4}\right]$ ...(ii)

Work done by gravity

$$W = U_i - U_f = \frac{1}{4}\rho g A[2(h_1^2 + h_2^2) - (h_1 + h_2)^2]$$

$$= \frac{1}{4}\rho g A(h_1 - h_2)^2$$

426 **(b)**

$f = \mu mg\cos\theta$

or $f = 0.30 \times 10 \times 10\cos 45°$

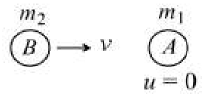
or $f = \frac{30}{\sqrt{2}}$ N

$W = f \times s$

$$= \frac{30}{\sqrt{2}} \times 5 = \frac{150}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} = 75\sqrt{2}\text{ J}$$

This is negative work because f and s are oppositely directed

427 **(d)**



Conservation of linear momentum along x-direction

$m_2 v = m_1 v_x$

$\frac{m_2 v}{m_1} = v_x$

Along y direction

$m_2 \times \frac{v}{2} = m_1 v_y$

$\tan\theta = \frac{1}{2}$

428 **(b)**

$$\frac{E_{k'}}{E_k} = \left(1 + \frac{1}{5}\right)^2 = \frac{36}{25}$$

$$\left(\frac{E_{k'}}{E_k} - 1\right) \times 100 = \left(\frac{36}{26}\right) \times 100 = 44$$

429 **(d)**

Initial K.E. of the body $= \frac{1}{2}mv^2 = \frac{1}{2} \times 25 \times 4 = 50\,J$

Work done against resistive force

= Area between F-x graph $= \frac{1}{2} \times 4 \times 20 = 40J$

Final K.E. = Initial K.E. – work done against resistive force

$= 50 - 40 = 10J$

430 **(a)**

Kinetic energy is the energy possessed by a body due to its velocity(v)given by

$K = \frac{1}{2}mv^2$ ...(i)

Momentum(P)=$m \times v$ ...(ii)

Given, $K = p$

$\therefore \frac{1}{2}mv^2 = mv$ or $v = 2ms^{-1}$

431 **(a)**

$V(x) = (x^2 - 3x)\,J$

For a conservation field. Force, $F = -\frac{dV}{dx}$

$$\therefore F = -\frac{d}{dx}(x^2 - 3x) = -(2x - 3) = -2x + 3$$

At equilibrium position, $F = 0$

$-2x + 3 = 0$

$x = \frac{3}{2}m = 1.5\,m$

432 **(a)**

Let initial kinetic energy, $E_1 = E$

Final kinetic energy, $E_2 = E + 300\%$ of $E = 4E$

As $P \propto \sqrt{E} \Rightarrow \frac{P_2}{P_1} = \sqrt{\frac{E_2}{E_1}} = \sqrt{\frac{4E}{E}} = 2 \Rightarrow P_2 = 2P_1$

$\Rightarrow P_2 = P_1 + 100\%$ of P_1

i.e., Momentum will increase by 100%

433 **(c)**

Between two collisions direction of velocity of ball get reserved at the highest point

434 **(c)**

$P = \vec{F}.\vec{v} = Fv\cos\theta$

Just before hitting θ is zero and both F, v are maximum

435 **(a)**

The ratio of masses=1:3

Therefore ,$m_1 = xkg, m_2 = 3x\ kg$

Applying law of conservation of momentum

$m_1v_1 + m_2v_2 = 0$

$\Rightarrow \quad x \times v_1 + 3x \times 4 = 0$

Or $\quad v_1 = -12ms^{-1}$

Therefore, velocity of lighter mass is opposite to that of heavier mass.

436 **(c)**

Kinetic energy $= \frac{1}{2}mv^2$

As both balls are falling through same height, therefore they possess same velocity.

$\therefore \quad \frac{(\text{KE})_1}{(\text{KE})_2} = \frac{m_1}{m_2} = \frac{2}{4} = \frac{1}{2}$

437 **(d)**

There is no loss of energy. Therefore, the final velocity is the same as the initial velocity.

Hence, The speed of roller coaster at point D is u

438 **(b)**

In case of non-conservative forces, the work done is dissipated as heat, sound etc. *ie*, it does not increase the potential energy. But in case of conservative forces, work done is responsible for increasing the potential energy

440 **(c)**

From energy conservation,

$\frac{1}{2}kx^2 = \frac{1}{2}(4k)y^2$

$\frac{y}{x} = \frac{1}{2}$

442 **(c)**

From equation of motion,

$v^2 = u^2 - 2as$

$(500)^2 = (1000)^2 - 2 \times a \times s$

$s = \frac{(1000)^2 - (500)^2}{2a} = \frac{375000}{a}$

$\therefore$work done against air resistance

$w = Fs$

$= ma \times s$

$= \frac{10}{1000}a \times \frac{375000}{a}$

$= 3750$ J

443 **(d)**

KE of colliding body before collision=$\frac{1}{2}mv^2$

After collision its velocity becomes

V'=$\left(\frac{m_1 - m_2}{m_1 + m_2}\right)v = \frac{m}{3m}v = \frac{v}{3}$

KE after collision=$\frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{v}{3}\right)^2$

$= \frac{1}{2}\frac{mv^2}{9}$

Ratio of kinetic energy=$\frac{KE_{before}}{KE_{after}}$

$= \frac{\frac{1}{2}mv^2}{\frac{1}{2}\frac{mv^2}{9}} = \frac{9}{1}$

444 **(b)**

$a_A = \frac{F}{m_A} = \frac{4 \times 10}{20} = 2ms^{-2}$

$a_B = \frac{F}{m_B} = \frac{4 \times 10}{5} = 8ms^{-2}$

Given that, $\quad K_A = K_B$

i.e., $\quad \frac{1}{2}m_Av_A^2 = \frac{1}{2}m_Bv_B^2$

Or $\quad m_A(u + a_At_A)^2 = m_B(u + a_Bt_B)^2 \quad (\because v = u + at)$

Or $\quad m_Aa_A^2t_A^2 = m_Ba_B^2t_B^2 \quad (\because u = 0)$

Or $\quad \frac{t_A}{t_B} = \sqrt{\frac{m_B}{m_A} \times \frac{a_B^2}{a_A^2}}$

$= \sqrt{\frac{5}{20} \times \frac{(8)^2}{(2)^2}} = \sqrt{\frac{5 \times 64}{20 \times 4}} = 2$

445 **(d)**

$E = \frac{p^2}{2m} \therefore m \propto \frac{1}{E}$ [If momentum are constant]

$\frac{m_1}{m_2} = \frac{E_2}{E_1} = \frac{1}{4}$

446 **(d)**

Given$k_p = 2k_Q$

By stretched spring gain get energy

$E = \frac{1}{2}kx^2 \qquad (\because F = kx)$

OR $\quad E = \frac{1}{2}\frac{F^2}{K}$

$\because$ *For spring P*

$E_P = \frac{1}{2}\frac{F^2}{K_P}$

$\because$ *For spring Q*

$E_Q = \frac{1}{2}\frac{F^2}{K^Q}$

$\frac{E_P}{E_Q} = \frac{K_Q}{K_P} = \frac{1}{2}$

$E_P = \frac{E_Q}{2} = \frac{E}{2}$

448 **(c)**

Potential energy U$= \frac{1}{2}kx^2$

$\therefore \frac{U_1}{U_2} = \left(\frac{x_1}{x_2}\right)^2$

Or$\frac{U}{U_2} = \left(\frac{1}{4}\right)^2$

Or $U^2 = 16\,U$

450 **(a)**

$P = \frac{mv^2}{2t} = \frac{80 \times 10 \times 10}{2 \times 4} = 1000$ W

451 **(b)**

To leave the block, it oscillates in vertical plane. If maximum extension in spring in extreme position of block is x_1 , then

Work done by weight of the block

=Potential energy stored in spring

$mg\,x = \frac{1}{2}kx^2$

$\therefore x = 2\frac{mg}{k}\;2d \qquad \left(\because d = \frac{mg}{k}\right)$

452 **(c)**

Energy stored $(E) = \frac{75}{100} \times (12) = 9$ J

As $E = \frac{1}{2}mv^2$

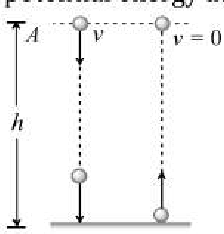
$\therefore\ v = \sqrt{\frac{2E}{m}} = \sqrt{\frac{2 \times 9}{1}} = \sqrt{18}$ ms^{-1}

453 **(a)**

Let ball is projected vertically downward with velocity v from height h

Total energy at point $A = \frac{1}{2}mv^2 + mgh$

During collision loss of energy is 50% and the ball rises up to same height. It means it possess only potential energy at same level



$50\%\left(\frac{1}{2}mv^2 + mgh\right) = mgh$

$\frac{1}{2}\left(\frac{1}{2}mv^2 + mgh\right) = mgh$

$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20}$

$\therefore v = 20\,m/s$

454 **(b)**

Percentage of energy saved is

$\frac{\frac{1}{2}mv^2 \times 100}{\frac{1}{2}mv^2 + mgh} = \frac{v^2 \times 100}{v^2 + 2gh}$

$ie, = \frac{12 \times 12 \times 100}{12 \times 12 + 2 \times 10 \times 12}$

$= \frac{14400}{144 + 240} = \frac{14400}{384} = 37.5$

455 **(a)**

This condition is applicable for simple harmonic motion. As particle moves from mean position to extreme position its potential energy increases according to expression $U = \frac{1}{2}kx^2$ and accordingly kinetic energy decreases

456 **(c)**

Let velocity of masses after explosion be $v_1 and\ v_2$, then from law of conservation of momentum, we have

Momentum before explosion = Momentum after explosion

$MV = m_1v_1 + m_2v_2$

$Given\ \ m_1 = m_2 = m, v_2 = 0$,

$\therefore\ Mv = mv_1 + m \times 0$

$\Rightarrow\ v_1 = \frac{Mv}{m}.$

458 **(a)**

Here, Force, $\vec{F} = (4\hat{\imath} + \hat{\jmath} - 2\hat{k})N$

Velocity, $\vec{v} = (2\hat{\imath} + 2\hat{\jmath} + 3\hat{k})ms^{-1}$

Power, $P = \vec{F}.\vec{v} = (4\hat{\imath} + \hat{\jmath} - 2\hat{k}).(2\hat{\imath} + 2\hat{\jmath} + 3\hat{k})$

$= (8 + 2 - 6)\ W = 4W$

459 **(b)**

The instantaneous power is the limiting value of the average power as the time interval $\Delta\ t$ approaches zero.

$P = \lim_{\Delta t \to 0} \frac{\Delta W}{\Delta t}$

$\therefore\ W = \int P\,dt$

Given $P = 3t^2 - 2t + 1$

$\therefore\ W = \int_2^4 (3t^2 - 2t + 1)\,dt$

$W = [t^3 - t^2 + t]_2^4 = 56 - 12 + 2$

$\Rightarrow \quad W = 46\,J$

460 **(d)**

$R = u\sqrt{\frac{2h}{g}} \Rightarrow 20 = V_1\sqrt{\frac{2\times5}{10}}$ and $100 = V_2\sqrt{\frac{2\times5}{10}}$

$\Rightarrow V_1 = 20\ m/s, V_2 = 100\ m/s$

Applying momentum conservation just before and just after the collision $(0.01)(V) = (0.2)(20) + (0.01)(100)$

$V = 500\ m/s$

461 **(c)**

Volume= $av = \pi r^2 v$

Mass = $\pi r^2 v \times 1000$ SI units

Power of water jet

$= \frac{\frac{1}{2}mv^2}{t} = \frac{1}{2} \times \pi r^2 v \times 1000 \times v^2 = 500\pi r^2 v^3$

462 **(a)**

Both part will have numerically equal momentum and lighter part will have more velocity

463 **(d)**

$h = 0 \times 3 + \frac{1}{2} \times 10 \times 3 \times 3 = 45$ m

Loss of PE = $3 \times 10 \times 45$ J = 1350 J

this will be the kinetic energy at $t = 3$ s

464 **(a)**

Relative density = $\frac{\text{Weight in air}}{\text{Loss weight in water}}$

$\therefore$ Loss of weight in water = $\frac{5\times10}{3}$ N

Weight in water = $\left(50 - \frac{50}{3}\right)$ N = $\frac{100}{3}$ N

Work done= $\frac{100}{3}$ N × 5m = $\frac{500}{3}$ J

465 **(c)**

$m_G = \frac{m_B v_B}{v_G} = \frac{50 \times 10^{-3} \times 30}{1} = 1.5\ kg$

466 **(b)**

$W = mg \sin\theta \times s$

$= 2 \times 10^3 \times \sin 15° \times 10$

$= 5.17\ kJ$

467 **(c)**

$K_1 = mgh_1, K_2 = mgh_2$

% Loss = $\frac{K_1 - K_2}{K_1} \times 100$

$= \frac{h_1 - h_2}{h_1} \times 100 = 50\%$

468 **(d)**

Work done = change in kinetic energy

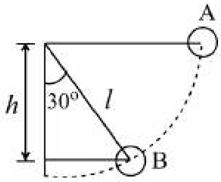
$W = \frac{1}{2}mv^2$

$\therefore W \propto v^2$ graph will be parabolic in nature

469 **(c)**

Vertical height = $h = l\cos 30°$

Loss of potential energy = mgh



$= mgl\cos 30° = \frac{\sqrt{3}}{2}mgl$

$\therefore$ Kinetic energy gained = $\frac{\sqrt{3}}{2}mgl$

470 **(b)**

Potential energy stored in the spring is given by

$U = \frac{1}{2}kx^2$

$\therefore \frac{U_1}{U_2} = \left(\frac{x_1}{x_2}\right)^2$

Or $\frac{100}{U_2} = \frac{(2)^2}{(4)^2}$

Or $U_2 = 400J$

$\therefore$ Potential energy increases by 400-100=300J

471 **(c)**

Work done on the wire to strain it will be stored as energy which is converted to heat. Therefore the temperature increases

472 **(a)**

Initial height of CG = 4 cm

Final height of CG =10 cm

Increase in height = 6 cm = 0.06 m

Work done = $5 \times 10 \times 0.06 = 3$ J

473 **(c)**

Velocity exchange takes place when the masses of bodies are equal

474 **(c)**

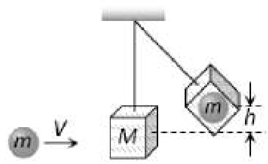
Initial kinetic energy $E = \frac{1}{2}mv^2$ ...(i)

Final kinetic energy $2E = \frac{1}{2}m(v+2)^2$ ...(ii)

By solving equation (i) and (ii) we get

$v = (2 + 2\sqrt{2})\ m/s$

475 **(a)**



By the conservation of linear momentum

Initial momentum of sphere = Final momentum of system

$mV = (m + M)v_{\text{sys.}}$ ...(i)

If the system rises up to height h then by the conservation of energy

$\frac{1}{2}(m+M)v_{sys.}^2 = (m+M)gh$ ...(ii)

$\Rightarrow v_{sys.} = \sqrt{2gh}$

Substituting this value in equation (i)

$V = \left(\frac{m+M}{m}\right)\sqrt{2gh}$

476 **(b)**

Efficiency, $\eta = \frac{\text{output power}}{\text{consuming power}} \times 100\%$

Here , $P_{\text{output}} = 10\text{kW}$

$P_{input} = 2 \times 10^3 \text{calg}^{-1} \times \text{gs}^{-1}$

$= 2 \times 10^3 \text{cals}^{-1}$

$= 2 \times 10^3 \times 4.2\text{Js}^{-1}$

8.4kW

As, $P_{output} > P_{input}$, hence it is never possible.

477 **(b)**

Given $W = 25$ J, $F = 5$ N, $\Delta s = 10$m

Work=Force× displacement

$W = (F\cos\theta) \times \Delta s$

Or $\cos\theta = \frac{W}{F \cdot \Delta s}$

Or $\cos\theta = \frac{25}{5\times10} = \frac{1}{2}$ or $\theta = \cos^{-1}\left(\frac{1}{2}\right) = 60°$

Hence, angle between force and direction of body is 60°.

478 **(b)**

By momentum conservation before and after collision

$m_1V + m_2 \times 0 = (m_1+m_2)v \Rightarrow v = \frac{m_1}{m_1+m_2}V$

$i.e.$ Velocity of system is less than V

479 **(a)**

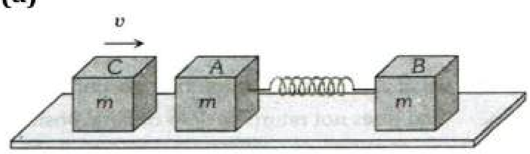
$v_1 = \left(\frac{m_1-m_2}{m_1+m_2}\right)u_1 + \frac{2m_2u_2}{m_1+m_2}$

Substituting $m_1 = 0, v_1 = -u_1 + 2u_2$

$\Rightarrow v_1 = -6 + 2(4) = 2\ m/s$

$i.e.$ the lighter particle will move in original direction with the speed of 2 m/s

480 **(a)**



Initial momentum of the system (block C) $= mv$

After striking with A, the block C comes to rest and now both block A and B moves with velocity V, when compression in spring is maximum

By the law of conservation of linear momentum

$mv = (m+m)V \Rightarrow V = \frac{v}{2}$

By the law of conservation of energy

K.E. of block C = K.E. of system + P.E. of system

$\frac{1}{2}mv^2 = \frac{1}{2}(2m)V^2 + \frac{1}{2}kx^2$

$\Rightarrow \frac{1}{2}mv^2 = \frac{1}{2}(2m)\left(\frac{v}{2}\right)^2 + \frac{1}{2}kx^2 \Rightarrow kx^2 = \frac{1}{2}mv^2$

$\Rightarrow x = v\sqrt{\frac{m}{2k}}$

481 **(c)**

$100 = \frac{1}{2}kx^2$ [Given]

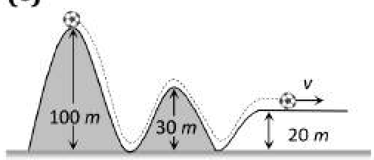
$W = \frac{1}{2}k(x_2^2 - x_1^2) = \frac{1}{2}k[(2x)^2 - x^2]$

$= 3 \times \left(\frac{1}{2}kx^2\right) = 3 \times 100 = 300\ J$

482 **(d)**

$W = FS\cos\theta = 10 \times 4 \times \cos 60° = 20\ Joule$

483 **(c)**



Ball starts from the top of a hill which is 100 m high and finally rolls down to a horizontal base which is 20 m above the ground so from the conservation of energy $mg(h_1 - h_2) = \frac{1}{2}mv^2$

$\Rightarrow v = \sqrt{2g(h_1-h_2)} = \sqrt{2 \times 10 \times (100-20)}$

$= \sqrt{1600} = 40\ m/s$

484 **(a)**

Momentum of earth-ball system remains conserved

485 **(d)**

From $v = u + at, v_1 = 0 + at_1$ $\left(\because a = \frac{v_1}{t_1}\right)$

$F = ma = mv_1/t_1$

Velocity acquired in t sec $= at = \frac{v_1}{t_1}t$

Power $= F \times v = \frac{mv_1}{t_1} \times \frac{v_1 t}{t_1} = \frac{mv_1^2 t}{t_1^2}$

486 **(d)**

Speed of car, $v = 72\ \text{kmh}^{-1} = 72 \times \frac{5}{18} =$ $20\ \text{ms}^{-1}$

$\text{KE} = \frac{1}{2}mv^2 = \frac{1}{2} \times 800 \times 400$

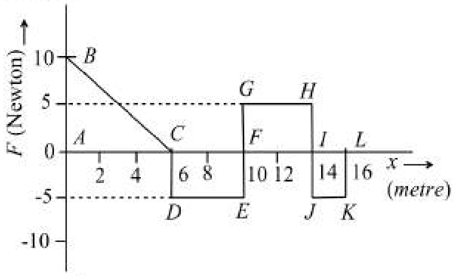
$= 400 \times 400$ J

$P = \frac{\text{KE}}{\text{time}} = \frac{400 \times 400}{32}$

$= 5000$ W $= 5$ kW

487 **(a)**

Work done W = Area under F-x graph with proper sign W = Area of triangle ABC + Area of rectangle $CDEF$ + Area of rectangle $FGHI$ + Area of $IJKL$



$$W = \left[\frac{1}{2} \times 6 \times 10\right] + [4 \times (-5)] + [4 \times 5] + [2 \times (-5)]$$

$\Rightarrow W = 30 - 20 + 20 - 10 = 20 J$ ....(i)

According to work energy theorem

$K_f - K_i = W \Rightarrow (K_f)_{x=16m} - (K_i)_{x=0m} = W$

$(K_f)_{x=16m} = (K_i)_{x=0m} + W$

$= 25 J + 20 J = 45 J$ [Using (i)]

488 **(c)**

Work done on the ball by the table surface is the work done by the frictional force. Since a ball moves on a frictionless inclined table (or smooth surface), therefore frictional force is zero. Hence the work done on the ball by the table surface is zero

489 **(b)**

$$W = \frac{1}{2}k(x_2^2 - x_1^2) = \frac{1}{2} \times 800 \times (15^2 - 5^2) \times 10^{-4} = 8J$$

490 **(b)**

If the body strikes the sand floor with a velocity v, then $Mgh = \frac{1}{2}mv^2$

With this velocity v, when body passes through the sand floor it comes to rest after travelling a distance x. Let F be the resisting force acting on the body. Net force in downwards direction $= Mg - F$

Work done by all the forces is equal to change in KE

$(Mg - F)x = 0 - \frac{1}{2}Mv^2$

$(Mg - F)x = -Mgh$ or $Fx = Mgh + Mgx$

or $F = Mg\left(1 + \frac{h}{x}\right)$

491 **(b)**

$$F = \frac{dp}{dt} = m\frac{dv}{dt} = \frac{m \times 2v}{1/50} = \frac{2 \times 2 \times 100}{1/50} = 2 \times 10^4 N$$

492 **(d)**

$$S = \frac{t^3}{3} \therefore dS = t^2 dt \Rightarrow a = \frac{d^2S}{dt^2} = \frac{d^2}{dt^2}\left[\frac{t^3}{3}\right] = 2t\ m/s^2$$

Now work done by the force $W = \int_0^2 F.dS = \int_0^2 ma.dS$

$$\int_0^2 3 \times 2t \times t^2 dt = \int_0^2 6t^3\, dt = \frac{3}{2}[t^4]_0^2 = 24 J$$

493 **(d)**

$$U \propto x^2 \Rightarrow \frac{U_2}{U_1} = \left(\frac{x_2}{x_1}\right)^2 = \left(\frac{0.1}{0.02}\right)^2 = 25 \therefore U_2 = 25 U$$

494 **(b)**

Total initial momentum=Total final momentum

ie $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$\therefore M \times v + m \times 0 = Mv_1 + mv_2$

$or\ Mv = Mv_1 + Mv_2$

Or $M(v - v_1) = mv_2$ ......(i)

Again kinetic energy is also conserved.

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

$\therefore Mv^2 + m \times 0 = Mv_1^2 + mv_2^2$

$or\ Mv^2 = Mv_1^2 + mv_2^2$

Or $M(v^2 - v_1^2) = mv_2^2$ ....(ii)

Dividing Eq.(ii)by Eq.(i), we get

$$\frac{M(v^2 - v_1^2)}{M(v - v_1)} = \frac{mv_2^2}{mv_2}$$

Or $v + v_1 = v_2$

As $M >> m, so\ v_1 = v$

$\therefore v_2 = v + v = 2v$

495 **(b)**

$$U = A - Bx^2 \Rightarrow F = -\frac{dU}{dx} = 2Bx \Rightarrow F \propto x$$

496 **(a)**

$$v' = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v$$

$$\left(\frac{1.008665 - 4.002603}{1.008665 + 4.002603}\right) \approx -\frac{3}{5}v$$

497 **(d)**

Mass to be lifted = 10×10^2kg

[$\therefore$ density of water = 10^3kgm^{-3}]

Height, $h = 10$ m

Work done = $10^4 \times 10 \times 10 = 10^6$J

498 **(c)**

Let m_1, m_2be the masses of first and second fragments respectively and v_1, v_2be their velocities after explosion.

From conservation of momentum

$Mv = m_1, m_2 + m_2v_2$

Where, M is mass of bomb before explosion and vits velocity.

Since, bomb is stationary, hence v=0

Given ,$m_1 = 1g = 1 \times 10^{-3} kg = 0.001 kg$

$m_2 = 3g = 3 \times 10^{-3} kg = 0.003$kg and $E_k = 6.4 \times 10^4$J

$\therefore 0 = m_1 v_1 + m_2 v_2$

or $0 = 0.001 v_1 + 0.003 v_2$

Or $v_2 = -\frac{v_1}{3}$ ....(i)

Total kinetic energy is

$$E_K = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$$

$$E_k = \frac{1}{2} \times (0.001) v_1^2 + \frac{1}{2} \times (0.003) v_2^2 \quad ...(ii)$$

$$\therefore E_k = \frac{1}{2} \times (0.001) v_1^2 + \frac{1}{2}(0.003) \times \left(-\frac{v_1^2}{3}\right)^2$$

$$E_k = \frac{1}{2} \times (0.001)\left(v_1^2 + 3 \times \frac{v_1^2}{9}\right)$$

$$E_k = \frac{1}{2} \times (0.001) \times \frac{4v_1^2}{3} = \frac{(0.002)v_1^2}{3} \quad ...(iii)$$

$$\therefore \quad 6.4 \times 10^4 = \frac{(0.002)v_1^2}{3}$$

Or $v_1^2 = \frac{3 \times 6.4 \times 10^4}{0.002}$

Or $v_1^2 = \frac{3 \times 6.4 \times 10^4}{0.002}$

or $v_1^2 = 96 \times 10^6 = 9.6 \times 10^7 ms^{-1}$

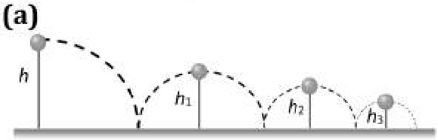
Hence, kinetic energy of smaller fragment is

$$E_K' = \frac{1}{2} m_1 v_1^2$$

$$E_k' = \frac{1}{2} \times (0.001) \times 9.6 \times 10^7$$

$$E_k' = 4.8 \times 10^4 \text{J}.$$

499 **(a)**



Particle falls from height h then formula for height covered by it in nth rebound is given by

$h_n = he^{2n}$

Where e = coefficient of restitution, n = No. of rebound

Total distance travelled by particle before rebounding has stopped

$$H = h + 2h_1 + 2h_2 + 2h_3 + 2h_4 + \cdots$$
$$= h + 2he^2 + 2he^4 + 2he^6 + 2he^8 + \cdots$$
$$= h + 2h(e^2 + e^4 + e^6 + e^8 + \cdots)$$
$$= h + 2h\left[\frac{E^2}{1-e^2}\right] = h\left[1 + \frac{2e^2}{1-e^2}\right] = h\left(\frac{1+e^2}{1-e^2}\right)$$

500 **(d)**

Central of the mass of the rod lies at the midpoint and when the is displaced.

Through an angle 60° it lises to point B.

From the figure

$$\sin 30° = \frac{BC}{AB}$$

Or $\sin 30° = \frac{1}{l/2}$

Or $\frac{1}{2} = \frac{L}{l/2}$

Or $L = \frac{l}{4}$

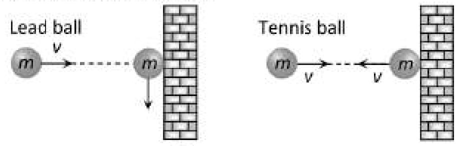
The potential energy of the rod in this position is

$U = mgL$

$U = mg\frac{1}{4}$

502 **(c)**

Change in the momentum = Final momentum – initial momentum



For lead ball $\Delta\vec{P}_{\text{lead}} = 0 - m\vec{v} = -m\vec{v}$

For tennis ball $\Delta\vec{P}_{\text{tennis}} = -m\vec{v} - m\vec{v} = -2m\vec{v}$

i.e. tennis ball suffers a greater change in momentum

503 **(b)**

By applying law of conservation of energy

$$mgR = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{2Rg}$$

504 **(d)**

$P = \vec{F}.\vec{v} = ma \times at = ma^2 t$ [as $u = 0$]

$= m\left(\frac{v_1}{t_1}\right)^2 t = \frac{mv_1^2 t}{t_1^2}$ [As $a = v_1/t_1$]

505 **(a)**

Work done = Area covered in between force displacement curve and displacement axis

= Mass × Area covered in between acceleration-displacement curve and displacement axis

$$= 10 \times \frac{1}{2}(8 \times 10^{-2} \times 20 \times 10^{-2}) = 8 \times 10^{-2} J$$

506 **(a)**

Let v be the velocity with which the bullet will emerge

Now, change in kinetic energy = work done

For first case, $\frac{1}{2}m(100)^2 - \frac{1}{2}m \times 0 = F$

For second case, $\frac{1}{2}m(100)^2 - \frac{1}{2}mv^2 = F \times 0.5$

Dividing eq. (ii) by Eq. (i), we get

$$\frac{(100)^2 - (v)^2}{(100)^2} = \frac{0.5}{1} = \frac{1}{2} \text{ or } v = \frac{100}{\sqrt{2}}$$
$$= 50\sqrt{2}\text{ms}^{-1}$$

509 **(c)**

Force $F = (5 + 3x)$N

Work done $W = \int_{x_1}^{x_2} F.dx = \int_2^6 (5 + 3x)dx$

$= \left[5x + \frac{3x^2}{2}\right]_2^6 = 68$ J

510 **(a)**

As 20% energy lost in collision therefore

$mgh_2 = 80\%$ of $mgh_1 \Rightarrow \frac{h_2}{h_1} = 0.8$

But $e = \sqrt{\frac{h_2}{h_1}} = \sqrt{0.8} = 0.89$

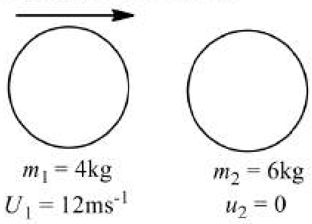
511 **(b)**

Energy required $= mgh$

In both cases, h is the same. Hence, energy given by both is same. [It is worth noting here that powers of two men will be different as power is the energy expense per unit time and times are different]

512 **(c)**

In an inelastic collision, kinetic energy is not conserved but the total energy and momentum remains conserved.



Momentum before collision

= Momentum after collision

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$\therefore \quad 4 \times 12 = (4 + 6)v$

Or $\quad v = 4.8ms^{-1}$

Kinetic energy before collision $= \frac{1}{2}m_1u_1^2$

$= \frac{1}{2} \times 4 \times (12)^2$

$= 288$J

Kinetic energy after collision $= \frac{1}{2}(m_1 + m_2)v^2$

$= \frac{1}{2}(10)(4.8)^2$

=115.2 J

Loss in kinetic energy=288 J-115.2 J

=172.8 J

513 **(a)**

Work done in lifting water and drum

$= 60 \times 10 \times 20$ J $= 12000$ J

Total mass of ropes $= 40 \times 0.5$ kg= 20 kg

Work done in the case of ropes

$= 20 \times 10 \times 10 = 2000$ J

Total work done = 14000 J

514 **(d)**

$h_n = he^{2n} = 1 \times e^{2\times1} = 1 \times (0.6)^2 = 0.36\, m$

515 **(c)**

Initial velocity of ball is zero *ie* $u = 0$

$\therefore$ Displacement of ball in t^{th} second

$s = gt - \frac{1}{2}g = g\left(t - \frac{1}{2}\right)$

$s \propto \left(t - \frac{1}{2}\right)$

or $s_1 : s_2 : s_3 = \left(1 - \frac{1}{2}\right) : \left(2 - \frac{1}{2}\right) : \left(3 - \frac{1}{2}\right)$

$= 1 : 3 : 5$

Now, $W = mgs$

$W \propto s$

$\therefore W_1 : W_2 : W_3 = 1 : 3 : 5$

516 **(a)**

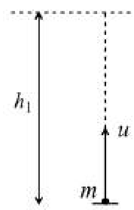
By the particle of conservation of linear momentum,

$Mv = mv_1 + mv_2 \Rightarrow Mv = 0 + (M - m)v_2 \Rightarrow v_2$

$= \frac{Mv}{M - m}$

517 **(d)**

For first ball, $mgh_1 = \frac{1}{2}mu^2$



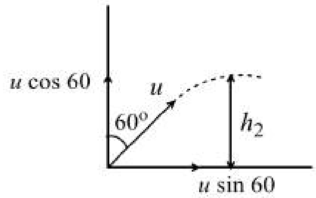
i.e., $h_1 = \frac{u^2}{2g}$

For second ball

$mgh_2 = mg\frac{u^2\cos^2\theta}{2g} = \frac{1}{2}mu^2\cos^2\theta$

$= \frac{1}{2}mu^2\cos^2 60°$

$= \frac{1}{2}mu^2\left(\frac{1}{2}\right)^2 = \frac{1}{2}mu^2\left(\frac{1}{4}\right)$



$\Rightarrow h_2 = \frac{u^2}{8g}$

$\therefore \frac{h_1}{h_2} = \frac{u^2}{2g} \times \frac{8g}{u^2} \Rightarrow \frac{h_1}{h_2} = \frac{4}{1}$

518 **(b)**

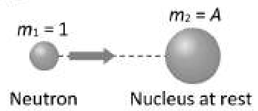
Kinetic energy $K = \frac{1}{2}mr^2\omega^2$

ie, $\quad K \propto r^2$

The ratio of new kinetic energy to the original KE is given

$$\frac{K_2}{K_1} = \left(\frac{r_2}{r_1}\right)^2$$

519 **(a)**



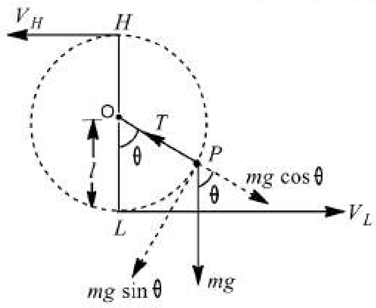
$$\left(\frac{\Delta k}{k}\right)_{\text{retained}} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 = \left(\frac{1-A}{1+A}\right)^2$$

520 **(c)**

When a particle is moved in a circle under the action of a torque then such motion is non-uniform circular motion.

Applying principle of conservation of energy, total mechanical energy at L

=total mechanical energy at H



$$\therefore \frac{1}{2}mv_L^2 = \frac{1}{2}mv_H^2 + MG(2l)$$

But $v_H^2 = gl$

$$\therefore \frac{1}{2}mv_L^2 = \frac{1}{2}m(gl) + 2mgl$$

Or $v_L^2 = 5gl$

Or $v_L = \sqrt{5gl}$

Hence for looping the vertical loop, the minimum velocity at the lowest point L IS $\sqrt{5gl}$.

521 **(c)**

$F = \frac{-dU}{dx}$ it is clear that slope of $U - x$ curve is zero at point B and C

$\therefore F = 0$ for point B and C

522 **(a)**

Potential energy increases and kinetic energy decreases when the height of the particle increases it is clear from the graph (a)

523 **(d)**

When trolley are released then they possess same linear momentum but in opposite direction. Kinetic energy acquired by any trolley will dissipate against friction

$\therefore \mu\, mg\, s = \frac{P^2}{2m} \Rightarrow s \propto 1/m^2$ [As P and u are constants]

$$\Rightarrow \frac{s_1}{s_2} = \left(\frac{m_2}{m_1}\right)^2 = \left(\frac{3}{1}\right)^2 = \frac{9}{1}$$

524 **(b)**

$$K = \frac{1}{2}mv^2$$

$$v^2 = \frac{98 \times 2}{2} = 98$$

$$h = \frac{v^2}{2g} = \frac{98}{2 \times 9.8} = 5$$

$$K_1 = \frac{1}{2}mv^2 = \frac{1}{2}m \times 2gh$$

$$\therefore \quad \frac{K_2}{K_1} = \frac{h_2}{h_1}$$

Given $K_2 = \frac{K_1}{2}$

$$\therefore \ = \frac{K_1}{2K_1} = \frac{h_2}{5}$$

$\therefore h_2 = 2.5$ m

525 **(d)**

Velocity of combined mass, $v = \frac{m_1v_1 - m_2v_2}{m_1 + m_2}$

$$= \frac{0.1 \times 1 - 0.4 \times 0.1}{0.5} = 0.12\ m/s$$

$\therefore$ Distance travelled by combined mass

$= v \times t = 0.12 \times 10 = 1.2\ m$

526 **(b)**

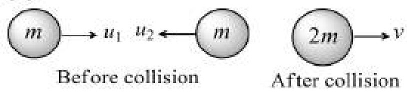
$$E = \frac{P^2}{2m} = \frac{4}{2 \times 3} = \frac{2}{3}J$$

528 **(b)**

$E = \frac{P^2}{2m}$ If momentum are same then $E \propto \frac{1}{m}$

$$\therefore \frac{E_1}{E_2} = \frac{m_2}{m_1} = \frac{2m}{m} = \frac{2}{1}$$

529 **(c)**



Here, $m = 0.25\ kg, u_1 = 3ms^{-1}, u_2 = -1ms^{-1}$

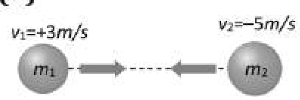
It is an inelastic collision

According to conservation of momentum

$mu_1 + mu_2 = (m + m)v$

$$\Rightarrow v = \frac{mu_1 + mu_2}{2m} = \frac{u_1 + u_2}{2} = \frac{3-1}{2} = 1ms^{-1}$$

530 **(d)**



As $m_1 = m_2$ therefore after elastic collision velocities of masses get interchanged

$i.e.$ velocity of mass $m_1 = -5\ m/s$

and velocity of mass $m_2 = +3\ m/s$

531 **(c)**

According to work-energy theorem

$W =$ Change in kinetic energy

$$FS\cos\theta = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

Substituting the given values, we get

$20 \times 4 \times \cos\theta = 40 - 0 \quad [\because u = 0]$

$$\cos\theta = \frac{40}{80} = \frac{1}{2}$$

$$\theta = \cos^{-1}\left(\frac{1}{2}\right) = 60°$$

532 **(b)**

The height (h) traversed by particle while going up is

$$h = \frac{u^2}{2g} = \frac{25}{2 \times 9.8}$$

work done by gravity force$= mg.h$

$$= 0.1 \times g \times \frac{25}{2 \times 9.8}\cos 180°$$

[angle between force and displacement is 180°]

$\therefore \quad W = -0.1 \times \frac{25}{2} = -1.25$ J

533 **(a)**

Momentum conservation

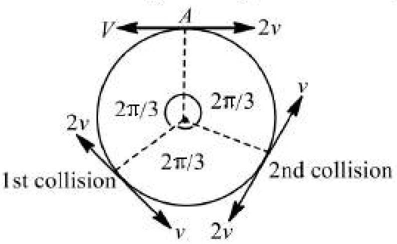
$5 \times 10 + 20 \times 0 = 5 \times 0 + 20 \times v \Rightarrow v = 2.5\ m/s$

534 **(c)**

A s first collision one particle having speed 2v will rotate

$240°\left(or\ \frac{4\pi}{3}\right)$while other particle having speed v will rotate

$120°\left(or\ \frac{2\pi}{3}\right)$. At first collision they will exchange their velocities. Now as shown in figure, after two collisions they will again reach at point A.



535 **(a)**

When the distance between atoms is large then interatomic force is very weak. When they come closer, force of attraction increases and at a particular distance force becomes zero. When they are further brought closer force becomes repulsive in nature

This can be explained by slope of $U - x$ curve shown in graph (a)

536 **(c)**

At the highest point of its flight, vertical component of velocity is zero and only horizontal component is left which is

$u_x = u\cos\theta$

Given $\theta = 45°$

$$\therefore \quad u_x = u\cos 45° = \frac{u}{\sqrt{2}}$$

Hence, at the highest point kinetic energy

$$E' = \frac{1}{2}mu_x^2$$

$$= \frac{1}{2}m\left(\frac{u}{\sqrt{2}}\right)^2 = \frac{1}{2}m\left(\frac{u^2}{2}\right)$$

$$= \frac{E}{2} \quad \left(\because \frac{1}{2}mu^2 = E\right)$$

537 **(b)**

The angle between the displacement and the applied retarded force is 180^0

$\therefore$Work done$= Fs\cos 180° - Fs$

$= -$Ve

538 **(b)**

$$\text{Power} = \frac{\text{Work done}}{\text{time}} = \frac{\frac{1}{2}m(v^2 - u^2)}{t}$$

$$P = \frac{1}{2} \times \frac{2.05 \times 10^6 \times [(25)^2 - (5^2)]}{5 \times 60}$$

$P = 2.05 \times 10^6 W = 2.05\ MW$

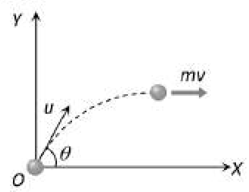
539 **(a)**

$P = \sqrt{2mE}\ \therefore P \propto \sqrt{E}$

Percentage increase in $P = \frac{1}{2}$(percentage increase in E)

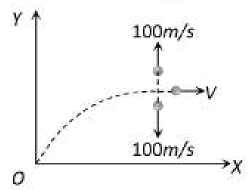
$$= \frac{1}{2}(0.1\%) = 0.05\%$$

540 **(b)**



Momentum of ball (mass m) before explosion at the highest point $= mv\hat{\imath} = mu\cos 60°\hat{\imath}$

$$= m \times 200 \times \frac{1}{2}\hat{\imath} = 100\ m\hat{\imath}\ kgms^{-1}$$



Let the velocity of third part after explosion is V

After explosion momentum of system = $\vec{P}_1 + \vec{P}_2 + \vec{P}_3$

$= \frac{m}{3} \times 100\hat{j} - \frac{m}{3} \times 100\hat{j} + \frac{m}{3} \times V\hat{i}$

By comparing momentum of system before and after the explosion

$\frac{m}{3} \times 100\hat{j} - \frac{m}{3} \times 100\hat{j} + \frac{m}{3} V\hat{i} = 100m i \Rightarrow V = 300 m/s$

541 **(d)**

Angle will be 90° if collision is perfectly elastic

542 **(d)**

From conservation of momentum.

Momentum before collision =Momentum after collision

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$20\times 6 + 30 \times 0 = 20v + 30v$

$\therefore 20 \times 6 = 50v$

Or $v = \frac{120}{50} = 2.4 ms^{-1}$

543 **(d)**

Work done $W = F \times s$

$W \propto \frac{1}{2}(x) \therefore W \propto x^0$

544 **(d)**

The tension in the string at any position is

$T = \frac{mv^2}{r} + mg\cos\theta$

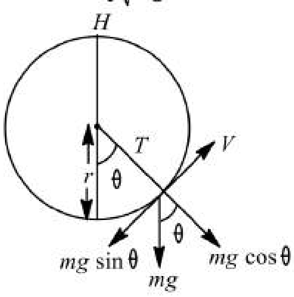
For critical position

$\theta = 180°$

$v = v_c$

T=0

Hence $v_c\sqrt{rg}$



545 **(a)**

$K = \frac{1}{2}mv^2$

$\frac{dK}{dt} = mv.\frac{dv}{dt}$

$= \left(m\frac{dv}{dt}\right)v = (ma\ v = 4v)$

As $m = 2$ kg and $a = 2$ ms^{-2}

546 **(b)**

$v_1 = \sqrt{4^2 + 3^2} = \sqrt{25} = 5$ ms^{-1}

$v_2 = 6$ ms^{-1}

Work done = Increase in kinetic energy

$= \frac{1}{2} \times 2[6^2 - 5^2]$ J

$= (36 - 25)$ J $= 11$ J

547 **(a)**

$v = \frac{dx}{dt} = 3 - 8t + 3t^2$

$\therefore v_0 = 3\ m/s$ and $v_4 = 19\ m/s$

$W = \frac{1}{2}m(v_4^2 - v_0^2)$ [According to work energy theorem]

$= \frac{1}{2} \times 0.03 \times (19^2 - 3^2) = 5.28\ J$

548 **(d)**

Loss in K.E. = (initial K.E. – Final K.E.)of system

$\frac{1}{2}\ m_1u_1^2 + \frac{1}{2}\ m_2u_2^2 - \frac{1}{2}(m_1 + m_2)V^2$

$= \frac{1}{2}\ 3 \times (32)^2 + \frac{1}{2} \times 4 \times (5)^2 - \frac{1}{2} \times (3 + 4) \times (5)^2$

$= 1498.5\ J$

549 **(d)**

Work done for a distance s is given by

$W = \frac{1}{2}ks^2$

$or\ \ 10 = \frac{1}{2}ks^2 \quad \dots\dots\dots(i)$

Where k is spring constant.

Now, work done for a distance 2 s is given by

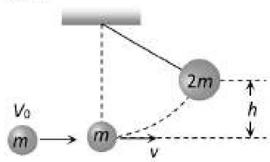
$W = \frac{1}{2}K(2s)^2 = 4 \times \frac{1}{2}ks^2$

$4 \times 10 = 40$J

∴Required work done

=40-10=30 J

550 **(a)**



Initial momentum of particle = mV_0

Final momentum of system (particle + pendulum) = $2mv$

By the law of conservation of momentum

$\Rightarrow mV_0 = 2mv \Rightarrow$ Initial velocity of system $v = \frac{V_0}{2}$

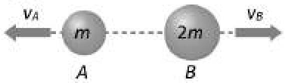
$\therefore$ Initial K.E. of the system $= \frac{1}{2}(2m)v^2 = \frac{1}{2}(2m)\left(\frac{V_0}{2}\right)^2$

If the system rises up to height h then P.E. = $2mgh$

By the law of conservation of energy

$$\frac{1}{2}(2m)\left(\frac{V_0}{2}\right)^2 = 2mgh \Rightarrow h = \frac{V_0^2}{8g}$$

552 **(a)**



By the conservation of momentum, $m_A v_A = m_B v_B$

$\Rightarrow m \times 16 = 2m \times v_B \Rightarrow v_B = 8\ m/s$

Kinetic energy of system $= \frac{1}{2}m_A v_A^2 + \frac{1}{2}m_B v_B^2$

$= \frac{1}{2} \times m \times (16)^2 + \frac{1}{2} \times (2m) \times 8^2 = 192mJ$

553 **(a)**

If a body has momentum, it must have kinetic energy also, (a) is the wrong statement

If the energy is totally potential, it need not have momentum (b) is correct (c) and (d) are also correct

554 **(b)**

Force F=$(2\hat{i}+15\hat{j}+6\hat{k})$N

Displacement s = $10\hat{j}$m

W =F$\cdot$ s=$(2\hat{i}+15\hat{j}+6\hat{k})\cdot(10\hat{j}) = 150$J

555 **(a)**

KE left, $\frac{1}{2}mv^2 = \frac{1}{2}\left(\frac{1}{2}mu^2\right)$

$\therefore$ velocity left, $v = \frac{u}{\sqrt{2}} = \frac{10^4}{\sqrt{2}} = 7071.06\ \text{ms}^{-1}$

556 **(c)**

Law of conservation of momentum $0.5 \times 2 + 1 \times 0 = 1.5 \times v$

(assumed that 2nd body is at rest)

Or $v = \frac{2}{3}$

The energy loss during the collision

$\Delta K = K_f - K_i$

$= \frac{\frac{3}{2} \times \left(\frac{2}{3}\right)^2}{2} - \left(\frac{1}{2}\right) \times \frac{2^2}{2}$

$= -\frac{2}{3}\text{J} = -0.67\text{J}$

So, energy lost is 0.67 J

557 **(c)**

Given, velocity of river,(v)=2m/s

Density of water p=1.2 gcc^{-1}

Mass of each cubic metre

$$m = \frac{1.2 \times 10^{-3}}{(10^{-2})^3} = 1.2 \times 10^3\ \text{kg}$$

$\therefore$ kinetic energy= $\frac{1}{2}mv^2$

$= \frac{1}{2} \times 1.2 \times 10^3 \times (2)^2$

$= 2.4 \times 10^3$ J = 2.4 KJ

559 **(a)**

According to conservation of linear momentum,

$m_1 v_1 = m_1 v + m_2 v_2$

Where v is the velocity of bullet after the collision and v_2 is the velocity of block ,

$\therefore 0.02 \times 600 = 0.02v + 4v_2$

Here, $v_2 = \sqrt{2gh} = \sqrt{2 \times 10 \times 0.2} = 2ms^{-1}$

$\therefore 0.02 \times 600 = 0.02v + 4x_2$

Or $0.02v = 12 - 8$

Or $v = \frac{4}{0.02} = 200\ ms^{-1}$

560 **(b)**

Because the efficiency of machine is 90%, hence, potential energy gained by the mass

$= \frac{90}{100} \times$ energy spend $= \frac{90}{100} \times 5000 = 4500$ J

When the mass is released now, gain in KE on hitting the ground

= Loss of potential energy

= 4500 J

561 **(d)**

Using conservation of linear momentum, we have

$mv_0 = mv + 2mv$

Or $v = \frac{v_0}{3}$

Using conservation of energy, we have

$\frac{1}{2}mv_0^2 = \frac{1}{2}kx_0^2 + \frac{1}{2}(3m)v^2$

Where x_0=compression in the spring ,

$\therefore mv_0^2 = kx_0^2 + (3m)\ \frac{v_0^2}{9}$

Or $kx_0^2 = mv_0^2 - \frac{mv_0^2}{3}$

Or $kx_0^2 = \frac{2mv_0^2}{3}$

$\therefore k = \frac{2mv_0^2}{3x_0^2}$

562 **(b)**

As the area above the time axis is numerically equal to area below the time axis therefore net momentum gained by body will be zero because momentum is a vector quantity

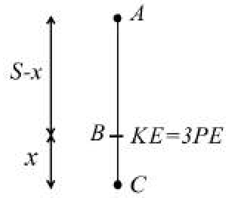
563 **(d)**

Velocity at B when dropped from A where $AC = S$

$v^2 = 0 + 2g(S - x)$

Or $v^2 = 2g(S - x)$ ...(i)

Potential energy at $B = mgx$ ...(ii)



$\because$ Kinetic energy = 3 × potential energy

$\therefore \frac{1}{2} m \times 2g(S-x) = 3 \times mgx$

$\Rightarrow S - x = 3x$ or $S = 4x$ or $x = S/4$

From (i),

$$v^2 = 2g(S-x) = 2g\left(S - \frac{S}{4}\right) = \frac{2g \times 3S}{4} = \frac{3gS}{2}$$

$\Rightarrow v = \sqrt{\frac{3gS}{2}}$ $\therefore x = \frac{S}{4}$ and $v = \sqrt{\frac{3gS}{2}}$

564 **(b)**

Tension in the string

$$T = M(g-a) = M\left(g - \frac{g}{2}\right) = \frac{Mg}{2}$$

$W =$ Force $\times$ displacement

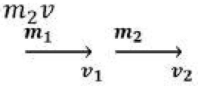
$$= -\frac{Mgh}{2}$$

565 **(d)**

If it is a completely inelastic collision then

$m_1v_1 + m_2v_2 = m_1v + m_2v$

$v = \frac{m_1v_1 + m_2v_2}{m_1 + m_2}$



$$KE = \frac{p_1^2}{2m_1} + \frac{p_2^2}{2m_2}$$

As p_1 *and* p_2 both simultaneously cannot be zero therefore total KE cannot lost.

566 **(c)**

By the conservation of momentum in the absence of external force total momentum of the system (ball + earth) remains constant

567 **(c)**

If momentum is Zero ie, if p=0,then kinetic energy

$$K = \frac{p^2}{2m} = 0$$

But potential energy cannot be zero, thus a body can have energy without momentum.

568 **(d)**

Elastic force in string is conservative in nature

$W = -\Delta V_1$ where W = work done by elastic force of string

$W = -(V_f - V_i) = V_i - V_f$ or $W = \frac{1}{2}kx^2 - \frac{1}{2}k(x+y)^2$

or $W = \frac{1}{2}kx^2 - \frac{1}{2}k(x^2 + y^2 + 2xy)$

$$= \frac{1}{2}kx^2 - \frac{1}{2}kx^2 - \frac{1}{2}ky^2 - \frac{1}{2}k(2xy)$$

$$= -kxy - \frac{1}{2}ky^2$$

$$= \frac{1}{2}ky(-2x - y)$$

The work done against elastic force is

$$W_{\text{ext}} = -W = \frac{ky}{2}(2x + y)$$

569 **(d)**

According to conservation of momentum

$$mv = \left(\frac{m}{4}\right)v_1 + \left(\frac{3m}{4}\right)v_2 \Rightarrow \frac{4}{3}v$$

570 **(b)**

$P = \frac{mgh}{t}$ or $\frac{m}{t} = \frac{P}{gh}$

or $\frac{m}{t} = \frac{1000}{10 \times 10}$ kg $= 10$ kg

571 **(d)**

Work done=force× displacement

Hence, displacement-force curve gives work done,

572 **(b)**

In elastic head on collision velocities gets interchanged

573 **(a)**

Kinetic energy, $k = \frac{1}{2}mv^2$

$$= \frac{1}{2} \times \frac{m(mv^2)}{m}$$

$$= \frac{(mv^2)}{2m} \text{ or } k = \frac{p^2}{2m}$$

$$= \frac{k_1}{k_2} = \frac{p_1^2}{2m_1} \times \frac{2m_2}{p_2^2}\frac{3}{1}$$

$$= \frac{p_1^2}{p_2^2} \times \frac{6}{2}$$

$p_1 : p_2 = 1:1$

574 **(b)**

$$E = \frac{1}{2}m(20^2 - 10^2) = \frac{1}{2}m \times 30 \times 10$$

$$E = \frac{1}{2}m \times 10 \times 10$$

$$\therefore \frac{E'}{E} = \frac{\frac{1}{2}m \times 30 \times 10}{\frac{1}{2}m \times 10 \times 10} = 3 \text{ or } E' = 3E$$

575 **(c)**

Mass of the shell $= m_1 = 0.2\,kg$

Mass of the gun $= m_2 = 4kg$

Let energy of shell $= E_1$, energy of gun $= E_2$

Total energy liberated

$= E_1 + E_2 = 1050\,Joule$ ...(i)

As $E = \frac{P^2}{2m}$

$\therefore \frac{E_1}{E_2} = \frac{m_2}{m_1} = \frac{4}{0.2} = 20 \Rightarrow E_2 = \frac{E_1}{20}$ ...(ii)

From equation (i) and (ii) we get $E_1 = 1000\,Joule$

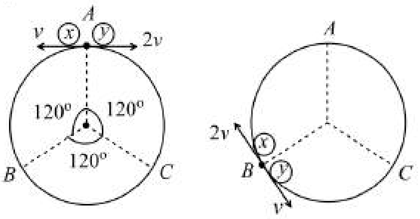
$\therefore$ Kinetic energy of the shell $= \frac{1}{2}m_1v_1^2 = 1000$

$$\Rightarrow \frac{1}{2}(0.2)v_1^2 = 1000 \Rightarrow v_1 = \sqrt{10000} = 100\,m/s$$

576 **(c)**

Let initially particle x is moving in anticlockwise direction and y in clockwise direction

As the ratio of velocities of x and y particles are $\frac{v_x}{v_y} = \frac{1}{2}$, therefore ratio of their distance covered will be in the ratio of 2 : 1. It means they collide at point B



After first collision at B, velocities of particles get interchanged, $i.e.$, x will move with $2v$ and particle y with v

Second collision will take place at point C. Again at this point velocities get interchanged and third collision take place at point A

So, after two collision these two particles will again reach the point A

577 **(d)**

Slope of inclined plane, $\sin\theta = 1/100$

Component o weight down the inclined plane

$F = mg\sin\theta = 100 \times 9.8 \times 1/100 = 9.8$ N

s = distance moved = 10 m

$W = F\,s = 9.8 \times 10 = 98$ J

578 **(c)**

Work done by stopping force = loss in KE

$F \times 0.40 = \dfrac{1}{2} \times 0.05 \times (80)^2 \Rightarrow F = 400\ N$

579 **(b)**

Work done $W = \int_{x_0}^{x_1} F \cdot dx$

$= \displaystyle\int_0^{x_1} kx\,dx$

$= k\left[\frac{x^2}{2}\right]_0^{x_1} = \frac{1}{2}kx_1^2$

580 **(d)**

$x = 2t^4 + 5t + 4 = v = \dfrac{dx}{dt} = 8t + 5$

At $t = 0, v = 5$ m/s

At $t = 1$s, $v = 8 \times 1 + 5 = 13$ m/s

Increase in KE

$= \dfrac{1}{2}m[(13)^2 - (5)^2] = 144$ J

581 **(b)**

$p = \sqrt{2mE_k}$

E_k is increased by a factor of 4, p becomes double.

So, percentage increase in momentum is 100%

582 **(b)**

According to question, $\frac{1}{2}m_A v_A^2 = \frac{1}{2}m_B v_B^2$

$\Rightarrow \dfrac{v_A}{v_B} = \sqrt{\dfrac{m_B}{m_A}} = \sqrt{\dfrac{5}{20}} = \dfrac{1}{2}$

Using Impulse Momentum

$\dfrac{F\Delta t_A}{F\Delta t_B} = \dfrac{m_A \Delta v_A}{m_B \Delta v_B} \Rightarrow \dfrac{\Delta t_A}{\Delta t_B} = \dfrac{20}{5} \times \dfrac{1}{2} = 2$

583 **(c)**

Stopping distance $= \frac{\text{kinetic energy}}{\text{retarding force}} \Rightarrow s = \frac{1}{2}\frac{mu^2}{F}$

If lorry and car both possess same kinetic energy and retarding force is also equal then both come to rest in the same distance

584 **(d)**

mgh = initial potential energy

mgh' = final potential energy after rebound

As 40% energy lost during impact

$\therefore mgh' = 60\%$ of mgh

$\Rightarrow h' = \dfrac{60}{100} \times h = \dfrac{60}{100} \times 10 = 6m$

585 **(d)**

Net force on body $= \sqrt{4^2 + 3^2} = 5N$

$\therefore a = F/m = 5/10 = 1/2\ m/s^2$

Kinetic energy $= \frac{1}{2}mv^2 = \frac{1}{2}m(at)^2 = 125\ J$

586 **(a)**

Max. K.E. of the system = Max. P.E. of the system

$\dfrac{1}{2}kx^2 = \dfrac{1}{2} \times (16) \times (5 \times 10^{-2})^2 = 2 \times 10^{-2} J$

587 **(a)**

When the length of spring is halved, its spring constant will becomes double

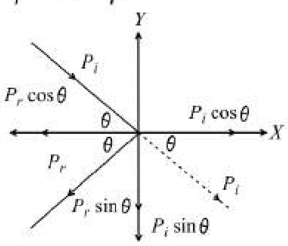
$\left[\text{Because } k \propto \dfrac{1}{x} \propto \dfrac{1}{L} \therefore k \propto \dfrac{1}{L}\right]$

Slope of force displacement graph gives the spring constant (k) of spring

If k becomes double then slope of the graph increases $i.e.$ graph shifts towards force- axis

588 **(b)**

Linear momentum of water striking per second to the wall $P_1 = mv = Av\rho\ v = Av^2\rho$, similarly linear momentum of reflected water per second $P_r = Av^2\rho$



Now making components of momentum along x-axes and y-axes. Change in momentum of water per second

$= P_i \cos\theta + P_r \cos\theta$

$= 2Av^2 \rho \cos\theta$

By definition of force, force exerted on the Wall = $2Av^2 \rho \cos\theta$

589 **(b)**

$E = \frac{P^2}{2m} \therefore E \propto \frac{1}{m}$ [If P = constant]

$i.e.$, the lightest particle will possess maximum kinetic energy and in the given option mass of electron is minimum

591 **(a)**

If x is the extension produced in spring

$$F = kx \Rightarrow x = \frac{F}{k} = \frac{mg}{k} = \frac{20 \times 9.8}{4000} = 4.9\ cm$$

592 **(a)**

$$1\ kcal = 10^3\ Calorie = 4200\ J = \frac{4200}{3.6 \times 10^6} kWh$$

$$\therefore 700\ kcal = \frac{700 \times 4200}{3.6 \times 10^6} kWh = 0.81 kWh$$

593 **(a)**

Applying principle of conservation of linear momentum, velocity of the system (v) is

$$m_1 v_1 = (m_1 + m_2)V, \Rightarrow V = \frac{m_1 v_1}{m_1 + m_2}$$

$$= \frac{50 \times 10}{(50 + 950)} = \frac{1}{2} \text{ms}^{-1}$$

Initial KE, $E_1 = \frac{1}{2} m_1 v_1^2 = \frac{1}{2} \times \left(\frac{50}{1000}\right) \times 10^2 = 2.5$ J

Final KE, $E^2 = \frac{1}{2}(m^1 + m^2)v^2$

$$= \frac{1}{2} \frac{(50 + 950)}{1000} \times \frac{1}{2} = 0125 \text{ J}$$

Percentage loss is KE

$$\frac{E_1 - E_2}{E_1} \times 100 = \frac{2.5 - 0.125}{2.5} = 95\%$$

594 **(b)**

If the masses are equal and target is at rest and after collision both masses moves in different direction. Then angle between direction of velocity will be 90°, if collision is elastic

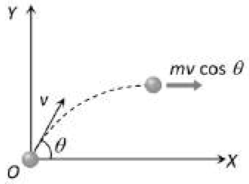
595 **(a)**

Shell is fired with velocity v at an angle θ with the horizontal

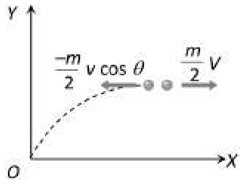
So its velocity at the highest point

= horizontal component of velocity = $v \cos\theta$

So momentum of shell before explosion = $mv \cos\theta$



When it breaks into two equal pieces one piece retraces its path to the canon, then other part moves with velocity V



So momentum of two pieces after explosion

$$= \frac{m}{2}(-v\cos\theta) + \frac{m}{2}V$$

By the law of conservation of momentum

$$mv\cos\theta = \frac{-m}{2} v\cos\theta + \frac{m}{2} V \Rightarrow V = 3v\cos\theta$$

596 **(c)**

While moving from (0,0) to $(a, 0)$

Along positive x-axis, $y = 0 \therefore \vec{F} = -kx\hat{j}$

$i.e.$, force is in negative y- direction while displacement is in positive x-direction

$\therefore W_1 = 0$

Because force is perpendicular to displacement

Then particle moves from $(a, 0)$ to $(a. a)$ along a line parallel to y-axis ($x = +a$) during this $\vec{F} = -k(y\hat{i} + a\hat{j})$

The first component of force, $-ky\hat{i}$ will not contribute any work because this component is along negative x-direction $(-\hat{i})$ while displacement is in positive y-direction $(a, 0)$ to (a, a). The second component of force $i.e.$ $-ka\hat{j}$ will perform negative work

$\therefore W_2 = (-ka\hat{j})(a\hat{j}) = (-ka)(a) = -ka^2$

So net work done on the particle $W = W_1 + W_2$

$= 0 + (-ka^2) = -ka^2$

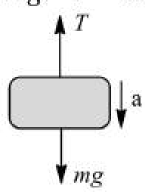
597 **(d)**

$$E = \frac{P^2}{2m} \Rightarrow E \propto \frac{1}{m} \Rightarrow \frac{E_1}{E_2} = \frac{m_2}{m_1}$$

598 **(b)**

From force diagram as shown in figure

$mg - T = ma$



$T = mg - ma = mg - \frac{mg}{4} = \frac{3mg}{4}$

$\therefore W_T =$ work done by tension

$= \vec{\mathbf{T}}.\vec{\mathbf{s}} = Ts\cos 180° = -\frac{3mgd}{4}$

599 **(a)**

The potential energy of a particle is given by

$V(x) = \left(\frac{x^4}{4} - \frac{x^2}{2}\right)$

For minimum value of V, $\frac{dV}{dx} = 0$

$\therefore \frac{4x^3}{4} - \frac{2x}{2} = 0 \implies x = 0, x = \pm 1$

So, $V_{MIN}(x = \pm 1) = \frac{1}{4} - \frac{1}{2} = \frac{-1}{4} J$

$\therefore K_{MAX} + V_{MIN}$=Total mechanical energy

$K_{MAX} = \left(\frac{1}{4}\right) + 2 \implies K_{MAX} = \frac{9}{4}$

Or $\frac{mv^2}{2} = \frac{9}{4} \Rightarrow v = \frac{3}{\sqrt{2}} ms^{-1}$

600 **(c)**

Force = Rate of change of momentum

Initial momentum $\vec{P}_1 = mv\sin\theta\ \hat{\imath} + mv\cos\theta\ \hat{\jmath}$

Final momentum $\vec{P}_2 = -mv\sin\theta\ \hat{\imath} + mv\cos\theta\ \hat{\jmath}$

$\therefore \vec{F} = \frac{\Delta\vec{P}}{\Delta t} = \frac{-2mv\sin\theta}{2\times 10^{-3}}$

Substituting $m = 0.1\ kg, v = 5\ m/s, \theta = 60°$

Force on the ball $\vec{F} = -250\sqrt{3}N$

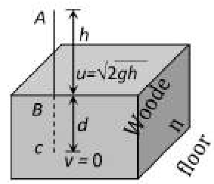
Negative sign indicates direction of the force

601 **(a)**

Since bodies exchange their velocities , hence their masses are equal so that $\frac{m_A}{m_B} = 1$

602 **(c)**

Let the blade stops at depth d into the wood



$v^2 = u^2 + 2aS$

$\Rightarrow 0 = \left(\sqrt{2gh}\right)^2 + 2(g-a)d$

By solving $a = \left(1 + \frac{h}{d}\right)g$

So the resistance offered by the wood $= mg\left(1 + \frac{h}{d}\right)$

603 **(a)**

$U_1 = mgh_1$ and $U_2 = mgh_2$

% energy lost $= \frac{U_1 - U_2}{U_1} \times 100$

$= \frac{mgh_1 - mgh_2}{mgh_1} 100 = \left(\frac{h_1 - h_2}{h_1}\right) \times 100$

$= \frac{2 - 1.5}{2} \times 100 = 25\%$

604 **(a)**

Velocity of 50 kg mass after 5 sec of projection

$v = u - gt = 100 - 9.8 \times 5 = 51\ m/s$

At this instant momentum of body is an upward direction

$P_{\text{initial}} = 50 \times 51 = 2550\ kg - m/s$

After breaking 20 kg piece travels upwards with 150 m/s let the speed of 30 kg mass is V

$P_{\text{final}} = 20 \times 150 + 30 \times V$

By the law of conservation of momentum

$P_{\text{initial}} = P_{\text{final}}$

$\Rightarrow 2550 = 20 \times 150 + 30 \times V \Rightarrow V = -15\ m/s$

$i.e.$ it moves in downward direction

605 **(b)**

Due to theory of relativity

WORK ENERGY AND POWER

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 1 to 0. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

1

Statement 1: According to law of conservation of mechanical energy change in potential energy is equal and opposite to the change in kinetic energy.

Statement 2: Mechanical energy is not conserved.

2

Statement 1: Energy released when a mass of one microgram disappears in a process is 9×10^7 J

Statement 2: It follows from $E = \frac{1}{2}mv^2$

3

Statement 1: In case of bullet fired from gun, the ratio of kinetic energy of gun and bullet is equal to ratio of mass of bullet and gun

Statement 2: In firing, momentum is conserved

4

Statement 1: The change in kinetic energy of a particle is equal to the work done on it by the net force

Statement 2: Change in kinetic energy of particle is equal to the work done only in case of a system of one particle

5

Statement 1: A block of mass m starts moving on a rough horizontal surface with a velocity v. It stops due to friction between the block and the surface after moving through a certain distance. The surface is now titled to an angle of 30° with the horizontal and the same block is made to go up on the surface with the same initial velocity v. The decrease in the mechanical energy in the second situation is smaller than that in the first situation

Statement 2: The coefficient of friction between the block and the surface decreases with the increase in the angle of inclination

6

Statement 1: Work done by or against gravitational force in moving a body from one point to another is independent of the actual path followed between the two points

Statement 2: Gravitational forces are conservative forces

7

Statement 1: Wire through which current flows gets heated

Statement 2: When current is drawn from a cell, chemical energy is converted into heat energy

8

Statement 1: Mountain roads rarely go straight up the slope

Statement 2: Slope of mountains are large therefore more chances of vehicle to slip from roads

9

Statement 1: A spring has potential energy, Whether it is compressed or stretched.

Statement 2: In compressing or stretching work is done on the spring against the restoring force.

10

Statement 1: When a gas is allowed to expand, work done by gas is positive

Statement 2: Force due to gaseous pressure and displacement (of piston) are in the same direction

11

Statement 1: Graph between potential energy of a spring versus the extension or compression of the spring is a straight line

Statement 2: Potential energy of a stretched or compressed spring, proportional to square of extension or compression

12

Statement 1: $\text{Stopping distance} = \frac{\text{Kinetic energy}}{\text{Stopping force}}$

Statement 2: Work done in stopping a body is equal to KE of the body

13

Statement 1: A quick collision between two bodies is more violent than slow collision, even when initial and final velocities are identical

Statement 2: The rate of change of momentum determines that force is small or large

14

Statement 1: The rate of change of total momentum of a many particle system is proportional to the sum of the internal forces of the system

Statement 2: Internal forces can change the kinetic energy but not the momentum of the system

15

Statement 1: A light body and heavy body have same momentum. Then they also have same kinetic energy

Statement 2: Kinetic energy does not depend on mass of the body

16

Statement 1: Mass and energy are not conserved separately, but are conserved as a single entity called mass-energy

Statement 2: Mass and energy conservation can be obtained by Einstein equation for energy

17

Statement 1: Power developed in circular motion is always zero

Statement 2: Work done in case of circular motion is zero

18

Statement 1: Two springs of force constants k_1 and k_2 are stretched by the same force. If $k_1 > k_2$, then work done in stretching the first (W_1) is less than work done in stretching the second (W_2)

Statement 2: $F = k_1x_1 = k_2x_2 \therefore \frac{x_1}{x_2} = \frac{k_2}{k_1}\ \frac{W_1}{W_2} = \frac{\frac{1}{2}k_1x_1^2}{\frac{1}{2}k_2x_2^2} = \frac{k_1}{k_2}\left(\frac{k_2}{k_1}\right)^2 = \frac{k_2}{k_1}$ As $k_1 > k_2, W_1 < W_2$

19

Statement 1: Comets move around the sun in elliptical orbits. The gravitational force on the comet due to sun is not normal to the comet's velocity but the work done by the gravitational force over every complete orbit of the comet is zero

Statement 2: Gravitational force is a non conservative force

20

Statement 1: If two protons are brought near one another, the potential energy of the system will increase

Statement 2: The change on the proton is $+1.6 \times 10^{-19}C$

21

Statement 1: Mass and energy are not conserved separately, but are conserved as a single identity called mass energy.

Statement 2: This is because one can be obtained at the cost of the other as per Einstein equation, $E=mc^2$.

22

Statement 1: If a light body and heavy body have equal kinetic energies, momentum is greater for the heavy body.

Statement 2: If a light body and heavy body have same momentum, the light body will possess more kinetic energy.

23

Statement 1: Power of machine gun is determined by both, the number of bullet fired per second and kinetic energy of bullets

Statement 2: Power of any machine is defined as work done (by it) per unit time

24

Statement 1: A weight lifter does not work in holding the weight up

Statement 2: Work done is zero because distance moved is zero

25

Statement 1: In an elastic collision between two bodies, the relative speed of the bodies after collision is equal to the relative speed before the collision

Statement 2: In an elastic collision, the linear momentum of the system is conserved

26

Statement 1: Work done by friction on a body sliding down an inclined plane is positive

Statement 2: Work done is greater than zero, if angle between force and displacement is acute or both are in same direction

27

Statement 1: Two particles moving in the same direction do not lose all their energy in a completely inelastic collision

Statement 2: Principle of conservation of momentum holds true for all kinds of collisions

28

Statement 1: According to law of conservation of mechanical energy change in potential energy is equal and opposite to the change in kinetic energy

Statement 2: Mechanical energy is not a conserved quantity

29

Statement 1: When the force retards the motion of a body, the work done is zero

Statement 2: Work done depends on angle between force and displacement

30

Statement 1: When two moving bodies collide, their temperatures rise.

Statement 2: The potential energy of the colliding bodies converts into heat energy.

31

Statement 1: Kinetic energy of a body is quadrupled, when its velocity is doubled

Statement 2: Kinetic energy is proportional to square of velocity

32

Statement 1: Work done in moving a body over a closed loop is zero for every force in nature

Statement 2: Work done does not depend on nature of force

33

Statement 1: Mass and energy are not conserved separately, but are conserved as a single entity called 'mass-energy'

Statement 2: This is because one can be obtained at the cost of the other as per Einstein equation. $E = mc^2$

34

Statement 1: In an elastic collision of two bodies, the momentum and energy of each body is conserved

Statement 2: If two bodies stick to each other, after colliding, the collision is said to be perfectly elastic

35

Statement 1: Heavy water is used as moderator in nuclear reactor

Statement 2: Water cools down the fast neutrons

36

Statement 1: A spring has potential energy, both when it is compressed or stretched

Statement 2: In compressing or stretching, work is done on the spring against the restoring force

WORK ENERGY AND POWER

: ANSWER KEY :

1)	c	2)	c	3)	a	4)	c	21)	a	22)	a	23)	a	24)	a
5)	c	6)	a	7)	c	8)	a	25)	b	26)	d	27)	b	28)	c
9)	a	10)	a	11)	d	12)	a	29)	d	30)	a	31)	a	32)	d
13)	a	14)	d	15)	d	16)	a	33)	a	34)	d	35)	c	36)	a
17)	a	18)	a	19)	c	20)	b								

WORK ENERGY AND POWER

: HINTS AND SOLUTIONS :

1 **(c)**
According to conservation of mechanical energy as for conservation forces the sum of kinetic energy and potential energy remains constant and throughout the motion it is independent of time. This is the law of conservation of mechanical energy.

ie, KE+PE=total energy =constant.

3 **(a)**
$E = \frac{p^2}{2m}$. In firing momentum is conserved $\therefore E \propto \frac{1}{m}$

So $\frac{E_{\text{gun}}}{E_{\text{bullet}}} = \frac{m_{\text{bullet}}}{m_{\text{gun}}}$

4 **(c)**
Change in kinetic energy = work done by net force

This relationship is valid for particle as well as system of particles

5 **(c)**
The coefficient of friction between two surface is independent of angle of inclination of the surface

6 **(a)**
From, definition, work done in moving a body against a conservative force is independent of the path followed

7 **(c)**
When we supply current through the cell, chemical reactions takes place, so chemical energy of cell is converted into electrical energy

8 **(a)**
If roads of the mountain were to go straight up, the slope θ would have been large, the frictional force $\mu mg \cos\theta$ would be small. Due to small friction, wheels of vehicle would slip. Also for going up a large slope, a greater power shall be required

9 **(a)**
When a spring is compressed or stretched, work is to be done against restoring force. This work done is stored in the spring in from of potential energy

10 **(a)**
Since the gaseous pressure and the displacement (of piston) are in the same direction. Therefore $\theta = 0°$

$\therefore$ Work done $= Fs\cos\theta = Fs =$ Positive

Thus during expansion work done by gas is positive

11 **(d)**
Potential energy $U = \frac{1}{2}kx^2$ $i.e.$ $U \propto x^2$

This is a equation of parabola, so graph between U and x is a parabola, not straight line

13 **(a)**
In a quick collision, time t is small. As $F \times t =$ constant, therefore, force involved is large, $i.e.$ collision is more violent in comparison to slow collision

14 **(d)**
Rate of change of momentum is proportional to external forces acting on the system. The total momentum of whole system remain constant when no external force is acted upon it

15 **(d)**
When two bodies have same momentum then lighter body masses more kinetic energy because $E = \frac{P^2}{2m}$

$\therefore E \propto \frac{1}{m}$ when $P =$ constant

16 **(a)**
From Einstein equation $E = mc^2$

17 **(a)**
Work done and power developed is zero in uniform circular motion only

19 **(c)**
The gravitational force on the comet due to the sun is a conservative force. Since the work done by a conservative force over a closed path is always zero (irrespective of the nature of path), the work done by the gravitational forces over every complete orbit of the comet is zero

20 **(b)**
If two protons are brought near one another, work has to be done against electrostatic force because same charge repel each other. The work done is stored as potential energy in the system

21 **(a)**
Einstein mass-energy equivalence relation is given by

$\mathrm{E} = \mathrm{mc}^2$

From the relation, it can be said that if energy is conserved, then mass is conserved or vice-versa. Also, per this equation, Whole of the energy can be converted into mass or can be converted wholly into energy.

22 **(a)**
From the formula,

$$K = \frac{p^2}{2m} \Rightarrow p^2 \propto m$$

Thus, if kinetic energy is same for both bodies then momentum will be greater for heavy body.

Also if momentum is equal for both the bodies then kinetic energy will be higher for lighter body.

23 **(a)**
K.E. of one bullet $= k \therefore$ K.E. of n bullet $= nk$

According to law of conservation of energy, the kinetic energy of bullets be equal to the work done by machine gun per sec

25 **(b)**
Both the statement 1 & statement 2 is true, statement 2 is not a correct explanation for statement 1. In fact the momentum is conserved both in elastic as well as in inelastic collision. But in elastic collision the total kinetic energy of the system is also conserved

26 **(d)**
When a body slides down on inclined plane, work done by friction is negative because it opposes the motion ($\theta = 180°$ between force and displacement)

If $\theta < 90°$ then $W =$ positive because $W = F.s.\cos\theta$

28 **(c)**
For conservative forces the sum of kinetic and potential energies at any point remains constant throughout the motion. This is known as law of conservation of mechanical energy. According to this law,

Kinetic energy + Potential energy = constant

Or, $\Delta K + \Delta U = 0$ or, $\Delta K = -\Delta U$

29 **(d)**
When the force retards the motion, the work done is negative

Work done depends on the angle between force and displacement $W = Fs\cos\theta$

30 **(a)**
When two moving bodies collide, their temperatures rise due to some part of KE is converted into heat energy of two colliding bodies.

31 **(a)**
$K = \frac{1}{2}mv^2 \therefore K \propto v^2$

If velocity is doubled then K.E. will be quadrupled

32 **(d)**
Work done in the motion of a body over a closed loop is zero only when the body is moving under the action of conservative forces (like gravitational or electrostatic forces). *i.e.* work done depends upon the nature of force

34 **(d)**

In an elastic collision both the momentum and kinetic energy remains conserved. But this rule is not for individual bodies, but for the system of bodies before and after the collision. While collision in which there occurs some loss of kinetic energy is called inelastic collision. Collision in daily life are generally inelastic. The collision is said to be perfectly inelastic, if two bodies stick to each other

35 **(c)**

When two bodies of same mass undergo an elastic collision, their velocities get interchanged after collision. Water and heavy water are hydrogenic materials containing protons having approximately the same mass as that of a neutron. When fast moving neutrons collide with protons, the neutrons come to rest and protons move with the velocity of that of neutrons

36 **(a)**

The work done on the spring against the restoring force is stored as potential energy in both conditions when it is compressed or stretched