KINETIC THEORY

1. The speeds of 5 molecules of a gas (in arbitrary units) are as follows: 2,3,4,5,6. The root mean square speed for these molecules is
a) 2.91 b) 3.52 c) 4.00 d) 4.24
2. The rate of cooling at 600 K, if surrounding temperature is 300 K is$R$. The rate of cooling at 900 K is
a) $\frac{16}{3}R$ b) $2R$ c) $3R$ d) $\frac{2}{3}R$
3. For a diatomic gas change in internal energy for unit change in temperature for constant volume is U_1 and U_2 respectively. $U_1 : U_2$ is
a) 5 : 3 b) 3 : 5 c) 1 : 1 d) 5 : 7
4. The temperature of a piece of metal is increased from 27°C to 84°C. The rate at which energy is radiated is increased to
a) Four times b) Two times c) Six times d) Eight times
5. The kinetic energy of translation of 20 g of oxygen at 47°C is (molecular wt. of oxygen is 32 g/mol and R = $8.3J/mol/K$)
a) 2490 $joules$ b) 2490 $ergs$ c) 830 $joules$ d) 124.5 $joules$
6. Two thermally insulated vessels 1 and 2 are filled with air at temperatures (T_1, T_2) volume (V_1, V_2) and pressure (P_1, P_2) respectively. If the valve joining the two vessels is opened, the temperature inside the vessel at equilibrium will be
a) $T_1 + T_2$ b) $(T_1 + T_2)/2$ c) $\frac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_2 + P_2V_2T_1}$ d) $\frac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_1 + P_2V_2T_2}$
7. The pressure and volume of saturated water vapour are P and V respectively. It is compressed isothermally thereby volume becomes $V/2$, the final pressure will be
a) More than $2P$ b) P c) $2P$ d) $4P$
8. At which temperature the velocity of O_2 molecules will be equal to the velocity of N_2 molecules at 0°C
a) 40°C b) 93°C c) 39°C d) Cannot be calculated
9. Kinetic theory of gases provide a base for
a) Charle's law b) Boyle's law
c) Charle's law and Boyle's law d) None of these
10. The time average of the kinetic energy of one molecule of a gas taken over a long period of time
a) Is proportional to the square root of the absolute temperature of the gas
b) Is proportional to the absolute temperature of the gas
c) Is proportional to the square of the absolute temperature of the gas
d) Does not depend upon the absolute temperature of the gas
11. Kinetic theory of gases was put forward by
a) Einstein b) Newton c) Maxwell d) Raman
12. In kinetic theory of gases, which of the following statements regarding elastic collisions of the molecules is wrong
a) Kinetic energy is lost in collisions
b) Kinetic energy remains constant in collision
c) Momentum is conserved in collision
d) Pressure of the gas remains constant in collisions

13. If γ is the ratio of specific heats and R is the universal gas constant, then the molar specific heat at constant volume C_v is given by

a) γR b) $\frac{(\gamma-1)R}{\gamma}$ c) $\frac{R}{\gamma-1}$ d) $\frac{\gamma R}{\gamma-1}$

14. The vapour of a substance behaves as a gas

a) Below critical temperature b) Above critical temperature
c) At 100°C d) At 1000°C

15. If the temperature of an ideal gas increases three times, then its rms velocity will become

a) $\sqrt{3}$ times b) 3 times c) One third d) Remains same

16. The relationship between pressure and the density of a gas expressed by Boyle's law, $P = KD$ holds true

a) For any gas under any conditions b) For some gases under any conditions
c) Only if the temperature is kept constant d) Only if the density is constant

17. If the ratio of vapour density for hydrogen and oxygen is $\frac{1}{16}$, then under constant pressure the ratio of their rms velocities will be

a) $\frac{4}{1}$ b) $\frac{1}{4}$ c) $\frac{1}{16}$ d) $\frac{16}{1}$

18. The gases carbon-monoxide (CO) and nitrogen at the same temperature have kinetic energies E_1 and E_2 respectively. Then

a) $E_1 = E_2$ b) $E_1 > E_2$
c) $E_1 < E_2$ d) E_1 and E_2 cannot be compared

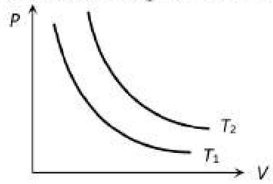
19. What is the mass of 2 L of nitrogen at 22.4 atm pressure and 273 K?

a) 28 g b) 14×22.4 g c) 56 g d) None of these

20. The average kinetic energy of a gas molecules is

a) Proportional to pressure of gas b) Inversely proportional to volume of gas
c) Inversely proportional to absolute temperature of gas d) Directly proportional to absolute temperature of gas

21. The adjoining figure shows graph of pressure and volume of a gas at two temperatures T_1 and T_2. Which of the following inferences is correct



a) $T_1 > T_2$ b) $T_1 = T_2$
c) $T_1 < T_2$ d) No interference can be drawn

22. At room temperature (27°C) the rms speed of the molecules of a certain diatomic gas is found to be 1920 ms^{-1}. The gas is

a) Cl_2 b) O_2 c) N_2 d) H_2

23. At a given temperature, the pressure of an ideal gas of density ρ is proportional to

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

24. Temperature remaining constant, the pressure of gas is decreased by 20%. The percentage change in volume

a) Increases by 20% b) Decreases by 20% c) Increases by 25% d) decreases by 25%

25. The rms velocity of gas molecules is 300 ms^{-1}. The rms velocity of molecules of gas with twice the molecular weight and half the absolute temperature is

a) 300 ms^{-1} b) 600 ms^{-1} c) 75 ms^{-1} d) 150 ms^{-1}

26. A jar contains a gas and few drops of water at T K. The pressure in the jar is 830 mm of mercury. The temperature of jar is reduced by 1%. The saturated vapour pressure of water at the two temperatures are 30 mm and 25 mm of mercury. Then the new pressure in the jar will be

a) 917 mm of Hg b) 717 mm of Hg c) 817 mm of Hg d) None of these

27. The gas equation $\frac{PV}{T}$ = constant is true for a constant mass of an ideal gas undergoing

a) Isothermal change b) Adiabatic change c) Isobaric change d) Any type of change

28. The pressure and temperature of two different gases is P and T having the volume V for each. They are mixed keeping the same volume and temperature, the pressure of the mixture will be

a) $P/2$ b) P c) $2P$ d) $4P$

29. Vessel A is filled with hydrogen while vessel B, whose volume is twice that of A, is filled with the same mass of oxygen at the same temperature. The ratio of the mean kinetic energies of hydrogen and oxygen is

a) 16 : 1 b) 1 : 8 c) 8 : 1 d) 1 : 1

30. The root mean square speed of hydrogen molecules at 300 K is 1930 m/s. Then the root mean square speed of oxygen molecules at 900 K will be

a) $1930\sqrt{3}\ m/s$ b) 836 m/s c) 63 m/s d) $\frac{1930}{\sqrt{3}} m/s$

31. A cylinder rolls without slipping down an inclined plane, the number of degrees of freedom it has, is

a) 2 b) 3 c) 5 d) 1

32. Two spheres made of same material have radii in the ratio1 : 2. Both are at same temperature. Ratio of heat radiation energy emitted per second by them is

a) 1 : 2 b) 1 : 4 c) 1 : 8 d) 1 : 16

33. If $r.m.s.$ velocity of a gas is $V_{rms} = 1840\ m/s$ and its density $\rho = 8.99 \times 10^{-2} kg/m^3$, the pressure of the gas will be

a) $1.01\ N/m^2$ b) $1.01 \times 10^3 N/m^2$ c) $1.01 \times 10^5 N/m^2$ d) $1.01 \times 10^7 N/m^2$

34. An ideal gas ($\gamma = 1.5$) is expanded adiabatically. How many times has the gas to be expanded to reduce the root mean square velocity of molecules 2.0 times?

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

35. The quantity of heat required to raise one mole through one degree kelvin for a monoatomic gas at constant volume is

a) $\frac{3}{2}R$ b) $\frac{5}{2}R$ c) $\frac{7}{2}R$ d) $4R$

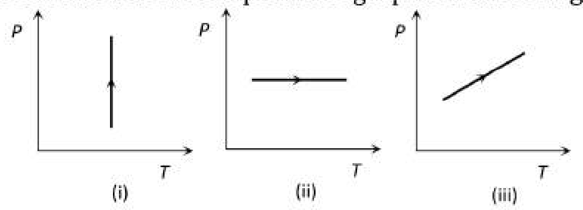
36. Calculate the ratio of rms speeds of oxygen gas molecules to that of hydrogen gas molecules kept at the same temperature.

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

37. At constant pressure, the ratio of increase in volume of an ideal gas per degree rise in kelvin temperature to it's original volume is (T = absolute temperature of the gas)

a) T^2 b) T c) $1/T$ d) $1/T^2$

38. Pressure versus temperature graphs of an ideal gas are as shown in figure. Choose the wrong statement



a) Density of gas is increasing in graph (i) b) Density of gas is decreasing in graph (ii)

c) Density of gas is constant in graph (iii) d) None of these

39. A body takes 10 min to cool from 60°C to 50°C. If the temperature of surroundings is 25°C and 527°C respectively. The ratio of energy radiated by P and Q is

a) 48°C b) 46°C c) 49°C d) 42.85°C

40. A cylinder of radius r and thermal conductivity K_1 is surrounded by a cylindrical shell of linear radius r and outer radius$2r$, whose thermal conductivity is K_2. There is no loss of heat across cylindrical surfaces,

when the ends of the combined system are maintained at temperatures T_1 and T_2. The effective thermal conductivity of the system, in the steady state is

a) $\frac{K_1K_2}{K_1+K_2}$ b) K_1+K_2 c) $\frac{K_1+3K_2}{4}$ d) $\frac{3K_1+K_2}{4}$

41. A gaseous mixture consists of $16g$ of helium and $16g$ of oxygen. The ratio $\frac{C_P}{C_V}$ of the mixture is

a) 1.4 b) 1.54 c) 1.59 d) 1.62

42. Mean free path of a gas molecule is

a) Inversely proportional to number of molecules per unit volume

b) Inversely proportional to diameter of the molecule

c) Directly proportional to the square root of the absolute temperature

d) Directly proportional to the molecular mass

43. The value of densities of two diatomic gases at constant temperature and pressure are d_1 and d_2, then the ratio of speed of sound in these gases will be

a) d_1d_2 b) $\sqrt{d_2/d_1}$ c) $\sqrt{d_1/d_2}$ d) $\sqrt{d_1d_2}$

44. If the internal energy of n_1 moles of He at temperature 10 T is equal to the internal energy of n_2 mole of hydrogen at temperature 6 T. the ratio of $\frac{n_1}{n_2}$ is

a) $\frac{3}{5}$ b) 2 c) 1 d) $\frac{5}{3}$

45. The heat capacity per mole of water is (R is universal gas constant)

a) $9R$ b) $\frac{9}{2}R$ c) $6R$ d) $5R$

46. If number of molecules of H_2 are double than that of O_2, then ratio of kinetic energy of hydrogen and that of oxygen at 300 K is

a) 1 : 1 b) 1 : 2 c) 2 : 1 d) 1 : 16

47. According to the kinetic theory of gases, the temperature of a gas is a measure of average

a) Velocities of its molecules b) Linear momenta of its molecules

c) Kinetic energies of its molecules d) Angular momenta of its molecules

48. Air is filled in a bottle at atmospheric pressure and it is corked at 35°C. If the cork can come out at 3 atmospheric pressure than upto what temperature should the bottle be heated in order to remove the cork

a) 325.5°C b) 851°C c) 651°C d) None of these

49. The temperature at which the average translational kinetic energy of a molecule is equal to the energy gained by an electron in accelerating from rest through a potential difference of 1 *volt* is

a) $4.6 \times 10^3 K$ b) $11.6 \times 10^3 K$ c) $23.2 \times 10^3 K$ d) $7.7 \times 10^3 K$

50. The average momentum of a molecule in an ideal gas depends on

a) Temperature b) Volume c) Molecular mass d) None of these

51. If pressure of CO_2 (real gas) in a container is given by $P = \frac{RT}{2V-b} - \frac{a}{4b^2}$, then mass of the gas in container is

a) 11 g b) 22 g c) 33 g d) 44 g

52. For an ideal gas of diatomic molecules

a) $C_p = \frac{5}{2}R$ b) $C_v = \frac{3}{2}R$ c) $C_p - C_v = 2R$ d) $C_p = \frac{7}{2}R$

53. What is the value of $\frac{R}{C_P}$ for diatomic gas

a) 3/4 b) 3/5 c) 2/7 d) 5/7

54. When volume of system is increased two times and temperature is decreased half of its initial temperature, then pressure becomes

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

55. A vessel of volume 4 L contains a mixture of 8 g of oxygen, 14 g of nitrogen and 22 g of carbon dioxide at 27°C. The pressure exerted by the mixture is

a) 5.79×10^5 Nm^{-2} b) 6.79×10^5 Nm^{-2} c) 7.79×10^3 Nm^{-2} d) 7.79×10^5 Nm^{-2}

56. 2 g of O_2 gas is taken at 27°C and pressure 76 $cm.Hg$. Find out volume of gas (in litre)
a) 1.53 b) 2.44 c) 3.08 d) 44.2

57. When an air bubble of radius $'r'$ rises from the bottom to the surface of a lake, its radius becomes $5r/4$ (the pressure of the atmosphere is equal to the 10 m height of water column). If the temperature is constant and the surface tension is neglected, the depth of the lake is
a) 3.53 m b) 6.53 m c) 9.53 m d) 12.53 m

58. At what temperature will the rms speed of air molecules be double than that at NTP?
a) 519°C b) 619°C c) 719°C d) 819°C

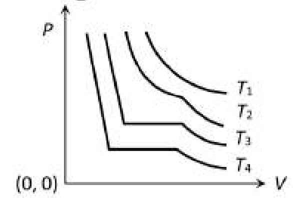
59. The kinetic energy per $g\ mol$ for a diatomic gas at room temperature is
a) 3 RT b) $\frac{5}{2}RT$ c) $\frac{3}{2}RT$ d) $\frac{1}{2}RT$

60. The average kinetic energy of a gas at -23°C and 75 cm pressure is $5 \times 10^{-14} erg$ for H_2. The mean kinetic energy of the O_2 at 227°C and 150 cm pressure will be
a) $80 \times 10^{-14} erg$ b) $20 \times 10^{-14} erg$ c) $40 \times 10^{-14} erg$ d) $10 \times 10^{-14} erg$

61. A monoatomic gas molecule has
a) Three degrees of freedom b) Four degrees of freedom
c) Five degrees of freedom d) Six degrees of freedom

62. Considering the gases to be ideal, the value of $\gamma = \frac{C_P}{C_V}$ for a gaseous mixture consisting of 3 moles of carbon dioxide and 2 moles of oxygen will be ($\gamma_{O_2} = 1.4, \gamma_{CO_2} = 1.3$)
a) 1.37 b) 1.34 c) 1.55 d) 1.63

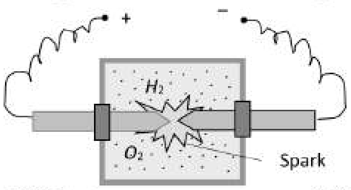
63. The change in volume V with respect to an increase in pressure P has been shown in the figure for a non-ideal gas at four different temperatures T_1, T_2, T_3 and T_4. The critical temperature of the gas is



a) T_1 b) T_2 c) T_3 d) T_4

64. At a given temperature the ratio of $r.m.s.$ velocities of hydrogen molecule and helium atom will be
a) $\sqrt{2} : 1$ b) $1 : \sqrt{2}$ c) $1 : 2$ d) $2 : 1$

65. A vessel contains 14 g (7 moles) of hydrogen and 96 g (9 moles) of oxygen at STP. Chemical reaction is induced by passing electric spark in the vessel till one of the gases is consumed. The temperature is brought back to it's starting value 273 K. The pressure in the vessel is



a) 0.1 atm b) 0.2 atm c) 0.3 atm d) 0.4 atm

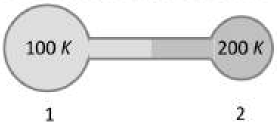
66. When the temperature of a gas is raised from 27°C to 90°C, the percentage increase in the $r.m.s.$ velocity of the molecules will be
a) 10% b) 15% c) 20% d) 17.5%

67. One litre of oxygen at a pressure of 1 atm and two litres of nitrogen at a pressure of 0.5 atm, are introduced into a vessel of volume 1 L. If there is no change in temperature, the final pressure of the mixture of gas (in atm) is
a) 1.5 b) 2.5 c) 2 d) 4

68. The power radiated by a black body is P, and it radiates maximum energy around the wavelength λ_0. If the temperature of black body is now changed so that it radiates maximum energy around a wavelength $\lambda_0/4$, the power radiated by it will increase by a factor of

a) $\frac{4}{3}$ b) $\frac{16}{9}$ c) $\frac{64}{27}$ d) $\frac{256}{81}$

69. Figure shows two flasks connected to each other. The volume of the flask 1 is twice that of flask 2. The system is filled with an ideal gas at temperature 100 K and 200 K respectively. If the mass of the gas in 1 be m then what is the mass of the gas in flask 2



a) m b) $m/2$ c) $m/4$ d) $m/8$

70. Under constant temperature, graph between P and $1/V$ is
a) Parabola b) Hyperbola c) Straight line d) Circle

71. A gas mixture consists of molecules of type 1,2 and 3, with molar masses $m_1 > m_2 > m_3$. V_{rms} and $\bar{K}$ are the $r.m.s.$ speed and average kinetic energy of the gases. Which of the following is true
a) $(V_{rms})_1 < (V_{rms})_2 < (V_{rms})_3$ and $(\bar{K})_1 = (\bar{K})_2 = (\bar{K}_3)$
b) $(V_{rms})_1 = (V_{rms})_2 \leq (V_{rms})_3$ and $(\bar{K})_1 = (\bar{K})_2 > (\bar{K})_3$
c) $(V_{rms})_1 > (V_{rms})_2 < (V_{rms})_3$ and $(\bar{K})_1 < (\bar{K})_2 > (\bar{K}_3)$
d) $(V_{rms})_1 > (V_{rms})_2 > (V_{rms})_3$ and $(\bar{K})_1 < (\bar{K})_2 < (\bar{K})_3$

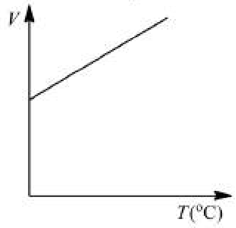
72. The ratio of mean kinetic energy of hydrogen and nitrogen at temperature 300 K and 450 K respectively is
a) 3 : 2 b) 2 : 3 c) 2 : 21 d) 4 : 9

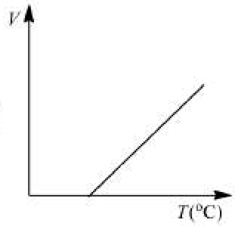
73. Equation of gas in terms of pressure (P), absolute temperature (T) and density (d) is
a) $\frac{P_1}{T_1 d_1} = \frac{P_2}{T_2 d_2}$ b) $\frac{P_1 T_1}{d_1} = \frac{P_2 T_2}{d_2}$ c) $\frac{P_1 d_2}{T_1} = \frac{P_2 d_1}{T_1}$ d) $\frac{P_1 d_1}{T_1} = \frac{P_2 d_2}{T_2}$

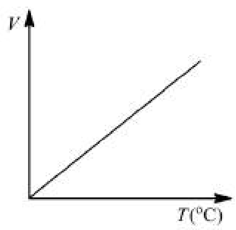
74. On 0°C pressure measured by barometer is 760 mm. What will be pressure at 100°C
a) 760 mm b) 730 mm c) 780 mm d) None of these

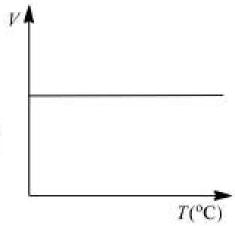
75. The $r.m.s.$ speed of the molecules of a gas in a vessel is 400 ms^{-1}. If half of the gas leaks out, at constant temperature, the $r.m.s.$ speed of the remaining molecules will be
a) 800 ms^{-1} b) $400\sqrt{2}$ ms^{-1} c) 400 ms^{-1} d) 200 ms^{-1}

76. Volume-temperature graph at atmospheric pressure for a monoatomic gas (V in m^3, T in °C) is

a)


b)


c)


d)


77. The temperature of argon, kept in a vessel, is raised by 1°C at a constant volume. The total heat supplied to the gas is a combination of translation and rotational energies. Their respective shares are
a) 60% and 40% b) 40% and 60% c) 50% and 50% d) 100% and 0%

78. The molar heat capacity at constant volume of oxygen gas at STP is nearly $\frac{5R}{2}$ and it approaches $\frac{7R}{2}$ as the temperature is increased. This happens because at higher temperature
a) Oxygen becomes triatomic
b) Oxygen does not behaves as an ideal gas
c) Oxygen molecules rotate more vigorously
d) Oxygen molecules start vibrating

79. Three containers of the same volume contain three different gases. The masses of the molecules are m_1, m_2 and m_3 and the number of molecules in their respective containers are N_1, N_2 and N_3. The gas pressure in the containers are P_1, P_2 and P_3 respectively. All the gases are now mixed and put in one of the containers. The pressure P of mixture will be

a) $P < (P_1 + P_2 + P_3)$ b) $P = \frac{P_1 + P_2 + P_3}{3}$ c) $P = P_1 + P_2 + P_3$ d) $P > (P_1 + P_2 + P_3)$

80. If temperature of gas increases from 27°C to 927°C the $K.E.$ will be

a) Double b) Half c) One fourth d) Four times

81. A mixture of 2 moles of helium gas (atomic mass = 4 amu), and 1 mole of argon gas (atomic mass = 40amu) is kept at 300K in a container. The ratio of the rms speeds $\left[\frac{V_{rms}(\text{helium})}{V_{rms}(\text{argon})}\right]$ is

a) 0.32 b) 0.45 c) 2.24 d) 3.16

82. The value of the gas constant (R) calculated from the perfect gas equation is 8.32 $joules/g$ mole K, whereas its value calculated from the knowledge of C_P and C_V of the gas is 1.98 cal/g mole K. From this data, the value of J is

a) 4.16 J/cal b) 4.18 J/cal c) 4.20 J/cal d) 4.22 J/cal

83. S.I. unit of universal gas constant is

a) $cal/°C$ b) J/mol c) $J\ mol^{-1}K^{-1}$ d) J/kg

84. In Boyle's law what remains constant

a) PV b) TV c) $\frac{V}{T}$ d) $\frac{P}{T}$

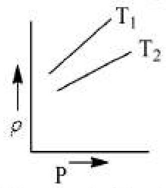
85. To what temperature should the hydrogen at 327°C be cooled at constant pressure, so that the root mean square velocity of its molecules becomes half of its previous value?

a) -123°C b) 123°C c) -100°C d) 0°C

86. Two gases A and B having same pressure p, volume V and absolute temperature T are mixed. If the mixture has the volume and temperature as V and T respectively, then the pressure of the mixture is

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

87. The density (ρ) versus pressure (P) of a given mass of an ideal gas is shown at two temperatures T_1 and T_2



Then relation between T_1 and T_2 may be

a) $T_1 > T_2$ b) $T_2 > T_1$

c) $T_1 = T_2$ d) All the three are possible

88. The gas in vessel is subjected to a pressure of 20 atmosphere at a temperature 27°C. The pressure of the gas in a vessel after one half of the gas is released from the vessel and the temperature of the remainder is raised by 50°C is

a) 8.5 atm b) 10.8 atm c) 11.7 atm d) 17 atm

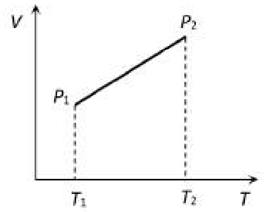
89. On any planet, the presence of atmosphere implies (C_{rms} = root mean square velocity of molecules and V_e = escape velocity)

a) $C_{rms} << V_e$ b) $C_{rms} > V_e$ c) $C_{rms} = V_e$ d) $C_{rms} = 0$

90. The degrees of freedom of a stationary rigid body about its axis will be

a) One b) Two c) Three d) Four

91. From the following $V - T$ diagram we can conclude



a) $P_1 = P_2$ b) $P_1 > P_2$ c) $P_1 < P_2$ d) None of these

92. An electron tube was sealed off during manufacture at a pressure of $1.2 \times 10^{-7} mm$ of mercury at 27°C. Its volume is $100\ cm^3$. The number of molecules that remain in the tube is
a) 2×10^{16} b) 3×10^{15} c) 3.86×10^{11} d) 5×10^{11}

93. The average kinetic energy of hydrogen molecules at 300 K is E. At the same temperature, the average kinetic energy of oxygen molecules will be
a) $E/4$ b) $E/16$ c) E d) $4E$

94. The temperature of an ideal gas is increased from 27°C to 927°C. The root mean square speed of its molecules becomes
a) Twice b) Half c) Four times d) One-fourth

95. A given mass of a gas is allowed to expand freely until its volume becomes double. If C_b and C_a are the velocities of sound in this gas before and after expansion respectively, then C_a is equal to
a) $2C_b$ b) $\sqrt{2}C_b$ c) C_b d) $\frac{1}{\sqrt{2}}C_b$

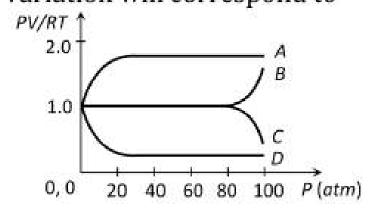
96. For a gas at a temperature T the root-mean-square velocity v_{rms}, the most probable speed v_{mp}, and the average speed v_{av} obey the relationship
a) $v_{av} > v_{rms} > v_{mp}$ b) $v_{rms} > v_{av} > v_{mp}$ c) $v_{mp} > v_{av} > v_{rms}$ d) $v_{mp} > v_{rms} > v_{av}$

97. Two chambers containing m_1 and m_2 gram of a gas at pressures p_1 and p_2 respectively are put in communication with each other, temperature remaining constant. The common pressure reached will be
a) $\frac{p_1p_2(m_1+m_2)}{p_2m_1+p_1m_2}$ b) $\frac{p_1p_2m_1}{p_2m_1+p_1m_2}$ c) $\frac{m_1m_2(p_1+p_2)}{p_2m_1+p_1m_2}$ d) $\frac{m_1m_2p_2}{p_2m_1+p_1m_2}$

98. The root mean square speed of the molecules of a diatomic gas is v. When the temperature is doubled, the molecules dissociate into two atoms. The new root mean square speed of the atom is
a) $\sqrt{2}v$ b) v c) $2v$ d) $4v$

99. The ends of 2 different materials with their thermal conductivities, radii of cross section and length all in the ratio of 1 : 2 maintained at temperature difference. If the rate of the flow of heat in the longer rod is 4 cals^{-1}, that in the shorter rod in cals^{-1} will be
a) 1 b) 2 c) 8 d) 6

100. An experiment is carried on a fixed amount of gas at different temperatures and at high pressure such that it deviates from the ideal gas behavior. The variation of $\frac{PV}{RT}$ with P is shown in the diagram. The correct variation will correspond to



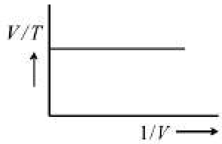
a) Curve A b) Curve B c) Curve C d) Curve D

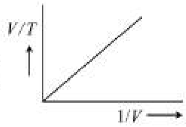
101. A gas is filled in a cylinder, its temperature is increased by 20% on kelvin scale and volume is reduced by 10%. How much percentage of the gas will leak out
a) 30% b) 40% c) 15% d) 25%

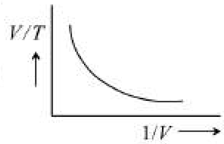
102. The degrees of freedom of a molecule of a triatomic gas are
a) 2 b) 4 c) 6 d) 8

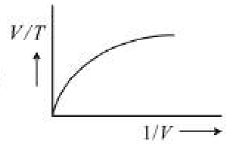
103. Six molecules speeds 2 unit, 5 unit, 3 unit, 6 unit, 3 unit, and 5 unit respectively. The rms speed is
a) 4 unit b) 1.7 unit c) 4.2 unit d) 5 unit

104. Which one of the following graph is correct at constant pressure

a) 

b) 

c) 

d) 

105. The tyre of a motor car contains air at 15°C . If the temperature increases to 35°C , the approximate percentage increase is (ignore to expansion of tyre)

a) 7 b) 9 c) 11 d) 13

106. The temperature of the hydrogen at which the average speed of its molecules is equal to that of oxygen molecules at a temperature of 31°C, is

a) −216°C b) −235°C c) −254°C d) −264°C

107. The kinetic energy of one gram molecule of a gas at normal temperature and pressure is ($R = 8.31\ J/mol - K$)

a) $0.56 \times 10^4\ J$ b) $1.3 \times 10^2\ J$ c) $2.7 \times 10^2\ J$ d) $3.4 \times 10^3 J$

108. The temperature of a gas contained in a closed vessel of constant volume increases by 1°C when the pressure of the gas is increased by 1%. The initial temperature of the gas is

a) 100 K b) 273°C c) 100°C d) 200 K

109. 70 cal of heat is required to raise the temperature of 2 moles of an ideal gas from 30°C to 35°C while the pressure of the gas is kept constant. The amount of the heat required to raise the temperature of the same gas through the same temperature range at constant volume is (gas constant $R = 2$ cal $\text{mol}^{-1} - \text{K}^{-1}$)

a) 70 cal b) 60 cal c) 50 cal d) 30 cal

110. A sample of gas is at 0°C. To what temperature it must be raised in order to double the $r.m.s.$ speed of the molecule

a) 270°C b) 819°C c) 1090°C d) 100°C

111. If p is the pressure, V the volume, R the ags constant, k the Boltzmann's constant and T the absolute temperature, then the number of molecules in the given mass of the gas is given by

a) $\frac{pV}{RT}$ b) $\frac{pV}{kT}$ c) $\frac{pR}{T}$ d) pV

112. The pressure is P, volume V and temperature T of a gas in the jar A and the other gas in the jar B is at pressure $2P$, volume $V/4$ and temperature $2T$, then the ratio of the number of molecules in the jar A and B will be

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

113. Suppose ideal gas equation follows VP^3 = constant. Initial temperature and volume of the gas are T and V respectively. If gas expands to 27 V then its temperature will become

a) T b) $9T$ c) 27 T d) $T/9$

114. For ideal gas, which statement is not true

a) It obeys Boyle's law b) If follows $PV = RT$

c) Internal energy depends on temperature only d) It follows Vander-Waal's equation

115. ½ mole of helium gas is contained in a container at S.T.P. The heat energy needed to double the pressure of the gas, keeping the volume constant (specific heat of the gas = $3\ J\ gm^{-1}K^{-1}$) is

a) 3276 J b) 1638 J c) 819 J d) 409.5 J

116. A vertical column 50 cm long at 50°C balances another column of liquid 60 cm long at 100°C. The coefficient of absolute expansion of the liquid is

a) $0.005°\text{C}^{-1}$ b) $0.0005°\text{C}^{-1}$ c) $0.002°\text{C}^{-1}$ d) $0.0002°\text{C}^{-1}$

117. The diameter of oxygen molecule is $2.94 \times 10^{-10} m$. The Vander Waal's gas constant $'b'$ in m^3/mol will be

a) 3.2 b) 16 c) 32×10^{-4} d) 32×10^{-6}

118. In a certain region of space there are only 5 molecules per cm^2 on an average. The temperature there is 3 K. The pressure of this dilute gas is ($k = 1.38 \times 10^{-23}\ \text{JK}^{-1}$)

a) 20.7×10^{-17} Nm^{-1} b) 15.3×10^{-13} Nm^{-1} c) 2.3×10^{-10} Nm^{-1} d) 5.3×10^{-5} Nm^{-1}

119. The temperature at which the $r.m.s.$ speed of hydrogen molecules is equal to escape velocity on earth surface, will be
a) 1060 K b) 5030 K c) 8270 K d) 10063 K

120. What is the velocity of wave in monoatomic gas having pressure 1 $kilopascal$ and density 2.6 kg/m^3
a) 3.6 m/s b) $8.9 \times 10^3 m/s$ c) Zero d) None of these

121. The temperature at which protons in proton gas would have enough energy to overcome. Coulomb barrier of $4.14 \times 10^{-14} J$ is (Boltzman constant $= 1.38 \times 10^{-23} JK^{-1}$)
a) $2 \times 10^9 K$ b) $10^9 K$ c) $6 \times 10^9 K$ d) $3 \times 10^9 K$

122. KE per unit volume is E. The pressure exerted by the gas is given by
a) $\frac{E}{3}$ b) $\frac{2E}{3}$ c) $\frac{3E}{2}$ d) $\frac{E}{2}$

123. Two cylindrical conductors A and B of same metallic material have their diameters in the ratio 1 : 2 and lengths in the ratio2 : 1. If the temperature difference between their ends is same, the ratio of heat conducted respectively by A and B per second is
a) 1 : 2 b) 1 : 4 c) 1 : 16 d) 1 : 8

124. A gas is collected over the water at 25°C. The total pressure of moist gas was 735 mm of mercury. If the aqueous vapour pressure at 25°C is 23.8 mm. Then the pressure of dry gas is
a) 760 mm b) 758.8 mm c) 710.8 mm d) 711.2 mm

125. Two moles of oxygen is mixed with eight moles of helium. The effective specific heat of the mixture at constant volume is
a) 1.3 R b) 1.4 R c) 1.7 R d) 1.9 R

126. Mean kinetic energy (or average energy) per g molecule of a monoatomic gas is given by
a) $\frac{3}{2}RT$ b) $\frac{1}{2}kT$ c) $\frac{1}{2}RT$ d) $\frac{3}{2}kT$

127. A cylinder of fixed capacity 44.8 $litre$ contains a monoatomic gas at standard temperature and pressure. The amount of heat required to cylinder by 10°C will be
(R = universal gas constant)
a) R b) $10R$ c) $20R$ d) $30R$

128. Air is pumped into an automobile tube upto a pressure of 200 kPa in the morning when the air temperature is 22°C. During the day, temperature rises to 42°C and the tube expands by 2%. The pressure of the air in the tube at this temperature, will be approximately
a) 212 kPa b) 209 kPa c) 206 kPa d) 200 kPa

129. The volume of a gas at pressure $21 \times 10^4 N/m^2$ and temperature 27°C is 83 $litres$. If $R = 8.3 J/mol\,K$, then the quantity of gas in $g - mole$ will be
a) 15 b) 42 c) 7 d) 14

130. What is an ideal gas?
a) One that consists of molecules
b) A gas satisfying the assumptions of kinetic theory
c) A gas having Maxwellian distribution of speed
d) A gas consisting of massless particles

131. The relation between the gas pressure P and average kinetic energy per unit volume E is
a) $P = \frac{1}{2}E$ b) $P = E$ c) $P = \frac{3}{2}E$ d) $P = \frac{2}{3}E$

132. For a gas $\gamma = 7/5$. The gas may probably be
a) Helium b) Hydrogen c) Argon d) Neon

133. When a vander waal's gas undergoes free expansion then its temperature
a) Decreases
b) Increases
c) Does not change
d) Depends upon the nature of the gas

134. If the oxygen (O_2) has root mean square velocity of $C\ ms^{-1}$, then root mean square velocity of the hydrogen (H_2) will be

a) $C\ ms^{-1}$ b) $\frac{1}{C} ms^{-1}$ c) $4C\ ms^{-1}$ d) $\frac{C}{4} ms^{-1}$

135. A gas at the temperature 250 K is contained in a closed vessel. If the gas is heated through $1K$, then the percentage increase in its pressure will be

a) 0.4% b) 0.2% c) 0.1% d) 0.8%

136. To what temperature should the hydrogen at room temperature (27°C) be heated at constant pressure so that the R.M.S. velocity of its molecules becomes double of its previous value

a) 1200°C b) 927°C c) 600°C d) 108°C

137. Consider a collection of a large number of particles each with speed v. The direction of velocity is randomly distributed in the collection. What is the magnitude of the relative velocity between a pairs in the collection

a) $2V/\pi$ b) V/π c) $8V/\pi$ d) $4V/\pi$

138. A pressure cooker contains air at 1 atm and 30°C. If the safety value of the cooler blows when the inside pressure $\geq 3\ atm$, then the maximum temperature of the air, inside the cooker can be

a) 90°C b) 636°C c) 909°C d) 363°C

139. The value of $\frac{pV}{T}$ for one mole of an ideal gas is nearly equal to

a) 2 J mol^{-1} K^{-1} b) 8.3 J mol^{-1} K^{-1} c) 4.2 J mol^{-1} K^{-1} d) 2 cal mol^{-1} K^{-1}

140. $CO_2(O - C - O)$ is a triatomic gas. Mean kinetic energy of one gram gas will be (If N-Avogadro's number, k-Boltzmann's constant and molecular weight of $CO_2 = 44$)

a) $(3/88)NkT$ b) $(5/88)NkT$ c) $(6/88)NkT$ d) $(7/88)NkT$

141. To double the volume of a given mass of an ideal gas at 27°C keeping the pressure constant, one must raise the temperature in degree centigrade to

a) 54^{o} b) 270^{o} c) 327^{o} d) 600^{o}

142. The following sets of values for C_V and C_P of a gas has been reported by different students. The units are $cal/g\text{-}mole\text{-}K$. Which of these sets is most reliable

a) $C_V = 3, C_P = 5$ b) $C_V = 4, C_P = 6$ c) $C_V = 3, C_P = 2$ d) $C_V = 3, C_P = 4.2$

143. At what temperature is the root mean square velocity of gaseous hydrogen molecules equal to that of oxygen molecules at 47°C

a) 20 K b) 80 K c) -73 K d) 3 K

144. Molecules of a gas behave like

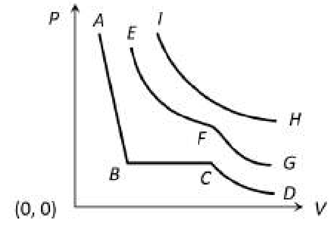
a) Inelastic rigid sphere b) Perfectly elastic non-rigid sphere

c) Perfectly elastic rigid sphere d) Inelastic non-rigid sphere

145. A cylinder contains 10 kg of gas at pressure of $10^7\ N/m^2$. The quantity of gas taken out of the cylinder, if final pressure is $2.5 \times 10^6\ N/m^2$, will be (Temperature of gas is constant)

a) 15.2 kg b) 3.7 kg c) Zero d) 7.5 kg

146. In the adjoining figure, various isothermals are shown for a real gas. Then



a) EF represents liquification b) CB represents liquification

c) HI represents the critical temperature d) AB represents gas at a high temperature

147. One mole of an ideal monoatomic gas requires 210 J heat to raise the temperature by $10K$, when heated at constant temperature. If the same gas is heated at constant volume to raise the temperature by $10K$ then heat required is

a) 238 J b) 126 J c) 210 J d) 350 J

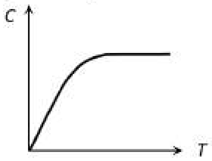
148. The ratio of root mean square velocity of O_3 and O_2 is

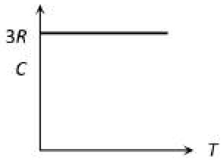
a) 1: 1 b) 2: 3 c) 3: 2 d) $\sqrt{2} : \sqrt{3}$

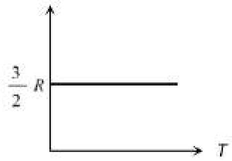
149. At a given temperature the $r.m.s.$ velocity of molecules of the gas is

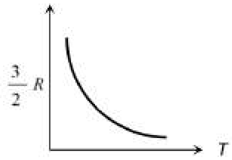
a) Same
b) Proportional to molecular weight
c) Inversely proportional to molecular weight
d) Inversely proportional to square root of molecular weight

150. Graph of specific heat at constant volume for a monoatomic gas is

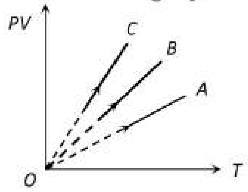
a) 

b) 

c) 

d) 

151. PV versus T graph of equal masses of H_2, He and O_2 is shown in fig. Choose the correct alternative



a) C corresponds to H_2, B to He and A to O_2
b) A corresponds to He, B to H_2 and C to O_2
c) A corresponds to He, B to O_2 and C to H_2
d) A corresponds to O_2, B to H_2 and C to He

152. Which of the following cylindrical rods will conduct maximum heat, when their ends are maintained at a constant temperature difference?

a) $l = 1\text{m}, r = 0.2\text{m}$
b) $l = 1\text{m}, r = 0.1\text{m}$
c) $l = 10\text{m}, r = 0.1\text{m}$
d) $l = 0.1\text{m}, r = 0.3\text{m}$

153. A container with insulating walls is divided into two equal parts by a partition fitted with a value. One part is filled with an ideal gas at a pressure p and temperature T, whereas the other part is completely evacuated. If the valve is suddenly opened, the pressure and temperature of the gas will be

a) $\frac{p}{2}, T$
b) $\frac{p}{2}, \frac{T}{2}$
c) p, T
d) $p, \frac{T}{2}$

154. Four molecules of a gas have speeds 1, 2, 3 and 4 kms^{-1}. The value of rms speed of the gas molecules is

a) $\frac{1}{2}\sqrt{15}\ \text{kms}^{-1}$
b) $\frac{1}{2}\sqrt{10}\ \text{kms}^{-1}$
c) $2.5\ \text{kms}^{-1}$
d) $\sqrt{\frac{15}{2}}\ \text{kms}^{-1}$

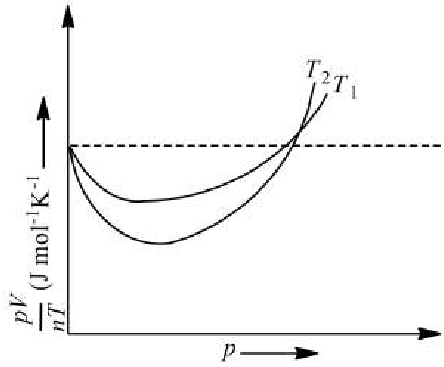
155. A body cools from 50°C to 40°C in 5 min. Its temperature comes down to 33.33°C in next 5 min. The temperature of surroundings is

a) 15°C
b) 20°C
c) 25°C
d) 10°C

156. Which of the following statements is true

a) Absolute zero degree temperature is not zero energy temperature
b) Two different gases at the same temperature pressure have equal root mean square velocities
c) The root mean square speed of the molecules of different ideal gases, maintained at the same temperature are the same
d) Given sample of 1 cc of hydrogen and 1 cc of oxygen both at NTP; oxygen sample has a large number of molecules

157. The figure below shows the plot of $\frac{pV}{nT}$ *versus* p for oxygen gas at two different temperatures.



Read the following statements concerning the above curves.

I. The dotted line corresponds to the ideal gas behavior

II. $T_1 > T_2$

III. The value of $\frac{pV}{nT}$ at the point where the curves meet on the y-axis is the same for all gases.

a) (i) only b) (i) and (ii) only c) All of these d) None of these

158. The absolute temperature of a gas is determined by

a) The average momentum of the molecules b) The velocity of sound in the gas

c) The number of molecules in the gas d) The mean square velocity of the molecules

159. If V_H, V_N and V_0 denote the root –mean square velocities of molecules of hydrogen, nitrogen and oxygen respectively at a given temperature, then

a) $V_N > V_O > V_H$ b) $V_H > V_N > V_O$ c) $V_O = V_N = V_H$ d) $V_O > V_H > V_N$

160. Air inside a closed container is saturated with water vapour. The air pressure is p and the saturated vapour pressure of water is $\bar{p}$. If the mixture is compressed to one half of its volume by maintaining temperature constant, the pressure becomes

a) $2(p + \bar{p})$ b) $(2p + \bar{p})$ c) $(p + \bar{p}/2$ d) $p + 2\bar{p}$

161. The average kinetic energy of a gas molecule can be determined by knowing

a) The number of molecules in the gas b) The pressure of the gas only

c) The temperature of the gas only d) None of the above is enough by itself

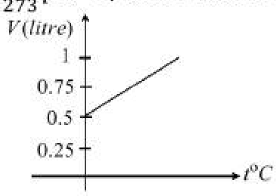
162. Volume, pressure and temperature of an ideal gas are V, P and T respectively. If mass of its molecule is m, then its density is [k = boltzmann's constant]

a) mkT b) $\frac{P}{kT}$ c) $\frac{P}{kTV}$ d) $\frac{Pm}{kT}$

163. One kg of a diatomic gas is at a pressure of 8×10^4 Nm^{-2}. The density of the gas is 4 kgm^{-3}. What is the energy of the gas due to its thermal motion?

a) 3×10^4 J b) 5×10^4 J c) 6×10^4 J d) 7×10^4 J

164. Graph between volume and temperature for a gas is shown in figure. If α = volume coefficient of gas = $\frac{1}{273}$ per°C, then what is the volume of gas at a temperature of 819°C



a) $1 \times 10^{-3}\ m^3$ b) $2 \times 10^{-3}\ m^3$ c) $3 \times 10^{-3}\ m^3$ d) $4 \times 10^{-3}\ m^3$

165. A lead bullet of 10 g travelling at 300 ms^{-1} strikes against a block of wood comes to rest. Assuming 50% of heat is absorbed by the bullet, the increase in is temperature is (Specific heat of lead = 150 JkgK^{-1})

a) 100°C b) 125°C c) 150°C d) 200°C

166. When the pressure on 1200 ml of a gas in increased from 70 cm to 120 cm of mercury at constant temperature, the new volume of the gas will be

a) 700 ml b) 600 ml c) 500 ml d) 400 ml

167. At constant temperature on increasing the pressure of a gas by 5% its volume will decrease by
a) 5% b) 5.26% c) 4.26% d) 4.76%

168. The average kinetic energy of a helium atom at 30°C is
a) Less than 1 eV b) A few keV c) $50-60\ eV$ d) 13.6 eV

169. A diatomic gas is heated at constant pressure. What fraction of the heat energy is used to increase the thermal energy
a) 3/5 b) 3/7 c) 5/7 d) 5/9

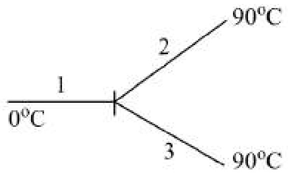
170. The molecules of a given mass of a gas have a rms velocity of 200 m/s at 27°C and $1.0\times10^5\ \mathrm{N/m^2}$ pressure. When the temperature is 127°C and pressure is $0.5\times10^5\mathrm{N/m^2}$, the rms velocity in m/s will be
a) $\frac{100\sqrt{2}}{3}$ b) $100\sqrt{2}$ c) $\frac{400}{\sqrt{3}}$ d) None of these

171. Three perfect gases at absolute temperature T_1, T_2 and T_3 are mixed. The masses of molecules are m_1, m_2 and m_3 and the number of molecules are n_1, n_2 and n_3 respectively. Assuming no loss of energy, the final temperature of the mixture is
a) $\frac{n_1T_1+n_2T_2+n_3T_3}{n_1+n_2+n_3}$ b) $\frac{n_1T_1^{\ 2}+n_2T_2^{\ 2}+n_3T_3^{\ 2}}{n_1T_1+n_2T_2+n_3T_3}$
c) $\frac{n_1^{\ 2}T_1^{\ 2}+n_2^{\ 2}T_2^{\ 2}+n_3^{\ 2}T_3^{\ 2}}{n_1T_1+n_2T_2+n_3T_3}$ d) $\frac{T_1+T_2+T_3}{3}$

172. The density of a substance at 0°C is 10 g/cc and at 100°C, its density is 9.7 g/cc. The coefficient of linear expansion of the substance is
a) $10^{-4}\ ^\circ\mathrm{C}^{-1}$ b) $10^{-2}\ ^\circ\mathrm{C}^{-1}$ c) $10^{-3}\ ^\circ\mathrm{C}^{-1}$ d) $10^{2}\ ^\circ\mathrm{C}^{-1}$

173. Molecular motion shows itself as
a) Temperature b) Internal Energy c) Friction d) Viscosity

174. Three rods made of same material and having same cross-section have been joined as shown in figure. Each rod is of same length. The left and right ends are kept at 0°C and 90°C respectively. The temperature of the junction of the three rods will be



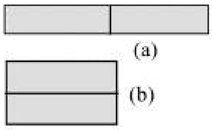
a) 45°C b) 60°C c) 30°C d) 20°C

175. An air bubble of volume 1.0 cm^3 rises from the bottom of a lake 40m deep at a temperature of 12°C. The volume of the bubble when it reaches the surface, which is at a temperature of 35°C, will be
a) 5.4 cm^3 b) 4.9 cm^3 c) 2.0 cm^3 d) 10.0 cm^3

176. The mean kinetic energy of a gas at 300 K is 100 J. The mean energy of the gas at 450 K is equal to
a) 100 J b) 3000 J c) 450 J d) 150 J

177. Two identical vessels A and B with frictionless pistons conatin the same ideal gas at the same temperature and the same volume V. The masses of gas in A and B are m_A and m_B respectively. The gases are allowed to expand isothermally to same final volume 2 V. The change in pressures of the gas in A and B are found to be Δp and 1.5 Δp respectively. Then
a) $9m_A = 4m_B$ b) $3m_A = 2m_B$ c) $2m_A = 3m_B$ d) $4m_A = 9m_B$

178. The identical square rods of metal are welded end to end as shown in figure, Q cal of heat flow through this combination in 4 min. If the rods were welded as shown in figure, the same amount of heat will flow through the combination in



a) 16 min b) 12 min c) 1 min d) 4 min

179. A steel ball of mass 0.1 kg falls freely from a height of 10 m of 10 m and bounces to a height of 5.4 m from the ground. If the dissipated energy in this process is absorbed by the ball, the rise in its temperature is

a) 0.01°C b) 0.1°C c) 1.1°C d) 1°C

180. The ratio of the vapour densities of two gases at a given temperature is 9: 8. The ratio of the rms velocities of their molecules is

a) $3: 2\sqrt{2}$ b) $2\sqrt{2}: 3$ c) 9: 8 d) 8: 9

181. The $r.m.s.$ velocity of a gas at a certain temperature is $\sqrt{2}$ times than that of the oxygen molecules at that temperature. The gas can be

a) H_2 b) He c) CH_4 d) SO_2

182. The equation of state for 5g of oxygen at a pressure p and temperature T, when occupying a volume V, will be

a) $pV = (5/32)RT$ b) $pV = 5RT$ c) $pV = (5/2)RT$ d) $pV = (5/16)RT$

183. At NTP, sample of equal volume of chlorine and oxygen is taken. Now ratio of no. of molecules is

a) 1 : 1 b) 32 : 27 c) 2 : 1 d) 16 : 14

184. 125 ml of gas A at 0.60 atmosphere and 150 ml of gas B at 0.80 atmospheric pressure at same temperature is filled in a vessel of 1 $litre$ volume. What will be the total pressure of mixture at the same temperature

a) 0.140 atmosphere b) 0.120 atmosphere c) 0.195 atmosphere d) 0.212 atmosphere

185. The gas having average speed four times as that of SO_2 (molecular mass 64) is

a) He (molecular mass 4) b) O_2 (molecular mass 32)

c) H_2 (molecular mass 2) d) CH_4 (molecular mass 16)

186. A bubble of 8 mole of helium is submerged at a certain depth in water. The temperature of water increases by 30°C. How much heat is added approximately to helium during expansion?

a) 4000 J b) 3000 J c) 3500 J d) 4500 J

187. In Vander Waal's equation a and b represent $\left(P + \frac{a}{V^2}\right)(V - b) = RT$

a) Both a and b represent correction in volume

b) Both a and b represent adhesive force between molecules

c) a represents adhesive force between molecules and b correction in volume

d) a represents correction in volume and b represents adhesive force between molecules

188. The molar specific heat at constant pressure for a monoatomic gas is

a) $\frac{3}{2}R$ b) $\frac{5}{2}R$ c) $\frac{7}{2}R$ d) $4R$

189. The rate of diffusion is

a) Faster in solids than in liquids and gases b) Faster in liquids than in solids and gases

c) Equal to solids, liquids and gases d) Faster in gases than in liquids and solids

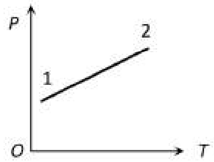
190. At what temperature the kinetic energy of gas molecule is half of the value at 27°C?

a) 13.5°C b) 150°C c) 75 K d) −123°C

191. A horizontal uniform glass tube of 100 cm length sealed at both ends contains 10 cm mercury column in the middle. The temperature and pressure of air on either side of mercury column are respectively 31°C and 76 cm of mercury. If the air column at one end is kept at 0°C and the other end at 273°C , the pressure of air which is at 0°C is (in cm of Hg)

a) 76 b) 88.2 c) 102.4 d) 12.2

192. A pressure P-absolute temperature T diagram was obtained when a given mass of gas was heated. During the heating process from the state 1 to state 2 the volume



a) Remained constant b) Decreased c) Increased d) Changed erratically

193. If mass of He atom is 4 times that of hydrogen atom then mean velocity of He is

a) 2 times of H-mean value
b) 1/2 times of H-mean value
c) 4 times of H-mean value
d) Same as H-mean value

194. $r.m.s.$ velocity of nitrogen molecules at NTP is

a) 492 m/s b) 517 m/s c) 546 m/s d) 33 m/s

195. Two gases of equal mass are in thermal equilibrium. If P_a, P_b and V_a and V_b are their respective pressure and volumes, then which relation is true

a) $P_a \neq P_b; V_a = V_b$ b) $P_a = P_b; V_a \neq V_b$ c) $\frac{P_a}{V_a} = \frac{P_b}{V_b}$ d) $P_aV_a = P_bV_b$

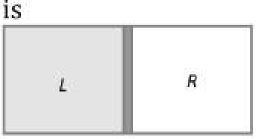
196. The ratio of the molar heat capacities of a diatomic gas at constant pressure to that at constant volume is

a) $\frac{7}{2}$ b) $\frac{3}{2}$ c) $\frac{3}{5}$ d) $\frac{7}{5}$

197. It is seen that in proper ventilation of building, windows must be opened near the bottom and the top of the walls, so as to let pass

a) In hot near the roof and cool air out near the bottom
b) Out hot air near the roof
c) In cool air near the bottom and hot air our near the roof
d) In more air

198. A vessel is partitioned in two equal halves by a fixed diathermic separator. Two different ideal gases are filled in left (L) and right (R) halves. The rms speed of the molecules in L part is equal to the mean speed of molecules in the R part. Then the ratio of the mass of a molecule in L part to that of a molecule in R part is



a) $\sqrt{\frac{3}{2}}$ b) $\sqrt{\pi/4}$ c) $\sqrt{2/3}$ d) $3\pi/8$

199. An ideal gas is filled in a vessel, then

a) If it is placed inside a moving train, its temperature increases
b) Its centre of mass moves randomly
c) Its temperature remains constant in a moving car
d) None of these

200. If one mole of a monoatomic gas $\left(\gamma = \frac{5}{3}\right)$ is mixed with one mole of a diatomic gas $\left(\gamma = \frac{7}{5}\right)$, the value of γ for the mixture is

a) 1.40 b) 1.50 c) 1.53 d) 3.07

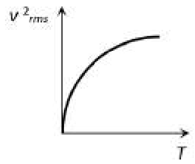
201. The kinetic energy of one g-mole of a gas at normal temperature and pressure is ($R = 8.31\ J/mol - K$)

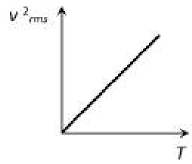
a) $0.56 \times 10^4 J$ b) $1.3 \times 10^2 J$ c) $2.7 \times 10^2 J$ d) $3.4 \times 10^3 J$

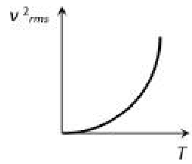
202. 1 mol of gas occupies a volume of 200 mL at 100 mm pressure. What is the volume occupied by two moles of gas at 400 mm pressure and at same temperature?

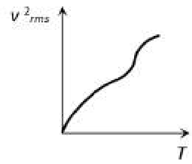
a) 50 mL b) 100 mL c) 200 mL d) 400 mL

203. The curve between absolute temperature and v_{rms}^2 is

a) 

b) 

c) 

d) 

204. The temperature of the mixture of one mole of helium and one mole of hydrogen is increased from 0°C to 100°C at constant pressure. The amount of heat delivered will be

a) 600 *cal* b) 1200 *cal* c) 1800 *cal* d) 3600 *cal*

205. The velocity of 4 gas molecules are given by 1 km/s, 3 km/s, 5 km/s and 7 km/s. Calculate the difference between average and rms velocity.

a) 0.338 b) 0.438 c) 0.583 d) 0.683

206. A perfect gas at 27°C is heated at constant pressure to 327°C. If original volume of gas at 27°C is V then volume at 327°C is

a) V b) $3V$ c) $2V$ d) $V/2$

207. Two containers of equal volume contain the same gas at the pressure p_1 and p_2 and absolute temperatures T_1 *and* T_2 respectively. On joining the vessels, the gas reaches a common pressure p and a common temperature T. The ratio p/T is equal to

a) $\frac{p_1T_2 + p_2T_1}{T_1 \times T_2}$ b) $\frac{p_1T_2 + p_2T_1}{T_1 + T_2}$ c) $\frac{1}{2}\left[\frac{p_1T_2 + p_2T_1}{T_1T_2}\right]$ d) $\frac{p_1T_2 - p_2T_1}{T_1 \times T_2}$

208. The kinetic energy, due to translation motion, of most of the molecules of an ideal gas at absolute temperature T is

a) kT b) k/T c) T/k d) $1/kT$

209. The latent heat of vaporization of water is 2240 J. If the work done in the process of vaporization of 1 g is 168 J, then increase in internal energy is

a) 2072 J b) 1904 J c) 2408 J d) 2240 J

210. At what temperature the rms velocity of helium molecules will be equal to that of hydrogen molecules at NTP?

a) 844 K b) 64 K c) 273°C d) 273 K

211. Which law states that effect of pressure is same for all portions

a) Pascal's law b) Gay Lussac's law c) Dalton's law d) None of these

212. A closed vessel is maintained at a constant temperature. It is first evacuated and then vapour is injected into it continuously. The pressure of the vapour in the vessel

a) Increases continuously b) First increases and then remains constant

c) First increases and then decreases d) None of the above

213. An ideal gas is expanding such that $pT^2=$ constant. The coefficient of volume expansion of the gas is

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

214. Mean free path of gas molecule of constant temperature is inversely proportional to

a) P b) V c) m d) n (number density)

215. A closed compartment containing gas is moving with some acceleration in horizontal direction. Neglect effect of gravity. Then the pressure in the compartment is

a) Same everywhere b) Lower in the front side

c) Lower in the rear side d) Lower in the upper side

216. At what temperature rms speed of air molecules is doubled of that at NTP?

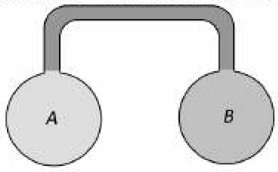
a) 819°C b) 719°C c) 909°C d) None of these

217. In the two vessels of same volume, atomic hydrogen and helium at pressure 1 *atm* and 2 *atm* are filled. If temperature of both the samples is same, then average speed of hydrogen atoms $< C_H >$ will be related to that of helium $< C_{He} >$ as

a) $< CH >= \sqrt{2} < C_{He} >$ b) $< C_H >=< C_{He} >$

c) $< C_H > = 2 < C_{He} >$ d) $< C_H > = \frac{< C_{He} >}{2}$

218. Two spherical vessel of equal volume, are connected by a a narrow tube. The apparatus contains an ideal gas at one atmosphere and $300K$. Now if one vessel is immersed in a bath of constant temperature $600K$ and the other in a bath of constant temperature $300K$. Then the common pressure will be



a) 1 atm b) $\frac{4}{5}atm$ c) $\frac{4}{3}atm$ d) $\frac{3}{4}atm$

219. At constant volume the specific heat of a gas is $\frac{3R}{2}$, then the value of $'\gamma'$ will be

a) $\frac{3}{2}$ b) $\frac{5}{2}$ c) $\frac{5}{3}$ d) None of the above

220. Gas at a pressure P_0 in contained is a vessel. If the masses of all the molecules are halved and their speeds are doubled, the resulting pressure P will be equal to

a) $4P_0$ b) $2P_0$ c) P_0 d) $\frac{P_0}{2}$

221. The translational kinetic energy of gas molecule for one mole of the gas is equal to

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

222. The product of the pressure and volume of an ideal gas is

a) A constant b) Approx. equal to the universal gas constant
c) Directly proportional to its temperature d) Inversely proportional to its temperature

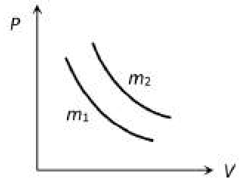
223. The diameter of oxygen atom is 3Å. The fraction of molecular volume to the actual volume occupied by oxygen at STP is

a) 6×10^{-28} b) 8×10^{-4} c) 4×10^{-10} d) 4×10^{-4}

224. A gas is allowed to expand isothermally. The root mean square velocity of the molecules

a) Will increase b) Will decrease
c) Will remain unchanged d) Depends on the other factors

225. Two different isotherms representing the relationship between pressure p and volume V at a given temperature of the same ideal gas are shown for masses m_1 and m_2 of the gas respectively in the figure given, then



a) $m_1 > m_2$ b) $m_1 = m_2$ c) $m_1 < m_2$ d) $m_1 \gtrless m_2$

226. At 100 K and 0.1 atmospheric pressure, the volume of helium gas is 10 $litres$. If volume and pressure are doubled, its temperature will change to

a) 400 K b) 127 K c) 200 K d) 25 K

227. Two balloons are filled, one with pure He gas and the other by air, respectively. If the pressure and temperature of these balloons are same, then the number of molecules per unit volume is

a) More in the He filled balloon b) Same in both balloons
c) More in air filled balloon d) In the ratio of 1:4

228. If the rms velocity of a gas is v ,then

a) v^2T = constant b) v^2/T = constant
c) vT^2 = constant d) v is independent of T

229. The ratio of two specific heats $\frac{C_P}{C_V}$ of CO is

a) 1.33 b) 1.40 c) 1.29 d) 1.66

230. A gas is filled in a closed container and its molecules are moving in horizontal direction with uniform acceleration. Neglecting acceleration due to gravity, the pressure inside the container is

a) Uniform everywhere
b) Less in the front
c) Less at the back
d) Less at the top

231. A closed gas cylinder is divided into two parts by a piston held tight. The pressure and volume of gas in two parts respectively are $(P, 5V)$ and $(10P, V)$. If now the piston is left free and the system undergoes isothermal process, then the volume of the gas in two parts respectively are

a) $2V, 4V$ b) $3V, 3V$ c) $5V, V$ d) $4V, 2V$

232. On colliding in a closed container the gas molecules

a) Transfer momentum to the walls
b) Momentum becomes zero
c) Move in opposite directions
d) Perform Brownian motion

233. A sealed container with negligible coefficient of volumetric expansion contains helium (a monoatomic gas). When it is heated from 300 K to 600 K, the average K.E. of helium atoms is

a) Halved
b) Unchanged
c) Doubled
d) Increased by factor $\sqrt{2}$

234. A monoatomic gas is kept at room temperature $300K$. Calculate the average kinetic energy of gas molecule (Use $k = 1.38 \times 10^{-23} MKS$ units)

a) $0.138eV$ b) $0.062eV$ c) $0.039eV$ d) $0.013eV$

235. When the temperature of a gas increases by 1°C, its pressure increases 0.4%. What is its initial temperature?

a) 250 K b) 125 K c) 195 K d) 329 K

236. A bubble is at the bottom of the lake of depth h. As the bubble comes to sea level, its radius increases three times. If atmospheric pressure is equal to l metre of water column, then h is equal to

a) 26 l b) l c) 25 l d) 30 l

237. A diatomic gas molecule has translational, rotational and vibrational degrees of freedom. The C_P/C_V is

a) 1.67 b) 1.4 c) 1.29 d) 1.33

238. In the absence of intermolecular forces of attraction, the observed pressure p will be

a) p b) $< p$ c) $> p$ d) Zero

239. At 0 K which of the following properties of a gas will be zero

a) Kinetic energy b) Potential energy c) Vibrational energy d) Density

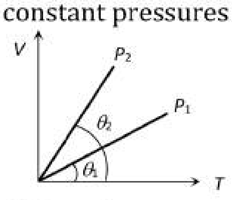
240. The equation for an ideal gas is $PV = RT$, where V represents the volume of

a) 1 g gas b) Any mass of the gas c) One g mol gas d) One *litre* gas

241. A gas at 27°C has a volume V and pressure P. On heating its pressure is doubled and volume becomes three times. The resulting temperature of the gas will be

a) 1800°C b) 162°C c) 1527°C d) 600°C

242. The figure shows the volume V versus temperature T graphs for a certain mass of a perfect gas at two constant pressures of P_1 and P_2. What inference can you draw from the graphs



a) $P_1 > P_2$
b) $P_1 < P_2$
c) $P_1 = P_2$
d) No interference can be drawn due to insufficient information

243. For hydrogen gas $C_P - C_V = a$ and for oxygen gas $C_P - C_V = b$. So the relation between a and b is given by

a) $a = 16b$ b) $b = 16a$ c) $a = 4b$ d) $a = b$

244. For a real gas (van der Waal's gas)

a) Boyle temperature is a/Rb

b) Critical temperature is a/Rb

c) Triple temperature is $2a/Rb$

d) Inversion temperature is $a/2Rb$

245. According to the kinetic theory of gases the $r.m.s.$ velocity of gas molecules is directly proportional to

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

246. Root mean square velocity of a particle is v at pressure P. If pressure is increased two times, then the $r.m.s.$ velocity becomes

a) $2\ v$ b) $3\ v$ c) $0.5\ v$ d) v

247. The average translational kinetic energy of a hydrogen gas molecules at NTP will be [Boltzmann's constant $k_B = 1.38 \times 10^{-23} J/K$]

a) $0.186 \times 10^{-20} Joule$ b) $0.372 \times 10^{-20} Joule$ c) $0.56 \times 10^{-20} Joule$ d) $5.6 \times 10^{-20} Joule$

248. The efficiency of a Carnot engine is 50% and temperature of sink is 500 K. If temperature of source is kept constant and its efficiency raised to 60%, then the required temperature of sink will be

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

249. The temperature of a given mass is increased from 27°C to 327°C . The rms velocity of the molecules increases

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

250. A real gas behaves like an ideal gas if its

a) Pressure and temperature are both high b) Pressure and temperature are both low

c) Pressure is high and temperature is low d) Pressure is low and temperature is high

251. A gas mixture consists of 2 moles of oxygen and 4 moles of argon at temperature T. Neglecting all vibrational moles, the total internal energy of the system is

a) $4\ RT$ b) $15\ RT$ c) $9\ RT$ d) $11\ RT$

252. Six moles of O_2 gas is heated from 20°C to 35°C at constant volume. If specific heat capacity at constant pressure is 8 cal $mol^{-1} - K^{-1}$ and $R = 8.31$ $Jmol^{-1} - K^{-1}$, what is change in internal energy of gas?

a) 180 cal b) 300 cal c) 360 cal d) 540 cal

253. Read the given statements and decide which is/are correct on the basis of kinetic theory of gases

(I) Energy of one molecule at absolute temperature is zero

(II) $r.m.s.$ speeds of different gases are same at same temperature

(III) For one gram of all ideal gas kinetic energy is same at same temperature

(IV) For one mole of all ideal gases mean kinetic energy is same at same temperature

a) All are correct b) I and IV are correct c) IV is correct d) None of these

254. A perfect gas at 27°C is heated at constant pressure so as to double its volume. The increase in temperature of the gas will be

a) 300°C b) 54°C c) 327°C d) 600°C

255. Cooking gas containers are kept in a lorry moving with uniform speed. The temperature of the gas molecules inside will

a) Increase b) Decrease

c) Remain same d) Decrease for some, while increase for others

256. The root mean square speed of the molecules of a gas is

a) Independent of its pressure but directly proportional to its Kelvin temperature

b) Directly proportional to the square roots of both its pressure and its Kelvin temperature

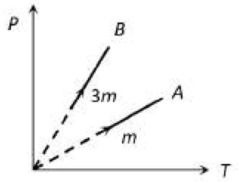
c) Independent of its pressure but directly proportional to the square root of its Kelvin temperature

d) Directly proportional to both its pressure and its kelvin temperature

257. The mean kinetic energy of one mole of gas per degree of freedom (on the basis of kinetic theory of gases) is

a) $\frac{1}{2}\ k\ T$ b) $\frac{3}{2}\ k\ T$ c) $\frac{3}{2}\ R\ T$ d) $\frac{1}{2}\ R\ T$

258. Two different masses m and $3m$ of an ideal gas are heated separately in a vessel of constant volume, the pressure P and absolute temperature T, graphs for these two cases are shown in the figure as A and B. The ratio of slopes of curves B to A is



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

259. Mean kinetic energy per degree of freedom of gas molecules is

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

260. 22 g of carbon dioxide at 27°C is mixed in a closed container with 16 g of oxygen at 37°C. If both gases are considered as ideal gases, then the temperature of the mixture is

a) 24.2°C b) 28.5°C c) 31.5°C d) 33.5°C

261. 70 cal of heat are required to raise the temperature of 2 mole of an ideal gas at constant pressure from 30°C to 35°C. The amount of heat required to raise the temperature of the same sample of the gas through the same range at constant volume is nearly (Gas coristant = 1.99 cal $K^{-1}-mol^{-1}$)

a) 30 cal b) 50 cal c) 70 cal d) 90 cal

262. Which of the following formula is wrong

a) $C_V=\frac{R}{\gamma-1}$ b) $C_P=\frac{\gamma R}{\gamma-1}$ c) $C_P/C_V=\gamma$ d) $C_P-C_V=2R$

263. Ideal gas and real gas has major difference of

a) Phase transition b) Temperature c) Pressure d) None of them

264. If mass of He is 4 times that of hydrogen, then mean velocity of He is

a) 2 times of H-mean value

b) $\frac{1}{2}$ times of H-mean value

c) 4 times of H-mean value

d) Same as H-mean value

265. Supposing the distance between the atoms of a diatomic gas to be constant, its specific heat at constant volume per mole (gram mole) is

a) $\frac{5}{2}R$ b) $\frac{3}{2}R$ c) R d) $\frac{1}{2}R$

266. At what temperature is the kinetic energy of a gas molecule double that of its value of 27°C

a) 54°C b) 300 K c) 327°C d) 108°C

267. A flask of volume 10^3 cc is completely filled with mercury at 0°C. The coefficient of cubical expansion of mercury is $180\times10^{-6}{}^{\circ}C^{-1}$ and that of glass is$40\times10^{-6}{}^{\circ}C^{-1}$.

If the flask in now placed in boiling water at 100°C, how much mercury will overflow?

a) 7 cc b) 14 cc c) 21 cc d) 28 cc

268. The pressure is exerted by the gas on the walls of the container because

a) It loses kinetic energy b) It sticks with the walls

c) On collision with the walls there is a change in momentum d) It is accelerated towards the walls

269. A balloon contains $500m^3$ of helium at 27°C and 1 atmosphere pressure. The volume of the helium at -3°C temperature and 0.5 atmosphere pressure will be

a) 500 m^3 b) 700 m^3 c) 900 m^3 d) 1000 m^3

270. An ideal gas has an initial pressure of 3 pressure units and an initial volume of 4 volume units. The table gives the final the final pressure and volume of the gas (in those same units) in four, processes. Which processes start and end on the same isotherm

	A	B	C	D
P	5	4	12	6
V	7	6	1	3

a) A b) B c) C d) D

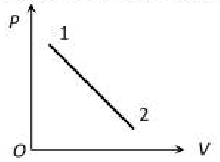
271. Specific heats of monoatomic and diatomic gases are same and satisfy the relation which is

a) $C_p(mono) = C_p(dia)$ b) $C_p(mono) = C_v(dia)$ c) $C_v(mono) = C_v(dia)$ d) $C_v(mono) = C_p(dia)$

272. The root mean square velocity of gas molecules at 27°C is 1365 ms^{-1}. The gas is

a) O_2 b) He c) N_2 d) CO_2

273. A volume V and pressure P diagram was obtained from state 1 to state 2 when a given mass of a gas is subjected to temperature changes. During this process the gas is



a) Heated continuously b) Cooled continuously

c) Heated in the beginning and cooled towards the end d) Cooled in the beginning and heated towards the end

274. At constant pressure, which of the following is true?

a) $v \propto \sqrt{\rho}$ b) $v \propto \frac{1}{\rho}$ c) $v \propto \rho$ d) $v \propto \frac{1}{\sqrt{\rho}}$

275. A vessel contains 32 g of O_2 at a temperature T. The pressure of the gas is p. An identical vessel containing 4 g of H_2 at a temperature $2T$ has a pressure of

a) 8 p b) 4 p c) p d) $\frac{p}{8}$

276. Root mean square speed of the molecules of ideal gas is v. If pressure is increased two times at constant temperature, the rms speed will become

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

277. Relationship between P, V, and E for a gas is

a) $P = \frac{3}{2}EV$ b) $V = \frac{2}{3}EP$ c) $PV = \frac{3}{2}E$ d) $PV = \frac{2}{3}E$

278. The specific heat relation for ideal gas is

a) $C_P + C_V = R$ b) $C_P - C_V = R$ c) $C_P/C_V = R$ d) $C_V/C_P = R$

279. The temperature of an ideal gas is increased from 27°C to 127°C, then percentage increase in V_{rms} is

a) 37% b) 11% c) 33% d) 15.5%

280. The coefficiency of apparent expansion of a liquid when determined using two different vessels A and B are λ_1 and λ_2, respectively. If the coefficient of linear expansion of the vessel A is α, the coefficient of linear expansion of vassel B is

a) $\frac{\alpha\gamma_1\gamma_2}{\gamma_1+\gamma_2}$ b) $\frac{\gamma_1-\gamma_2}{2\alpha}$ c) $\frac{\gamma_1-\gamma_2+\alpha}{3\alpha}$ d) $\frac{\gamma_1-\gamma_2}{3}+\alpha$

281. A steel tape measures the length of a copper rod as 90.0 cm, when both are at 10°C, the calibration temperature, for the tape. What would be tape read for the length of the rod when both are at 30°C.Given, α for steel 1.2×10^{-5}°C^{-1} and α for copper is 1.7×10^{-5}°C^{-1}.

a) 90.01 cm b) 89.90 cm c) 90.22 cm d) 89.80 cm

282. According to the kinetic theory of gases, at absolute temperature

a) Water freezes
b) Liquid helium freezes
c) Molecular motion stops
d) Liquid hydrogen freezes

283. At the same temperature and pressure and volume of two gases, which of the following quantities is constant
a) Total number of molecules
b) Average kinetic energy
c) Root mean square velocity
d) Mean free path

284. A diatomic molecule has how many degrees of freedom
a) 3
b) 4
c) 5
d) 6

285. For a gas if $\gamma = 1.4$, then atomicity, C_P and C_V of the gas are respectively
a) Monoatomic, $\frac{5}{2}R, \frac{3}{2}R$
b) Monoatomic, $\frac{7}{2}R, \frac{5}{2}R$
c) Diatomic, $\frac{7}{2}R, \frac{3}{2}R$
d) Triatomic, $\frac{7}{2}R, \frac{5}{2}R$

286. Simple behaviour under all conditions of real gas is governed by the equation
a) $Pv = \mu RT$
b) $\left(P + \frac{a}{v^2}\right)(v - b) = \mu RT$
c) $Pv =$ constant
d) $Pv^\gamma =$ constant

287. A metal ball immersed in water weights w_1 at 0°C and w_2 at 50°C. The coefficient of cubical expansion of metal is less than that water. Then
a) $w_1 < w_2$
b) $w_1 > w_2$
c) $w_1 = w_2$
d) Data is not sufficient

288. If the volume of the gas containing n number of molecules is V, then the pressure will decrease due to force of intermolecular attraction in the proportion
a) n/V
b) n/V^2
c) $(n/V)^2$
d) $1/V^2$

289. The temperature of an ideal at atmospheric pressure is $300K$ and volume $1m^3$. If temperature and volume become double, then pressure will be
a) $10^5 N/m^2$
b) $2 \times 10^5 N/m^2$
c) $0.5 \times 10^5 N/m^2$
d) $4 \times 10^5 N/m^2$

290. Volume of gas becomes four times if
a) Temperature becomes four times at constant pressure
b) Temperature becomes one fourth at constant pressure
c) Temperature becomes two times at constant pressure
d) Temperature becomes half at constant pressure

291. The root mean square velocity of a gas molecule of mass m at a given temperature is proportional to
a) m^0
b) m
c) $\sqrt{m}$
d) $\frac{1}{\sqrt{m}}$

292. If universal gas constant is R, the essential heat to increase from 273 K to 473 K at constant volume for ideal gas of 4 mol is
a) 200 R
b) 400 R
c) 800 R
d) 1200 R

293. Universal gas constant is
a) $\frac{C_p}{C_V}$
b) $C_p - C_V$
c) $C_P + C_V$
d) $\frac{C_V}{C_p}$

294. 22 g of CO_2 at 27°C is mixed with 16 g of oxygen at 37°C. The temperature of the mixture is
a) 32°C
b) 27°C
c) 37°C
d) 30°C

295. The molecular weight of a gas is 44. The volume occupied by 2.2 g of this gas at 0°C and 2 $atm.$ pressure will be
a) 0.56 *litre*
b) 1.2 *litres*
c) 2.4 *litres*
d) 5.6 *litres*

296. A box contains n molecules of a gas. How will the pressure of the gas be effected, if the number of molecules is made $2n$
a) Pressure will decrease
b) Pressure will remain unchanged
c) Pressure will be doubled
d) Pressure will become three times

297. Consider a gas with density ρ and $\bar{c}$ as the root mean square velocity of its molecules contained in a volume. If the system moves as whole with velocity v, then the pressure exerted by the gas is

a) $\frac{1}{3}\rho\bar{c}^2$ b) $\frac{1}{3}\rho(c+v)^2$ c) $\frac{1}{3}\rho(\bar{c}-v)^2$ d) $\frac{1}{3}\rho(c^{-2}-v)^2$

298. At constant volume, temperature is increased. Then

a) Collision on walls will be less
b) Number of collisions per unit time will increase
c) Collisions will be in straight lines
d) Collisions will not change

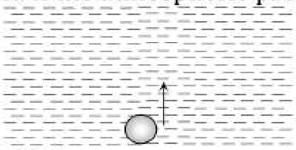
299. One mole of an ideal gas requires 207 J heat to raise the temperature by 10 K when heated at constant pressure. If the same gas is heated at constant volume to raise the temperature by the same 10 K, the heat required is
(Given the gas constant $R = 8.3\ J/mol - K$)

a) 198.7 J b) 29 J c) 215.3 J d) 124 J

300. At what temperature volume of an ideal gas at 0°C becomes triple

a) 546°C b) 182°C c) 819°C d) 646°C

301. An air bubble doubles its radius on raising from the bottom of water reservoir to be the surface of water in it. If the atmospheric pressure is equal to 10 m of water, the height of water in the reservoir is



a) 10 m b) 20 m c) 70 m d) 80 m

302. A cylinder of 5 *litre* capacity, filled with air at N.T.P. is connected with another evacuated cylinder of 30 *litres* of capacity. The resultant air pressure in both the cylinders will be

a) 38.85 cm of Hg b) 21.85 cm of Hg c) 10.85 cm of Hg d) 14.85 cm of Hg

303. In gases of diatomic molecules, the ratio of the two specific heats of gases C_P/C_V is

a) 1.66 b) 1.40 c) 1.33 d) 1.00

304. Oxygen boils at (−183°C). The temperature on the Fahrenheit scale is

a) −297.4°F b) −253.6°F c) −342.6°F d) −225.3°F

305. The specific heats at constant pressure is greater than that of the same gas at constant volume because

a) At constant pressure work is done in expanding the gas
b) At constant volume work is done in expanding the gas
c) The molecular attraction increases more at constant pressure
d) The molecular vibration increases more at constant pressure

306. A type kept outside in sunlight bursts off after sometime because of

a) Increases in pressure b) Increases in volume c) Both (a) and (b) d) None of these

307. 10 moles of an ideal monoatomic gas at 10°C is mixed with 20 moles of another monoatomic gas at 20°C. Then the temperature of the mixture is

a) 15.5°C b) 15°C c) 16°C d) 16.6°C

308. The number of translational degrees of freedom for a diatomic gas is

a) 2 b) 3 c) 5 d) 6

309. Let A and B the two gases and given $\frac{T_B}{M_A} = 4.\frac{T_B}{M_B}$; where T is the temperature and M is molecular mass. If C_A and C_B are the $r.m.s.$ speed, then the ratio $\frac{C_A}{C_B}$ will be equal to

a) 2 b) 4 c) 1 d) 0.5

310. The value of C_V for one mole of neon gas is

a) $\frac{1}{2}R$ b) $\frac{3}{2}R$ c) $\frac{5}{2}R$ d) $\frac{7}{2}R$

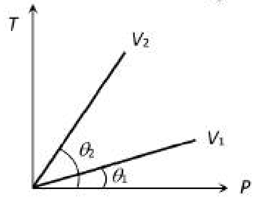
311. Two spheres made of same substance have diameters in the ratio1 : 2. Their thermal capacities are in the ratio of

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

312. For an ideal gas

a) C_p is less than C_V
b) C_p is equal to C_V
c) C_p is greater than C_V
d) $C_p = C_V = 0$

313. From the following $P - T$ graph what inference can be drawn



a) $V_2 > V_1$ b) $V_2 < V_1$ c) $V_2 = V_1$ d) None of the above

314. Some gas at 300 K is enclosed in a container. Now, the container is placed on a fast moving train. While the train is in motion, the temperature of the gas

a) Rises above 300 K b) Falls below 300 K
c) Remains unchanged d) Become unsteady

315. According to Maxwell's law of distribution of velocities of molecules, the most probable velocity is

a) Greater than the mean velocity b) Equal to the mean velocity
c) Equal to the root mean square velocity d) Less than the root mean square velocity

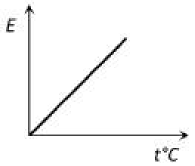
316. If C_p and C_v denote the specific heats of nitrogen per unit mass at constant pressure and constant volume respectively, then

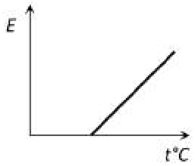
a) $C_p - C_v = R/28$ b) $C_p - C_v = R/14$ c) $C_p - C_v = R$ d) $C_p - C_v = 28R$

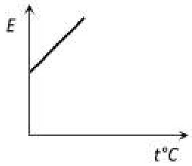
317. A cubical box with porous walls containing an equal number of O_2 and H_2 molecules is placed in a large evacuated chamber. The entire system is maintained at constant temperature T. The ratio of v_{rms} of O_2 molecules to that of the v_{rms} of H_2 molecules, found in the chamber outside the box after a short interval is

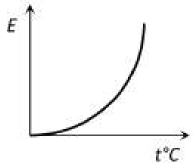
a) $\frac{1}{2\sqrt{2}}$ b) $\frac{1}{4}$ c) $\frac{1}{\sqrt{2}}$ d) $\sqrt{2}$

318. The graph which represents the variation of mean kinetic energy of molecules with temperature t°C is

a) 

b) 

c) 

d) 

319. Boyle's law holds for an ideal gas during

a) Isobaric changes b) Isothermal changes c) Isochoric changes d) Isotonic changes

320. The kinetic energy of one mole gas at $300K$ temperature, is E. At 400 K temperature kinetic energy is E'. The value of E'/E is

a) 1.33 b) $\sqrt{\left(\frac{4}{3}\right)}$ c) $\frac{16}{9}$ d) 2

321. Saturated vapour is compressed to half is volume without any change in temperature, then the pressure will be

a) Doubled b) Halved c) The same d) Zero

322. The amount of heat required to convert 10 g of ice at -10°C into steam at 100°C is (in calories)

a) 6400 b) 5400 c) 7200 d) 7250

323. Inside a cylinder closed at both ends is a movable piston. On one side of the piston is a mass m of a gas, and on the other side a mass 2 m of the same gas. What fraction of the volume of the cylinder will be occupied by the larger mass of the gas when the piston is in equilibrium? The temperature is the same throughout.

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

324. O_2 gas is filled in a vessel. If pressure is doubled, temperature becomes four times, how many times its density will become

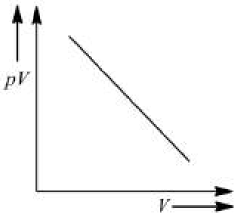
a) 2 b) 4 c) $\frac{1}{4}$ d) $\frac{1}{2}$

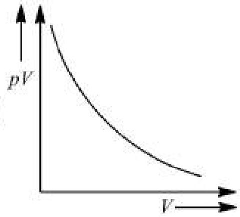
325. The ratio of mean kinetic energy of hydrogen and oxygen at a given temperature is

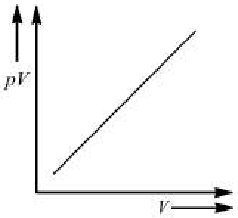
a) 1 : 16 b) 1 : 8 c) 1 : 4 d) 1 : 1

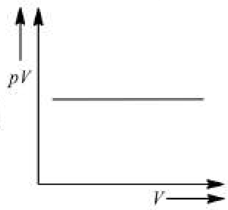
326. For matter to exist simultaneously in gas and liquid phases
a) The temperature must be 0 K
b) The temperature must be less than 0°C
c) The temperature must be less than the critical temperature
d) The temperature must be less than the reduced temperature

327. Which one of the following graphs represents the behaviour of an ideal gas?

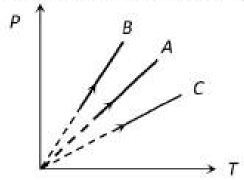
a) 

b) 

c) 

d) 

328. Pressure versus temperature graph of an ideal gas at constant volume V of an ideal gas is shown by the straight line A. Now mass of the gas is doubled and the volume is halved, then the corresponding pressure versus temperature graph will be shown by the line



a) A b) B c) C d) None of these

329. If a Vander-Waal's gas expands freely, then final temperature is
a) Less than the initial temperature
b) Equal to the initial temperature
c) More than the initial temperature
d) Less or more than the initial temperature depending on the nature of the gas

330. Oxygen and hydrogen are at the same temperature T. The ratio of the mean kinetic energy of oxygen molecules to that of the hydrogen molecules will be
a) 16: 1 b) 1: 1 c) 4: 1 d) 1: 4

331. At temperature T, the $r.m.s.$ speed of helium molecules is the same as $r.m.s.$ speed of hydrogen molecules at normal temperature and pressure. The value of T is
a) 273°C b) 546°C c) 0°C d) 136.5°C

332. The pressure and temperature of an ideal gas in a closed vessel are 720 kPa and 40°C respectively. If $\frac{1}{4}$ th of the gas is released from the vessel and the temperature of the remaining gas is raised to 353°C, the final pressure of the gas is
a) 1440 kPa b) 1080 kPa c) 720 kPa d) 540 kPa

333. A cylinder of fixed capacity (of 44.8 litres) contains 2 moles of helium gas at STP. What is the amount of heat needed to raise the temperature of the gas in the cylinder by 20°C (Use $R = 8.31\, J\, mol^{-1}K^{-1}$)
a) 996 J b) 831 J c) 498 J d) 374 J

334. A thin copper wire of length l increase in length by 1%, when heated from 0°C to 100°C. If a thin copper plate of area $2l \times l$ is heated from 0°C to 100°C, the percentage increase in its area would be
a) 1% b) 4% c) 3% d) 2%

335. The $r.m.s.$ speed of the molecules of a gas at a pressure $10^5 Pa$ and temperature 0°C is $0.5 km\ sec^{-1}$. If the pressure is kept constant but temperature is raised to 819°C, the velocity will become

a) $1.5\ kms^{-1}$ b) $2\ kms^{-1}$ c) $5\ kms^{-1}$ d) $1\ kms^{-1}$

336. For one gram mol of a gas, the value of R in the equation $PV = RT$ is nearly

a) $2\ cal/K$ b) $10\ cal/K$ c) $0.2\ cal/K$ d) $200\ cal/K$

337. A solid whose volume does not change with temperature floats in liquid. For two different temperaturest_1 and t_2, the fractions f_1 and f_2 of volume of solid remain submerged. What is the coefficient of volume expansion of liquid?

a) $\frac{f_1 - f_2}{f_2 t_1 - f_1 t_2}$ b) $\frac{f_1 - f_2}{f_1 t_1 - f_2 t_2}$ c) $\frac{f_1 + f_2}{f_2 t_1 - f_1 t_2}$ d) $\frac{f_1 + f_2}{f_1 t_1 - f_2 t_2}$

338. Find the ratio of specific heat at constant pressure to the specific heat constant volume for NH_3

a) 1.33 b) 1.44 c) 1.28 d) 1.67

339. What is the ratio of specific heats of constant pressure and constant volume for NH_3

a) 1.33 b) 1.44 c) 1.28 d) 1.67

340. For a gas molecule with 6 degrees of freedom the law of equipartition of energy gives the following relation between the molecular specific heat (C_V) and gas constant (R)

a) $C_V = \frac{R}{2}$ b) $C_V = R$ c) $C_V = 2R$ d) $C_V = 3R$

341. A polyatomic gas with n degrees of freedom has a mean energy per molecule given by (N is Avogadro's number)

a) $\frac{nkT}{N}$ b) $\frac{nkT}{2N}$ c) $\frac{nkT}{2}$ d) $\frac{3kT}{2}$

342. If the mean free path of atoms is doubled then the pressure of gas will become

a) $P/4$ b) $P/2$ c) $P/8$ d) P

343. The temperature of a gas is -68°C. At what temperature will the average kinetic energy of its molecules be twice that of at -68°C?

a) 137°C b) 127°C c) 100°C d) 105°C

344. For a gas $\frac{R}{C_V} = 0.67$. This gas is made up of molecules which are

a) Diatomic b) Mixture of diatomic and polyatomic molecules
c) Monoatomic d) Polyatomic

345. The specific heat of a gas

a) Has only two values C_P and C_V b) Has a unique value at a given temperature
c) Can have any value between 0 and ∞ d) Depends upon the mass of the gas

346. For a certain gas, the ratio of specific heats is given to be $\gamma = 1.5$. For this gas

a) $C_V = \frac{3R}{J}$ b) $C_P = \frac{3R}{J}$ c) $C_P = \frac{5R}{J}$ d) $C_V = \frac{5R}{J}$

347. For the specific heat of 1 mole of an ideal gas at constant pressure (C_P) and at constant volume (C_V) which is correct

a) C_P of hydrogen gas is $\frac{5}{2}R$ b) C_V of hydrogen gas is $\frac{7}{2}R$
c) H_2 has very small values of C_P and C_V d) $C_P - C_V = 1.99\ cal/mole - K$ for H_2

348. The value of critical temperature in terms of Vander Waal's constant a and b is

a) $T_c = \frac{8a}{27Rb}$ b) $T_c = \frac{a}{2Rb}$ c) $T_c = \frac{8}{27Rb}$ d) $T_c = \frac{27a}{8Rb}$

349. When temperature of an ideal gas is increased from 27°C to 227°C, its $r.m.s.$ speed changed from 400 $metre/s$ to V_s. The V_s is

a) 516 $metre/s$ b) 450 $metre/s$ c) 310 $metre/s$ d) 746 $metre/s$

350. The temperature of a gas at pressure P and volume V is 27°C. Keeping its volume constant if its temperature is raised to 927°C, then its pressure wil be

a) 2 P b) 3 P c) 4 P d) 6 P

351. If the degree of freedom of a gas are f, then the ratio of two specific heats C_P/C_V is given by

a) $\frac{2}{f}+1$ b) $1-\frac{2}{f}$ c) $1+\frac{1}{f}$ d) $1-\frac{1}{f}$

352. A gas at 27°C temperature and 30 atmospheric pressure is allowed to expand to the atmospheric pressure. If the volume becomes 10 times its initial volume, then the final temperature becomes

a) 100°C b) 173°C c) 273°C d) −173°C

353. In thermal equilibrium, the average velocity of gas molecules is

a) Proportional to $\sqrt{T}$ b) Proportional to T^2 c) Proportional to T^3 d) Zero

354. In kinetic theory of gases, a molecule of mass m of an ideal gas collides with a wall of vessel with velocity V. The change in the linear momentum of the molecule is

a) $2mV$ b) mV c) $-mV$ d) Zero

355. The translatory kinetic energy of a gas per g is

a) $\frac{3}{2}\frac{RT}{N}$ b) $\frac{3}{2}\frac{RT}{M}$ c) $\frac{3}{2}RT$ d) $\frac{3}{2}NKT$

356. 310 J of heat is required to raise the temperature of 2 mole of an ideal gas at constant pressure from 25°C to 35°C. The amount of heat required to raise the temperature of the gas through the same range at constant volume is

a) 384 J b) 144 J c) 276 J d) 452 J

357. Which of the following statements about kinetic theory of gases is wrong

a) The molecules of a gas are in continuous random motion

b) The molecules continuously undergo inelastic collisions

c) The molecules do not interact with each other except during collisions

d) The collisions amongst the molecules are of short duration

358. At what temperature, the mean kinetic energy of O_2 will be the same for H_2 molecules at −73°C

a) 127°C b) 527°C c) −73°C d) −173°C

359. The relation between two specific heats of a gas is

a) $C_P - C_V = \frac{R}{J}$ b) $C_V - C_P = \frac{R}{J}$ c) $C_P - C_V = J$ d) $C_V - C_P = J$

360. One mole of a monoatomic ideal gas is mixed with one mole of a diatomic ideal gas. The molar specific heat of the mixture at constant volume is

a) $(3/2)R$ b) $(5/2)R$ c) $2\,R$ d) $4\,R$

361. Two moles of monoatomic gas is mixed with three moles of a diatomic gas. The molar specific heat of the mixture at constant volume is

a) 1.55 R b) 2.10 R c) 1.63 R d) 2.20 R

362. In the relation $n = \frac{PV}{RT}$, $n =$

a) Number of molecules b) Atomic number c) Mass number d) Number of moles

363. The root mean square speed of hydrogen molecules of an ideal hydrogen gas kept in a gas chamber at 0°C is 3180 $metres/second$. The pressure on the hydrogen gas is (Density of hydrogen gas is $8.99 \times 10^{-2} kg/m^3$, $1\ atmosphere = 1.01 \times 10^5 N/m^2$)

a) 1.0 atm b) 1.5 atm c) 2.0 atm d) 3.0 atm

364. Pressure of an ideal gas is increased by keeping temperature constant. What is the effect on kinetic energy of molecules?

a) Increases b) Decrease

c) No change d) Can't be determined

365. The volume of a gas at 20°C is 200 ml. If the temperature is reduced to −20°C at constant pressure, its volume will be

a) 172.6 ml b) 17.26 ml c) 192.7 ml d) 19.27 ml

366. At 0°C the density of a fixed mass of a gas divided by pressure is x. At 100°C, the ratio will be

a) x b) $\frac{273}{373}x$ c) $\frac{373}{273}x$ d) $\frac{100}{273}x$

367. A wheel is 80.3 cm in circumference. An iron tyre measures 80.0 cm around its inner face. If the coefficient of linear expansion for iron is $12 \times 10^{-6}°C^{-1}$, the temperature of the tyre must be raised by
a) 105°C b) 417°C c) 312°C d) 223°C

368. Which one of the following is not an assumption of kinetic theory of gases?
a) The volume occupied by the molecules of the gas is negligible
b) The force of attraction between the molecules is negligible
c) The collision between the molecules are elastic
d) All molecules have same speed

369. The equation of state of a gas is given by $\left(P + \frac{aT^2}{V}\right) V^c = (RT + b)$, where a, b, c and R are constants. The isotherms can be represented by $P = AV^m - BV^n$, where A and B depend only on temperature and
a) $m = -c$ and $n = -1$ b) $m = c$ and $n = 1$ c) $m = -c$ and $n = 1$ d) $m = c$ and $n = -1$

370. The temperature gradient in the earth's crust is $32°C\ km^{-1}$ and the mean conductivity of earth is 0.008 $cal s^{-1} cm^{-1} °C^{-1}$. Considering earth to be a sphere of radius 6000 km loss of heat by earth everyday is about
a) 10^{30} cal b) 10^{40} cal c) 10^{20} cal d) 10^{18} cal

371. For a gas, the $r.m.s.$ speed at 800 K is
a) Four times the value at 200 K
b) Half the value at 200 K
c) Twice the value at 200 K
d) Same as at 200 K

372. 8 g of O_2, 14 g of N_2 and 22 g of CO_2 is mixed in a container of 10 L capacity at 27°C. The pressure exerted by the mixture in terms of atmospheric pressure is
($R = 0.082$ L atm K^{-1} mol^{-1})
a) 1.4 atm b) 2.5 atm c) 3.7 atm d) 8.7 atm

373. Vapour is injected at a uniform rate in a closed vessel which was initially evacuated. The pressure in the vessel
a) Increases continuously
b) Decreases continuously
c) First increases and then decreases
d) First increases and then becomes constant

374. At what temperature the molecule of nitrogen will have same rms velocity as the molecule of oxygen at 127°C ?
a) 457°C b) 273°C c) 350°C d) 77°C

375. The temperature of an ideal gas is reduced from 927°C to 27°C. The $r.m.s.$ velocity of the molecules becomes
a) Double the initial value
b) Half of the initial value
c) Four times the initial value
d) Ten times the initial value

376. At a given temperature the root mean square velocities of oxygen and hydrogen molecules are in the ratio
a) 16 : 1 b) 1 : 16 c) 4 : 1 d) 1 : 4

377. The temperature of 5 moles of a gas at constant volume is changed from 100°C to 120°C. The change in internal energy is 80 J. the total heat capacity of the gas at constant volume will be in JK^{-1} is
a) 8 b) 4 c) 0.8 d) 0.4

378. One mole of monoatomic gas and three moles of diatomic gas are put together in a container. The molar specific heat (in J K^{-1} mol^{-1}) at constant volume is ($R = 8.3$ J K^{-1} mol^{-1})
a) 18.7 b) 18.9 c) 19.2 d) None of these

379. If masses of all molecules of a gas are halved and their speeds are doubles, then the ratio of initial and final pressures is
a) 1: 2 b) 2: 1 c) 4: 1 d) 1: 4

380. The molar specific heat at constant pressure of an ideal gas is (7/2)R. The ratio of specific heat at constant pressure to that at constant volume is
a) 5/7 b) 9/7 c) 7/5 d) 8/7

381. The specific heat of an ideal gas is

a) Proportional to T b) Proportional to T^2 c) Proportional to T^3 d) Independent of T

382. Speed of sound in a gas is v and $r.m.s.$ velocity of the gas molecules is c. The ratio of v to c is

a) $\frac{3}{\gamma}$ b) $\frac{\gamma}{3}$ c) $\sqrt{\frac{3}{\gamma}}$ d) $\sqrt{\frac{\gamma}{3}}$

383. The molecular weights of O_2 and N_2 are 32 and 28 respectively. At 15°C, the pressure of 1 g O_2 will be the same as that of 1 g N_2 in the same bottle at the temperature

a) −21°C b) 13°C c) 15°C d) 56.4°C

384. On giving equal amount of heat at constant volume to 1 *mole* of a monoatomic and a diatomic gas the rise in temperature

a) Monoatomic b) Diatomic c) Same for both d) Can not be predicted

385. The $r.m.s.$ speed of gas molecules is given by

a) $2.5\sqrt{\frac{RT}{M}}$ b) $1.73\sqrt{\frac{RT}{M}}$ c) $2.5\sqrt{\frac{M}{RT}}$ d) $1.73\sqrt{\frac{M}{RT}}$

386. A sample of an ideal gas occupies a volume V at a pressure P and absolute temperature T, the mass of each molecule is m. The expression for the density of gas is (k = Boltzmaan's constant)

a) mkT b) P/kT c) P/kTV d) Pm/kT

387. A gaseous mixture contains equal number of hydrogen and nitrogen and nitrogen molecules. Specific heat measurements on this mixture at temperatures below 100 K would indicate that the of γ (ratio specific heats) for this mixture is

a) 3/2 b) 4/3 c) 5/3 d) 7/5

KINETIC THEORY

: ANSWER KEY :

1)	d	2)	a	3)	c	4)	b	161)	c	162)	d	163)	b	164)	b
5)	a	6)	c	7)	b	8)	c	165)	c	166)	a	167)	d	168)	a
9)	c	10)	b	11)	c	12)	a	169)	c	170)	c	171)	a	172)	a
13)	c	14)	b	15)	a	16)	c	173)	a	174)	b	175)	a	176)	d
17)	a	18)	a	19)	a	20)	d	177)	a	178)	c	179)	b	180)	b
21)	c	22)	d	23)	d	24)	c	181)	c	182)	a	183)	a	184)	c
25)	d	26)	c	27)	d	28)	c	185)	a	186)	b	187)	c	188)	b
29)	d	30)	b	31)	a	32)	b	189)	d	190)	d	191)	c	192)	c
33)	c	34)	b	35)	a	36)	a	193)	b	194)	b	195)	d	196)	d
37)	c	38)	c	39)	d	40)	c	197)	c	198)	d	199)	c	200)	c
41)	d	42)	a	43)	b	44)	c	201)	d	202)	b	203)	b	204)	b
45)	a	46)	a	47)	c	48)	c	205)	c	206)	c	207)	c	208)	a
49)	d	50)	d	51)	b	52)	d	209)	a	210)	c	211)	a	212)	b
53)	c	54)	c	55)	d	56)	a	213)	c	214)	d	215)	b	216)	a
57)	c	58)	d	59)	b	60)	d	217)	c	218)	c	219)	c	220)	b
61)	a	62)	b	63)	b	64)	a	221)	a	222)	c	223)	b	224)	c
65)	a	66)	a	67)	c	68)	d	225)	c	226)	a	227)	b	228)	b
69)	c	70)	c	71)	a	72)	b	229)	b	230)	a	231)	a	232)	a
73)	a	74)	d	75)	c	76)	c	233)	c	234)	c	235)	a	236)	a
77)	d	78)	d	79)	c	80)	d	237)	d	238)	c	239)	a	240)	c
81)	d	82)	c	83)	c	84)	a	241)	c	242)	a	243)	d	244)	b
85)	a	86)	a	87)	b	88)	c	245)	b	246)	d	247)	c	248)	c
89)	a	90)	c	91)	b	92)	c	249)	a	250)	c	251)	d	252)	d
93)	c	94)	a	95)	c	96)	b	253)	d	254)	a	255)	c	256)	c
97)	a	98)	c	99)	a	100)	b	257)	d	258)	a	259)	c	260)	c
101)	d	102)	c	103)	c	104)	a	261)	b	262)	d	263)	a	264)	b
105)	a	106)	c	107)	d	108)	a	265)	a	266)	c	267)	b	268)	c
109)	c	110)	b	111)	b	112)	d	269)	c	270)	c	271)	b	272)	b
113)	b	114)	d	115)	b	116)	a	273)	c	274)	d	275)	b	276)	b
117)	d	118)	a	119)	d	120)	d	277)	d	278)	b	279)	d	280)	d
121)	a	122)	b	123)	d	124)	d	281)	a	282)	c	283)	b	284)	c
125)	c	126)	a	127)	d	128)	b	285)	c	286)	b	287)	a	288)	c
129)	c	130)	b	131)	d	132)	b	289)	a	290)	a	291)	d	292)	d
133)	a	134)	c	135)	a	136)	b	293)	b	294)	a	295)	a	296)	c
137)	d	138)	b	139)	d	140)	d	297)	a	298)	b	299)	d	300)	a
141)	c	142)	a	143)	a	144)	c	301)	c	302)	c	303)	b	304)	a
145)	d	146)	b	147)	b	148)	d	305)	a	306)	a	307)	d	308)	b
149)	d	150)	c	151)	a	152)	d	309)	a	310)	b	311)	b	312)	c
153)	a	154)	d	155)	b	156)	a	313)	a	314)	a	315)	d	316)	a
157)	c	158)	d	159)	b	160)	b	317)	b	318)	c	319)	b	320)	a

321)	c	322)	d	323)	a	324)	d	357)	b	358)	c	359)	a	360)	c
325)	d	326)	c	327)	d	328)	b	361)	b	362)	d	363)	d	364)	c
329)	a	330)	b	331)	a	332)	b	365)	a	366)	b	367)	c	368)	d
333)	c	334)	d	335)	d	336)	a	369)	a	370)	d	371)	c	372)	c
337)	a	338)	c	339)	a	340)	d	373)	c	374)	d	375)	b	376)	d
341)	c	342)	b	343)	a	344)	c	377)	b	378)	a	379)	b	380)	c
345)	c	346)	b	347)	d	348)	a	381)	d	382)	d	383)	a	384)	a
349)	a	350)	c	351)	a	352)	d	385)	b	386)	d	387)	c		
353)	a	354)	a	355)	b	356)	b								

KINETIC THEORY

: HINTS AND SOLUTIONS :

1 **(d)**

$$v_{rms} = \sqrt{\frac{v_1^2 + v_2^2 + v_3^2 + v_4^2 + v_5^2}{5}} = 4.24$$

2 **(a)**

Rate of cooling proportional to $(T^4 - T_0^4)$, as per Stefan's Law.

$$\therefore \quad \frac{R'}{R} = \frac{(900)^4 - (300)^4}{(600)^4 - (300)^4}$$

$$= \frac{9^4 - 3^4}{6^4 - 3^4} = \frac{3^4(3^4 - 1)}{3^4(2^4 - 1)}$$

$$= \frac{80}{15} = \frac{16}{3}$$

$$R' = \frac{16}{3} R$$

3 **(c)**

The temperature rises by the same amount in the two cases and the internal energy of an ideal gas depends only on it's temperature

Hence $\frac{U_1}{U_2} = \frac{1}{1}$

4 **(b)**

$$\frac{E_2}{E_1} = \left(\frac{T_2}{T_1}\right)^4$$

$$= \left(\frac{273+84}{273+27}\right)^4 = \left(\frac{357}{300}\right)^4 = 2.0$$

5 **(a)**

Kinetic energy for m g gas $E = \frac{f}{2} mrT$

If only translational degree of freedom is considered

Then $f = 3 \Rightarrow E_{\text{Trans}} = \frac{3}{2} mrT = \frac{3}{2} m \left(\frac{R}{M}\right) T$

$$= \frac{3}{2} \times 20 \times \frac{8.3}{32} \times (273 + 47) = 2490 J$$

6 **(c)**

The number of moles of the system remains same,

$$\frac{P_1V_1}{RT_1} + \frac{P_2V_2}{RT_2} = \frac{P(V_1 + V_2)}{RT} \Rightarrow T$$

$$= \frac{P(V_1 + V_2)T_1T_2}{(P_1V_1T_2 + P_2V_2T_1)}$$

According to Boyle's law,

$$P_1V_1 + P_2V_2 = P(V_1 + V_2) \; \therefore T$$

$$= \frac{(P_1V_1 + P_2V_2)T_1T_2}{(P_1V_1T_2 + P_2V_2T_1)}$$

7 **(b)**

Saturated water vapour do not obey gas laws

8 **(c)**

$$v_{rms} = \sqrt{\frac{3RT}{M}} \Rightarrow T \propto M \quad [\because v_{rms}, R \rightarrow \text{constant}]$$

$$\Rightarrow \frac{T_{O_2}}{T_{N_2}} = \frac{M_{O_2}}{M_{N_2}} \Rightarrow \frac{T_{O_2}}{(273 + 0)} = \frac{32}{28} \Rightarrow T_{O_2} = 312K$$

$$= 39°\text{C}$$

9 **(c)**

Boyle's and Charle's law follow kinetic theory of gases

10 **(b)**

$$F = \frac{3}{2} kT \Rightarrow E \propto T$$

12 **(a)**

In elastic collision kinetic energy is conserved

13 **(c)**

From the Mayer's formula

$$C_p - C_V = R$$

...(i)

and $\quad \gamma = \frac{C_p}{C_V}$

$\Rightarrow \quad \gamma C_V = C_p$

...(ii)

Substituting Eq. (ii) in Eq. (i) we get

$\Rightarrow \quad \gamma C_V - C_V = R$

$$C_V(\gamma - 1) = R$$

$$C_V = \frac{R}{\gamma - 1}$$

14 **(b)**

From Andrews curve

15 **(a)**

The rms velocity of an ideal gas is

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

Where T is the absolute temperature and M is the molar mass of an ideal gas

Since M remains the same

$\therefore v_{rms} \propto \sqrt{T}$

$$\frac{v'_{rms}}{v_{rms}} = \sqrt{\frac{T'}{T}} = \sqrt{\frac{3T}{T}}$$

$\Rightarrow v'rms = \sqrt{3}v_{rms}$

16 **(c)**

At constant temperature; $PV =$ constant

$\Rightarrow P \times \left(\frac{m}{D}\right) =$ constant

$\Rightarrow \frac{P}{D} =$ constant $= K$. [$D =$ Density]

17 **(a)**

$$v_{rms} = \sqrt{\frac{3p}{\rho}} \Rightarrow \frac{v_1}{v_2} = \sqrt{\frac{\rho_2}{\rho_1}} = \sqrt{\frac{16}{1}} = \frac{4}{1}$$

18 **(a)**

The gases carbon monoxide (CO) and nitrogen (N_2) are diatomic, so both have equal kinetic energy $\frac{5}{2}kT$, *ie*. $E_1 = E_2$.

19 **(a)**

From ideal gas equation, we have

$$pV = nRT$$

$$\therefore \quad n = \frac{pV}{RT}$$

Given, $p = 22.4$ atm pressure

$= 22.4 \times 1.01 \times 10^5$ Nm^{-2},

$V = 2\text{L} = 2 \times 10^{-3}$ m^3,

$R = 8.31$ J mol^{-1} $-$ K^{-1},

$T = 273$ K

$$\therefore \quad n = \frac{22.4 \times 1.01 \times 10^5 \times 2 \times 10^{-3}}{8.31 \times 273}$$

$$n = 1.99 \approx 2$$

Since, $\quad n = \frac{\text{Mass}}{\text{Atomic weight}}$

We have,

mass $= n \times$ atomic weight $= 2 \times 14 = 28$ g

20 **(d)**

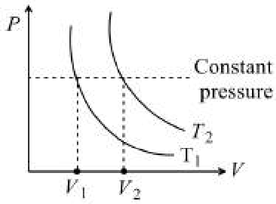
Average kinetic energy $E = \frac{3}{2}kT$

$\Rightarrow \quad E \propto T$

Thus, average kinetic energy of a gas molecule is directly proportional to the absolute temperature of gas.

21 **(c)**

For a given pressure, volume will be more if temperature is more [Charle's law]



From the graph it is clear that $V_2 > V_1 \Rightarrow T_2 > T_1$

22 **(d)**

$$C_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

Or $M = \frac{3RT}{C^2_{\text{rms}}} = \frac{3 \times 8.31 \times 300}{(1920)^2}$

$= 2 \times 10^{-3}$ kg $=$ 2g

Since, $M = 2$ for the hydrogen molecule. Hence, the gas is hydrogen.

23 **(d)**

$v_{rms} = \sqrt{\frac{3P}{\rho}} = P \propto \rho$ [v_{rms} is constant for fixed temperature]

24 **(c)**

According to Boyle's law

$$p_1V_1 = p_2V_2$$

As the pressure is decreased by 20%, so

$$p_2 = \frac{80}{100}p_1$$

$$p_1V_1 = \frac{80}{100}p_1V_2$$

$$V_1 = \frac{80}{100}V_2$$

Percentage increase in volume

$$= \frac{V_2 - V_1}{V_1} \times 100$$

$$= \frac{100-80}{80} \times 100 = 25\%$$

25 **(d)**

Root mean square velocity,

$$c = \sqrt{\frac{3pV}{M}} = \sqrt{\frac{3RT}{M}}$$

$$c_1 = \sqrt{\frac{3R(T/2)}{2M}} = \frac{1}{2}\sqrt{\frac{3RT}{M}}$$

$$= \frac{c}{2} = \frac{300}{2} = 150 \text{ ms}^{-1}$$

26 **(c)**

At TK, pressure of gas (P) in the jar

= Total pressure – saturated vapour pressure

$\Rightarrow P = (830 - 30) = 800 mm\ of\ Hg$

New temperature $T' = \left(T - \frac{T}{100}\right) = \frac{99T}{100}$

Using Charle's law $\frac{P}{T} = \frac{P'}{T'} \Rightarrow P' = \frac{PT'}{T}$

$= \frac{800 \times 99T}{100T} = 792 mm\ of\ Hg$

Saturated vapour pressure at $T' = 25\ mm\ of\ Hg$

$\therefore$ Total pressure in the jar

= Actual pressure of gas + Saturated vapour pressure

$= 792 + 25 = 817\ mm$ of Hg

28 **(c)**

$$\mu_1 = \frac{PV}{RT}, \mu_2 = \frac{PV}{RT}$$

$$P' = \frac{(\mu_1 + \mu_2)RT}{V} = \frac{2PV}{RT} \times \frac{RT}{V} = 2P$$

29 **(d)**

Average kinetic energy $E = \frac{f}{2}kT$

Sinec f and T are same for both the gases so they will have equal energies also

30 **(b)**

$$V_{rms} = \sqrt{\frac{3RT}{M}} \Rightarrow \frac{(V_{rms})_{O_2}}{(V_{rms})_{H_2}} = \sqrt{\frac{T_{O_2}}{T_{H_2}} \times \frac{M_{H_2}}{M_{O_2}}}$$

$$\Rightarrow \frac{(V_{rms})_{O_2}}{(V_{rms})_{H_2}} = \sqrt{\frac{900}{300} \times \frac{2}{32}} = \frac{\sqrt{3}}{4}$$

$$\Rightarrow (v_{rms})_{O_2} = 836 m/s$$

31 **(a)**

As degree of freedom is defined as the number of independent variables required to define body's motion completely. Here $f = 2$ (1 Translational + 1 Rotational)

32 **(b)**

$$\frac{E_1}{E_2} = \frac{A_1}{A_2}.\left(\frac{T_1}{T_2}\right)^4 = \frac{4\pi r_1^2}{4\pi r_2^2} \times 1 = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$$

33 **(c)**

$$V_{rms} = \sqrt{\frac{3P}{\rho}} \text{ or } P = \frac{\rho V_{rms}^2}{3}$$

$$= \frac{8.99 \times 10^{-2} \times 1840 \times 1840}{3} = 1.01 \times 10^5 N/m^2$$

34 **(b)**

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}} \quad \text{or} \quad v_{\text{rms}} \propto \sqrt{T}$$

v_{rms} is to reduce two times, *ie*, the temperature of the gas will have to reduce force times or

$$\frac{T'}{T} = \frac{1}{4}$$

During adiabatic process,

$$TV^{\gamma-1} = T'V'^{\gamma-1}$$

or $\frac{V'}{V} = \left(\frac{T}{T'}\right)^{\frac{1}{\gamma-1}}$

$$= (4)^{\frac{1}{1.5-1}} = 4^2 = 16$$

$\therefore \quad V' = 16\ V$

35 **(a)**

$$(\Delta Q)_V = \mu C_V \Delta T \Rightarrow (\Delta Q)_V = 1 \times C_V \times 1 = C_V$$

For monoatomic gas $C_V = \frac{3}{2}R$

$$\therefore (\Delta Q)_V = \frac{3}{2}R$$

36 **(a)**

Root mean square velocity

$$v_{rms} \propto \frac{1}{\sqrt{M}}$$

So $\frac{(v_{rms})_{O_2}}{(v_{rms})_{H_2}} = \sqrt{\frac{M_{H_2}}{M_{O_2}}}$

$$= \sqrt{\frac{2}{32}} = \frac{1}{4}$$

37 **(c)**

At constant pressure $V \propto T \Rightarrow \frac{\Delta V}{V} = \frac{\Delta T}{T}$

Hence ratio of increase in volume per degree rise in kelvin temperature to it's original volume = $\frac{(\Delta V/\Delta T)}{V} = \frac{1}{T}$

38 **(c)**

$$\rho = \frac{PM}{RT}$$

Density ρ remains constant when P/T or volume remains constant.

In graph (i) Pressure is increasing at constant temperature hence volume is decreasing so density is increasing. Graphs (ii) and (iii) volume is increasing hence, density is decreasing. Note that volume would had been constant in case the straight line the graph (iii) had passed through origin

39 **(d)**

According to Newton's law

$$\frac{\theta_1 - \theta_2}{t} = K\left[\frac{\theta_1 + \theta_2}{2} - \theta_0\right]$$

$$\therefore \frac{60-50}{10} = K\left[\frac{60+50}{2} - 25\right] \quad ....(i)$$

Let θ be the temperature after another 10 min

$$\therefore \frac{50-\theta}{10} = K\left[\frac{\theta+50}{2} - 25\right] \quad ....(ii)$$

Dividing Eq.(i) by Eq. (ii), we get

$$\frac{10}{50-\theta} = \frac{30 \times 2}{\theta} \quad \therefore \theta = 42.85°C$$

40 **(c)**

$$\left(\frac{\Delta Q}{\Delta t}\right)_{\text{inner}} + \left(\frac{\Delta Q}{\Delta t}\right)_{\text{outer}} = \left(\frac{\Delta Q}{\Delta t}\right)_{\text{total}}$$

$$\frac{K_1\pi r^2(T_2 - T_1)}{l} + \frac{K_2\pi[(2r)^2 - r^2](T_2 - T_1)}{l}$$

$$= \frac{K\pi(2r)^2(T_2 - T_1)}{l}$$

or $(K_1 + 3K_2)\frac{\pi r^2(T_2-T_1)}{l} = \frac{K\pi\, 4\, r^2(T_2-T_1)}{l}$

$$\therefore K = \frac{K_1 + 3K_2}{4}$$

41 **(d)**

$$\gamma_{\text{mixture}} = \frac{\frac{\mu_1\gamma_1}{\gamma_1-1} + \frac{\mu_2\gamma_2}{\gamma_2-1}}{\frac{\mu_1}{\gamma_1-1} + \frac{\mu_2}{\gamma_2-1}}$$

$\mu_1 =$ moles of helium $= \frac{16}{4} = 4$

$\mu_2 =$ moles of oxygen $= \frac{16}{32} = \frac{1}{2}$

$$\Rightarrow \gamma_{\text{mix}} = \frac{\frac{4\times5/3}{\frac{5}{3}-1} + \frac{1/2\times7/5}{\frac{7}{5}-1}}{\frac{4}{\frac{5}{3}-1} + \frac{1/2}{\frac{7}{5}-1}} = 1.62$$

42 **(a)**

Mean free path, $\lambda = \frac{1}{\sqrt{2}\pi d^2 n}$

Where, $n =$ Number of molecules per unit volume

$d =$ Diameter of the molecules

43 **(b)**

Speed of sound in gases in given by

$$v_{\text{sound}} = \sqrt{\frac{\gamma P}{\rho}} \Rightarrow \frac{v_1}{v_2} = \sqrt{\frac{\rho_2}{\rho_1}} = \sqrt{\frac{d_2}{d_1}}$$

44 **(c)**

$n_1 C_{v1} \Delta T_1 = n_2 C_{v2} \Delta T_2$

$$\Rightarrow n_1 \times \frac{3}{2} R \times 10 = n_2 \times \frac{5}{2} R \times 6 \Rightarrow \frac{n_1}{n_2} = 1$$

45 **(a)**

We treat water like a solid. For each atom average energy is $3k_BT$. Water molecule has three atoms, two hydrogen and one oxygen. The total energy of one mole of water is

$$U = 3 \times 3k_BT \times N_A = 9RT \quad \left[\because k_B = \frac{R}{N_A}\right]$$

$\therefore$ Heat capacity per mole of water is

$$C = \frac{\Delta Q}{\Delta T} = \frac{\Delta U}{\Delta T} = 9R$$

46 **(a)**

K.E. is function of temperature. So $\frac{E_{H_2}}{E_{O_2}} = \frac{1}{1}$

47 **(c)**

According to kinetic theory of gases the temperature of a gas is a measure of the kinetic energies of the molecules of the gas.

48 **(c)**

At constant volume

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow T_2 = \left(\frac{P_2}{P_1}\right) T_1$$

$$\Rightarrow T_2 = \left(\frac{3P}{P}\right) \times (273 + 35) = 3 \times 308 = 924K$$

$$= 651°C$$

49 **(d)**

$$\frac{3}{2}kT = 1\ eV \Rightarrow T = \frac{2}{3}\frac{eV}{k} = \frac{\frac{2}{3} \times 1.6 \times 10^{-19}}{1.38 \times 10^{-23}}$$

$$= 7.7 \times 10^3 K$$

51 **(b)**

Vander Waal's gas equation for μ mole of real gas

$$\left(P + \frac{\mu^2 a}{V^2}\right)(V - \mu b) = \mu RT$$

$$P = \left(\frac{\mu RT}{V - \mu b} - \frac{\mu^2 a}{V^2}\right)$$

Given equation,

$$P = \left(\frac{RT}{2V - b} = \frac{a}{4b^2}\right)$$

On comparing the given equation with this standard equation, we get

$$\mu = \frac{1}{2}$$

Hence , $\mu = \frac{m}{M}$

$$\Rightarrow \text{mass of gas}, m = \mu M = \frac{1}{2} \times 44 = 22g$$

52 **(d)**

$$C_P = \left(\frac{f}{2} + 1\right) R = \left(\frac{5}{2} + 1\right) R = \frac{7}{2} R$$

53 **(c)**

$$\frac{R}{C_P} = \frac{R}{7/2R} = \frac{2}{7} \quad \left[\because C_P = \frac{7}{2}R\right]$$

54 **(c)**

As temperature decreases to half and volume made twice, hence pressure becomes $\frac{1}{4}$ times

55 **(d)**

$p = p_1 + p_2 + p_3$

$$= \left(\frac{nRT}{V}\right)_{O_2} + \left(\frac{nRT}{V}\right)_{N_2} + \left(\frac{nRT}{V}\right)_{CO_2}$$

$$= (n_{O_2} + n_{N_2} + n_{CO_2})\frac{RT}{V}$$

$$= \frac{(0.25+0.5+0.5)(8.31)\times300}{4\times10^{-3}}$$

$$= 7.79 \times 10^5\ \text{Nm}^{-2}$$

56 **(a)**

$$PV = \mu RT = \frac{m}{M}RT \Rightarrow V = \frac{mRT}{MP}$$

$$= \frac{2 \times 10^{-3} \times 8.3 \times 300}{32 \times 10^{-3} \times 10^5} = 1.53 \times 10^{-3} m^3$$

$$= 1.53\ litre$$

57 **(c)**

According to Boyle's law

$$(P_1V_1)_{\text{At top of the lake}} = (P_2V_2)_{\text{At the bottom of the lake}}$$

$$\Rightarrow P_1V_1 = (P_1 + h)V_2 \Rightarrow 10 \times \frac{4}{3}\pi\left(\frac{5r}{4}\right)^3$$

$$\Rightarrow (10 + h) \times \frac{4}{3}\pi r^3 \Rightarrow h = \frac{610}{64} = 9.53m$$

58 **(d)**

We have $v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$; at $T = T_0$(NTP)

$$v_{\text{rms}} = \sqrt{\frac{3RT_0}{M}}$$

But at temperature T,

$$v_{\text{rms}} = 2 \times \sqrt{\frac{3RT_0}{M}}$$

$$\Rightarrow \sqrt{\frac{3RT}{M}} = 2\sqrt{\frac{3RT_0}{M}}$$

$$\Rightarrow \sqrt{T} = \sqrt{4T_0}$$

or $T = 4T_0$

$T = 4 \times 273\text{K} = 1092\text{K}$

$\therefore$ $T = 819°\text{C}$

59 **(b)**

$E = \frac{f}{2}RT; f = 5$ for diatomis gas $\Rightarrow E = \frac{5}{2}RT$

60 **(d)**

Average kinetic energy

$$E = \frac{3}{2}kT \Rightarrow \frac{E_1}{E_2} = \frac{T_1}{T_2} = \frac{(273-23)}{(273+227)} = \frac{250}{500} = \frac{1}{2}$$

$$\Rightarrow E_2 = 2E_1 = 2 \times 5 \times 10^{-14} = 10 \times 10^{-14} erg$$

61 **(a)**

A monoatomic gas molecule has only three translational degrees of freedom

62 **(b)**

$$\gamma_{\text{mix}} = \frac{\frac{\mu_1\gamma_1}{\gamma_1-1} + \frac{\mu_2\gamma_2}{\gamma_2-1}}{\frac{\mu_1}{\gamma_1-1} + \frac{\mu_2}{\gamma_2-1}} = \frac{\frac{3\times1.3}{(1.3-1)} + \frac{2\times1.4}{(1.4-1)}}{\frac{3}{(1.3-1)} + \frac{2}{(1.4-1)}} = 1.33$$

63 **(b)**

At critical temperature the horizontal portion in $P-V$ curve almost vanishes as at temperature T_2. Hence the correct answer will be (b)

64 **(a)**

$$v_{rms} \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{(v_{rms})_{H_2}}{(v_{rms})_{He}} = \sqrt{\frac{M_{He}}{M_{H_2}}} = \sqrt{\frac{4}{2}} = \frac{\sqrt{2}}{1}$$

65 **(a)**

When electric spark is passed, hydrogen reads with oxygen to form water (H_2O). Each gram of hydrogen reacts with eight grams of oxygen. Thus 96 gm of oxygen will be totally consumed together with 12 gm of hydrogen. The gas left in the vessel will be 2 gm of hydrogen $i.e.$

Number of moles $\mu = \frac{2}{2} = 1$

Using $PV = \mu RT \Rightarrow P \propto \mu \Rightarrow \frac{P_2}{P_1} = \frac{\mu_2}{\mu_1}$

(μ_1 = Initial number of moles $= 7 + 3 = 10$ and μ_2 = Final number of moles $= 1$)

$$\Rightarrow \frac{P_2}{1} = \frac{1}{10} \Rightarrow P_2 = 0.1\ atm$$

66 **(a)**

$$v_{rms} = \sqrt{\frac{3RT}{M}} \Rightarrow \frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}} = \sqrt{\frac{(273+90)}{(273+27)}} = 1.1$$

% increase $= \left(\frac{v_2}{v_1} - 1\right) \times 100 = 0.1 \times 100 = 10\%$

67 **(c)**

Ideal gas equation is given by

$$pV = nRT$$

...(i)

For oxygen, $p = 1$ atm, $V = 1$ L, $n = n_{O_2}$

Therefore, Eq. (i) becomes

$\therefore$ $1 \times 1 = n_{O_2}RT$

$$\Rightarrow n_{O_2} = \frac{1}{RT}$$

For nitrogen p =0.5 atm, V =2 L, $n = n_N$

$\therefore$ $0.5 \times 2 = n_{N_2}RT$

$$\Rightarrow n_{N_2} = \frac{1}{RT}$$

For mixture of gas

$$p_{\text{mix}}V_{\text{mix}} = n_{\text{mix}}RT$$

Here, $n_{\text{mix}} = n_{O_2} + n_{N_2}$

$$\therefore \frac{p_{\text{mix}}V_{\text{mix}}}{RT} = \frac{1}{RT} + \frac{1}{RT}$$

$\Rightarrow$ $p_{\text{mix}}V_{\text{mix}} = 2$ ($V_{\text{mix}} =$ 1)

68 **(d)**

Let T_0 be the initial temperature of the black body

$\therefore$ $\lambda_0 T_0 = b$ (Wien's law)

Power radiated, $P_0 = CT_0^4$, where, C is constant.

If T is new temperature of black body, then

$$\frac{3\lambda_0}{4}T = b = \lambda_0 T_0 \text{ or } T = \frac{4}{3}T_0$$

Power radiated, $P = CT^4 = CT_0^4\left(\frac{4}{3}\right)^4$

$$P = P_0 \times \frac{256}{81} \text{ or } \frac{P}{P_0} = \frac{256}{81}$$

69 **(c)**

$$PV = \frac{m}{M}RT \Rightarrow V \propto mT \Rightarrow \frac{V_1}{V_2} = \frac{m_1}{m_2}.\frac{T_1}{T_2}$$

$$= \frac{2V}{V} = \frac{m}{m_2} \times \frac{100}{200} \Rightarrow m_2 = \frac{m}{4}$$

70 **(c)**

At constant temperature PV = constant $\Rightarrow P \propto \frac{1}{V}$

71 **(a)**

$v_{rms} \propto \frac{1}{\sqrt{M}} \Rightarrow (v_{rms})_1 < (v_{rms})_2 < (v_{rms})_3$ also in mixture temperature of each gas will be same, hence kinetic energy also remains same

72 **(b)**

$$\frac{E_1}{E_2} = \frac{T_1}{T_2} = \frac{300}{450} = \frac{2}{3}$$

73 **(a)**

$$PV = \mu RT = \frac{m}{M} RT \Rightarrow P = \frac{d}{M} RT \left[\text{Density } d = \frac{m}{V}\right]$$

$$\Rightarrow \frac{P}{dT} = \text{constant or} \frac{P_1}{d_1 T_1} = \frac{P_2}{d_2 T_2}$$

74 **(d)**

$$P \propto T \Rightarrow \frac{P_2}{P_1} = \frac{T_2}{T_1} = \frac{(273+100)}{(273+0)} = \frac{373}{273}$$

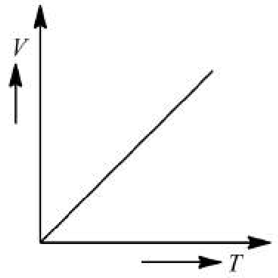
$$\Rightarrow P_2 = \frac{760 \times 373}{273} = 1038mm$$

75 **(c)**

Since temperature is constant, so v_{rms} remains same

76 **(c)**

At constant pressure, the volume of a given mass of a gas is directly proportional to its absolute temperature (T).



ie., $\frac{V}{T}$=constant

This is another form of Charles' law. Hence, variation of volume with temperature is as shown.

Hence, correct graph will be (C).

77 **(d)**

Argon is a monoatomic gas so it has only translational energy

79 **(c)**

According to the Dalton's law of partial pressure, the total pressure will be $P_1 + P_2 + P_3$

80 **(d)**

Kinetic energy ∝ Temperature

$$\Rightarrow \frac{E_1}{E_2} = \frac{T_1}{T_2} \Rightarrow \frac{E_1}{E_2} = \frac{(273+27)}{(273+927)} = \frac{300}{1200} = \frac{1}{4}$$

$$\Rightarrow E_2 = 4E_1$$

81 **(d)**

$$\frac{V_{rms\,He}}{V_{rms\,Ar}} = \frac{\sqrt{\frac{3RT}{m_{He}}}}{\sqrt{\frac{3RT}{m_{Ar}}}} = \sqrt{\frac{m_{Ar}}{m_{He}}} = \sqrt{\frac{40}{4}} = \sqrt{10} \approx 3.16$$

82 **(c)**

We know that $C_P - C_V = \frac{R}{J}$

$$\Rightarrow J = \frac{R}{C_P - C_V}$$

$$C_P - C_V = 1.98 \frac{cal}{g - mol - K}$$

$$R = 8.32 \frac{J}{g - mol - K}$$

$$\therefore J = \frac{8.32}{1.98} = 4.20 J/cal$$

83 **(c)**

S.I. unit of R is $J/mol - K$

84 **(a)**

According to Boyle's law PV = constant

85 **(a)**

$$v_{\text{rms}} \propto \sqrt{\frac{3RT}{M}}$$

$$\Rightarrow \quad T \propto v_{\text{rms}}^2$$

$$\Rightarrow \quad \frac{T_2}{T_1} = \left[\frac{v_2}{v_1}\right]^2 = \frac{1}{4} \Rightarrow T_2 = \frac{T_1}{4}$$

$$= \frac{273+327}{4}$$

$$= 150 \text{ K} = -123°\text{C}$$

86 **(a)**

The total pressure exerted by a mixture of non-reacting gases occupying a vessel is equal to the sum of the individual pressure which each gas exert if it alone occupied the same volume at a given temperature.

For two gases,

$$p = p_1 + p_2 = p + p = 2p$$

87 **(b)**

According to ideal gas equation $PV = nRT$

$PV = \frac{m}{M} RT, P = \frac{\rho}{M} RT$ or $\frac{\rho}{P} = \frac{M}{RT}$or $\frac{\rho}{P} \propto \frac{1}{T}$

Here, $\frac{\rho}{P}$ represent the slope of graph

Hence $T_2 > T_1$

88 **(c)**

$$PV = \mu RT = \frac{m}{M} RT \Rightarrow P \propto mT$$

$$\Rightarrow \frac{P_2}{P_1} = \frac{m_2}{m_1} \frac{T_2}{T_1} = \frac{1}{2} \times \frac{(273+27+50)}{(273+27)} = \frac{7}{12}$$

$$\Rightarrow P_2 = \frac{7}{12} P_1 = \frac{7}{12} \times 20 = 11.67 atm. \approx 11.7 atm$$

89 **(a)**

Since $c_{rms} << V_e$, hence molecules do not escape out

91 **(b)**

In case of given graph, V and T are related as $V = aT - b$, where a and b are constants.

From ideal gas equation, $PV = \mu RT$

We find $P = \frac{\mu RT}{aT-b} = \frac{\mu R}{a-b/T}$

Sinec $T_2 > T_1$, therefore $P_2 < P_1$

92 **(c)**

Gas equation for N molecules $PV = NkT$

$$\Rightarrow N = \frac{PV}{kT}$$

$$= \frac{1.2 \times 10^{-10} \times 13.6 \times 10^3 \times 10 \times 10^{-4}}{1.38 \times 10^{-23} \times 300}$$

$= 3.86 \times 10^{11}$

93 **(c)**

$E \propto T$

94 **(a)**

$$v_{rms} \propto \sqrt{T}, \frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}} \Rightarrow v_2 = \sqrt{\frac{(273+927)}{(273+27)}} v_1$$

$$\Rightarrow v_2 = 2v_1$$

95 **(c)**

For ideal gas, on free expansion there is no change in temperature. Hence $C_a = C_b$

96 **(b)**

$v_{rms} > v_{av} > v_{mp}$

97 **(a)**

According to Boyle's law, $pV = k$ (a constant)

Or $p\frac{m}{p} = k$ or $p = \frac{pm}{k}$

Or $p = \frac{p}{k}$ (where, $\frac{k}{m} = k$ a constant)

So, $\rho_1 = \frac{p_1}{k}$ and $V_1 \frac{p_1}{k} = \frac{m_1}{p_1} = \frac{m_1}{p_1/k} = \frac{km_1}{\rho_1}$

Similarly , $V_2 = \frac{km_2}{p_2}$

Total volume $= V_1 + V_2 = k\left(\frac{m_1}{p_1} + \frac{m_2}{p_2}\right)$

Let p be the common pressure and ρ be the common density of mixture. Then

$$\rho = \frac{m_1 + m_2}{V_1 + V_2} = \frac{m_1 + m_2}{k\left(\frac{m_1}{P_1} + \frac{m_2}{P_2}\right)}$$

$$\therefore\ p = k\rho = \frac{m_1 + m_2}{\frac{m_1}{P_1} + \frac{m_2}{P_2}} = \frac{P_1P_2(m_1 + m_2)}{(m_1P_2 + m_2P_1)}$$

98 **(c)**

$v_{rms} = \sqrt{\frac{3RT}{M}}$. According to problem T will become $2T$ and M will becomes $M/2$ so the value of v_{rms} will increase by $\sqrt{4} = 2$times, $i.e.$, new root mean square velocity will be $2v$

99 **(a)**

Here, $\frac{K_1}{K_2} = \frac{1}{2}, \frac{r_1}{r_2} = \frac{1}{2}$

$\therefore\ \frac{A_1}{A_2} = \frac{1}{4}$

$\frac{dx_1}{dx_2} = \frac{1}{2}, \frac{dQ_2}{dt} = 4\ \text{cals}^{-1}$, $\frac{dQ_1}{dt} = ?$

$$\frac{dQ_2/dt}{dQ_1/dt} = \frac{K_2A_2dT/dx_2}{K_1A_1dT/dx_1} = \frac{K_2}{K_1}\frac{A_2}{A_1}\frac{dx_1}{dx_2}$$

$= 2 \times 4 \times \frac{1}{2} = 4$

$$\frac{dQ_1}{dt} = \frac{dQ_2/dt}{4} = \frac{4}{4} = 1\ \text{cals}^{-1}$$

100 **(b)**

At lower pressure we can assume that given gas behaves as ideal gas so $\frac{PV}{RT}$ = constant but when pressure increases, the decrease in volume will not take place in same proportion so $\frac{PV}{RT}$ will increase

101 **(d)**

Let initial conditions $= V, T$

And final conditions $= V', T'$

By Charle's law $V \propto T$ [P remains constant]

$$\frac{V}{T} = \frac{V'}{T'} \Rightarrow \frac{V}{T} = \frac{V'}{1.2T'} \Rightarrow V' = 1.2V$$

But as per question, volume is reduced by 10% means

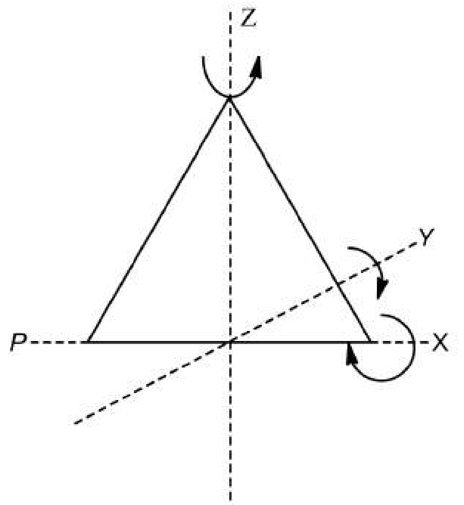
$V' = 0.9V$

So percentage of volume leaked out

$$= \frac{(1.2 - 0.9)V}{1.2V} \times 100 = 25\%$$

102 **(c)**

As temperature requirement is not given so, the molecule of a triatomic gas has a tendency of rotating about any of three coordinate axes. So, it has 6 degrees of freedom; 3 translational and 3 rotational.



Thus,
(3 translational+3 rotational) at room temperature.

103 **(c)**

We have $v_{\text{rms}} = \sqrt{\frac{v_1^2+v_2^2+...+v_n^2}{n}}$

$= \sqrt{\frac{4+25+9+36+9+25}{6}}$

$= \sqrt{\frac{108}{6}} = \sqrt{18} = 3\sqrt{2} = 3 \times$

$1.414 = 4.242$ unit.

104 **(a)**

According to ideal gas equation

$PV = nRT$ or $\frac{V}{T} = \frac{nR}{P}$

At constant pressure

$\frac{V}{T} =$ constant

Hence graph (a) is correct

105 **(a)**

Temperatures $T_1 = 15°\text{C} = 15 + 273 = 288$ K

$T_2 = 35°\text{C} = 35 + 273 = 308$ K

Volume remains constant.

So, $\frac{p_1}{T_1} = \frac{p_2}{T_2}$

$\frac{p_1}{p_2} = \frac{T_1}{T_2} \quad \Rightarrow \frac{p_1}{p_2} = \frac{288}{308}$

$\frac{p_2}{p_1} = \frac{308}{288}$

% increases in pressure$=\frac{p_2-p_1}{p_1} \times 100$

$= \frac{308 - 288}{288} \times 100$

$\approx 7\%$

106 **(c)**

$v_{av} = \sqrt{\frac{8RT}{\pi M}} \Rightarrow T \propto M \quad [\because v_{av}, R \rightarrow \text{constant}]$

$\Rightarrow \frac{T_{H_2}}{T_{O_2}} = \frac{M_{H_2}}{M_{O_2}} \Rightarrow \frac{T_{H_2}}{(273+31)} = \frac{2}{32}$

$\Rightarrow T_{H_2} = 19\,K = -254°\text{C}$

107 **(d)**

Kinetic energy per $g\ mole$ $E = \frac{f}{2}RT$

If nothing is said about gas then we should calculate the translational kinetic energy

$i.e., E_{\text{Trans}} = \frac{3}{2}RT = \frac{3}{2} \times 8.31 \times (273 + 0)$

$= 3.4 \times 10^3 J$

108 **(a)**

According to Gay Lussac's law $p \propto T$

$\therefore \quad \frac{dp}{p} \times 100 = \frac{dT}{T} \times 100$

$1 = \frac{1}{T} \times 100$

$\Rightarrow \quad T = 100$ K

109 **(c)**

Specific heat at constant pressure (C_p) is the amount of heat (Q) required to raise n moles of substance by $\Delta\theta$ when pressure is kept constant. Then

$C_p = \frac{Q}{n\Delta\theta}$

Given, Q=70 cal, $n = 2$,

$\Delta\theta = (35 - 35)°\text{C} = 5°\text{C}$

$\therefore \quad C_p = \frac{70}{2\times5}$=7 cal mol^{-1} $-$K^{-1}

From Mayer's formula $C_p - C_V = R$

where R is gas constant (= 2 cal mol^{-1})

$\therefore \quad 7 - C_V = 2$

$\Rightarrow \quad C_V = 5$ cal mol^{-1} $-$ K^{-1}

Hence, amount of heat required at constant volume (C_V) is

$Q' = nC_V\Delta\theta$

$Q' = 2 \times 5 \times 5 = 50$ cal

110 **(b)**

$v_{rms} \propto \sqrt{T}$; To double the rms velocity temperature should be made four times, $i.e.$,

$T_2 = 4T_1 = 4(273 + 0) = 1092K = 819°\text{C}$

111 **(b)**

In a given mass of the gas

$n = \frac{pV}{kT}$

k being Boltzmann's constant.

112 **(d)**

$PV = NkT \Rightarrow \frac{N_A}{N_B} = \frac{P_A V_A}{P_B V_B} \times \frac{T_B}{T_A}$

$$\Rightarrow \frac{N_A}{N_B} = \frac{P \times V \times (2T)}{2P \times \frac{V}{4} \times T} = \frac{4}{1}$$

113 **(b)**

$VP^3 = \text{constant} = k \Rightarrow P = \frac{k}{V^{1/3}}$

Also $PV = \mu RT \Rightarrow \frac{k}{V^{1/3}}.V = \mu RT \Rightarrow V^{2/3} = \frac{\mu RT}{k}$

Hence $\left(\frac{V_1}{V_2}\right)^{2/3} = \frac{T_1}{T_2} \Rightarrow \left(\frac{V}{27V}\right)^{2/3} = \frac{T}{T_2} \Rightarrow T_2 = 9T$

114 **(d)**

Vander waal's equation is followed by real gases

115 **(b)**

Molecular mass of He; $M = 4g$

$\Rightarrow$ Molar value of $C_V = Mc_V = 4 \times 3 = 12 \frac{J}{mole-kelvin}$

At constant volume $P \propto T$, therefore on doubling the pressure temperature also doubles

$i.e., T_2 = 2T_1 \Rightarrow \Delta T = T_2 - T_1 = 273K$

Also $(\Delta Q)_V = \mu C_V \Delta T = \frac{1}{2} \times 12 \times 273 = 1638J$

116 **(a)**

Here, $h_1 = 50$ cm, $t_1 = 50$°C

$h_2 = 60$ cm, $t_2 = 100$°C

Now, $\frac{h_1}{h_2} = \frac{d_2}{d_1} = \frac{d_0}{1+\gamma t_2} \times \frac{1+\gamma t_1}{d_0}$

$$\frac{50}{60} = \frac{1 + \gamma \times 50}{1 + \gamma \times 100}$$

$$\therefore \gamma = \frac{1}{200} = 0.005°\text{C}^{-1}$$

117 **(d)**

Vander Waal's gas constant $b = 4 \times$ total volume of all the molecules of the gas in the enclosure

Or $b = 4 \times N \times \frac{4}{3}\pi\left(\frac{d}{2}\right)^3 = \frac{2}{3}\pi N d^3$

$$= \frac{2}{3} \times 3.14 \times 6.02 \times 10^{23} \times (2.94 \times 10^{-10})^3$$

$$= 32 \times 10^{-6} \frac{m^3}{mol}$$

118 **(a)**

From ideal gas equation

$$pV = nkT$$

$$p = \frac{n}{V}kT$$

Here, $\frac{n}{V} = 5/\text{cm}^3 = 5 \times 10^6/\text{m}^3$

$\therefore \quad p$

$= (5 \times 10^6/\text{m}^3)(1.38 \times 10^{-23}/\text{JK}^{-1}) \times 3\text{K}$

$$p = 20.7 \times 10^{-17} \text{ Nm}^{-2}$$

119 **(d)**

Escape velocity from the earth's surface is 11.2 km/sec

So, $v_{rms} = v_{\text{escape}} = \sqrt{\frac{3RT}{M}} \Rightarrow T = \frac{(v_{\text{escape}})^2 \times M}{3R}$

$$= \frac{(11.2 \times 10^3)^2 \times (2 \times 10^{-3})}{3 \times 8.31} = 10063K$$

120 **(d)**

$$v = \sqrt{\frac{\gamma P}{\rho}} = \sqrt{\frac{\frac{5}{3} \times 10^3}{2.6}} = 25m/s$$

121 **(a)**

The temperature at which protons in a proton gas would have enough energy to overcome Coulomb barrier between them is given by

$\frac{3}{2}k_B T = K_{av}$ ...(i)

Where k_{av} is the average kinetic energy of the proton, T is the temperature of the proton gas and k_B is the Boltzmann constant

From (i), we get $T = \frac{2K_{av}}{3K_B}$

Substituting the values, we get

$$T = \frac{2 \times 4.14 \times 10^{-14}J}{3 \times 1.38 \times 10^{-23}JK^{-1}} = 2 \times 10^9 K$$

122 **(b)**

The pressure exerted by the gas,

$$p = \frac{1}{3}\rho c^2$$

$$= \frac{1}{3}\frac{m}{V}\bar{c}^2$$

$$= \frac{2}{3}\left(\frac{1}{2}m\bar{c}^2\right)$$

$(\because \frac{1}{2}m\bar{c}^2 = \frac{E}{V} =$ energy per unit volume, $V = 1)$

$$p = \frac{2}{3}E$$

123 **(d)**

Here, $\frac{D_1}{D_2} = \frac{1}{2}$

$$\frac{A_1}{A_2} = \frac{D_1^2}{D_2^2} = \frac{1}{4}$$

$$\frac{dx_1}{dx_2} = \frac{2}{1}$$

$$\frac{dQ_1}{dt} = KA_1\frac{dT}{dx_1} : \frac{dQ_2}{dt} = KA_2\frac{dT}{dx_2}$$

$$\frac{dQ_1/dt}{dQ_2/dt} = \frac{A_1}{dx_1}.\frac{dx_2}{A_2} = \frac{1}{4} \times \frac{1}{2} = \frac{1}{8}$$

124 **(d)**

Total pressure (P) of gas = Actual pressure of gas P_a + aqueous vapour pressure (P_V)

$\Rightarrow P_a = P - P_V = 735 - 23.8 = 711.2mm$

125 **(c)**

Let for mixture of gases, specific heat at constant volume be C_V

$$C_V = \frac{n_1(C_V)_1+n_2(C_V)_2}{n_1+n_2}$$

where for oxygen; $C_{V_1} = \frac{5R}{2}, n_1 = 2$ mol

For helium; $C_{V_2} = \frac{3R}{2}, n_2 = 8$ mol

Therefore, $C_V = \frac{\frac{2\times5R}{2}+8\times\frac{3R}{2}}{2+8} = \frac{17R}{10} = 1.7\,R$

126 **(a)**

For one g $mole$; average kinetic energy $= \frac{3}{2}RT$

127 **(d)**

As we know 1 mol of any ideal gas at STP occupies a volume of 22.4 $litres$.

Hence number of moles of gas $\mu = \frac{44.8}{22.4} = 2$

Since the volume of cylinder is fixed,

Hence $(\Delta Q)_V = \mu C_V\, \Delta T$

$= 2 \times \frac{3}{2}R \times 10 = 30R \quad \left[\because (C_V)_{mono} = \frac{3}{2}R\right]$

128 **(b)**

The ideal gas law is the equation of state of an ideal gas. The state of an amount of gas is determined by its pressure, volume and temperature. The equation has the form

$$pV = nRT$$

where, p is pressure, V the volume, n the number of moles, R the gas constant and T the temperature.

$$\therefore \quad \frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$$

Given, $p_1 = 200$ kPa, $V_1 = V, T_1 = 273 + 22 = 295$ K, $V_2 = V + 0.02\,V$

$$T_2 = 273 + 42 = 315 \text{ K}$$

$$\frac{200\times V}{295} = \frac{p_2\times1.02V}{315}$$

$$\Rightarrow \quad p_2 = \frac{200\times315}{295\times1.02}$$

$$p_2 = 209 \text{ kPa}$$

129 **(c)**

$$PV = \mu RT \Rightarrow \mu = \frac{PV}{RT} = \frac{21\times10^4\times83\times10^{-3}}{8.3\times300} = 7$$

130 **(b)**

An ideal gas is a gas which satisfying the assumptions of the kinetic energy.

131 **(d)**

$$P = \frac{2}{3}E$$

132 **(b)**

$\gamma = 7/5$ for a diatomic gas

134 **(c)**

$$v_{rms} \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{v_{O_2}}{v_{H_2}} = \sqrt{\frac{M_{H_2}}{M_{O_2}}} \Rightarrow \frac{C}{v_{H_2}} = \sqrt{\frac{2}{32}} = \frac{1}{4}$$

$\Rightarrow v_{H_2} = 4C\ cm/s$

135 **(a)**

$$P \propto T \Rightarrow \frac{P_1}{P_2} = \frac{T_1}{T_2} \Rightarrow \frac{P_2 - P_1}{P_1} = \frac{T_2 - T_1}{T_1}$$

$$\Rightarrow \left(\frac{\Delta P}{P}\right)\% = \left(\frac{251-250}{250}\right)\times100 = 0.4\%$$

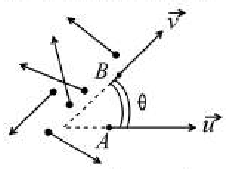
136 **(b)**

$$v_{rms} \propto \sqrt{T} \Rightarrow \frac{(v_{rms})_2}{(v_{rms})_1} = \sqrt{\frac{T_2}{T_1}}$$

$$\Rightarrow 2 = \sqrt{\frac{T_2}{300}} \Rightarrow T_2 = 1200K = 927°\text{C}$$

137 **(d)**

Figure shows the particles each moving with same speed v but in different directions. Consider any two particles having angle θ between directions of their velocities



Then, $\overrightarrow{v_{\text{rel}}} = \overrightarrow{v_B} - \overrightarrow{v_A}$

$i.e., v_{\text{rel}} = \sqrt{v^2+v^2-2vv\cos\theta}$

$\Rightarrow v_{\text{rel}} = \sqrt{2v^2(1-\cos\theta)} = 2v\sin(\theta/2)$

So averaging v_{rel} over all pairs

$$\bar{v}_{\text{rel}} = \frac{\int_0^{2\pi} v_{\text{rel}}d\theta}{\int_0^{2\pi} d\theta} = \frac{\int_0^{2\pi} 2v\sin(\theta/2)}{\int_0^{2\pi} d\theta}$$

$$= \frac{2v\times2[-\cos(\theta/2)]_0^{2\pi}}{2\pi}$$

$\Rightarrow \bar{v}_{\text{rel}} = (4v/\pi) > v \quad [\text{as } 4/\pi > 1]$

138 **(b)**

Since volume is constant,

Hence $\frac{P_1}{P_2} = \frac{T_1}{T_2} \Rightarrow \frac{1}{3} = \frac{(273+30)}{T_2}$

$\Rightarrow T_2 = 909K = 636°\text{C}$

139 **(d)**

The value of $\frac{pV}{T}$ for one mole of an ideal gas

$= $ gas constant

$= 2$ cal $\text{mol}^{-1}\text{K}^{-1}$

140 **(d)**

Mean kinetic energy for μ mole gas $= \mu.\frac{f}{2}RT$

$$\therefore E = \mu\frac{7}{2}RT = \left(\frac{m}{M}\right)\frac{7}{2}NkT = \frac{1}{44}\left(\frac{7}{2}\right)NkT$$

$= \frac{7}{88}NkT$ [As $f = 7$ and $M = 44$ for CO_2]

141 **(c)**

$V \propto T \Rightarrow \frac{V_1}{V_2} = \frac{T_1}{T_2} \Rightarrow \frac{V}{2V} = \frac{(273+27)}{T_2} = \frac{300}{T_2}$

$\Rightarrow T_2 = 600K = 327°C$

142 **(a)**

$C_P - C_V = R = 2.\frac{cal}{g-mol-K}$

Which is correct for option (a) and (b). Further the ratio $\frac{C_P}{C_V}(=\gamma)$ should be equal to some standard value corresponding to that of either, mono, di, or triatomic gases. From this point of view option (a) is correct because $\left(\frac{C_P}{C_V}\right)_{mono} = \frac{5}{3}$

143 **(a)**

$v_{rms} = \sqrt{\frac{3RT}{M}} \Rightarrow T \propto M \quad [\because v_{rms}, R \to \text{constant}]$

$\frac{T_{H_2}}{T_{O_2}} = \frac{M_{H_2}}{M_{O_2}} = \frac{T_{H_2}}{(273+47)} = \frac{2}{32} \Rightarrow T_{H_2} = 20K$

144 **(c)**

Molecules of ideal gas behaves like perfectly elastic rigid sphere

145 **(d)**

$PV = mrT \Rightarrow P \propto m \quad [\because V, r, T \to \text{constant}]$

$\Rightarrow \frac{m_1}{m_2} = \frac{P_1}{P_2} \Rightarrow \frac{10}{m_2} = \frac{10^7}{2.5 \times 10^6} \Rightarrow m_2 = 2.5\ kg.$

Hence mass of the gas taken out of the cylinder $= 10 - 2.5 = 7.5kg$

147 **(b)**

$(\Delta Q)_P = \mu C_P \Delta T$ and $(\Delta Q)_V = \mu C_V \Delta T$

$\Rightarrow \frac{(\Delta Q)_V}{(\Delta Q)_P} = \frac{C_V}{C_P} = \frac{\frac{3}{2}R}{\frac{5}{2}R} = 3/5$

$\left[\because (C_V)_{mono} = \frac{3}{2}R, (C_P)_{mono} = \frac{5}{2}R\right]$

$\Rightarrow (\Delta Q)_V = \frac{3}{5} \times (\Delta Q)_P = \frac{3}{5} \times 210 = 126\ J$

148 **(d)**

Root mean square velocity of gas molecules

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

or $$v_{\text{rms}} \propto \frac{1}{\sqrt{M}}$$

or $$\frac{v_{O_3}}{v_{O_2}} = \sqrt{\frac{M_{O_2}}{M_{O_3}}}$$

Here, $M_{O_2} = 32, \quad M_{O_3} = 48$

$\therefore \quad \frac{v_{O_3}}{v_{O_2}} = \sqrt{\frac{32}{48}} = \frac{\sqrt{2}}{\sqrt{3}}$

149 **(d)**

$v_{rms} = \sqrt{\frac{3RT}{M}} \Rightarrow v_{rms} \propto \frac{1}{\sqrt{M}}$

150 **(c)**

For mono atomic gas, C_V is constant $\left(\frac{3}{2}R\right)$. It doesn't vary with temperature

151 **(a)**

$PV = \mu RT = \frac{m}{M}RT$

$\Rightarrow \frac{PV}{T} \propto \frac{1}{M} \quad [\because M = \text{molecule mass}]$

From graph $\left(\frac{PV}{T}\right)_A < \left(\frac{PV}{T}\right)_B < \left(\frac{PV}{T}\right)_C$

$\Rightarrow M_A > M_B > M_C$

152 **(d)**

$\frac{\Delta Q}{\Delta t} = KA\left(\frac{\Delta T}{\Delta x}\right) = K\pi r^2\left(\frac{\Delta T}{l}\right) \propto \frac{r^2}{l}$

As $\frac{r^2}{l}$ is maximum for (d), it is the correct choice.

153 **(a)**

Internal energy of the gas remains constant, hence

$T_2 = T$

Using $p_1V_1 = p_2V_2$

$p.\frac{V}{2} = p_2V_2$

$p_2 = \frac{p}{2}$

154 **(d)**

The square root of $\bar{v}^2$ is called the root mean square velocity (rms) speed of the molecules.

$$v_{\text{rms}} = \sqrt{\bar{v}^2} = \sqrt{\frac{v_1^2+v_2^2+v_3^3+v_4^4}{4}}$$

$$= \sqrt{\frac{(1)^2+(2)^2+(3)^2+(4)^2}{4}}$$

$$= \sqrt{\frac{1+4+9+16}{4}} =$$

$\sqrt{\frac{30}{4}} = \sqrt{\frac{15}{2}}\ \text{kms}^{-1}$

155 **(b)**

Using Newton's law of cooling,

$\log\frac{\theta_2-\theta_0}{\theta_1-\theta_0} = -Kt$

$\text{Log}\frac{40-\theta_0}{50-\theta_0} = -K \times 5 \quad$ .....(i)

$\text{Log}\frac{33.33-\theta_0}{40-\theta_0} = -K \times 5 \quad$ .....(ii)

From Eqs.(i) and (ii),

$\frac{40-\theta_0}{50-\theta_0} = \frac{33.33-\theta_0}{40-\theta_0}$

On solving, we get

$\theta_0 = 19.95°C \approx 20°C$

157 **(c)**

1. The dotted line in the diagram shows that there is no derivation in the value of $\frac{pV}{nT}$ for different temperature T_1 and T_2 for increasing pressure so, this gas behaves ideally. Hence, dotted line corresponds to 'ideal' gas behavior.

2. At high temperature, the derivation of the gas is less and at low temperature the derivation of gas is more. In the graph, derivation for T_2 is greater than for T_1. Thus,

$$T_1 > T_2$$

3. Since, the two curves intersect at dotted line so, the value of $\frac{pV}{nT}$ at that point on the y-axis is same for all gases.

158 **(d)**

Since $v_{rms} \propto \sqrt{T}$. Also mean square velocity $\overline{v^2} = v_{rms}^2$

159 **(b)**

$v_{rms} \propto \frac{1}{\sqrt{M}} \Rightarrow V_H > V_N > V_O$ $[\because M_H < M_N < M_O]$

160 **(b)**

$P_f = 2p + \bar{p}$

Saturated vapour pressure will not change if temperature remains constant.

161 **(c)**

Kinetic energy ∝ Temperature

162 **(d)**

$PV = nRT$

$\Rightarrow PV = \frac{\omega}{M} RT$

$\frac{PM}{RT} = \frac{\omega}{V} = e$

$\Rightarrow e = \frac{PM}{RT} = \frac{P \times m \times N_A}{RT} = \frac{Pm}{\left(\frac{R}{N_A}\right) T} = \frac{Pm}{kT}$

163 **(b)**

Thermal energy corresponds to internal energy

Mass=1 kg

Density = 4 kg m^{-3}

Volume = $\frac{\text{Mass}}{\text{Density}} = \frac{1}{4}$ m^3

Pressure = 8×10^4 Nm^{-2}

$\therefore$ Internal energy $= \frac{5}{2} p \times V = 5 \times 10^4$ J

164 **(b)**

$$V_t = V_0(1 + \alpha t) = 0.5\left(1 + \frac{1}{273} \times 819\right) = 2\ litre$$
$$= 2 \times 10^{-3} m^3$$

165 **(c)**

Here, $m = 10$ g $= 10^{-2}$ kg

$v = 300$ ms^{-1}, $\theta = ?$ $C, = 150$ J-kg^{-1}K^{-1}

$Q = \frac{50}{100}\left(\frac{1}{2} mv^2\right) = \frac{1}{4} \times 10^{-2}(300)^2 = 225$ J

From $Q = cm\,\theta$

$\theta = \frac{Q}{cm} = \frac{225}{150 \times 10^{-2}} = 150$°C

166 **(a)**

At constant temperature

$PV =$ constant

$\Rightarrow \frac{P_1}{P_2} = \frac{V_2}{V_1} \Rightarrow \frac{70}{120} = \frac{V_2}{1200} \Rightarrow V_2 = 700\ ml$

167 **(d)**

$P \propto \frac{1}{V} \Rightarrow \frac{V_2}{V_1} = \frac{P_1}{P_2} = \frac{100}{105} \Rightarrow V_2 = \frac{100}{105} V_1$

$= 0.953\ V_1$

% change in volume = $\frac{V_1 - V_2}{V_1} \times 100$

$= \frac{V_1 - 0.953V_1}{V_1} \times 100 = 4.76\%$

168 **(a)**

Average kinetic energy $E = \frac{f}{2} kT = \frac{3}{2} kT$

$\Rightarrow E = \frac{3}{2} \times (1.38 \times 10^{-23})(273 + 30)$

$= 6.27 \times 10^{-21} J$

$= 0.039 eV < 1\ eV$

169 **(c)**

$\because C_P - C_v = R$

Fractional part of heat energy = $\frac{C_P - R}{C_P}$

$= \frac{\frac{7}{2}R - R}{\frac{7}{2}R} = \frac{5}{7}$

170 **(c)**

RMS velocity doesn't depend upon pressure, it depends upon temperature only,

ie., $v_{\text{rms}} \propto \sqrt{T}$.

$$\Rightarrow \quad \frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}} \Rightarrow \frac{200}{v_2}$$

$$= \sqrt{\frac{(273+27)}{(273+127)}} = \sqrt{\frac{300}{400}}$$

$$\Rightarrow \quad v_2 = \frac{400}{\sqrt{3}} \text{ m/s}$$

171 **(a)**

$$\frac{F}{2}n_1kT_1 + \frac{F}{2}n_2kT_2 + \frac{F}{2}n_3kT_3$$

$$= \frac{F}{2}(n_1+n_2+n_3)kT$$

$$T = \frac{n_1T_1+n_2T_2+n_3T_3}{n_1+n_2+n_3}$$

172 **(a)**

As $\rho - \rho_0(1-\gamma\Delta T)$

$\therefore\ 9.7 = 10(1-\gamma \times 100)$

$$\frac{9.7}{10} = 1 - \gamma \times 100$$

$$\gamma \times 100 = 1 - \frac{9.7}{10} = \frac{0.3}{10} = 3 \times 10^{-2}$$

$$\gamma = 3 \times 10^{-4} \ \therefore\ \alpha = \frac{1}{3}\gamma = 10^{-4}{}^\circ\text{C}^{-1}.$$

174 **(b)**

Let the temperature of junction be$Q$. In equilibrium, rate of flow of heat through rod 1= sum of rate of flow of heat through rods 2 and 3.

$$\left(\frac{dQ}{dt}\right)_1 = \left(\frac{dQ}{dt}\right)_2 + \left(\frac{dQ}{dt}\right)_3$$

$$KA\frac{(\theta-0)}{l} = \frac{KA(90^\circ-\theta)}{l} + \frac{KA(90^\circ-\theta)}{l}$$

$$\theta = 2(90^\circ - \theta)$$

$$3\theta = 180^\circ, \theta = \frac{180^\circ}{3} = 60^\circ$$

175 **(a)**

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{(P+h\rho g)1.0}{273+12} = \frac{P.V_2}{273+35}$$

$$V_2 = 5.4cm^3$$

176 **(d)**

Average kinetic energy ∝ Temperature

$$\Rightarrow \frac{E_1}{E_2} = \frac{T_1}{T_2} \Rightarrow \frac{100}{E_2} = \frac{300}{450} \Rightarrow E_2 = 150J$$

177 **(a)**

Let p_1 and p_2 are the initial and final pressures of the gas filled in A. Then

$$p_1 = \frac{n_ART}{V} \quad \text{and} \quad p_2 = \frac{n_ART}{2V}$$

$$\Delta p = p_2 - p_1 = -\frac{n_ART}{2V}$$

$$= -\left(\frac{m_A}{M}\right)\frac{RT}{2V}$$

...(i)

where M is the atomic weight of the gas.

Similarly, $\quad 1.5\Delta p = -\left(\frac{m_B}{M}\right)\frac{RT}{2V}$

...(ii)

Dividing Eq.(ii) by Eq. (i), we get

$$1.5 = \frac{m_B}{m_A} \quad \text{or} \quad \frac{3}{2} = \frac{m_B}{m_A}$$

or $\quad 3m_A = 2m_B$

178 **(c)**

From $\frac{\Delta Q}{\Delta t} = KA\left(\frac{\Delta T}{\Delta x}\right)$

$$\Delta t = \frac{\Delta Q \Delta x}{KA(\Delta T)}$$

In arrangement (b), A is doubled and Δx is halved.

$\therefore\ \Delta t \rightarrow \frac{1/2}{2} \rightarrow \frac{1}{4}$ time

ie, $\frac{1}{4} \times 4$ min= 1 min

179 **(b)**

Here, $m = 0.1$ kg, $h_1 = 10$m, $h_2 = 5.4$ m

$c = 460$ J-kg^{-1}°C^{-1}, g $= 10$ms^{-2}, $\theta = ?$

Energy dissipated, $Q = mg(h_1 - h_2)$

$= 0.1 \times 10(10 - 5.4) = 4.6j$ J

From $Q = c\,m\,\theta$

$$\theta = \frac{Q}{cm} = \frac{4.6}{460 \times 0.1} = 0.1^\circ\text{C}$$

180 **(b)**

Root mean square speed

$$v_{\text{rms}} \propto \frac{1}{\sqrt{\rho}}$$

$$\therefore \quad \frac{v_{\text{rms}_1}}{v_{\text{rms}_2}} = \sqrt{\frac{\rho_2}{\rho_1}}$$

Given, $\quad \frac{\rho_1}{\rho_2} = \frac{9}{8}$

$$\Rightarrow \quad \frac{v_{\text{rms}_1}}{v_{\text{rms}_2}} = \sqrt{\frac{8}{9}} = \frac{2\sqrt{2}}{3}$$

181 **(c)**

$$v_{rms} \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{v_1}{v_2} = \sqrt{\frac{M_2}{M_1}}$$

$\therefore \frac{1}{\sqrt{2}} = \sqrt{\frac{M_2}{32}} \Rightarrow M_2 = 16$. Hence the gas is CH_4

182 **(a)**

No. of moles $n = \frac{m}{\text{molecular weight}} = \frac{5}{32}$

So, from ideal gas equation

$$pV = nRT$$

$$\Rightarrow \quad pV = \frac{5}{32}RT$$

183 **(a)**

According to Avogadro's hypothesis

184 **(c)**

Pressure of gas $A, P_A = \frac{125 \times 0.6}{1000} = 0.075\ atm$

Pressure of gas $B, P_B = \frac{150 \times 0.8}{100} = 0.120\ atm$

Hence, by using Dalton's law of pressure

$P_{mixture} = P_A + P_B = 0.075 + 0.120 = 0.195\ atm$

185 **(a)**

Average speed (v_{av}) of gas molecules is

$$v_{av} = \sqrt{\frac{8RT}{\pi M}}$$

where R is gas constant and M the molecular weight.

Given, $v_1 = v, \quad M_1 = 64, \quad v_2 = 4v$

$$\therefore \quad \frac{v_1}{v_2} = \sqrt{\frac{M_2}{M_1}}$$

$$\frac{v}{4v} = \sqrt{\frac{M_2}{64}}$$

$$\Rightarrow \quad M_2 = \frac{64}{16} = 4$$

Hence, the gas is helium (molecular mass 4).

186 **(b)**

Heat added to helium during expansion

$H = nC_V \Delta T = 8 \times \frac{3}{2} R \times$

$30 \ \left(C_V \text{ for monoatomic gas} = \frac{3}{2}R\right)$

$= 360\ R$

$= 360 \times 8.31$ J $\qquad$ (R=8.31 J mol^{-1} – K^{-1})

≈ 3000 J

187 **(c)**

In Vander Waal's equation $\left(P + \frac{a}{V_2}\right)(V - b) = RT$

a represents intermolecular attractive force and b represents volume correction

188 **(b)**

$$C_P - C_V = R \Rightarrow C_P = R + C_V = R + \frac{f}{2}R$$

$$= R + \frac{3}{2}R = \frac{5}{2}R$$

189 **(d)**

It is because of their low densities

190 **(d)**

Kinetic energy of a gas molecule

$$E = \frac{3}{2}kT$$

where k is Boltzmann's constant.

$\therefore \quad E \propto T$

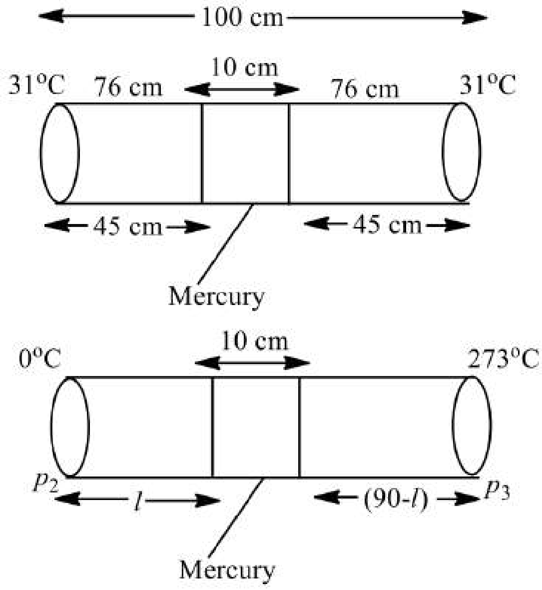
or $\quad \frac{E_1}{E_2} = \frac{T_1}{T_2} \quad$ or $\quad \frac{E}{(E/2)} = \frac{300}{T_2}$

or $\quad T_2 = 150$ K

$T_2 = 150 - 273 = -123$°C

191 **(c)**

On keeping the temperature of the ends of tube at 0°C and 273°C.



Applying ideal gas equation

$$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2} = \frac{p_3 V_3}{T_3}$$

$$\frac{76 \times 45}{(273+31)} = \frac{p_2 \times l}{(273+0)} = \frac{p_3(90-l)}{273+273}$$

$$\underset{\text{I}}{\frac{76 \times 45}{304}} = \underset{\text{II}}{\frac{p_2 \times l}{273}} = \underset{\text{III}}{\frac{p_3(90-l)}{546}}$$

From II and III

$$\frac{p_2 \times l}{273} = \frac{p_3(90-l)}{546}$$

(Mercury column is at rest, so pressure difference $p_2 - p_3 = 0 \Rightarrow p_2 = p_3$)

$$\therefore \quad \frac{p_2 \times l}{273} = \frac{p_2(90-l)}{546}$$

$\Rightarrow \quad 2l = 90 - l \Rightarrow l = 30$ cm

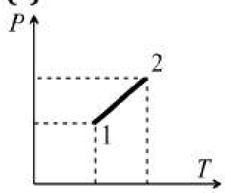
From I and II

$$\frac{76 \times 45}{304} = \frac{p_2 \times 30}{273}$$

$$\Rightarrow \quad p_2 = \frac{76 \times 45 \times 273}{30 \times 304}$$

$$p_2 = 102.4$$

192 **(c)**



$PV = \mu RT$

$\Rightarrow V \propto \frac{T}{P}$ ($\because \mu$ and R are fixed)

Since, T increases rapidly and P increases slowly thus volume of the gas increases

193 **(b)**

$$v_{av} \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{v_{He}}{v_H} = \sqrt{\frac{M_H}{M_{He}}} = \sqrt{\frac{1}{4}} = \frac{1}{2} \Rightarrow v_{He} = \frac{v_H}{2}$$

194 **(b)**

$$v_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3 \times 8.3 \times 300}{28 \times 10^{-3}}} = 517 m/s$$

195 **(d)**

Thermal equilibrium implies that the temperature of gases is same. Hence Boyle's law is applicable $i.e$

$P_aV_a = P_bV_b$

196 **(d)**

$$C_V = \frac{5}{2}R \text{ and } C_p = \frac{7}{2}R$$

$$\therefore \quad \gamma = \frac{C_p}{C_V} = \frac{7}{5}$$

197 **(c)**

Moist and hot air being lighter rises up and leaves the room throught the ventilator near the roof and fresh air rushes into the room throught the doors.

198 **(d)**

Root means square velocity of molecule in left part

$$v_{rms} = \sqrt{\frac{3KT}{m_L}}$$

Mean or average speed of molecule in right part

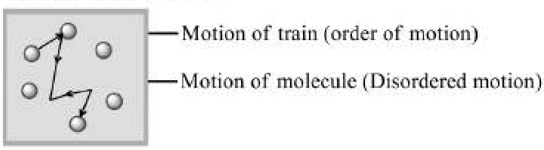
$$v_{av} = \sqrt{\frac{8}{\pi}\frac{KT}{m_R}}$$

According to problem $\sqrt{\frac{3KT}{m_L}} = \sqrt{\frac{8}{\pi}\frac{KT}{m_R}}$

$$\Rightarrow \frac{3}{m_L} = \frac{8}{\pi m_R} \Rightarrow \frac{m_L}{m_R} = \frac{3\pi}{8}$$

199 **(c)**

Temperature of the gas is concerned only with it's disordered motion. It is no way concerned with it's ordered motion



200 **(c)**

$$\gamma_{\max} = \frac{\frac{\mu_1\gamma_1}{\gamma_1-1} + \frac{\mu_2\gamma_2}{\gamma_2-1}}{\frac{\mu_1}{\gamma_1-1} + \frac{\mu_2}{\gamma_2-1}}$$

$$= \frac{\frac{1\times\frac{5}{3}}{\left[\frac{5}{3}-1\right]} + \frac{1\times\frac{7}{5}}{\left[\frac{7}{5}-1\right]}}{\left[\frac{1}{\frac{5}{3}-1}\right] + \left[\frac{1}{\frac{7}{5}-1}\right]} = \frac{3}{2} = 1.5$$

201 **(d)**

$$E = \frac{3}{2}RT = \frac{3}{2} \times 8.31 \times 273 = 3.4 \times 10^3 J$$

202 **(b)**

Given, $p_1 = 100$ mm, $V_1 = 200$ mL and $p_2 = 400$ mm

From Boyle' Law

$$p_1V_1 = p_2V_2$$

$$V_2 = \frac{p_1V_1}{p_2}$$

$$= \frac{100 \times 200}{400}$$

$$V_2 = 50 \text{ mL}$$

Volume of 2 mol gas$=2 \times 50 = 100$ mL

203 **(b)**

$$v_{rms} = \sqrt{\frac{3RT}{M}} \Rightarrow v_{rms}^2 \propto T$$

204 **(b)**

$$(C_P)_{mix} = \frac{\mu_1 C_{P_1} + \mu_2 C_{P_2}}{\mu_1 + \mu_2} (C_{P_1}(He)$$

$$= \frac{5}{2}R \text{ and } C_{P_2}(H_2) = \frac{7}{2}R)$$

$$= \frac{1 \times \frac{5}{2}R + 1 \times \frac{7}{2}R}{1+1} = 3R = 3 \times 2 = 6 cal/mol.°C$$

$\therefore$ Amount of heat needed to raise the temperature from 0°C to 100°C

$(\Delta Q)_P = \mu C_P \Delta T = 2 \times 6 \times 100 = 1200$ cal

205 **(c)**

The average velocity

$$v_{\text{av}} = \frac{v_1+v_2+v_3+...+v_n}{N}$$

$$= \frac{1+3+5+7}{4} = 4 \text{ km/s}$$

Root mean square velocity

$$v_{rms} = \sqrt{\frac{v_1^2+v_2^2+v_3^2+...+v_n^2}{N}}$$

$$= \sqrt{\frac{1+(3)^2+(5)^2+(7)^2}{4}}$$

$$= \sqrt{21} = 4.583 \text{ km/s}$$

Difference between average velocity and root mean square velocity

=4.583-4

=0.583 km/s

206 **(c)**

$V \propto T \Rightarrow \frac{V_1}{V_2} = \frac{T_1}{T_2}$

$\Rightarrow \frac{V}{V_2} = \frac{(273+27)}{(273+327)} = \frac{300}{600} = \frac{1}{2} \Rightarrow V_2 = 2V$

207 **(c)**

For a closed system, the total number of moles remains constant. So

$p_1V = n_1RT_1$ and $p_2V = n_2RT_2$

$\therefore\ p(2V) = (n_1+n_2)RT$

$\therefore\ \frac{p}{T} = \frac{(n_1+n_2)}{2}R = \frac{1}{2}\left[\frac{P_1}{T_1} + \frac{P_2}{T_2}\right]$

$= \frac{1}{2}\left[\frac{p_1T_2 + p_2T_1}{T_1T_2}\right]$

208 **(a)**

Most probable speed $v_{mp} = \sqrt{\frac{2kT}{m}} \Rightarrow \frac{1}{2}mv_{mp}^2 = kT$

209 **(a)**

As $dQ = dU + dW$

$\therefore\ dU = dQ - dW = 2240 - 168$

$= 2072$ J

210 **(c)**

The root mean square velocity

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

where R is gas constant, T the temperature and M the molecular weight.

Given, $v_{\text{He}} = v_{\text{H}}$, $T_{\text{H}} = 273$ K, $M_{\text{H}} = 2$, $M_{\text{He}} = 4$

$$\therefore\ \frac{v_{\text{H}}}{v_{\text{He}}} = \sqrt{\frac{T_{\text{H}}}{T_{\text{He}}} \times \frac{M_{\text{He}}}{M_{\text{H}}}}$$

$$\therefore\ 1 = \sqrt{\frac{273}{T_{\text{He}}} \times \frac{4}{2}}$$

$\Rightarrow\ T_{\text{He}} = 546$ K

In °C, $T_{\text{He}} = (546-273)°\text{C} = 273°\text{C}$

212 **(b)**

The molecules of a gas are in a state of random motion. They continuously collide against the walls of the container. Even at ordinary temperature and pressure, the number of molecular collisions with walls is very large. During each collision, certain momentum is transferred to the walls of the container. The pressure exerted by the gas is due to continuous bombardment of gas molecules against the walls of the container. Due to this continuous bombardment, the walls of the container experience a continuous force which is equal to the total momentum imparted to the walls per second. The average force experienced per unit area of the walls container determines the pressure exerted by the gas. This should be clear from the fact that although the molecular collisions are random the pressure remains constant.

213 **(c)**

Given, pT^2=constant

$\therefore\ \left(\frac{nRT}{V}\right)T^2$ =constant

or T^3V^{-1} = constant

Differentiating the equation, we get

$\frac{3T^2}{V}.dT - \frac{T^3}{V^2}.dV = 0$

or $3.dT = \frac{T}{V}.dV$

From the equation, $dV = V_\gamma.dT$

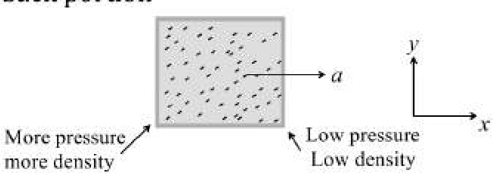
γ = coefficient of volume expansion of gas

$= \frac{dV}{V.dT}$

$\therefore\ \gamma = \frac{dV}{V.dT} = \frac{3}{T}$

215 **(b)**

Pressure will be less in front portion of the compartment because in accelerated frame molecules will feel pseudo force in backward direction. Also density of gas will be more in the back portion



216 **(a)**

$v_{\text{rms}} \propto \sqrt{T}$

$\Rightarrow\ \frac{v_1^2}{v_2^2} = \frac{T_1}{T_2}$

$\Rightarrow\ \frac{v^2}{2v^2} = \frac{273}{T_2}$

$\Rightarrow\ T_2 = 1092$ K

=819°C

217 **(c)**

Average velocity of gas molecule is

$$v_{av} = \sqrt{\frac{8RT}{\pi M}} \Rightarrow v_{av} \times \frac{1}{\sqrt{M}}$$

$$\Rightarrow \frac{< C_H >}{< C_{He} >} = \sqrt{\frac{M_{He}}{M_H}} = \sqrt{\frac{4}{1}} = 2 \Rightarrow < C_H > = 2 < C_{He} >$$

218 **(c)**

$\mu = \mu_1 + \mu_2$

$$\frac{P(2V)}{RT_1} = \frac{P'V}{RT_1} + \frac{P'V}{RT_2} \Rightarrow \frac{2P}{RT_1} = \frac{P'}{R}\left[\frac{T_2 + T_1}{T_1 T_2}\right]$$

$$P' = \frac{2PT_2}{(T_1 + T_2)} = \frac{2 \times 1 \times 600}{(300 + 600)} = \frac{4}{3} atm$$

219 **(c)**

$$C_V = \frac{R}{(\gamma - 1)} \Rightarrow \gamma = 1 + \frac{R}{C_V} = 1 + \frac{R}{\frac{3}{2}R} = \frac{5}{3}$$

220 **(b)**

$$v_{rms} = \sqrt{\frac{3P}{\rho}} = \sqrt{\frac{3PV}{m}} \Rightarrow v_{rms} \propto \sqrt{\frac{P}{m}}$$

$$\Rightarrow \frac{v_1}{v_2} = \sqrt{\frac{P_1}{P_2} \times \frac{m_2}{m_1}} \Rightarrow \frac{v}{2v} = \sqrt{\frac{P_0}{P2} \times \frac{m/2}{m}} \Rightarrow P_2 = 2P_0$$

221 **(a)**

Kinetic energy for 1 *mole gas* $E = \frac{f}{2}RT$

$$\Rightarrow E_{\text{Translation}} = \frac{3}{2}RT$$

[$\because$ For all gases translational degree of freedom $f = 3$]

222 **(c)**

$PV = \mu RT$ [Gas equation] $\Rightarrow PV \propto T$

223 **(b)**

Neglecting bond length, the volume of an oxygen molecule has been taken as 2 times that of one oxygen atom.

In 22.4 litres *i.e.*, $22.4 \times 10^{-3} m^3$, there are $N_A = 6.23 \times 10^{23}$ molecules

Total volume of oxygen molecules $= 2 \times \frac{4}{3}\pi r^3 \times N_A$

$22.4 \times 10^{-3} m^3$ is occupied by N_A molecules

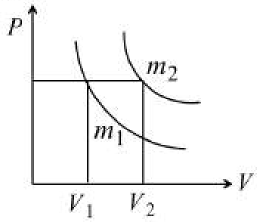
$\therefore$ Fraction of volume occupied

$$= \frac{2 \times \frac{4}{3} \times \pi \times (1.5 \times 10^{-10})^3 \times 6.2 \times 10^{23}}{(22.4 \times 10^{-3})} = 8 \times 10^{-4}$$

224 **(c)**

No change, because *rms* velocity of gas depends upon temperature only

225 **(c)**



$$PV = \mu RT = \frac{m}{M}RT$$

For 1st graph,

$P = \frac{m_1}{M}\frac{RT}{V_1}$ ...(i)

For 2nd graph,

$P = \frac{m_2}{M}\frac{RT}{V_2}$ ...(ii)

Equating the two, we get, $\frac{m_1}{m_2} = \frac{V_1}{V_2} \Rightarrow m \propto V$

As $V_2 > V_1 \Rightarrow m_1 < m_2$

226 **(a)**

$PV = \mu RT \Rightarrow PV \propto T$

If P and V are doubled then T becomes four times, *i.e.*,

$T_2 = 4T_1 = 4 \times 100 = 400K$

227 **(b)**

Ideal gas equation can be written as

$$pV = nRT$$

...(i)

From Eq. (i), we have

$$\frac{n}{V} = \frac{p}{RT} = \text{constant}$$

So, at constant pressure and temperature, all gases will contain equal number of molecules per unit volume.

228 **(b)**

RMS velocity is given by

$$v = \sqrt{\frac{3kT}{m}} \quad \text{or} \quad v^2 = \frac{3kT}{m}$$

For a gas, k and m are constants.

$$\therefore \quad \frac{v^2}{T} = \text{constant}$$

229 **(b)**

CO is diatomic gas, for diatomic gas

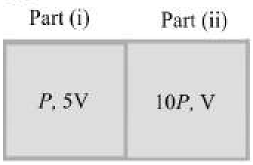
$C_P = \frac{7}{2}R$ and $C_V = \frac{5}{2}R \Rightarrow \gamma_{di} = \frac{C_P}{C_V} = \frac{7R/2}{5R/2} = 1.4$

230 **(a)**

When gas is filled in a closed container, it exerts pressure on the walls of the vessel. According to kinetic theory this pressure is developed due to the collisions of the moving molecules on the walls of the vessels.

Whenever a molecules collides with the wall, it return with changed momentum and an equal momentum is transferred to the wall. According to Newton's law of motion, the rate of change of momentum of the ball is equal to the force exerted on the wall. Since, the gas contains a large number of molecules which are colliding with the walls of the vessel, they exert a steady force on the walls. This force measured per unit area gives pressure, which is same as the molecules are moving in horizontal direction with constant acceleration.

231 **(a)**



When the piston is allowed to move the gases are kept separated but the pressure has to be equal. ($P_1 = P_2$) and final volume x and $(6V - x)$, the no of moles are same in initial and final position at each parts.

$\because P_1 = P_2 \qquad P_V = n_1RT$

$\dfrac{n_1RT}{x} = \dfrac{n_2RT}{6V - x} \quad n_1 = \dfrac{5PV}{RT}$

$\dfrac{n_1}{x} = \dfrac{n_2}{6V - x} \qquad n_2 = \dfrac{10PV}{RT}$

$\Rightarrow \dfrac{5PV}{xRT} = \dfrac{10PV}{(6V - x)RT} \Rightarrow \dfrac{1}{x} = \dfrac{2}{6V - x}$

$\Rightarrow 6V - x = 2x \Rightarrow x2V$ and $6V - x \Rightarrow 6V - 2V = 4V$

$\therefore (2V, 4V)$

233 **(c)**

Kinetic energy $\propto$ Temperature. Hence if temperature is doubles, kinetic energy will also be doubled

234 **(c)**

The average kinetic energy of monoatomic gas molecule is $K = \frac{3}{2}k_BT$

Where k_B is the Boltzmann constant and T is the temperature of the gas in kelvin

$K = \dfrac{3}{2} \times (1.38 \times 10^{-23}JK^{-1}) \times (300K)$

$= \dfrac{3 \times (1.38 \times 10^{-23}JK^{-1}) \times (300K)}{2 \times (1.6 \times 10^{-19}J/eV)}$

$= 3.9 \times 10^{-2}eV = 0.039eV$

235 **(a)**

If the volume remains constant, then

$$\frac{p_1}{p_2} = \frac{T_1}{T_2}$$

$$\Rightarrow \qquad \frac{p}{p + \frac{0.4}{100}p} = \frac{T}{T + 1}$$

or $\qquad T = 250$ K

236 **(a)**

From Boyle's law

$$pV = \text{constant}$$

$$\therefore \qquad p_1V_1 = p_2V_2$$

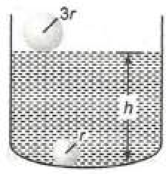
Here, $p_1 = (h + l),\ V_1 = \frac{4}{3}\pi r^3$

$p_2 = l,\ V_2 = \frac{4}{3}\pi(3r)^3$

$$\therefore \qquad (h + l)\frac{4}{3}\pi r^3 = l \times \frac{4}{3}\pi(3r)^3$$

or $\qquad h + l = 27l$

$\therefore \qquad h = 26l$



237 **(d)**

Degree of freedom $f = 3$

(Translatory)+2(rotatory)+1(vibratory) = 6

$\Rightarrow \dfrac{C_P}{C_V} = \gamma = 1 + \dfrac{2}{f} = 1 + \dfrac{2}{6} = \dfrac{4}{3} = 1.33$

238 **(c)**

In the absence of intermolecular forces, there will be no stickness of molecules. Hence, pressure will increase.

239 **(a)**

At $T = 0K, v_{rms} = 0$

240 **(c)**

The given equation is for 1 $g\ mol$ gas

241 **(c)**

$\dfrac{P_1V_1}{T_1} = \dfrac{P_2V_2}{T_2}$

$T_2 = \dfrac{P_2V_2}{P_1V_1}T_1 = \dfrac{2}{1} \times \dfrac{3}{1} \times 300 = 1800K = 1527°C$

242 **(a)**

$\because \theta_1 < \theta_2 \Rightarrow \tan\theta_1 < \tan\theta_2 \Rightarrow \left(\dfrac{V}{T}\right)_1 < \left(\dfrac{V}{T}\right)_2$

Form $PV = \mu RT; \frac{V}{T} \propto \frac{1}{P}$

Hence $\left(\frac{1}{P}\right)_1 < \left(\frac{1}{P}\right)_2 \Rightarrow P_1 > P_2$

243 **(d)**

$C_P - C_V = R$ and R is constant for all gases

244 **(b)**

For a real gas the two van der Waal's constants and Boyle's temperature (T_B) are related as

$$T_B = \frac{a}{bR}$$

245 **(b)**

$v_{rms} \propto \sqrt{T}$

246 **(d)**

$r.m.s.$ velocity does not depend upon pressure

247 **(c)**

$$E_{av} = \frac{f}{2}kT = \frac{3}{2} \times 1.38 \times 10^{-23} \times 273$$
$$= 0.56 \times 10^{-20} J$$

248 **(c)**

As $\eta = 1 = \frac{T_2}{T_1}$

$\therefore \frac{50}{100} = 1 = \frac{500}{T_1}$ or $T_1 = 1000\text{K}$

Again, $\frac{60}{100} = 1 - \frac{T_2}{1000}$

Or $T_2 = 400$ K

249 **(a)**

Root mean square velocity (v_{rms}), given by

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

where R is gas constant, T the temperature and M molecular weight.

Given, $T_1 = 27°\text{C} = 273 + 27 = 300$ K,

$T_2 = 327°\text{C} = 327 + 273 = 600$ K

$$\therefore \quad \frac{(v_{\text{rms}})_1}{(v_{\text{rms}})_2} = \sqrt{\frac{300}{600}} = \sqrt{\frac{1}{2}}$$

$$\Rightarrow \quad (v_{\text{rms}})_2 = \sqrt{2}\,(v_{\text{rms}})_1$$

Hence, rms speed increases $\sqrt{2}$ times.

251 **(d)**

Oxygen being a diatomic gas possesses 5 degrees of freedom, 3 translational and 2 rotational.

Argon being monoatomic has 3 translational degrees of freedom.

Total energy of the system

$$= E_{\text{oxygen}} + E_{\text{argon}}$$
$$= n_1 f_1 \left(\frac{1}{2}RT\right) + n_2 f_2 (\frac{1}{2}RT)$$
$$= 2 \times 5 \times \frac{1}{2}RT + 4 \times 3 \times \frac{1}{2}RT$$
$$= 5RT + 6RT = 11RT$$

252 **(d)**

Consider n moles of a gas which undergo isochoric process, ie, V=constant. From first law of thermodynamics,

$$\Delta Q = \Delta W + \Delta U$$

...(i)

Here, $\Delta W = 0$ as $V =$ constant

$$\Delta Q = nC_V \Delta T$$

Substituting in Eq. (i), we get

$$\Delta U = nC_V \Delta T$$

...(ii)

Mayer's relation can be written as

$$C_p - C_V = R$$

$$\Rightarrow \quad C_V = C_p - R$$

...(iii)

From Eqs. (ii) and (iii), we have

$$\Delta U = n(C_p - R)\Delta T$$

Given, $n = 6$, $C_p = 8 \text{ cal mol}^{-1} - \text{K}^{-1}$,

$R = 8.31 \text{ J mol}^{-1} - \text{K}^{-1}$

$\approx 2 \text{ cal mol}^{-1} - \text{K}^{-1}$

Hence, $\Delta U = 6(8 - 2)(35 - 20)$

$= 6 \times 6 \times 15 = 540$ cal

253 **(d)**

Mean kinetic energy of any ideal gas is given by $E = \frac{f}{2}RT$ which is different gases. (f is not same for all gases)

254 **(a)**

$\frac{V_1}{V_2} = \frac{T_1}{T_2}$

$\frac{1}{2} = \frac{300}{T_2}$

$T_2 = 600\text{ K} = 600 - 273 = 327°\text{C}$

$\Delta t = 327 - 27 = 300°\text{C}$

255 **(c)**

Since P and V are not changing, so temperature remains same

256 **(c)**

$v_{r.m.s.}$ is independent of pressure but depends upon temperature as $v_{rms} \propto \sqrt{T}$

257 **(d)**

The main kinetic energy of one mole of gas n degree of freedom.

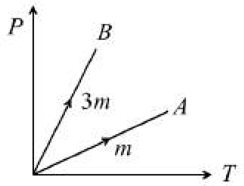
$$E = \frac{n}{2}RT$$

The mean kinetic energy of one mole of gas per degree of freedom.

$$E' = \frac{E}{n} = \frac{\frac{n}{2}RT}{n}$$

$$E' = \frac{1}{2}RT$$

258 **(a)**



For a gas, $PV = \mu RT = \frac{m}{M}RT$

For graph A, $PV = \frac{m}{M}RT$

Slope of graph A,

$\left(\frac{P}{T}\right) = \frac{m}{M}\frac{R}{V}$ ...(i)

For graph B, $PV = \frac{3m}{M}RT$

Slope of graph B,

$\left(\frac{P}{T}\right) = \frac{3m}{M}\frac{R}{V}$ ...(ii)

$$\frac{\text{Slope of curve } B}{\text{Slope of curve } A} = \frac{\frac{3m}{M}\frac{R}{V}}{\frac{m}{M}\frac{R}{V}} = \frac{3}{1}$$

259 **(c)**

According to law of equipartion of energy, kinetic energy per degree of freedom of a gas molecule is $\frac{1}{2}kT$

260 **(c)**

For carbon dioxide, number of moles $(n_1) = \frac{22}{44} = \frac{1}{2}$;

molar specific heat of CO_2 at constant volume $C_{V_1} = 3R$

For oxygen, number of moles $(n_2) = \frac{16}{32} = \frac{1}{2}$;

molar specific heat of O_2 at constant volume $C_{V_2} = \frac{5R}{2}$.

Let TK be the temperature of mixture.

Heat lost by O_2 = Heat gained by CO_2.

$n_2 C_{V_2}\Delta T_2 = n_1 C_{V_1}\Delta T_1$

$\frac{1}{2}\left(\frac{5}{2}R\right)(310 - T) = \frac{1}{2}\times(3R)(T - 300)$

Or $1550 - 5T = 6T - 1800$

Or $T = 304.54\text{K} = 31.5°\text{C}$

261 **(b)**

As $dQ = C_p m\Delta T$

$\therefore\ 70 = C_p \times 2(35 - 30)$

$C_V = C_p - R$

$= 7 - 1.99 = 5.01$ $\text{calmol}^{-1}°\text{C}^{-1}$

$\therefore\ dQ' = C_V m\Delta T$

$= 5.01 \times 2 \times (35 - 30) = 50.1$ cal

262 **(d)**

The difference of C_P and C_V is equal to R, not $2R$

264 **(b)**

Average speed or mean speed of gas molecules

$$\bar{v} = \sqrt{\frac{8RT}{\pi M}} \quad \text{or} \quad \bar{v} \propto \frac{1}{\sqrt{M}}$$

or $\frac{\bar{v}_\text{H}}{\bar{v}_\text{He}} = \sqrt{\frac{M_\text{He}}{M_\text{H}}}$

Here, $M_\text{He} = 4\,M_\text{H}$

$\therefore \quad \frac{\bar{v}_\text{H}}{\bar{v}_\text{He}} = \sqrt{\frac{4}{1}} = 2 \quad \text{or} \quad \bar{v}_\text{He} = \frac{1}{2}\bar{v}_\text{H}$

265 **(a)**

$C_V = \frac{f}{2}R$

For diatomic gas $f = 5$

$\therefore C_V = \frac{5}{2}R$

266 **(c)**

$\frac{E_1}{E_2} = \frac{T_1}{T_2} \Rightarrow \frac{E}{2E} = \frac{(273 + 27)}{T_2} \Rightarrow T_2 = 600K$

$= 327°\text{C}$

267 **(b)**

Here, $V_0 = 10^3$ cc

$\gamma_r = 180 \times 10^{-6}°\text{C}^{-1}$

$\text{g} = 40 \times 10^{-6}°\text{C}^{-1}$, $t = 100°\text{C}$

$\gamma_a = \gamma_r - \text{g} = (180 - 40)10^{-6}$

$V_t = V_0(1 + 140 \times 10^{-6} \times 10^2)$

$= (10^3 + 14)$cc

$\therefore$ Volume of mercury that will overflow

$= V_t - V_0 = 14\ cc$

268 **(c)**

Pressure, $P = \frac{F}{A} = \frac{1}{A}.\frac{\Delta p}{\Delta t}$ [Δp = change in momentum]

269 **(c)**

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow \frac{1 \times 500}{300} = \frac{0.5 \times V_2}{270} \Rightarrow V_2 = 900m^3$

270 **(c)**

For same isotherm; $T \rightarrow$ constant

$\therefore P \propto \frac{1}{V} \Rightarrow P_1V_1 = P_2V_2$

272 **(b)**

Given that, $T = 27°\text{C} = 300$ K

$v_\text{rms} = 1365\ \text{ms}^{-1}$

We know that

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

or $v_{rms}^2 = \frac{3RT}{M}$

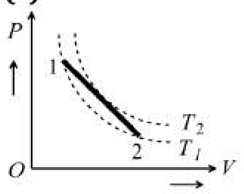
or $M = \frac{3RT}{v_{\text{rms}}^2}$

$\Rightarrow$ $M = \frac{3\times8.31\times300}{1365\times1365}$ kg

$= \frac{3\times8.31\times300}{1365\times1365} \times 1000$ g=4 g

The molecular weight of helium is 4.

273 **(c)**



Draw two isothermals one passing through points 1 and 2 the other through mid point of straight line joining 1 and 2

$T_2 > T_1$, at point 1 temperature is T_1 and that at mid point is T_2 and then at point 2 again it is T_1

∴ The gas is first heated and then cooled towards end

274 **(d)**

Pressure due to an ideal gas is given by

$$p = \frac{M}{3V} v^2$$

Putting $\frac{M}{V} = \rho$, the density of gas

$$p = \frac{1}{3} \rho v^2$$

$\Rightarrow$ $v = \sqrt{(\frac{3p}{\rho})}$

∴ $v \propto \frac{1}{\sqrt{\rho}}$

275 **(b)**

For first vessel, number of moles

$$n_1 = \frac{m_1}{M_1} = \frac{32}{32} = 1$$

Volume=V, Temperature=T

∴ $p_1 V = RT$

..(i)

For second vessel number of moles

$= n_2 = \frac{m_2}{M_2} = \frac{4}{2} = 2$

Volume=V, Temperature=$2T$

∴ $p_2 V = 2R(2T)$

...(ii)

From Eqs. (i) and (ii),

$$p_2 = 4p_1 = 4\,p$$

276 **(b)**

RMS speed of gas molecules does not depends on the pressure of gas (if temperature remains constant) because $p \propto \rho$. If pressure is increased n times density will also increase by n times but v_{rms} remains constant.

277 **(d)**

$P = \frac{2}{3} \times$ (Energy per unit volume) $= \frac{2}{3}\frac{E}{V} \Rightarrow PV = \frac{2}{3} E$

278 **(b)**

$C_P - C_V = R =$ Universal gas constant

279 **(d)**

$$V_{rms} = \sqrt{\frac{3RT}{M}}$$

% increase in $V_{rms} = \frac{\sqrt{\frac{3RT_2}{M}} - \sqrt{\frac{3RT_1}{M}}}{\sqrt{\frac{3RT_1}{M}}} \times 100\%$

$= \frac{20 - 17.32}{17.32} \times 100 = 15.5\%$

280 **(d)**

Using $\gamma_r = \gamma_a + g$, we get

$\gamma_r = \gamma_1 + 3\alpha = \gamma_2 + 3\beta$

$\therefore\ \beta = \frac{\gamma_1 - \gamma_2}{3} + \alpha$

281 **(a)**

As the steel tape is calibrated at 10°C, therefore, adjacent centimeter marks on the steel tape will be separated by a distance of

$l_t = l_{10}(1 + \alpha_s \Delta T) = (1 + \alpha_s 20)$ cm

Length of copper rod at 30°C

$= 90(1 + \alpha_c 20)$cm

Therefore, number of centimeters read on the tape will be

$= \frac{90(1+\alpha_c 20)}{1(1+\alpha_s 20)} = \frac{90(1+1.7\times10^{-5}\times20)}{1(1+1.2\times10^{-5}\times20)}$

$= \frac{90\times1.00034}{1.00024} = 90.01$ cm

282 **(c)**

At absolute temperature $T = 0 \Rightarrow v_{rms} = \sqrt{\frac{3RT}{M}} = 0$

Therefore, there is no motion of gas molecules at this temperature

283 **(b)**

Average kinetic energy ∝ Temperature

284 **(c)**

A diatomic molecule has three translational and two rotational degrees of freedom

Hence total degrees of freedom $f = 3 + 2 = 5$

285 **(c)**

$\gamma = 1 + \frac{2}{f} \Rightarrow 1.4 = 1 + \frac{2}{f} \Rightarrow$ Degree of freedom $f = 5$

$\Rightarrow$ Degree of freedom of diatomic gas is 5 and it's $C_P = \frac{7}{2}R$ and $C_V = \frac{5}{2}R$

287 **(a)**

Apparent weight (w_a)= Actual weight (w) – upthrust (F), where upthrust = weight of water displaced $= V\,p\omega\,g$

Now, $F_0 = V_0\,\rho_0\,g$ and $F_{50} = V_{50}\,\rho_{50}g$

$\therefore \frac{F_{50}}{F_0} = \frac{V_{50}\,\rho_{50}\,g}{V_0\,\rho_0\,g} = \frac{1+\gamma_m \times 50}{1+\gamma_w \times 50}$

As $\gamma_m < \gamma_w$, therefore, $F_{50} < F_0$

Hence , $(w_a)_{50}\ (w_a)_0$ or $w_2 > w_1$ or $w_1 < w_2$

288 **(c)**

For intermolecular attraction is considered in real gas and for real gases pressure is given by $P = \frac{nRT}{V-nb} - \frac{n^2a}{V^2}$. Here $\left(\frac{n}{V}\right)^2$ represents the reduction in pressure due to intermolecular attraction

289 **(a)**

$PV = \mu RT \Rightarrow P \propto \frac{T}{V}$. If T and V both doubled then pressure remains same, $i.e.$, $P_2 = P_1 = 1\,atm = 1 \times 10^5 N/m^2$

290 **(a)**

$V \propto T$ [as constant pressure]

291 **(d)**

$$v_{rms} = \sqrt{\frac{3kT}{m}} = v_{rms} \propto \frac{1}{\sqrt{m}}$$

292 **(d)**

Specific heat for a monoatomic gas

$$C_V = \frac{3}{2}R$$

$\therefore$ Heat $dQ = \mu C_V \Delta T$

$$dQ = \mu \times \frac{3}{2} \times R(473-273)$$

$$= 4 \times \frac{3}{2} \times R \times 200 \quad (\because \mu = 4)$$

$$\therefore \quad dQ = 4 \times 300R$$

$$= 1200R$$

293 **(b)**

Universal gas constant

$$R = C_p - C_V$$

294 **(a)**

22 g of CO_2 is half mole of CO_2 $ie, n_1 = 0.5$

16 g of O_2 is half mole of O_2 $ie, n_2 = 0.5$

$\therefore\ T = \frac{n_1T_1 + n_2T_2}{n_1+n_2}$

$= \frac{0.5\times(27+273)+0.5(37+273)}{0.5+0.5}$

$= 305$ K

$= 305-273 = 32$°C

295 **(a)**

$PV = mrT = m\left(\frac{R}{M}\right)T$

$\Rightarrow V = \left(\frac{m}{M}\right)\frac{RT}{P} = \left(\frac{2.2}{44}\right) \times \frac{8.31 \times (273+0)}{2 \times (1 \times 10^5)}$

$= 5.67 \times 10^{-4} m^3 = 0.56$ litre

296 **(c)**

If number of molecules in gas increases then number of collisions of molecules with walls of container would also increase and hence the pressure increses, $i.e.$, $P \propto N$.

$\Rightarrow \frac{P_2}{P_1} = \frac{N_2}{N_1} = \frac{2}{1} \Rightarrow P_2 = 2P_1$

297 **(a)**

Pressure of the gas will not be affected by motion of the system, hence by

$$v_{rms} = \sqrt{\frac{3P}{\rho}} \Rightarrow \bar{c}^2 = \frac{3P}{\rho} \Rightarrow P = \frac{1}{3}\rho\bar{c}^2$$

298 **(b)**

As the temperature increases, the average velocity increases. So the collisions are faster

299 **(d)**

$(\Delta Q)_P = \mu C_P \Delta T \Rightarrow 207 = 1 \times C_P \times 10$

$\Rightarrow C_P = 20.7\frac{Joule}{mol-K}$. Also $C_P - C_V = R$

$\Rightarrow C_V = C_P - R = 20.7 - 8.3 = 12.4\frac{Joule}{mole-K}$

So, $(\Delta Q)_V = \mu C_V \Delta T = 1 \times 12.4 \times 10 = 124\,J$

300 **(a)**

At sonstant pressure

$V \propto T \Rightarrow \frac{V_2}{V_1} = \frac{T_2}{T_1} \Rightarrow T_2 = \left(\frac{V_2}{V_1}\right)T_1$

$\Rightarrow T_2 = \left(\frac{3V}{V}\right) \times 273 = 819K = 546$°C

301 **(c)**

According to Boyle's law $(P_1V_1)_{\text{bottom}} = (P_2V_2)_{\text{top}}$

$(10+h) \times \frac{4}{3}\pi r_1^3 = 10 \times \frac{4}{3}\pi r_2^3$ but $r_2 = 2r_1$

$\therefore (10+h)r_1^3 = 10 \times 8r_1^3 \Rightarrow 10 + h = 80\ \therefore h = 70m$

302 **(c)**

Here temperature remain constant

So $P_1V_1 = P_2V_2 \Rightarrow 76 \times 5 = P_2 \times 35$

$\Rightarrow P_2 = \frac{76 \times 5}{35} = 10.85cm$ of Hg

303 **(b)**

For diatomic gases $\frac{C_P}{C_V} = \gamma = 1.4$

304 **(a)**

Using $\frac{C}{5} = \frac{F-32}{9}$

$$-\frac{183}{5} = \frac{F-32}{9}$$

$$F - 32 = -\frac{183 \times 9}{5} = -329.4$$

$$F = -329.4 + 32 = -297.4°$$

307 **(d)**

$n_1 C_v \Delta T_1 = n_2 C_v \Delta T_2$

$10 \times (T - 10) = 20(20 - T)$

$T - 10 = 40 - 2T$

$3T = 50 \Rightarrow T = 16.6°\text{C}$

308 **(b)**

Number of translational degrees of freedom (3) are same for all types of gases

309 **(a)**

$$\frac{T_A}{M_A} = 4\frac{T_B}{M_B} \Rightarrow \sqrt{\frac{T_A}{M_A}} = 2\sqrt{\frac{T_B}{M_B}}$$

$$\Rightarrow \sqrt{\frac{3RT_A}{M_A}} = 2\sqrt{\frac{3RT}{M_B}} \Rightarrow C_A = 2C_B \Rightarrow \frac{C_A}{C_B} = 2$$

310 **(b)**

Neon gas is monoatomic and for monoatomic gases

$$C_V = \frac{3}{2}R$$

311 **(b)**

Thermal capacity = Mass × Specific heat

Due to same material both spheres will have same specific heat.

Also mass = Volume (V) × Density (ρ)

∴ Ratio of thermal capacity

$$= \frac{m_1}{m_2} = \frac{V_1\rho}{V_2\rho} = \frac{\frac{4}{3}\pi r_1^3}{\frac{3}{4}\pi r_2^3} = \left(\frac{r_1}{r_2}\right)^3$$

$$= \left(\frac{1}{2}\right)^3 = \frac{1}{8}$$

312 **(c)**

C_p is always greater than C_V

ie, $\quad C_P > C_V$

313 **(a)**

As $\theta_2 > \theta_1 \Rightarrow \tan\theta_2 > \tan\theta_1 \Rightarrow \left(\frac{T}{P}\right)_2 > \left(\frac{T}{P}\right)_1$

Also from $PV = \mu RT; \frac{T}{P} \propto V \Rightarrow V_2 > V_1$

314 **(a)**

According to kinetic theory, molecules of a liquid are in a state of continuous random motion. They continuously collide against the walls of the container. During each collision, certain momentum is transferred to the walls of the container. So, kinetic energy of molecules increases, hence due to random motion, the temperature increase. So, random motion of molecules and not ordered motion cause rise of temperature.

315 **(d)**

From Maxwell's velocity distribution law, we infer that

$$v_{\text{rms}} > v > v_{\text{mp}}$$

ie, most probable velocity is less than the root mean square velocity.

316 **(a)**

Mayer Formula

317 **(b)**

Temperature remain constant so

$$v_{rms} \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{v_{O_2}}{v_{H_2}} = \sqrt{\frac{M_{H_2}}{M_{O_2}}} = \sqrt{\frac{1}{16}} = \frac{1}{4}$$

318 **(c)**

Mean kinetic energy of gas molecule

$$E = \frac{f}{2}kT = \frac{f}{2}k(t + 273) = \left(\frac{f}{2}k\right)t + \frac{f}{2} \times 273k;$$

Comparing it with standard equation of straight line

$y = mx + c$. We get $m = \frac{f}{2}k$ and $c = \frac{f}{2}273k$

So the graph between E and t will be straight line with positive intercept on E-axis and positive slope with t-axis

319 **(b)**

In isothermal changes, temperature remains constant

320 **(a)**

$$E = \frac{3}{2}RT \Rightarrow \frac{E'}{E} = \frac{T'}{T} = \frac{400}{300} = \frac{4}{3} = 1.33$$

321 **(c)**

When saturated vapour is compressed some of the vapour condenses but pressure does not change

322 **(d)**

10 g of ice at −10°C to ice at 0°C

$Q_1 = \text{cm}, \Delta\theta = 0.5 \times 10 \times 10 = 50$ cal

10 g of ice 0°C to water at 0°C

$Q_2 = mL = 10 \times 80 = 800$ cal

10 g of water at 0°C to water at 100°C

$Q_3 = \text{cm}, \Delta\theta = 1 \times 10 \times 100 = 1000$ cal

10 g water at 100°C to steam at 100°C

$Q_4 = mL = 10 \times 540 = 5400$ cal

Total heat required, $Q + Q_1 + Q_2 + Q_3 + Q_4$

= 50+800+1000+5400 = 7250 cal

323 **(a)**

When the piston is in equilibrium, the pressure is same on both the sides of the piston. It is given that temperature and weight of gas on the two sides of piston not change. From ideal gas equation, $pV = n\,RT$, we have $V \propto$ mass of the gas.

So, $\frac{V_1}{V_2} = \frac{m_1}{m_2}$ or $\frac{V_1}{V_2} + 1 = \frac{m_1}{m_2} + 1$

Or $\frac{V_1+V_2}{V_2} = \frac{m_1+m_2}{m_2}$

Or $\frac{V_2}{V_1+V_2} = \frac{m_2}{m_1+m_2} = \frac{2m}{m+2m} = \frac{2}{3}$

324 **(d)**

$$PV = \mu RT \Rightarrow P\left(\frac{m}{\rho}\right) = \mu RT \Rightarrow \rho \propto \frac{P}{T}$$

Since T becomes four times and P becomes twice so ρ becomes $\frac{1}{2}$ times

325 **(d)**

Kinetic energy is function of temperature

327 **(d)**

For an ideal gas keeping the temperature same throughout,

$$pV = \text{constant}$$

Hence, for a given mass, the graph between pV and V will be a straight line parallel to V-axis whatever may be the volume.

328 **(b)**

$$P = \frac{\mu RT}{V} = \frac{mRT}{MV} \quad \left(\mu = \frac{m}{M}\right)$$

So, at constant volume pressure-versus temperature graph is a straight line passing through origin with slope $\frac{mR}{MV}$. As the mass is doubled and volume is halved slope becomes four times. Therefore, pressure versus temperature graph will be shown by the line B

329 **(a)**

In free expansion of Vander waal's gas, its temperature decreases

330 **(b)**

The mean kinetic energy for gas molecules

$$E = \frac{3}{2}kT \Rightarrow E \propto T$$

So, $\frac{E_1}{E_2} = \frac{T_1}{T_2}$ ... (i)

According to question both gases are at the same temperature T.

So, $\frac{E_1}{E_2} = \frac{T}{T} = \frac{1}{1}$

$\Rightarrow$ $E_1 : E_2 = 1:1$

331 **(a)**

$$v_{rms} = \sqrt{\frac{3RT}{M}} \Rightarrow T \propto M \Rightarrow \frac{T_{He}}{T_H} = \frac{M_{He}}{M_H}$$

$$\Rightarrow \frac{(273+0)}{T_{He}} = \frac{2}{4} \Rightarrow T_{He} = 546K = 273°\text{C}$$

332 **(b)**

$P_1 = 720kPa, T_1 = 40°\text{C} = 273 + 40 = 313K$

$$P \propto mT \Rightarrow \frac{P_2}{P_1} = \frac{m_2}{m_1}\frac{T_2}{T_1} = \frac{3}{4} \times \frac{626}{313} = 1.5$$

$\Rightarrow P_2 = 1.5P_1 = 1.5 \times 720 = 1080kPa$

333 **(c)**

Since the volume of cylinder is fixed, the heat required is determined by C_V

He is a monoatomic gas.

Therefore, its molar specific heat at constant volume is

$$C_V = \frac{3}{2}R$$

$\therefore$ Heat required = no. of moles × molar specific × rise in temperature

$$= 2 \times \frac{3}{2}R \times 20 = 60R = 60 \times 8.31 = 498.6J$$

334 **(d)**

$$l = l_0\left(1 + \frac{1}{100}\right)$$

$$\therefore\ 2l^2 = 2l_0^2\left(1 + \frac{1}{100}\right)^2$$

Or $2l^2 - 2l_0^2 = 2l_0^2 \times \frac{2}{100}$

Or $\Delta S = S \times \frac{2}{100}$ or $\frac{\Delta S}{S} = \frac{2}{100} = 2\%$

335 **(d)**

$$\frac{(v_{rms})_1}{(v_{rms})_2} = \sqrt{\frac{T_1}{T_2}} \Rightarrow \frac{500}{(v_{rms})_2} = \sqrt{\frac{0+273}{819+273}}$$

$$= \sqrt{\frac{273}{1092}}$$

$$(v_{rms})_2 = 500\sqrt{\frac{1092}{273}} = 500\sqrt{4} = 1000\frac{m}{s} = 1\frac{km}{s}$$

336 **(a)**

The value of universal gas constant is approx.

$$2\frac{cal}{mole - Kelvin}$$

337 **(a)**

Let V be the volume of solid ; d be its density and m be its mass ; if g coefficient of volume expansion of liquid, then

Density at temperature t_1 is, $d_1 = \frac{d_0}{1+\gamma t_1}$

Density at temperature t_2 is, $d_2 = \frac{d_0}{1+\gamma t_2}$

According to Archimede's principle,

$f_1 V\, d_1 = m = f_2\, V d_2$

Or $\frac{d_1}{d_2} = \frac{f_2}{f_1} = \frac{d_0}{(1+\gamma t_1)} \frac{(1+\gamma t_2)}{d_0}$

Or $f_1 + f_1 \gamma t_2 = f_2 + f_2\, \gamma t_1$

$f_1 - f_2 = \gamma(f_2 t_1 - f_1 t_2)$

$$\gamma = \frac{(f_1 - f_2)}{f_2 t_1 - f_1 t_2}$$

338 **(c)**

$$\gamma_{poly} = \frac{(4 + f_{vib})}{(3 + f_{vib})}$$

f_{vib} = degree of freedom due to vibration ⇒ $\gamma_{poly} < \frac{4}{3}$

Or $\gamma_{poly} < 1.33$

Also you can remember that as the atomicity of gas increases the value of γ-decreases

339 **(a)**

For NH_3, degree of freedom $f = 6$

$$\Rightarrow \frac{C_P}{C_V} = \gamma = 1 + \frac{2}{f} = 1 + \frac{2}{6} = \frac{4}{3} = 1.33$$

340 **(d)**

From $C_V = \frac{1}{2} fR = \frac{1}{2} \times 6R = 3R$

341 **(c)**

Mean kinetic energy per molecule $E = \frac{f}{2} kT = \frac{n}{2} kT$

342 **(b)**

Mean free path $\lambda \propto \frac{1}{P}$; If λ is doubled then P becomes half

343 **(a)**

Average kinetic theory of one molecule is

$$E = \frac{3}{2} kT$$

where k is Boltzmann constant and T the absolute temperature.

Given, $T_1 = -68°\text{C} = 273 - 68 = 205$ K,

$E_1 = E, \quad E_2 = 2E$

$$\therefore \quad \frac{E_1}{E_2} = \frac{T_1}{T_2}$$

$$\Rightarrow \quad T_2 = \frac{T_1 E_2}{E_1}$$

$$\therefore \quad T_2 = \frac{205 \times 2E}{E} = 410 \text{ K}$$

344 **(c)**

$$C_V = \frac{R}{0.67} = 1.5R = \frac{3}{2} R$$

This is the value for monoatomic gases

345 **(c)**

$C_{\text{isothermal}} = \infty$ and $C_{\text{adiabatic}} = 0$

346 **(b)**

$$C_P - C_V = \frac{R}{J} \Rightarrow C_P = \frac{R}{J} + C_V = \frac{R}{J} + \frac{R}{J(\gamma - 1)}$$

$$\Rightarrow C_P = \frac{R}{J}\left(\frac{\gamma}{\gamma - 1}\right) = \frac{R}{J}\left(\frac{1.5}{1.5 - 1}\right) = \frac{3R}{J}$$

347 **(d)**

For any gas $C_P - C_V = 1.99 = 2 \frac{cal}{mol-K}$

349 **(a)**

$$\frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}} \Rightarrow \frac{v_S}{400} = \sqrt{\frac{(273 + 227)}{(273 + 27)}} = \sqrt{\frac{5}{3}}$$

$$\Rightarrow v_s = 400\sqrt{5/3} = 516 m/s$$

350 **(c)**

Using pressure or Gay-Lussac's law $\frac{P_1}{P_2} = \frac{T_1}{T_2}$

or $P_2 = \frac{P_1 T_2}{T_1} = \frac{P(273+927)}{(273+27)} = 4P$

351 **(a)**

$$\frac{C_P}{C_V} = \gamma = 1 + \frac{2}{f}$$

352 **(d)**

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow T_2 = \frac{P_2 V_2}{P_1 V_1} \times T_1$$

$$= T_2 = \frac{1}{30} \times \frac{10}{1} \times 300 = 100K = -173°\text{C}$$

353 **(a)**

$$v_{average} = \sqrt{\frac{8RT}{\pi M}} \Rightarrow v_{av} \propto \sqrt{T}$$

354 **(a)**

$\Delta p = mV - (-mV) = 2mV$

355 **(b)**

Kinetic energy for $1g \Rightarrow E_{\text{Trans}} = \frac{3}{2} rT = \frac{3}{2} \frac{RT}{M}$

356 **(b)**

$C_P - C_V = R$

At constant pressure, Heat $= nC_P\theta$

$\Rightarrow 310 = 2 \times C_P \times (35 - 25) = 20C_P$

$$\Rightarrow C_P = \frac{310}{20} = 15.5$$

At constant volume, Heat required $= nC_V\theta$

$\Rightarrow Q = 2 \times (C_P - R) \times (32 - 25)$

$= 2 \times (15.5 - 8.3) \times 10 = 2 \times 7.2 \times 10 = 144J$

357 **(b)**

The collision of molecules of ideal gas is elastic collision

358 **(c)**

Mean kinetic energy of molecule depends upon temperature only. For O_2 it is same as that of H_2 at the same temperature of $-73°C$

359 **(a)**

When C_P and C_V are given with *calorie* and R with *Joule* then $C_P - C_V = R/J$

360 **(c)**

$$C_V = \frac{n_1 C_{v_1} + n_2 C_{V_2}}{n_1 + n_2}$$

$$= \frac{1 \times \frac{3}{2}R + 1 \times \frac{5}{2}R}{1+1} = 2R$$

361 **(b)**

Molar specific heat of the mixture at constant volume is

$$C_V = \frac{n_1 C_{V_1} + n_2 C_{V_2}}{(n_1 + n_2)}$$

$$= \frac{2\left(\frac{3}{2}R\right) + 3\left(\frac{5}{2}R\right)}{2+3} = 2.1\ R$$

363 **(d)**

$$v_{rms} = \sqrt{\frac{3P}{\rho}} \Rightarrow P = \frac{v_{rms}^2 \rho}{3}$$

$$= \frac{(3180)^2 \times 8.99 \times 10^{-2}}{3}$$

$$= 3.03 \times 10^5 N/m^2 = 3\ atm$$

364 **(c)**

Kinetic energy of ideal gas depends only on its temperature. Hence, it remains constant whether its pressure is increased or decreased.

365 **(a)**

$$V \propto T \Rightarrow \frac{V_1}{V_2} = \frac{T_1}{T_2} \Rightarrow \frac{200}{V_2} = \frac{(273+20)}{(273-20)} = \frac{293}{253}$$

$$\Rightarrow V_2 = \frac{200 \times 253}{293} = 172.6 ml$$

366 **(b)**

$$PV = \mu RT = \frac{m}{M} RT \Rightarrow \frac{m}{VP} \Rightarrow \frac{\text{density}}{P} = \frac{M}{RT}$$

$$\left(\frac{\text{density}}{P}\right)_{At\ 0°C} = \frac{M}{R(273)} = x \quad ...(i)$$

$$\left(\frac{\text{density}}{P}\right)_{At\ 100°C} = \frac{M}{R(373)} \quad ...(ii)$$

$$\Rightarrow \left(\frac{\text{density}}{P}\right)_{At\ 100°C} = \frac{273x}{373}$$

367 **(c)**

Here, $\Delta l = 80.3 - 80.0 = 0.3$ cm

$l = 80$ cm, $\alpha = 12 \times 10^{-6}°C^{-1}$

Rise in temperature $\Delta T = \frac{\Delta l}{l\alpha}$

$$\Delta T = \frac{0.3}{80 \times 12 \times 10^{-6}} = 312.5°C$$

369 **(a)**

$$\left(P + \frac{aT^2}{V}\right)V^c = (RT + b) \Rightarrow P$$

$$= (RT+b)V^{-c} - (aT^2)V^{-1}$$

Comparing this equation with $P = AV^m - BV^n$

We get $m = -c$ and $n = -1$

370 **(d)**

$$\Delta Q = KA\left(\frac{\Delta T}{\Delta x}\right)\Delta t, \qquad \text{where } A = 4\pi r^2$$

$$= 0.008 \times 4 \times \frac{22}{7}(6 \times 10^8)^2 \times \left(\frac{32}{10^5}\right) \times 86400$$

$= 10^{18}$ cal

371 **(c)**

$$v_{rms} \propto \sqrt{T} \Rightarrow \frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}} = \sqrt{\frac{200}{800}} = \frac{1}{2} \Rightarrow v_2 = 2v_1$$

372 **(c)**

$$p = \frac{n_1 RT + n_2 RT + n_3 RT}{V}$$

$$= (n_1 + n_2 + n_3)\frac{RT}{V}$$

$$= \left(\frac{8}{16} + \frac{14}{28} + \frac{22}{44}\right) \times \frac{0.082 \times 300}{10} = 3.69 \text{ atm}$$

373 **(c)**

As number of moles increases, pressure increases and at certain pressure vapour condenses hence pressure now decreases

374 **(d)**

Root mean square velocity

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

where R is gas constant, T the temperature and M molecular weight.

Given, $M_{N_2} = 28$, $M_{O_2} = 32$, $T_{O_2} = 127°C = 127 + 273 = 400$ K

$$\therefore \quad \frac{v_{O_2}}{v_{N_2}} = \sqrt{\frac{T_{O_2}}{M_{O_2}} \times \frac{M_{N_2}}{T_{N_2}}} = \sqrt{\frac{400}{32} \times \frac{28}{T_{N_2}}} = 1$$

$$\Rightarrow \quad T_{N_2} = 350 \text{ K} = 77°C.$$

375 **(b)**

Temperature becomes $\frac{1}{4}th$ of initial value

$[1200K = 927°C \rightarrow 300K = 27°C]$

So, using $v_{rms} \propto \sqrt{T}$. $r.m.s.$ velocity will be half of the initial value

376 **(d)**

$$v_{rms} \propto \frac{1}{\sqrt{M}}; \text{so } \frac{(v_{rms})_{O_2}}{(v_{rms})_{H_2}} = \sqrt{\frac{M_{H_2}}{M_{O_2}}} = \sqrt{\frac{2}{32}} = 1:4$$

377 **(b)**

Number of moles $n = 5$ mol, $T_1 = 100°C$,
$T_2 = 120°C$, $\Delta U = 80$ J

Rise in temperature $\Delta t = 120 - 100 = 20°C$

$$\Delta U = ms\Delta t$$

$$\frac{80}{5} = 1 \times s \times 20$$

$$s = 0.8 \text{ J}$$

$\therefore$ For 5 mol, $s = 0.8 \times 5 \text{ JK}^{-1} = 4 \text{ JK}^{-1}$

378 **(a)**

Ratio of specific heat for a monoatomic gas is $\frac{5}{3}$ and for diatomic gas is $\frac{7}{5}$.

Given, $n_1 = 1, n_2 = 3, n = 4$

$\therefore$ $$\frac{n}{\gamma - 1} = \frac{n_1}{\gamma_1 - 1} + \frac{n_2}{\gamma_2 - 1}$$

$$\frac{4}{\gamma-1} = \frac{1}{\frac{5}{3}-1} + \frac{3}{\frac{7}{5}-1}$$

$\Rightarrow$ $$\frac{4}{\gamma-1} = \frac{3}{2} + \frac{15}{2} = 9$$

$\therefore$ $4 = 9\gamma - 9$

$\Rightarrow$ $9\gamma = 13 \quad \Rightarrow \gamma = \frac{13}{9}$

Now, $C_V(\gamma - 1) = R$

or $$C_V = \frac{R}{\gamma-1} = \frac{8.3}{\frac{13}{9}-1} = \frac{8.3\times9}{4}$$

$\Rightarrow$ $C_V = 18.7 \text{ J mol}^{-1} - \text{K}^{-1}$

379 **(b)**

Using the relation $p = \frac{1}{3}\frac{mnv^2}{V}$

...(i)

and also $p' = \frac{1}{3}\frac{\frac{m}{2}n(2v)^2}{V}$

...(ii)

Dividing Eq.(ii) by Eq. (i), we get

$$\frac{p'}{p} = 2$$

So, $p : p' = 1 : 2$

The ratio of initial and final pressures is 1: 2.

380 **(c)**

Molar specific heat at constant pressure $C_P = \frac{7}{2}R$

Since, $C_P - C_V = R \Rightarrow C_V = C_P - R = \frac{7}{2}R - R = \frac{5}{2}R$

$$\therefore \frac{C_P}{C_V} = \frac{(7/2)R}{(5/2)R} = \frac{7}{5}$$

381 **(d)**

According to the equilibrium theorem, the molar heat capacities should be independent of temperature. However, variations in C_V and C_P are observed as the temperature changes. At very high temperatures, vibrations are also important and that affects the values of C_V and C_P for diatomic and polyatomic gases. Here in this question according to given information (d) may be correct answer

382 **(d)**

We know $v_s = \sqrt{\frac{\gamma P}{\rho}}$ and $v_{rms} = \sqrt{\frac{3P}{\rho}}$

$$\therefore \frac{v_{rms}}{v_s} = \sqrt{\frac{\gamma}{3}}$$

383 **(a)**

For 1 g gas $PV = rT = \left(\frac{R}{M}\right)T$

Since P and V are constant $\Rightarrow T \propto M \Rightarrow \frac{T_{N_2}}{T_{O_2}} = \frac{M_{N_2}}{M_{O_2}}$

$$\Rightarrow \frac{T_{N_2}}{(273 + 15)} = \frac{28}{32} \Rightarrow T_{N_2} = 252K = -21°C$$

384 **(a)**

$$(\Delta Q)_V = C_V\Delta T = \frac{f}{2}R\Delta T$$

$$\Rightarrow \Delta T \propto \frac{1}{f}$$

Also $f_{Mono} < f_{Dia} \Rightarrow (\Delta T)_{Mono} > (\Delta T)_{Dia}$

385 **(b)**

$$v_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{3}\sqrt{\frac{RT}{M}} = 1.73\sqrt{\frac{RT}{M}}$$

386 **(d)**

$$PV = kT \Rightarrow P\left(\frac{m}{\rho}\right) = kT \Rightarrow \rho = \frac{Pm}{kT}$$

387 **(c)**

Below 100 K only translational degree of freedom is considered. Hence

$\gamma_{mixture} = \dfrac{\frac{\mu_1\gamma_1}{\gamma_1-1} + \frac{\mu_2\gamma_2}{\gamma_2-1}}{\frac{\mu_1}{\gamma_1-1} + \frac{\mu_2}{\gamma_2-1}}$ according to question, $\mu_1 = \mu_2$ and $\gamma_1 = \gamma_2 = 1 + \frac{2}{3} = \frac{5}{3}$

$$\Rightarrow \gamma_{mix} = \gamma_1 = \frac{5}{3}$$

KINETIC THEORY

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: For higher temperatures, the peak emission wavelength of a black body shifts to lower wavelengths.

Statement 2: Peak emission wavelength of a black body is proportional to the fourth power of temperature.

2

Statement 1: Specific heat of a gas at constant pressure (C_P) is greater than its specific heat at constant volume (C_V)

Statement 2: At constant pressure, some heat is spent in expansion of the gas

3

Statement 1: If a gas container in motion is suddenly siopped, the temperature of the gas tises

Statement 2: The kinetic energy of ordered mechanical motion is converted in to the kinetic energy of random motion of gas molecules

4

Statement 1: Mean free path of a gas molecules varies inversely as density of the gas

Statement 2: Mean free path varies inversely as pressure of the gas

5

Statement 1: The root mean square and most probable speeds of the molecules in gas are the same.

Statement 2: The Maxwell distribution for the speed of molecules in a gas is symmetrical.

6

Statement 1: Internal energy of an ideal gas does not depend upon volume of the gas

Statement 2: Internal energy of ideal gas depends on temperature of gas

7

Statement 1: Two bodies at different temperature, if brought in thermal contact do not necessary settle to the mean temperature.

Statement 2: The two bodies may have different thermal capacities.

8

Statement 1: For an ideal gas, at constant temperature, the product of the pressure and volume is constant

Statement 2: The mean square velocity of the molecules is inversely proportional to mass

9

Statement 1: When temperature of a black body is halved, wavelength corresponding to which energy radiated is maximum becomes twice.

Statement 2: This is as per Wien's law.

10

Statement 1: Equal masses of helium and oxygen gases are given equal quantities of heat. There will be a greater rise in the temperature of helium compared to that of oxygen

Statement 2: The molecular weight of oxygen is more than the molecular weight of helium

11

Statement 1: Air pressure in a car tyre increases during driving

Statement 2: Absolute zero temperature is not zero energy temperature

12

Statement 1: When temperature difference across the two sides of a wall is increased, its thermal conductivity increases.

Statement 2: Thermal conductivity depends on nature of material of the wall.

13

Statement 1: Cooking in a pressure cooker is faster.

Statement 2: Because steam does not leak out.

14

Statement 1: The root mean speed (rms) of oxygen molecules at a certain absolute temperature T is$c$. If the temperature is doubled and oxygen gas dissociates into atomic oxygen, the rms speed would be $2c$.

Statement 2: $c \propto \sqrt{\frac{T}{M}}$

15

Statement 1: When speed of sound in gas is c then $C_{rms} = \sqrt{\frac{3}{\gamma}} \times c$

Statement 2: $C = \sqrt{\frac{\gamma P}{p}}$

16

Statement 1: The number of degrees of freedom of triatomic molecules is 6.

Statement 2: Triatomic molecules have three translational degrees of freedom and three rotational degrees of freedom.

17

Statement 1: The ratio of specific heat gas at constant pressure and specific heat at constant volume for a diatomic gas is more than that for a monoatomic gas

Statement 2: The molecules of a monoatomic gas have more degree of freedom than those of a diatomic gas

18

Statement 1: A gas has a unique value of specific heat

Statement 2: Specific heat is defined as the amount of heat required to raise the temperature of unit mass of the substance through unit degree

19

Statement 1: The number of molecules in 1 cc. of water is nearly equal to $1/\,3 \times 10^{22}$.

Statement 2: The number of molecules per gm mole of water is equal to Avogadro's number ($= 6.023 \times 10^{23}\ g^{-1}\ mol^{-1}$)

20

Statement 1: When speed of sound in a gas is c, $c_{rms} = \sqrt{\frac{3}{\gamma} \times c}$

Statement 2: $c = \sqrt{\frac{\gamma p}{\rho}}$

21

Statement 1: The SI unit of Stefan's constant is $Wm^{-2}\ K^{-4}$.

Statement 2: This follows from Stefan's law, $E = \alpha T^4 \therefore \alpha = \frac{E}{T^4} = \frac{Wm^{-2}}{K^4}$

22

Statement 1: The internal energy of a real gas is function of both, temperature and volume

Statement 2: Internal kinetic energy depends on temperature and internal potential energy depends on volume

23

Statement 1: Maxwell speed distribution graph is symmetric about most probable speed

Statement 2: rms speed ideal gas, depends upon it's type (monoatomic, diatomic and polyatomic)

24

Statement 1: The rms velocity of gas molecules is doubled when temperature of gas becomes four times.

Statement 2: $C \propto \sqrt{T}$

25

Statement 1: In pressure-temperature $(P - T)$ phase diagram of water, the slope of the melting curve is found to be negative

Statement 2: Ice contracts on melting to water

26

Statement 1: For monoatomic gas atom the number of degrees of freedom is 3.

Statement 2: $\frac{C_p}{C_v}=\gamma=\frac{5}{3}$

27

Statement 1: The rate of loss of heat of a body at 300 K is$R$. At 900 K, the rate of loss becomes 81 R

Statement 2: This is as per Newton's Law of cooling.

28

Statement 1: Absolute zero is the temperature corresponding to zero energy

Statement 2: The temperature at which no molecular motion cease is called absolute zero temperature

29

Statement 1: The total translational kinetic energy of all the molecules of a given mass of an ideal gas is 1.5 times the product of its pressure and its volume

Statement 2: The molecules of a gas collide with each other and the velocities of the molecules change due to the collision

30

Statement 1: When small temperature difference between a liquid and its surrounding is doubled, the rate of loss of heat of the liquid becomes twice.

Statement 2: This is as per Newton's law of cooling.

31

Statement 1: A gas can be liquified at any temperature by increase of pressure alone

Statement 2: On increasing pressure the temperature of gas decreases

KINETIC THEORY

: ANSWER KEY :

1)	c	2)	a	3)	a	4)	a	17)	d	18)	d	19)	a	20)	b
5)	d	6)	b	7)	a	8)	b	21)	a	22)	a	23)	d	24)	a
9)	a	10)	b	11)	b	12)	d	25)	a	26)	b	27)	c	28)	d
13)	c	14)	a	15)	b	16)	a	29)	b	30)	a	31)	d		

KINETIC THEORY

: HINTS AND SOLUTIONS :

1 **(c)**

$\lambda_m \propto \frac{1}{T}$ as per Wien's displacement law. Assertion is true, but the Reason is false.

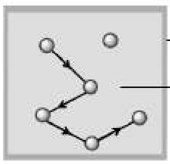
2 **(a)**

C_V is used in increasing the internal energy of the gas while C_P is used in two waqys (i) to change the internal energy and (ii) to do expansion of gas. Hence $C_P > C_V$

3 **(a)**

The motion of the container is known as the ordered motion of the gas and zigzag motion of gas molecules within the container is called disordered motion.

When the container suddenly stops, ordered kinetic energy gets converted into disordered kinetic energy which in turn increases the temperature of the gas



4 **(a)**

The mean free path of a gas molecule is the average distance between two successive collisions. It is represented by λ.

$\lambda = \frac{1}{\sqrt{2}}\frac{kT}{\pi\sigma^2 P}$ and $\lambda = \frac{m}{\sqrt{2}.\pi\sigma^2 d}$

Here, $\sigma = 0$ diameter of molecule and $k =$ Boltzmann's constant

$\Rightarrow \lambda \propto 1/d, \lambda \propto T$ and $\lambda \propto 1/P$

Hence, mean free path varies inversely as density of the gas.

It can be eaaily proved that the mean free path varies directly as the temperature and inversely as the pressure of the gas

5 **(d)**

Root mean square speed of

Or $V_{rms} = \sqrt{\frac{3RT}{M}}$

While most probable speed is

$V_{mp} = \sqrt{\frac{2RT}{M}}$

It is obvious that $V_{rms} > V_{mp}$

Also Maxwell distribution for the speed of molecules in a gas is asymmetrical.

6 **(b)**

Internal energy of an ideal gas does not depend upon volume of the gas, because there are no forces of attraction/repulsion amongst the molecules of an ideal gas.

Also internal energy of ideal gas depends on temperature

7 **(a)**

When two bodies at temperature T_1 and T_2 are brought in thermal contact, they do settle to the mean temperature$\left(\frac{T_1+T_2}{2}\right)$. They will do so, in case the two bodies were of same mass and material *ie*, same thermal capacities. In other words, the two bodies may be having different thermal capacities that's why they do not settle to the mean temperature, when brought together.

8 **(b)**

For an ideal gas $PV =$ constant (at constant temperature) and $\overline{v^2} = v_{rms}^2 = \frac{3kT}{m} \Rightarrow \overline{v^2} \propto \frac{1}{m}$

9 **(a)**

According to Wien's law, $\lambda_m \propto \frac{1}{T}$ when T is halved, λ_m becomes twice. Both, the Assertion and Reason are true and the latter is correct explanation of the former.

10 **(b)**

Helium is a monoatomic gas, while oxygen is diatomic. Therefore, the heat given to helium will be totally used up in increasing the translational kinetic energy of its molecules; whereas the heat given to oxygen will be used up in increasing the translational kinetic energy of the molecule and also in increasing the kinetic energy of rotation and vibration. Hence there will be a greater rise in the temperature of helium

11 **(b)**

When a person is driving a car then the temperature of air inside the tyre is increased because of motion. Form the Gay Lussac's law, $P \propto T$
Hence, when temperature increases the pressure also increase

12 **(d)**

Thermal conductivity of the wall depends only on nature of material of the wall; and not on temperature difference across its two sides. Assertion is false, but Reason is true.

13 **(c)**

On increasing pressure, boiling point of water increases. Therefore, cooking is faster. Assertion is true, Reason is false.

14 **(a)**

$c_{\text{rms}} \propto \sqrt{\frac{T}{M}}$; When T is doubled and M has become half, the, c_{rms} will become two times.

15 **(b)**

Both relation are correct but reason is not the correct explain for Assertion.

16 **(a)**

A non-linear molecule can rotate about any of three co-ordinate axes. Hence, it has 6 degrees of freedom: 3 translational and 3 rotational.

17 **(d)**

For a monoatomic gas, number of degrees of freedom, $f = 3$, and for a diatomic gas $f = 5$
As, $\frac{C_P}{C_V} = \gamma = 1 + \frac{2}{f}$,
$\left(\frac{C_P}{C_V}\right)_{mono} = 1 + \frac{2}{3} = \frac{5}{3}$ and $\left(\frac{C_P}{C_V}\right)_{di} = 1 + \frac{2}{5} = \frac{7}{5}$
$\Rightarrow \left(\frac{C_P}{C_V}\right)_{mono} > \left(\frac{C_P}{C_V}\right)_{di}$

18 **(d)**

This is because a gas can be heated under different conditions of pressure and volume. The amount of heat required to raise the temperature of unit mass through unit degree is different under different conditions of heating

19 **(a)**

Density of water = 1 g/cc

$\therefore$ Mass of 1 cc of water = volume × density

$= 1 \times 1 = 1$ g of water

In 1 g mole (or 18 g) of water, the total number of molecules

$= 6.023 \times 10^{23}$

$\therefore$ Number of molecules of water in 1 g

$= \frac{6.023 \times 10^{23}}{18} = \frac{1}{3} \times 10^{23}$

Thus, Assertion and Reason are true.

20 **(b)**

We know, $c_{\text{rms}} = \sqrt{\frac{3p}{\rho}}$ and $c = \sqrt{\frac{\gamma p}{\rho}}$

Dividing, we get $\frac{c_{\text{rms}}}{c} = \sqrt{\frac{3}{\gamma}}$

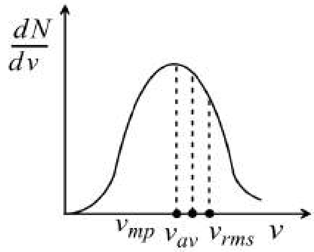
21 **(a)**

Both the Assertion and Reason are true and Reason is correct explanation of Assertion.

22 **(a)**

In real gas, intermolecular force exist. Work has to be done in changing the distance between the molecules. Therefore, internal energy of real gas is sum of internal kinetic and internal potential energy which are function of temperature and volume respectively. Also change in internal energy of a system depends only on initial and final states of the system

23 **(d)**



Maxwell speed distribution graph is asymmetric graph, because it has a long "tail" that extends to infinity.
Also v_{rms} depends upon nature of gas and it's temperature

24 **(a)**

The rms velocity of gas molecules is given by

$$V_{rms} = c = \sqrt{\frac{3KT}{m}}$$

So, $c \propto \sqrt{T}$

Hence, it is clear that when temperature becomes four times then rms velocity will be two times.

25 **(a)**

The negative slope is because of change of phase. This happens to liquids which contract on melting

26 **(b)**

Using the relation

$$y = 1 + \sqrt{\frac{2}{\mathcal{F}}}$$

($\mathcal{F} = the$ number of degrees of freedom for gas atom) For mono0atomic gas, $\mathcal{F} = 3$

Hence, $y_m = 1 + \frac{2}{3} = \frac{5}{3}$

27 **(c)**

Stefan's law applies here and not the Newton's law of cooling

According to Stefan's law,

$$\frac{E_2}{E_1} = \left(\frac{T_2}{T_1}\right)^4 = \left(\frac{900}{300}\right)^4 = 81$$

$$\frac{E_2}{R} = 81$$

$$\therefore\ E_2 = 81\ R$$

Assertion is true, Reason is false.

28 **(d)**

Only the energy of translatory motion of molecules is represented by temperature. Others forms of energy such as intermolecular potential energy, energy of molecular relation, *etc.* are not represented by temperature. Hence at absolute zero, the translatory motion of molecules ceases but other forms of molecular energy do not become zero. Therefore absolute zero temperature is not the temperature of zero-enerfy. At absolute zero molecular motion ceases

29 **(b)**

Total translational kinetic energy $= \frac{3}{2}nRT = \frac{3}{2}PV$
In an ideal gas all molecules moving randomly in all direction collide and their velocity changes after collision

30 **(a)**

According to Newton's law of cooling

$$\frac{dQ}{dt} \propto (\theta - \theta_0)$$

Both, the Assertion and Reason are true and latter is correct explanation of the former.

31 **(d)**

A vapour above the critical temperature is a gas and gas below the critical temperature for the substance is a vapour. As gas cannot be liquified by the application of pressure alone, how so ever large the pressure may be while vapour can be liquified under pressure alone. To liquify a gas it must be cooled upto or below its critical temperature