MID-TERM EXAMINATION (2023-24)
CLASS : XII
SUBJECT: PHYSICS (042)

समय : 3 घंटे **अधिकतम अंक - 70**

Time Allowed : 3 hours **Maximum Marks : 70**

सामान्य निर्देश:

1. इस प्रश्न पत्र में कुल 33 प्रश्न हैं। सभी प्रश्न अनिवार्य हैं।
2. प्रश्न प्रश्न पत्र में पांच खंड हैं। खंड-क, खंड-ख, खंड-ग, खंड-घ एवं खंड ङ।
3. खंड क में प्रश्न संख्या 1 से 16 तक बहुविकल्पीय प्रकार के एक-एक अंक के प्रश्न हैं।
4. खंड ख में प्रश्न संख्या 17 से 22 तक अतिलघु उत्तरीय प्रकार के दो-दो अंकों के प्रश्न हैं।
5. खंड ग में प्रश्न संख्या 23 से 28 तक अतिलघु उत्तरीय प्रकार के तीन-तीन अंकों के प्रश्न हैं।
6. खंड घ में प्रश्न संख्या 29 तथा 30 तक केस आधारित चार-चार अंकों के प्रश्न हैं।
7. खंड ङ में प्रश्न संख्या 31 तथा 33 तक दीर्घउत्तरीय प्रकार के पाँच-पाँच अंकों के प्रश्न हैं।
8. प्रश्न पत्र में कोई समग्र विकल्प नहीं है। यद्यपि खंड ख के एक प्रश्न में खंड ग में दो प्रश्नों में, खंड घ के दो प्रश्नों में और खंड ङ के तीनों प्रश्नों में आंतरिक विकल्प का प्रावधान दिया गया है।
9. कैलकूलेटर का प्रयोग वर्जित है।

GENERAL INSTRUCTIONS:

1. This question paper contains 33 questions in all. All questions are compulsory.
2. This question paper is divided into five sections - Section A, Section B, Section C, Section D and Section E.
3. In Section A question number 1 to 16 are MCQ type questions carrying 1 mark each.
4. In Section B question number 17 to 21 are SA-1 type questions carrying 2 marks each.
5. In Section C question number 22 to 28 are SA-2 type questions carrying 3 marks each.
6. In Section D question number 29 to 30 are case based questions carrying 4 marks each.
7. In Section E question number 31 to 33 are long answer type questions carrying 5 marks each.
8. There is no over all choice. However an internal choice has been given in one question in Section B, two questions in Section C, one question in each CBQ in Section D and all three questions in Section E.
9. Use of calculator is NOT permitted.

$c = 3 \times 10^8$ m/s

$e = 1.6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ Tm A^{-1}

$\epsilon_0 = 8.85 \times 10^{-12}$ C^2 N^{-1} m^{-2}

SECTION-A

1. Which of the following material is diamagnetic : (1)

(A) Iron (B) Aluminium

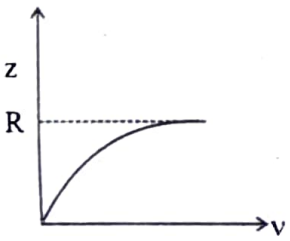
(C) Copper (D) AlNiCo

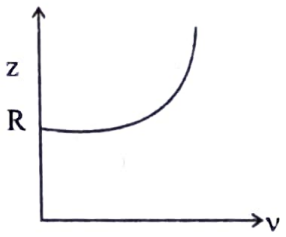
2. WbA^{-1}, is a unit of : (1)

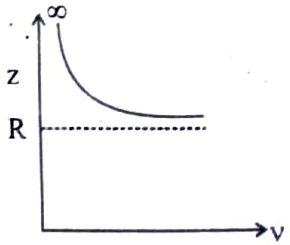
(A) Self inductance (B) Mutual inductance

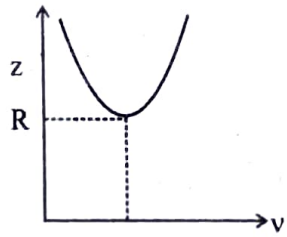
(C) Magnetic field (D) Both (A) and (B)

3. Which of the following graph shows correctly the variation in impedance of a CR circuit with frequency of source. (1)

(A) 

(B) 

(C) 

(D) 

4. The electro-magnetic waves are produced by : (1)

(A) Static charge (B) Charge moving with uniform speed

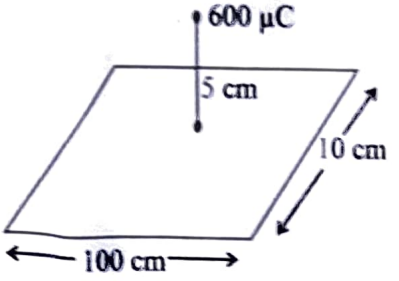
(C) Both (A) and (B) (D) Neither (A) nor (B)

5. Which of the following represent dependence of the electric field due to an electric dipole with distance, correctly : (1)

(A) $E \alpha r^{-2}$ (B) $E \alpha r^{-3}$

(C) $E \alpha r^{-3/2}$ (D) $E \alpha r^{-4}$

6. A point charge + 600 μC is at a distance 5 cm directly above the centre of a square of side 10 cm as shown in figure. The magnitude of electric flux through the sparse is : (ϵ_0 is permittingly of free space) (1)



(A) $\frac{1}{10^4 \epsilon_0}$ (B) $\frac{10^4}{\epsilon_0}$

(C) $6 \times \frac{10^4}{\epsilon_0}$ (D) $\frac{1}{60} \times \frac{10^4}{\epsilon_0}$

7. A system has two charge $q_A = 2.5 \times 10^{-7} C$ and $q_B = -2.5 \times 10^{-7} C$ located at points A : (–15,0,0) cm and B : (15,0,0) cm respectively The electric dipole moment of the system is : (1)

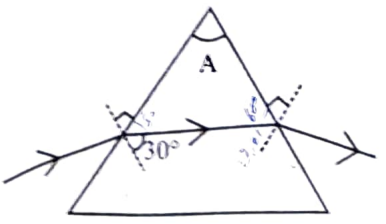
(A) 7.5×10^{-8} cm along negative x-axis

(B) 7.5×10^{-8} cm along positive x-axis

(C) 3.75×10^{-8} cm along negative x-axis

(D) 3.75×10^{-8} cm along positive x-axis

8. A monochromatic ray of light is passing through a prism such that refracted ray inside the prism is parallel to the base of the prism, as shown in figure. The refracting angle A of the prism is : (1)



(A) 30° (B) 45°

(C) 60° (D) 90°

9. The polarization $\vec{P}$ of a dielectric in the presence of an external electric field $\vec{E}$ is given by : (1)

(A) $\vec{P} = \chi_e^2 \vec{E}$ (B) $\vec{P} = \vec{E}/\chi_e^2$

(C) $\vec{P} = \vec{E}/\chi_e$ (D) $\vec{P} = \chi_e \vec{E}$

10. The average velocity of electrons in a conductor, when no external electric field is applied, is given by : (1)

(A) $\frac{e\tau m}{E}$ (B) Zero

(C) I/mA (D) $\frac{eE\tau}{m}$

Where symbols used have their usual meanings.

11. An object is placed at (i) 15 cm, (ii) 5 cm in front of a concave mirror of focal length 10 cm. The ratio of the magnification produced by mirror at these two positions is : (1)

(A) 3 : 1 (B) 1 : 1

(C) 1 : 3 (D) 3 : 2

12. A plane electromagnetic wave of frequency 25 MHz travels in free space along the x-direction. At a particular time and point electric fields $\vec{E} = 6.3\hat{j} Vm^{-1}$. The magnetic field at this point is : (1)

(A) $2.1 \times 10^{-8} T\hat{i}$ (B) $18.9 \times 10^{8} T\hat{i}$

(C) $2.1 \times 10^{-8} T\hat{k}$ (D) $18.9 \times 10^{8} T\hat{k}$

Note : In question number 13 to 16, two statements are given, one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the code (A), (B), (C) and (D) as given below:

(A) Both Assertion (A) and Reason (R) are true and (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true and (R) is the not correct explanation of Assertion (A).

(C) Assertion (A) is true and Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

13. Assertion (A) : An optical fibre can be used as a light pipe. (1)

Reason (R) : Optical fibre is based on total internal reflection of light.

14. Assertion (A) : The material used for spring in a moving coil galvanometer has low torosional constant. (1)

Reason (R) : Phosphor Bronze has low torosional constant.

15. Assertion (A) : The paths of electrons are straight lines between two successive collision in the presence of electric field. (1)

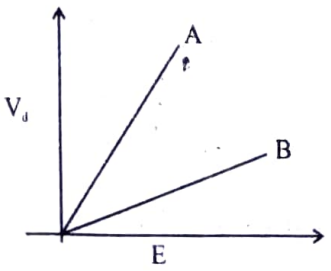
Reason (R) : The paths of electrons, inside the conductor are independent of any force.

16. Assertion (A) : Optical and radiotelescopes are built on the ground but X-ray astronomy is possible only from satellite orbiting the earth. (1)

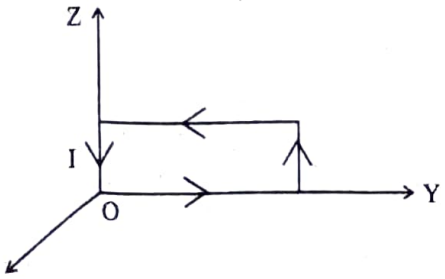
Reason (R) : Light travels along straight line.

SECTION-B

17. Define the term 'mobility'. Write its SI unit. Following graph shows variation in drift velocity with applied electric field for two different charge carriers A and B. Which one has greater mobility? Justify your answer. (2)

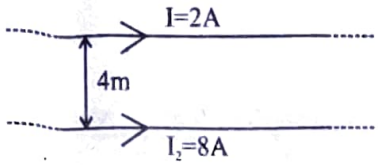


18. A uniform magnetic field of 3000 G is established along the positive z-direction. A rectangular loop of sides 10 cm and 5 cm carrying a current of 12 A is placed in this field. Calculate the torque on the loop, shown in the figure given below: (2)



OR

Figure shows two infinitely long, straight, parallel current carrying conductors. Find the fore on one unit length of each conductor.



19. Obtain the resonating frequency W_r of a series LCR circuit with L = 2.0 H, C = 32 μF and R = 10Ω. What is the power factor of the circuit at resonance? (2)

20. Why does a paramagnetic sample display greater magnetization (for the same magnetizing field) when cooled. Explain. How does magnetization of a diamagnetic sample affected when heated? (2)

21. Two concentric circular coils, one of small radius 'r_1' and the other of large radius 'r_2' ($r_1 <<< r_2$) are placed co-axially with centres coinciding. Obtain the mutual inductance of the arrangement. (2)

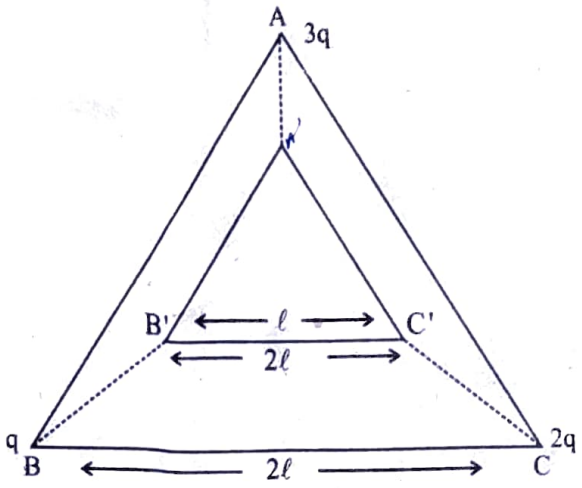
SECTION-C

22. Define magnetic dipole moment of a bar magnet. A bar magnet of magnetic moment 1.5 JT^{-1} lies aligned with direction of a uniform magnetic field of 0.22 T what is the amount of work done by an external torque to turn the bar magnet, so as to align its magnetic moment normal to the field direction. (3)

23. An electric dipole is placed in a uniform electric field. Show that it does not undergo any translational motion. Obtain an expression for the torque acting on the dipole. (3)

24. A small telescope has an objective lens of focal length 140 cm and an eye-piece of focal length 5.0 cm. If this telescope is used to view a 100 m tall tower 3 km away, calculate height of the final image of the tower of it is formed at 25 cm. (3)

25. Three charges are placed at the vertices of an equilateral triangle ABC. Calculate amount of work done in bringing these charges to the vertices of another equilateral triangle A'B'C', shown in the figure given below : (3)



2ℓ = side of triangle ABC and ℓ = is side of triangle A'B'C'

26. Identify electromagnetic waves which: (3)

(i) are used in radar system

(ii) affect a photographic plate

(iii) are used in surgery

Write their wavelength range.

OR

Name the electromagnetic waves which are produced by the following :

(i) Radio active decays of nuclei

(ii) Webling ares

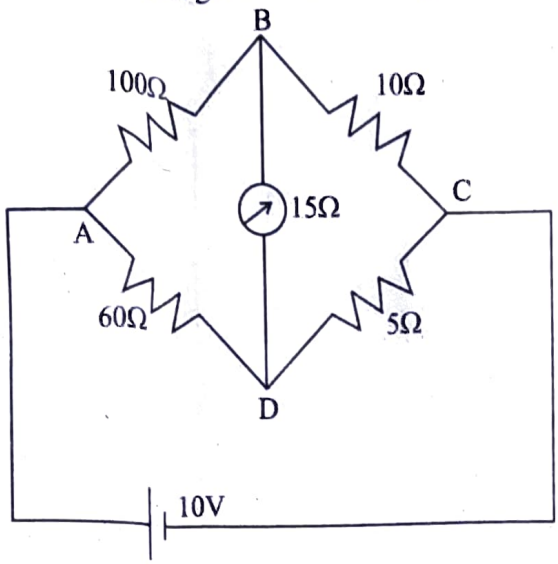
(iii) Hot bodies

Write one use each of these waves.

27. Three cells of emfs 2E, E and 4E and internal resistances r, r/2 and 2r respectively all connected in parallel across a resistor 'R'. Obtain an expression for current flowing through R in the circuit. (3)

OR

The four arms of a wheat stone bridge have following resistances as shown in figure:



A galvanometer of 15Ω resistance is connected across BD. Calculate current flowing through galvanometer.

28. A conductor of length 'ℓ' is rotated about one of its end at a constant angular speed W in a plane perpendicular to uniform magnetic field B. Obtain expression for emf induced across the ends of the conductor and plot of graph of induced emf and angular speed. (3)

SECTION-D

Note : Question number 29 and 30 are case study based question. Read following paragraph and answer the questions.

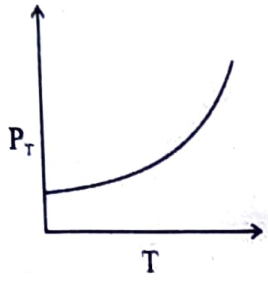
29. The electrical resistivity determines, how strongly it opposes the flow of current. The resistivity of a material is found to be dependent on the temperature. Different materials exhibit dependence on temperatures differently. Some materials exhibit a very weak dependence of resistivity with temperature and some shows strong dependence of resistivity with temperature. (4)

(i) Which of the following material shows strong dependence of resistivity with temperature:

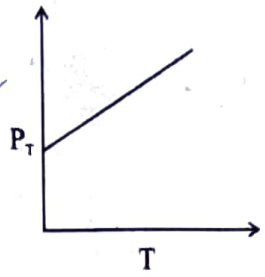
(A) Copper
(B) Maganin
(C) Nichrome
(D) None of the above

(ii) Which of the following graph shows dependence of resistivity ρ_T with temperature T for a semi-conductor.

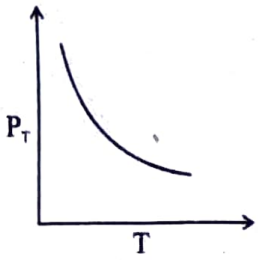
(A)



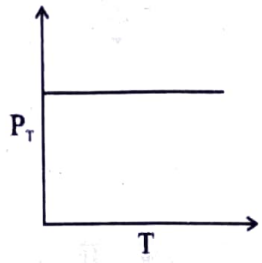
(B)



(C)



(D)



(iii) Which of the following represent temperature coefficient of resistivity 'd' correctly :

(A) $\alpha = \frac{\rho_o \Delta T}{\Delta P}$

(B) $\alpha = \frac{\Delta \rho}{\rho_o \Delta T}$

(C) $\alpha = \frac{\rho_o \Delta \rho}{\Delta T}$

(D) $\alpha = \frac{\Delta T}{\rho_o \Delta \rho}$

(iv) At temperature 250°C, the resistance of a conductor would be double its resistance at 0°C, the temperature coefficient of resistance of given conductor is :

(A) $0.002\ K^{-1}$

(B) $0.0004\ K^{-1}$

(C) $0.008\ K^{-1}$

(D) $0.004\ K^{-1}$

OR

The temperature at which the resistance of a conductor becomes 20% more than that its resistance at 27°C. (Given $\alpha = 2\times 10^{-4}/K$)

(A) 973°C

(B) 8558°C

(C) 1712°C

(D) 1027°C

30. A lens is a transparent optical medium bounded by two surfaces; atleast one of which should be spherical. Applying the formula for image formation by a single spherical surface successively at the two surfaces for a lens, we can obtain lens make; formula and then lens formula. A lens of desired focal length can be designed using lens makers formula. Combination of lenses helps to obtain diverging or converging lenses of desired magnification. (4)

(i) The focal length of equivalent lens when a concave lens of focal length 30 cm is in contact with convex lens of focal length 20 cm will be :

(A) 60 cm (B) 12 cm

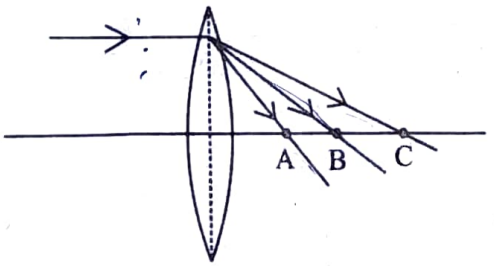
(C) 25 cm (D) 50 cm

(ii) The lens combination used in the above question is :

(A) Converging (B) Diverging

(C) Both converging and diverging (D) Neither converging nor diverging

(iii) A trichromatic light passes through a convex lens as shown :



If the light consist of red, blue and green colours, then which of following is the correct sequence of these colours at point A, B, C respectively.

(A) Red, Green, Blue (B) Green, Red, Blue

(C) Blue, Red, Green (D) Blue, Green, Red

(iv) The focal length of an equiconvex lens is two times its radius of curvature. The refractive index of material of lens when it is kept in air, is :

(A) 3/4 (B) 3/2

(C) 5/4 (D) 5/2

OR

The total magnification produced by a compound macroscope is 20. If magnification produced by objective is 4, then the focal length of eye piece when instrument is used in near point vision is : (take D = 20 cm)

(A) 2.5 cm (B) 6.25 cm

(C) 5 cm (D) 4 cm

SECTION-E

31. (a) A voltage source $V = V_0 \sin \omega t$ is applied to a series LCR circuit. Derive the expression for average power transferred to the circuit in one complete cycle.

(b) A series LCR circuit with R = 20 Ω, L = 1.5 H and C = 35 μF is connected to a variable frequency 200V ac supply. When the frequency of the supply equals the natural frequency of the circuit, calculate the average power transferred to the circuit in one complete cycle. (5)

OR

(a) Draw the diagram of a device which is used to decrease high ac-voltage into a low ac voltage. State its working principle. Write four sources of energy loss in this device.

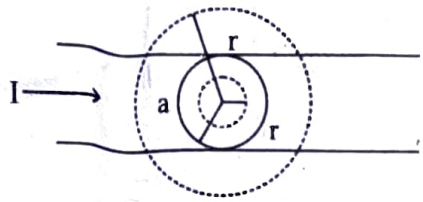
(b) A small town with a demand of 1200 kW of electric power at 220 V is situated 20 km away from an electric plant generating power at 440V. The resistance of two wire line carrying power is 0.5 Ω per km. The town get power from the line through a 40000-220V device at a sub-station in the town. Estimate the line power loss in the form of heat.

32. (a) State the law used to determine magnetic field at a point due to a current element (use required diagram). Derive the expression for the magnetic field due to a current carrying circular loop of radius r at its centre.

(b) An electric $\Delta\vec{\ell} = 1\text{ cm}\,\hat{i}$ is placed at the origin and carries current 10A along X-axis. Find the magnitude and direction of magnetic field due to element on Y-axis at a distance of 0.5 m from it. (5)

OR

Figure shows a long straight wire of circular cross-section (radius a) carrying a steady current I. The current I is uniformly distributed a cross this cross-section. Calculate the magnetic field in the region (i) $r < a$, and (ii) $r > a$.



33. (a) Write expression for electric potential due to a uniformly charged spherical shell at a point :

(i) outside the shell

(ii) on the shell

(iii) inside the shell

(b) Draw a graph showing variation of potential due to charged spherical shell with distance from the centre.

(c) 64 drops of same size are charged at 200 V each. They coalesce to form a bigger drop. Calculate potential of the bigger drop. (5)

OR

(a) A dielectric slab of thickness 't' is kept between the plates of a parallel plate capacitor separated by a distance 'd'. Derive the expression for the capacitance of the capacitor for $t < d$.

(b) Show that the force on each plate of a parallel plate capacitor has a magnitude equal to $\frac{1}{2}QE$, where Q is the charge on the capacitor and E is the magnitude of electric field between the plates.