RASHTRIYA MILLITRARY SCHOOL-BENGALURU

Physics Practice paper-

4

Class XII | 2023–24

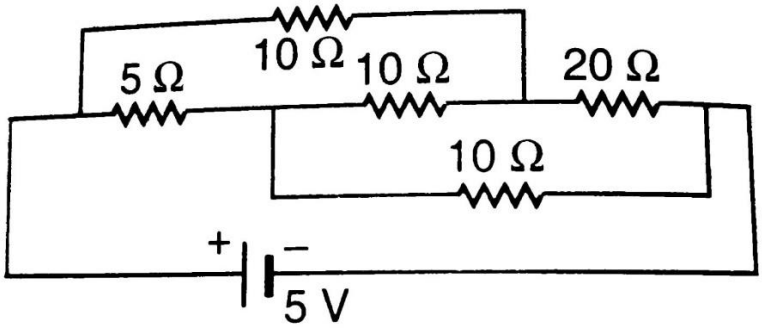
Maximum marks: 70 **Time Allowed: 3 hours**

General instructions:

(1) There are 33 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) All the sections are compulsory.
(4) **Section A** contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, **Section B** contains five questions of two marks each, **Section C** contains seven questions of three marks each, **Section D** contains two case study based questions of four marks each and **Section E** contains three long answer questions of five marks each.
(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.
(6) Use of calculators is not allowed.

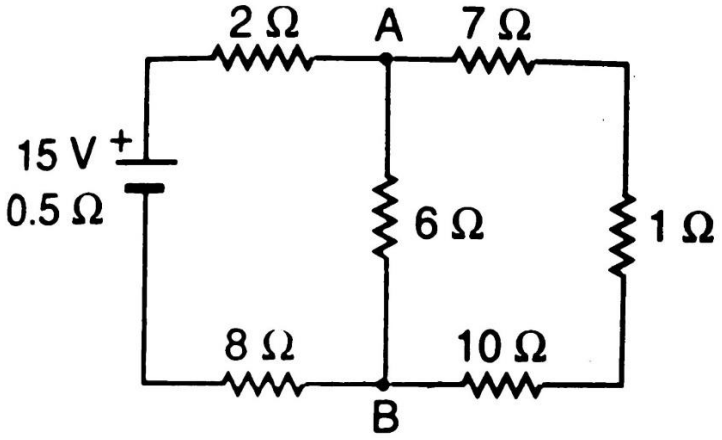
SECTION – A

1. What is the shape of a wave front emitted by a light source in the form of a narrow slit?
   (a) Spherical (b) Cylindrical (c) Plane (d) Oval
2. As shown in the following figure, the current 'I' drawn from the 5 V source will be



   (a) 0.5 A (b) 0.67 A (c) 0.17 A (d) 0.33 A
3. A coil has resistance 30 Ω and inductive reactance 20 Ω at 50 Hz frequency. If an AC source of 200 V, 100 Hz is connected across the coil, the current in the coil will be
   (a) $20/\sqrt{13}$ A (b) 2 A (c) 4 A (d) 8 A

4. A short bar magnet of magnetic moment 0.4 J/T is placed in a uniform magnetic field of 0.16 T. The magnet is in stable equilibrium when the potential energy is
   (a) -0.082 J (b) 0.064 J (c) -0.064 J (d) zero
5. Electron beam moves at right angles to a uniform magnetic field of 1.5×10^{-2} T with speed of 6×10^{7} m/s. If the specific charge of electron is 1.7×10^{11} C/kg, the radius of the circular path will be
   (a) 1.31 cm (b) 2.35 cm (c) 3.31 cm (d) 4.31 cm
6. Whenever a magnet is moved either towards or away from a conducting coil, an e.m.f is induced. The magnitude of induced e.m.f is independent of
   (a) The strength of the magnetic field (b) Number of turns in the coil
   (c) The speed with which the magnet is moved (d) The resistance of the coil
7. The frequencies of X-rays, γ-rays and ultraviolet rays are respectively a, b and c. Then,
   (a) a < b, b > c (b) a > b, b > c (c) a > b, b < c (d) a < b, b < c
8. An alternating voltage $E = 200\sqrt{2} \sin (100\ t)$ V is connected to a 1μF capacitor through an AC ammeter. The reading of the ammeter shall be
   (a) 10 mA (b) 20 mA (c) 40 mA (d) 80 mA
9. If two streams of protons move parallel to each other in the same direction, then they
   (a) Do not exert any force on each other.
   (b) Repel each other
   (c) Get rotated to be perpendicular to each other
   (d) Attract each other.
10. The current drawn from the battery in the following circuit is



   (a) 1A (b) 2 A (c) 3 A (d) 1.5 A
11. A point charge '+q' is placed at the origin 'O'. Work done in taking another point charge '-Q' from the point A (0,a) to another point B(a,0) along the straight path AB is
   (a) $\left(\frac{1}{4\pi\varepsilon_0}, \frac{9Q}{a^2}\right)\sqrt{2}a$ (b) $\left(-\frac{1}{4\pi\varepsilon_0}, \frac{9Q}{a^2}\right)\sqrt{2}a$ (c) $\left(\frac{1}{4\pi\varepsilon_0}, \frac{9Q}{a^2}\right)\frac{a}{\sqrt{2}}$ (d) zero
12. Ratio of force of repulsion between two electrons and two protons separated by same distance in air is
   (a) 1:1 (b) $m_e : m_p$ (c) $m_p : m_e$ (d) none of these
13. A given convex lens of glass (n = 3/2) can behave as concave when it is held in a medium of 'n' equal to
   (a) 1 (b) 3/2 (c) 2/3 (d) 7/4

14. A plane wave front passes through a convex lens. The geometrical shape of the wave front that emerges is
    (a) plane (b) diverging spherical (c) converging spherical (d) none of these
15. When area of the parallel plate air capacitor is halved and distance between the plates is doubled, its capacity becomes 'n' times, where n is
    (a) 1 (b) 2 (c) 4 (d) ¼
16. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.**
    a) Both A and R are true and R is the correct explanation of A
    b) Both A and R are true and R is NOT the correct explanation of A
    c) A is true but R is false
    d) A is false and R is also false
    Assertion (A): Only a change in magnetic flux will maintain an induced current in the coil
    Reason (R): the presence of large magnetic flux through a coil maintains a current in the coil if the circuit is continuous.
17. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.**
    a) Both A and R are true and R is the correct explanation of A
    b) Both A and R are true and R is NOT the correct explanation of A
    c) A is true but R is false
    d) A is false and R is also false
    Assertion (A): The average thermal velocity of the electrons in a conductor is zero.
    Reason (R): Direction of motion of electrons are randomly oriented.
18. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.**
    a) Both A and R are true and R is the correct explanation of A
    b) Both A and R are true and R is NOT the correct explanation of A
    c) A is true but R is false
    d) A is false and R is also false
    Assertion (A): Magnetic force is always perpendicular to the magnetic field.
    Reason (R): Electric force is along the direction of electric field.

SECTION – B

19. (a) How does a diamagnetic material behave when it is cooled to very low temperature?
    (b) Why does a paramagnetic sample display greater magnetization when cooled? Explain.

    OR

    Distinguish between diamagnetic and ferromagnetic materials in terms of (i) susceptibility and (ii) their behavior in a non-uniform magnetic field.

20. Describe a simple experiment (or activity) to show that the polarity of e.m.f induced in a coil is always such that it tends to produce a current which opposes the change of magnetic flux that produces it.
21. If dipole were kept in a uniform external electric field, diagrammatically represent the position of the dipole in stable and unstable equilibrium and write the expression for the torque acting on the dipole in both the cases.
22. How does Ampere-Maxwell law explain the flow of current through a capacitor when it is being charged by a battery? Write the expression for the displacement current in terms of rate of change of electric flux.
23. (a) Write the necessary conditions for the phenomenon of total internal reflection to occur.
    (b) Write the relation between the refractive index and critical angle for a given pair of optical media.
24. Define electric flux. Gauss's law in electrostatics is true for any closed surface, no matter what its shape or size is. Justify this statement with the help of suitable example.

OR

Two large parallel plane sheets have uniform charge densities '+ σ' and '-σ'. Determine the electric field (i) between the sheets, and (ii) outside the sheets.

25. When 100 V DC is applied across a coil, a current of 1A flows through it. When 100 V AC of 50 Hz is applied to the same coil, only 0.5A current flows. Calculate the resistance and inductance of the coil.

SECTION – C

26. A wire of length '*l*' is bent in the form of (a) a square loop and (b) a circular loop. A current 'I' is flown through the wire loop. In which case is the magnetic field developed at the centre of loop more? Find the ratio of magnetic fields in two cases.
27. (a) Write the conditions under which light sources can be said to be said to be coherent.
    (b) Why is it necessary to have coherent sources in order to produce an interference pattern?
    (c) Write the conditions on path difference under which (i) constructive (ii) destructive interference occur.

OR

Define wave front. Using Huygens principle to verify the laws of refraction.

28. Define the term conductivity of a metallic wire. Using the concept of free electrons in a conductor, derive the expression for the conductivity of a wire in terms of number density and relaxation time. Hence obtain the relation between current density and the applied electric field 'E'.

OR

State Kirchhoff's rules for an electric network. Using Kirchhoff's rules, obtain the balance condition in terms of the resistances of the four arms of Wheatstone bridge.

29. A capacitor of unknown capacitance is connected across a battery of 'V' volts. The charge stored in it is 360 μC. When potential across the capacitor is reduced by 120 V, the charge stored in it becomes

120 μC. Calculate (i) Potential 'V' and the unknown capacitance 'C'. (ii) What will be the charge stored in the capacitor, if the voltage applied had increased by 120 V?

30. An inductor 'L' of inductive reactance X_L is connected in series with a bulb B and an AC source. How would brightness of the bulb change when,
(i) Frequency of the AC source is increased. (ii) An iron rod is inserted in the inductor and (iii) a capacitor of reactance XC = XL is inserted in series in the circuit. Justify your answer in each case.

SECTION – D

31. (a) Draw a ray diagram to show the formation of the image of an object placed on the axis of a convex refracting surface of radius of curvature 'R', separating the two media of refractive indices 'n_1' and 'n_2' ($n_2 > n_1$). Use this diagram to deduce the relation between u, v, R, n_1 and n_2.
(b) A double convex lens is made of a glass of refractive index 1.55, with both the faces of the same radius of curvature. Find the radius of curvature required, if the focal length is 20 cm.

OR

(a) A ray of light incident on the face AB of a glass prism ABC and emerges out of face AC. Trace the path of the ray. Show that $A + \delta = i + e$.
(b) A ray of light passing from air through an equilateral glass prism undergoes minimum deviation when the angle of incidence is ¾ of the angle of prism. Calculate the speed of light in the prism.

32. A 2 μF capacitor, 100 Ω resistor and 8 H inductor are connected in series with an A.C source.
(i) What should be the frequency of the source such that current drawn in the circuit is maximum? What is this frequency called?
(ii) If the peak value of e.m.f of the source is 200 V, find the maximum current.
(iii) Draw a graph showing the variation of amplitude of the current with changing frequency of applied voltage in series LCR circuit for two different values of resistance R_1 and R_2 ($R_1 > R_2$).
(iv) Define the term ' Sharpness of resonance' under what condition, does a circuit become more selective?

OR

A device X is connected across an A.C source of voltage $V = V_0 \sin \omega t$. The current through X is given as $I = I_0 \sin (\omega t + \pi/2)$.
(i) Identify the device X and write the expression for its reactance.
(ii) Draw graphs showing variation of voltage and current with time over one cycle of A.C, for X.
(iii) How does the reactance of the device X vary with frequency of the A.C? Show this variation graphically.
(iv)Draw the phasor diagram for the device X.

33. (a) Explain using a labelled diagram, the principle and working of a moving coil galvanometer. What is the function of radial magnetic field and soft iron core?
(b) A voltmeter of a certain range is constructed by connecting a resistance of 980 Ω in series with a galvanometer. When the resistance of 470 Ω is connected in series, the range gets halved. Find the resistance of the galvanometer.

OR

(a) Write the expression for the force acting on a particle of mass 'm' and charge 'q' moving with velocity 'v' in a magnetic field B. under what condition will it move in (i) a circular path and (ii) a helical path?

(b) Show that the kinetic energy of the particle moving in magnetic field remains constant.

(c) An alpha particle is accelerated through a potential difference of 10 kV and moves along x-axis. It enters in a region of uniform magnetic field B = 2 x 10^{-3} T acing along y-axis. Find the radius of its path. (take mass of alpha particle = 6.4 x 10^{-27} kg)

SECTION – E

34. The telescope is used to provide angular magnification of distant objects. Light from a distant object enters the objective and a real image is formed in the tube at its second focal point. The eyepiece magnifies this image producing a final inverted image. Modern telescopes use a concave mirror rather than a lens for the objective. Telescopes with mirror objectives are called reflecting telescopes.

(a) Draw a schematic labelled ray diagram of a reflecting type telescope.

OR

Draw a schematic labelled ray diagram showing image formation by a refracting telescope.

(b) Write two important advantage justifying why reflecting type telescopes are preferred over refracting telescopes.

(c) The objective of a telescope is of larger focal length and larger aperture (Compared to the eyepiece). Why? Give reasons.

35. A simple device to maintain a steady current in an electric circuit is the electrolytic cell. Basically a cell has two electrodes, called the positive (P) and the negative (N). They are immersed in an electrolytic solution. Dipped in the solution, the electrodes exchange charges with the electrolyte. The potential difference between P and N is called the electromotive force (e.m.f) of the cell and is denoted by ε.

(a) Plot a graph showing the variation of potential difference (V) versus current (I) for a cell of e.m.f 'ε' having internal resistance 'r'.

OR

Plot a graph showing the variation of potential difference (V) versus external resistance (R) for a cell of e.m.f 'ε' having internal resistance 'r'.

(b) The e.m.f of a cell is always greater than its terminal voltage. Why? Give reason.

(c) A battery of e.m.f 'ε' and internal resistance 'r' when connected across an external resistance of 12 Ω, produces a current of 0.5 A. When connected across a resistance of 25 Ω, it produces a current of 0.25 A. Determine (i) the e.m.f and (ii) the terminal resistance of the cell.