INDIAN SCHOOL AL WADI AL KABIR
COMMON PREBOARD EXAMINATION
PHYSICS (042)

Class: XII | Time: 3 Hours
Date: 28/01/2024 | Max. Marks: 70

General Instructions

1) There are 33 questions in all. All questions are compulsory.
2) This question paper has five sections: Section A, B, C, D & E.

   Section A contains 16 questions, twelve MCQ's 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 question of 4 marks and **Section E** contains three long answer question of five marks.

3) There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks, one question for case study and for all long answer questions. You have to attempt only one of the choices in such questions.
4) You may use log tables if necessary but use of calculator is not allowed.
5) You may use the following values of physical constants wherever necessary:

   $c = 3 \times 10^8\ ms^{-1}$, $h = 6.626 \times 10^{-34} Js$, $e = 1.602 \times 10^{-19}\ C$,
   $\epsilon_o = 8.854 \times 10^{-12}\ C^2N^{-1}m^{-2}$, $k = 9 \times 10^9\ C^{-2}Nm^2$.
   $m_e = 9.1 \times 10^{-31} kg$,
   $m_n = 1.675 \times 10^{-27} kg$, $m_p = 1.673 \times 10^{-27}\ kg$,

SECTION A (1 x 16 = 16)

1.An electric dipole having a dipole moment of 4×10^{-9} C m is placed in a uniform electric field such that the dipole is in stable equilibrium. If the magnitude of the electric field is 3×10^3N/C, what is the work done in rotating the dipole to a position of unstable equilibrium?

(a) zero

(b) 1.2×10^{-5} J

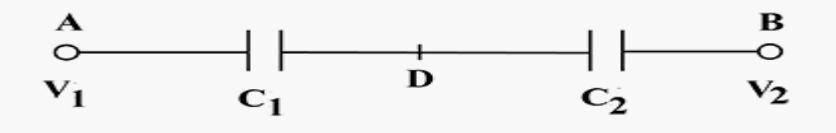
(c) 2.4×10^{-5} J

(d) -1.2×10^{-5} J

2. A charge is to be placed between two charges of 9e and 16e respectively, placed 70cm apart. The position of the third charge placed between the two charges so that the system is in

equilibrium will be:
(a) 30 cm from 9e
(b) 30 cm from 16e
(c) 40 cm from 9e
(d) 35 cm from either charge

3. When two charged capacitors having capacitance and potential C_1, V_1 and C_2, V_2 respectively, are joined with the help of a wire as shown in the figure, the common potential will be



(a) $C_1 + C_2$
(b) $\frac{C_1 V_1 + C_2 V_2}{C_1 + C_2}$
(c) $\frac{C_1 V_1 + C_2 V_2}{V_1 + V_2}$
(d) $\frac{C_1 V_1^2 + C_2 V_2^2}{V_1^2 + V_2^2}$

4. What is the resistance of a 40 W lamp which is lighted as full brilliance by a current of $\frac{1}{3}$ A?

(a) 120 Ω
(b) 240 Ω
(c) 360 Ω
(d) 480 Ω

5. A current-carrying loop is placed in a uniform magnetic field. The torque acting on it does not depend upon
(a) area of loop
(b) shape of loop
(c) number of turns in loop
(d) strength of current and magnetic field

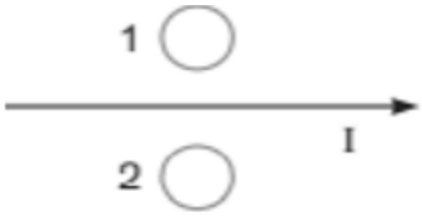
6. A current passing through a circular coil of two turns produces a magnetic field of 8 T at its centre. The coil is then rewound, so as to have four turns and current passed through it is doubled. Now magnetic field at the centre of the coil will be
(a) 64 T
(b) 32 T
(c) 16 T
(d) 8 T

7. The unit of ratio of magnetic field, B and electrical field, E (B/E) is
(a) ms^{-1}
(b) sm^{-1}
(c) ms
(d) m^{-2}

8. Susceptibility is positive for

(a) Ferromagnetic material
(b) Paramagnetic material
(c) Diamagnetic material
(d) Option (a) and (b)

9. Predict the directions of induced currents in metal rings 1 and 2 lying in the same plane when current I in the wire is increasing.



(a) Through 2 clockwise and through 1anticlockwise as the induced current wants to decrease the change in magnetic flux.

(b) Through 1 clockwise and through 2 anticlockwise as the induced current wants to increase the change in magnetic flux.

(c) Through 1 clockwise and through 2 anticlockwise as the induced current wants to decrease the change in magnetic flux.

(d) Through 1 clockwise and through 2 also clockwise as the induced current wants to decrease the change in magnetic flux.

10. An alternating voltage source of variable angular frequency 'ω' and fixed amplitude 'V' is connected in series with a capacitance C and electric bulb of resistance R (inductance zero). When 'ω' is increased-

(a) The bulb glows dimmer.
(b) The bulb glows brighter.
(c) Net impedance of the circuit remains unchanged.
(d) Total impedance of the circuit increases.

11. A metallic plate exposed to white light emits electrons. For which of the following colours of light, the stopping potential will be maximum?

(a) Blue (b) Yellow
(c) Red (d) Violet

12. The energy of an electron in nth orbit of hydrogen atom is $E_n = -13.6/n^2$ eV. The negative sign of energy indicates that

(a) electron is free to move.

(b) electron is bound to the nucleus.

(c) kinetic energy of electron is equal to potential energy of electron.

(d) atom is radiating energy.

For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

a) If both Assertion and Reason are true and Reason is correct explanation of Assertion.

b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

c) If Assertion is true but Reason is false.

d) If both Assertion and Reason are false.

13. **Assertion:** The angle of minimum deviation for a prism is lesser for red light than for blue light.

Reason: The refractive index of the material of a prism for blue light is greater than that of red light.

14. **Assertion:** For a particle to have De-Broglie wave associated with it, it must carry charge.

Reason: De-Broglie waves are electromagnetic in nature.

15. **Assertion:** Nuclear density is independent on the size of the nucleus.
Reason: Volume of the nucleus is directly proportional to the mass number of an element.

16. **Assertion**: The dominant mechanism for motion of charge carriers in forward and reverse bias for a PN junction diode are drift in both forward and reverse bias.
Reason: In reverse biasing, no current flow through the junction.

SECTION-B (2 x 5 = 10)

17. Define conductivity of a material. State its SI unit. What will be the conductance of a conductor if the length of the conductor is halved without changing the area of cross section?

OR

Two wires of equal length, one of copper and the other of manganin have the same resistance. Which wire is thicker? Explain with reason.

18. When the resistance of 9 Ω is connected at the ends of a battery, its potential difference decreases from 40 volts to 30 volts. What is the internal resistance of the battery?

19. A convex lens of focal length 20cm and made of glass ($\mu = 1.5$) is immersed in water of $\mu = 1.33$. Calculate the change in focal length of the lens.

20. Define the distance of closest approach. An α particle of kinetic energy K is bombarded on a thin gold foil. The distance of the closest approach is 'r'. What will be the distance of closest approach for an α particle of double the kinetic energy?

21. Why do we use doped semiconductor instead of intrinsic semiconductor? Draw energy band diagram of semiconductor (Si) doped with arsenic at temperature 20 ˚C.

SECTION- C (3 x 7 = 21)

22. a) Using Gauss's theorem, show mathematically that for any point outside the shell, the field due to a uniformly charged thin spherical shell is the same as if the entire charge of the shell is concentrated at the centre.

b) Draw a graph showing the variation of electric field E with distance r from the centre of a uniformly charged thin spherical shell.

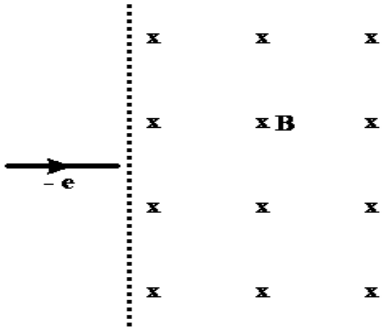
OR

a) Define electric dipole moment. Derive an expression for the electric field intensity at any point on the equatorial line of an electric dipole.

23. (a)Define mutual inductance between a pair of coils and write its SI unit.
(b) Derive the expression for the self-inductance of a long solenoid of cross-sectional area A and length l, having n turns per unit length.

24. (a) Distinguish between nuclear fission and nuclear fusion.
(b) Draw a plot of potential energy of a pair of nucleons as a function of their separation. Write two important conclusions that can be drawn from the graph.

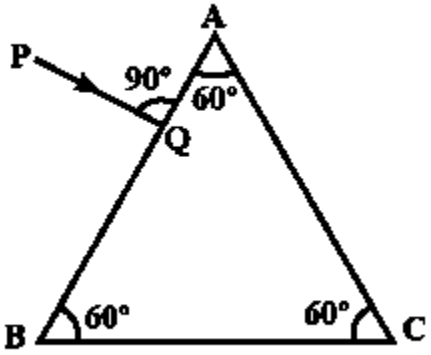
25. An electron moving horizontally with a velocity of 4×10^4 m/s enters region of uniform magnetic field of 10^{-5}T acting vertically downward as shown in the figure. Draw its trajectory and find out the time it takes to come out of the region of magnetic field.



26. (a) A plane electromagnetic wave of angular frequency ω is propagating with velocity v along the Z- axis. Write the vector equations of oscillating electric and magnetic fields and show these fields diagrammatically.

(b) The magnetic field vector of a plane electromagnetic wave oscillates with a frequency of 2×10^{10} Hz. What is its wavelength?

27. In the figure below, a ray of light PQ is incident normally on the face AB of an equilateral glass prism. Complete the ray diagram showing its emergence into air after passing through the prism.
(a) Write the angles of incidence at the faces AB and AC of the prism.
(b) Name the phenomenon which the ray of light suffers at the face AB, AC and BC of the prism.
The critical angle for refraction from glass to air is 42∘.



28. Using Bohr's postulates, derive an expression for radius and velocity of the orbiting electron and hence derive the orbital period of the electron moving in the nth orbit of hydrogen atom.

SECTION- D (4 x 2 = 8)

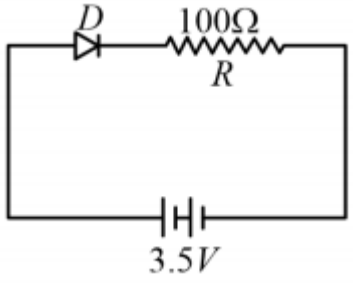
29. Read the passage given below and answer the questions

A semiconductor diode is basically a p-n junction with metallic contacts provided at the ends for the application of an external voltage. It is a two-terminal device. When an external voltage is applied across a semiconductor diode such that p-side is connected to the positive terminal of the battery and n-side to the negative terminal, it is said to be forward biased. When an external voltage is applied across the diode such that n-side is positive and p-side is negative, it is said to be reverse biased.

An ideal diode is one whose resistance in forward biasing is zero and the resistance is infinite in reverse biasing. When the diode is forward biased, it is found that beyond forward voltage called knee voltage, the conductivity is very high.

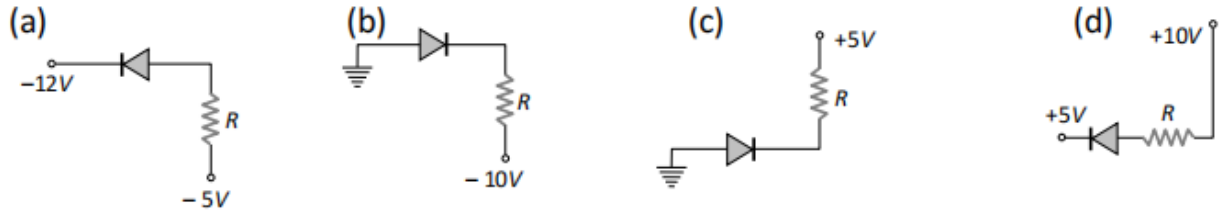
When the biasing voltage is more than the knee voltage the potential barrier is overcome and the current increases rapidly with increase in forward voltage. When the diode is reverse biased, the reverse bias voltage produces a very small current about a few microamperes which almost remains constant with bias. This small current is reverse saturation current.

(i) In the given figure, a diode *D* is connected to an external resistance *R* = 100 Ω and an emf of 3.5V. If the barrier potential developed across the diode is 0.5 V, the current in the circuit will be:



(a) 40 mA
(b) 20 mA
(c) 35 mA
(d) 30 mA

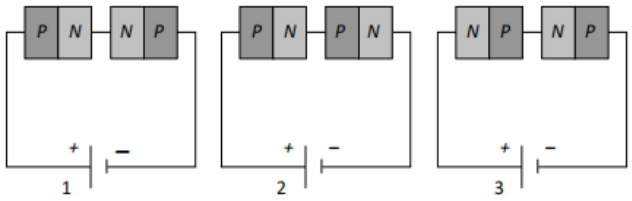
(ii) In which of the following figures, the p-n diode is reverse biased?



(iii) Based on the V-I characteristics of the diode, we can classify diode as
(a) bilateral device (b) ohmic device
(c) non-ohmic device (d) passive element

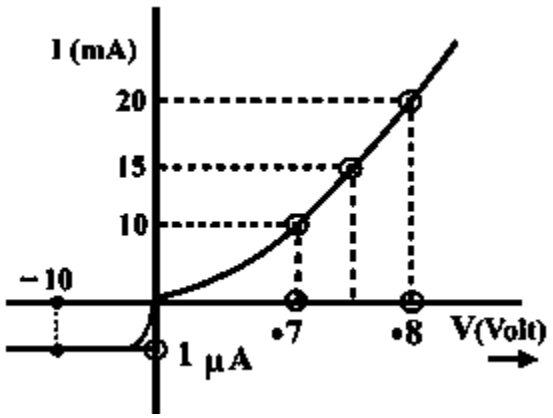
OR

Two identical *PN* junctions can be connected in series by three different methods as shown in the figure. If the potential difference in the junctions is the same, then the correct connections will be



(a) in the circuits (1) and (2) (b) in the circuits (2) and (3)
(c) in the circuits (1) and (3) (d) only in the circuit (1)

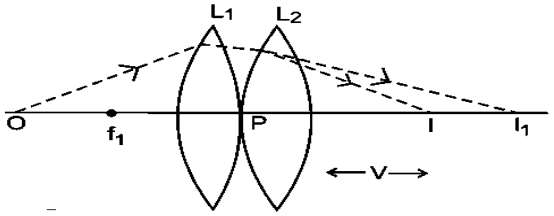
(iv) The V-I characteristic of a diode is shown in the figure. The ratio of forward bias resistance to reverse bias resistance is



(a) 100 (b) 10^6 (c) 10 (d) 10^{-6}

30. Read the passage given below and answer the questions

Power (*P*) of a lens is given by reciprocal of focal length (*f*) of the lens *i.e.*, P = 1/f, where *f* is in metre and *P* is in dioptre. For a convex lens, power is positive and for a concave lens, power is negative. When a number of thin lenses of powers *P*1, *P*2, *P*3 ,.....are held in contact with one another, the power of the combination is given by algebraic sum of the powers of all the lenses. Lenses are used in optical instruments such as microscopes and telescopes.



(i) A convex and a concave lens separated by distance d are then put in contact. The focal length of the combination

(a) becomes 0
(b) remains the same
(c) decreases
(d) increases.

(ii) If two lenses of power +1.5 D and -1.0 D are placed in contact, then the effective power of combination will be

(a) 2.5 D
(b) 1.5 D
(c) 0.5 D
(d) 3.25 D

(iii) If the power of a lens is +5 dioptre, what is the focal length of the lens?
(a) 10 cm
(b) 20 cm
(c) 15 cm
(d) 5 cm

OR

Two thin lenses of focal lengths +10 cm and –5 cm is kept in contact. The power of the combination is
(a) –10 D
(b) –20 D
(c) 10 D
(d) 15 D

(iv) If the focal length of objective lens is increased then magnifying power of
(a) Microscope will increase but that of telescope will decrease
(b) Microscope and telescope both will decrease
(c) Microscope and telescope both will increase
(d) Microscope will decrease but that of telescope will increase

SECTION E [5 x 3 = 15]

31. (a)State Huygen's wave theory.
(b) Light of wavelength 600nm is incident normally on a slit of width 0.2mm. What is the angular width of central maxima in the diffraction pattern?
(c)Verify laws of reflection or laws of light on the basis of Huygen's wave theory.

OR

(a) Explain Young's double slit experiment with diagram.
(b) State the conditions of constructive and destructive interference.
(c) In Young's experiment, the distance between the two slits is 0.8 mm and the distance of the screen from the slits is 1.2m. If the fringe width is 0.75 mm, calculate the wavelength of light.

32. (i) With the help of diagram, explain the principle, theory and working of an AC generator.
(ii) Define alternating current (AC), its peak value and its R.M.S. value.

OR

(i) Using phasor diagram for a series LCR circuit connected to an AC source of voltage $V = V_o \sin\omega t$, Derive the relation for the current flowing in the circuit and the phase angle between the voltage across the resistor and the net voltage in the circuit.
(ii) What is electrical resonance? Obtain a formula for resonant frequency.

33. (a) A capacitor of capacitance *C* is charged fully by connecting it to a battery of emf *E*. It is then disconnected from the battery. If the separation between the plates of the capacitor is now doubled, how will the following change? Explain with reason
(i) charge stored by the capacitor.

(ii) field strength between the plates.

(iii) energy stored by the capacitor.

(b) Draw a sketch of equipotential surfaces due to a single charge - q, depicting the electric field lines due to the charge.

(c) A capacitor with air between the plates has a capacitance of 8pF. The separation between the plates is now reduced by half and the space between them is filled with a medium of dielectric constant 6. Calculate the value of the capacitance of the capacitor in second case.

OR

(a) What is capacitance of a capacitor? Explain the principle of a parallel plate capacitor.
(b) A 4μF capacitor is charged by a 200V supply. It is then disconnected from the supply and is connected to another uncharged 2 μF capacitor. How much energy of the first capacitor is lost in the form of radiation?

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