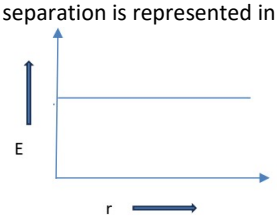
Class : XII || *CBSE* || Pre Board Examination , 2024-25
Subject : Physics ||Full marks : 70||Time : 3hours|| Set - 04

(The figures in the margin indicate full marks for the questions)

SECTION-A

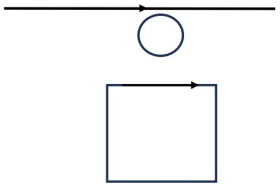
1. Name the charge distribution whose electric field Variation with separation is represented in the graph given below.



a. Uniformly charged thin wire c. charged spherical shell
b. Infinitely charged thin plane sheet d. a point charge

2. Ratio of specific charge of two charges is found to be 3:4, if these two charges enter into a uniform perpendicular Magnetic field with velocities in the ratio of 3:4 find the ratio of radii of the two charges.
a. 9:16 b. 16:9 c. 1:1 d: 4:3

3. Current through a straight conductor is increasing and current through the square loop is constant. How to move the square loop such that there would be no probability for induced current in the circular ring in between the two as shown.



a. Towards right b. Downwards c. towards left d. upwards

4. In a given AC Circuit it is found that current is leading voltage, on adding which element in series in the circuit one can expect maximum current.
a. Inductor b. Resistor c. capacitor d. transformer

5. Average power over a full cycle in a pure resistive circuit is P. If a capacitor of capacitive reactance R is connected in series with the resistor then the average power over full cycle is:
a. 0 b. P/2 c. P d. P/√2

6. If an electromagnetic wave is propagated along +x direction what is the probable direction of oscillating electric and magnetic fields at any given instant?
a. +X and +X b. +Y and -Z c. -Y and Z d. +Y and +Z

7. When a convex lens of power +10D is kept in contact with a lens, resultant power of the combination is observed to be -10D, focal length of the second lens is:
a. 5cm b. 5m c. -5cm d. -5m

8. A plane wave front is incident on a concave mirror of radius of curvature R. The radius of curvature of the reflected wave front will be:
a. 2R b. R c. R/2 d. R/4

9. Dynamic mass of a photon of energy E is:
a. 0 b. EC^2 c. C^2/E d. E/C^2

10. If the velocity of electron in the ground state of hydrogen atom is v, it's velocity in the second excited state would be:
a. 2v b. v/2 c. 3v d. v/3

11. nuclear forces are
i. strongest force in nature ii. short range force
iii. charge dependent iv. spin dependent
a. i and ii only b. i, ii and iii only c. i, ii and iv only d. all are correct

12. Energy gap of a semiconductor decreases with
i. increase in temperature ii. increase in doping concentration
a. i only b. ii only c. either i or ii only d. both i and ii

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 the 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. A: If a dielectric is inserted between the plates of a charged capacitor which is disconnected from the battery, then charge on the capacitor remains the same.
R: Charge on isolated system remains conserved.

14. **A**: if two charges of same magnitude and opposite polarity are projected against each other into a perpendicular magnetic field then they execute circular paths of the same sense of revolution. (i.e. either both in clockwise sense or in anti-clockwise sense).
R: If velocity of two charge particles is in opposite direction in perpendicular magnetic field then the force will be in opposite direction.

15. A: An alternating current of frequency 50Hz becomes zero for 100 times in one second.
R: Alternating current changes direction and becomes zero twice in a cycle.

16. A: Among the particles of same kinetic energy, lighter particles have greater de-Broglie wavelength.
R: The de-Broglie wavelength of a particle depends only on the charge of the particle.

SECTION B

17. A circular loop of radius R has linear charge density λ C/m. Find the potential at a distance 2R from its centre on its axis.

18. Suppose that the electric field amplitude of an electromagnetic wave is E_0 = 120 N/C and that its frequency ν=50M Hz. determine B_0, ω ,K & λ.
OR
How does an oscillating charge radiate an electromagnetic wave? give the relation between frequency of radiated wave and the frequency of oscillating charge.

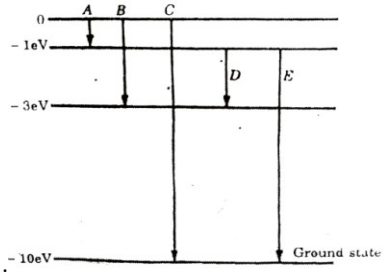
19. Explain how one can convert a full cycle of AC into DC with the help of circuit diagram.

20. Plot the suitable graphs to show the variation of photoelectric current with the collector plate potential for
the incident radiation.
i. the same intensity but different frequencies ν_1,ν_2 and ν_3 ($\nu_1 < \nu_2 < \nu_3$)
ii. the same frequency but different intensities I_1, I_2 and I_3 ($I_1 < I_2 < I_3$)

21. Light from a point source in air falls on a spherical glass surface (n = 1.5 and radius of curvature = 20 cm). The distance of the light source from the glass surface is 100 cm. At what position the image is formed?

SECTION-C

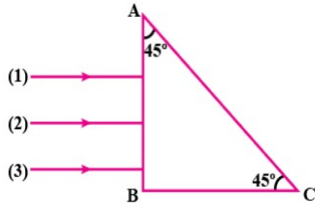
22. The energy levels of an atom of element X are shown in the diagram



Which one of the level transitions will result in the emission of photons of wavelength 620nm? support your answer with mathematical calculations.
Name the hydrogen spectral series that can be observed in the visible region.

23. Draw the graph showing the variation of binding energy per nucleon with the mass number. Explain with the help of this plot the release of energy in the processes of nuclear fission and fusion.

24. Three rays (1,2,3) of different colours fall normally on one of the sides of an isosceles right-angle prism as shown. The refractive index of prism for these rays is 1.36, 1.44 and 1.51 respectively. find which of these rays get internally reflected and which get only refracted from AC. Trace the paths of rays justify your answer
with the help of necessary calculations.



25. Draw the ray diagram of image formation by a reflecting type of telescope. Write any three advantages of reflecting telescope over refracting telescope.

26. A bar magnet of magnetic moment 1.5 JT^{-1} lies aligned with the direction of a uniform magnetic field 0.22 T.

a. what is the amount of work required by an external torque to turn the magnet so as to align its magnetic moment.

(i) normal to the field direction? and (ii) opposite to the field direction

b. what is the torque on the magnet in cases (i) and (ii)

OR

The magnitude F of the force between two straight parallel current carrying conductors kept distance d apart in air is given by $F = \frac{\mu_0 I_1 I_2}{2\pi d}$

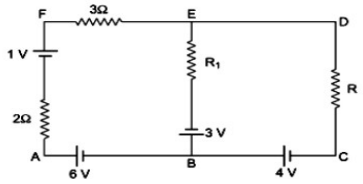
Where I_1 and I_2 are the currents flowing through the two wires. use this expression, and the sign convention that the: "Force of attraction is assigned a negative sign and force of repulsion is assigned a positive sign". Draw graphs showing dependence of F on

i. $I_1 I_2$ when d is kept constant

ii. d when the product $I_1 I_2$ is maintained at a constant positive value.

iii. d when the product $I_1 I_2$ is maintained at a constant negative value.

27. Using Kirchhoff's rules to determine the potential difference between the points A and D when no current flows in the arm BE of the electric network shown in the figure



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28. Show, on a plot, variation of resistivity of (i) a conductor, and (ii) a typical semiconductor as a function of temperature.

Using the expression for the resistivity in terms of number density and relaxation time between the collisions, explain how resistivity in the case of a conductor increases while it decreases in a semiconductor, with the rise of temp

SECTION -D(Case study based)

When the atomic dipoles are aligned partially or fully, there is a magnetic moment in the direction of the field in any small volume of the material. The actual magnetic field inside material placed in a magnetic field is the sum of the applied magnetic field and the magnetic field due to magnetization. This field is called magnetic intensity (H) , $H = B/\mu_0 - M$, where M is magnetization of the material, μ_o is the permittivity of the vacuum and B is the total magnetic field. The measure that tells us how a magnetic material responds to an external field is given by a dimensionless quantity is appropriately known as magnetic susceptibility: for a certain magnetic materials, intensity of magnetization is directly proportional to the magnetic intensity.

(i) Magnetisation of a sample is

(a) Volume of sample per unit magnetic moment

(b) Net magnetic moment per unit volume

(c) Ratio of magnetic moment and pole strength

(d) Ratio of pole strength to magnetic moment.

(ii) Identify wrongly matched quantity

(a) Pole strength------ Am

(b) Magnetic susceptibility …….. dimensionless quantity

(c) Intensity of magnetisation----A/m

(d) Magnetic permeability---------Henry m

(iii) A solenoid has core of a material with relative permeability 500 and its windings carrying a current of 1A. The number of turns of the solenoid is 500 per meter. The magnetization of the material is nearly

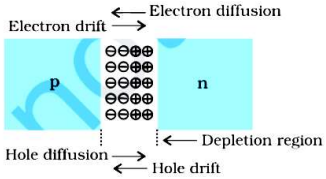
(a) 2.5 x 10^3 A/m (b) 2.5 x 10^5 A/m (c) 2.0 x 10^3 A/m (d) 2.5 x 10^5 A/m

(iv) The relative permeability of iron is 6000. Its magnetic susceptibility is

(a) 5999 (b) 6001 (c) 6000 x 10^{-7} (d) 6000x10^7

30. Motions of the Charge Carriers: If you burst a helium-filled balloon, helium atoms will diffuse(spread) outward into the surrounding air. This happens because these are very few helium atoms in normal air. In more formal language, there is a helium density gradient at the balloon-air interface (the number density of helium atoms varies across the interface), the helium atoms move so as to reduce the gradient.

In the same way, electrons on n-side are close to the junction plane tend to diffuse across it and into the pside, where there are very few free electrons. Similarly, holes on p-side are close to the junction plane tend to diffuse across that plane and into the n-side, where there are very few holes. The motions of both the electrons and the holes contribute to diffusion current (I_{diff}).



i. Silicon is doped with which of the following to obtain p-type semiconductor?

a. Phosphorus b. Gallium c. Germanium d. Bismuth

ii. A semiconductor has an electron concentration of 6x10^{22} per m^3 and hole concentration of 8.5x10^9 per m^3.Then it is

a. n-type b. p-type c. intrinsic d. conductor

iii. In p-n junction diode

a. the current in the reverse biased condition is generally very small (in μA

b. the current in the reverse biased condition is small but the forward biased current is independent of the biased voltage

c. the reverse biased current is strongly dependent on the applied voltage

d. the forward biased current is very small in comparison to reverse biased current

iv. In the middle of the depletion layer of a reverse biased p-n junction, the

a. electric field is zero c. electrified is maximum

b. potential is maximum d. potential is zero

OR

The dominant mechanism for the motion of charge carriers in forward and reverse biased silicon junctions are

a. drift in forward bias, diffusion in reverse bias

b. diffusion in forward bias, drift in reverse bias

c. diffusion in both forward and reverse bias

d. drift in both forward and reverse bias

SECTION-E

31. a. Use Gauss' law to derive the expression for the electric field due to a straight uniformly charged infinite line of charge density λ C/m.

b. Draw a graph to show the variation of E with perpendicular distance r from the line of charge.

c. Find the work done in bringing a charge q from perpendicular distance r_1 to r_2 ($r_1 < r_2$) from the line charge.

OR

i. finds the capacitance of a capacitor which is partially filled with a dielectric. hence write the expression for the capacitance when it is fully filled with dielectric.

ii. two parallel plate capacitors, X and Y, have the same area of plates and same separation between them. X has air between the plates while Y contains a dielectric of dielectric constant 4. calculate capacitance of each capacitor if equivalent capacitance of the combination is 4μF.

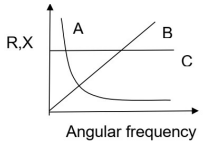
32. a. Draw the schematic arrangement for winding of primary and secondary coils in a transformer when the two coils are wound on top of each other.

b. state the underlying principle of a step-up transformer and obtain the expression for the ratio of secondary to primary voltage in terms of number of turns.

c. A transformer of 100% efficiency has 200 turns in the primary and 40,000 turns in the secondary. it is connected to a 220V a.c. mains and the secondary feeds to a 100 k Ohm resistance. calculate the output potential difference per turn.

OR

a. Figure shows the variation of resistance and reactance versus angular frequency. Identify the curve which corresponds to inductive reactance and capacitive reactance write the mathematical form of their reactances



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b. A series LCR circuit is connected to an ac source (200V, 50Hz). The voltages across the resistor, capacitor and inductor are respectively 200V, 250V and 250V.

i. The algebraic sum of the voltages across the three elements is greater than the voltage of the source. How is this paradox resolved?

ii. Given the value of the resistance of the resistance of R is 40 Ohm, calculate the current in the circuit.

33. a. Draw a ray diagram to show the refraction of a ray of light through a prism hence derive the expression for refraction through it.

b. A ray of light passing through an equilateral triangular glass from air undergoes minimum deviation when angle of incidence is 3/4th of the angle of prism. calculate the speed of light in the prism.

OR

a. Plot the variation intensity of interference when a monochromatic source is incident on a plane of double slit with path difference. also plot the variation in intensity if one of the slits is closed.

b. Write two characteristic features to distinguish between the interference fringes in YDSE and diffraction due to single slit.

c. A parallel beam of light of wavelength 500 nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1 m away. It is observed that the first minimum is a distance of 2.5 mm away from the centre. find the width of the slit