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MG-130+70=200

HALF YEARLY EXAMINATION 2024-25

PHYSICS

Class XII

Time : 3 hrs.] [M.M. : 70

General Instructions—

(i) There are 33 questions in all. All questions are compulsory

(ii) This question paper has five sections : Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.

Section A contains sixteen questions in which twelve MCQ of 1 mark and four Assertion and Reasoning based, 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 4 marks each and section E contains three long questions of five marks each.

(iii) There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.

Use of calculators is not allowed.

(iv) You may use the following values of physical constants where ever necessary :

$c = 3\times10^{8}$ m/s $\quad m_e = 9.1\times10^{-31}$ kg

$e = 1.6\times10^{-19}$ C $\quad \mu_0 = 4\pi\times10^{-7}$ TmA^{-1}

$h = 6.63\times10^{-34}$ Js $\quad \varepsilon_0 = 8.854\times10^{-12}$ C^{2}N^{-1}m^{-2}

Avogadro's number = 6.023×10^{23} per gram mole

SECTION-A

Multiple Choice Questions (MCQ)— **1×16=16**

1. Fusion reations place at high temp, because :

(a) Kinetic energy is high enough to overcome repulsion between nuclei.

P. T. O.

(b) Nuclei break up at high temperature.

(c) Atoms are ionised at high temperature.

(d) Molecules break up at high temperature.

2. For an ideal-step-down transformer, the quantity which is constant for both the coils is :

(a) current in the coils (b) voltage across the coils

(c) resistance of coils (d) power in the coils

3. When an electron jumps from some outer orb it to the innermost orbit in the hydrogen atom, the spectral line belongs to :

(a) Lyman series (b) Balmer series

(c) Paschen series (d) Pfund series

4. Photoelectrons are being obtained by irradiating zinc by a radiation of 3100 Å. In order to increase the kinetic energy of ejected photoelectrons.

(a) the intensity of radiation should be increased.

(b) the wave length of radiation should be increased.

(c) the wavelength of radiation should be decreased.

(d) both wavelength and intesity of radiation should be increased.

5. Which of the following statements is not correct ?

(a) Whenever the amount of magnetic flux linked with a circuit changes, an emf is induced in circuit.

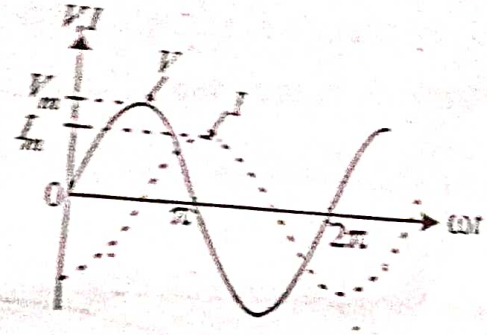
(b) The induced emf lasts so long as the change in magnetic flux continues.

(c) The direction of induced emf is given by Lenz's law.

(d) Lenz's law is a consequence of the law of conservation of momentum.

6. The phase relationship between current and voltage in a pure resistive circuit is best represented by :

(a)



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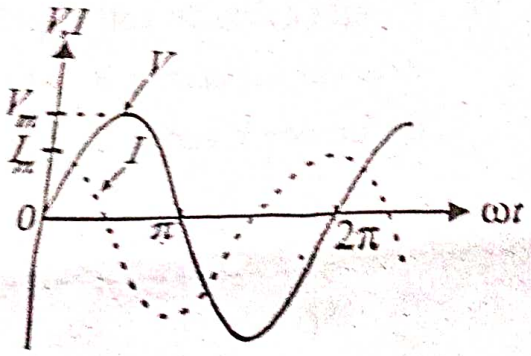

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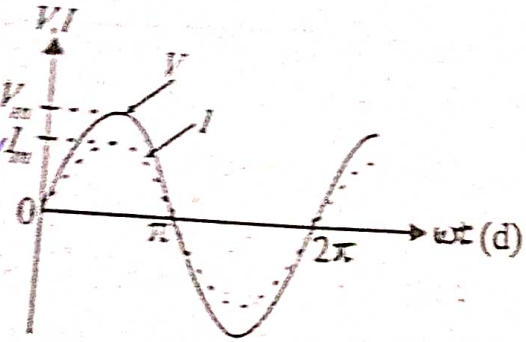

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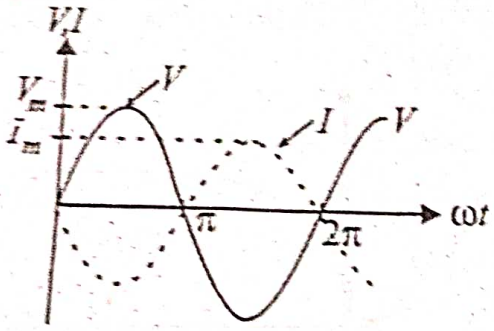


7. The threshold frequency for a certain metal is ν_0. When light of frequency $\nu = 2\nu_0$ is incident on it, the maximum velocity of photo electrons is 4×10^6 ms^{-1}. If the frequency of incident radiation is increased to 5 photoelectrons (m/s) is :

(a) 8×10^5
(b) 2×10^6
(c) 2×10^7
(d) 8×10^6

8. In Bohr's model of the hydrogen atom, the ratio between the period of revolution of an electron in the orbit n = 1 to the period of revolution of electron in the orbit n = 2 is :

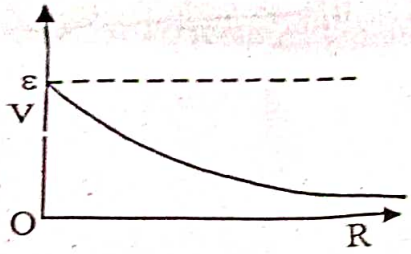
(a) 1/2
(b) 1/4
(c) 1/8
(d) 2

9. The magnetic moment of a current I carrying circular coil of radius r and number of turns N varies as :

(a) $1r^2$
(b) 1/r
(c) r
(d) r^2

10. A cell having an emf E and internal resistance r is connected across a variable external resistance R. As the resistance R is increased, the plot of potential difference V across R is given by :

(a)



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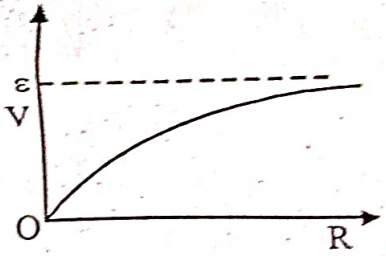

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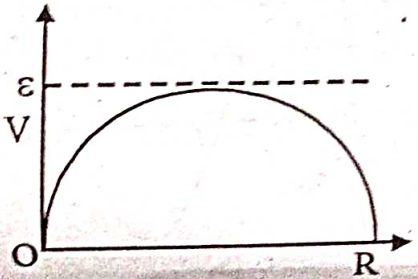

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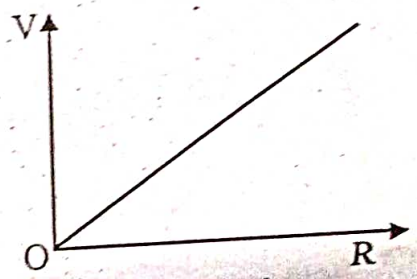


11. Equipotential surfaces :

(a) are closer in regions of large electric fields compared to regions of lower electric fields.

(b) will be more crowded near sharp edges of a conductor.

(c) will always be equally spaced.

(d) both (a) and (b) are correct.

12. Which of the following statements is not true about Gauss's law ?

(a) Gauss's law is true for any closed surface.

(b) The term q on the right side side of Gauss's law includes the sum of all charges enclosed by the surface.

(c) Gauss's law is not much useful in calculating electrostatic field when the system has some symmetry.

(d) Gauss's law is based on the inverse square dependence on distance contained in the coulomb's law.

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.

(e) A is false but R is true.

$P = I^2 R$

13. **Assertion :** Ferro-magnetic substances become paramagnetic above Curie temp.
(b) **Reason :** Domains are destroyed at high temperature.

14. **Assertion :** Lenz's law violates the principle of conservation of energy.
(c) **Reason :** Induced emf always opposes the change in magnetic flux responsible for its production.

15. **Assertion :** Density of all the nuclei is same.
(a) ***Reason :*** *Radius of nucleus is directly proportional to the cube root of mass number.*

16. **Assertion :** The force of repulsion between atomic nucleus and α-particle varies with distance according to inverse square law.
(b) **Reason :** Rutherford did α-particle scattering experiment.

SECTION-B

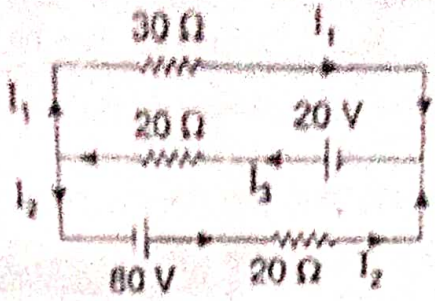
Short answer type questions— **2×5=10**

17. A light bulb is rated 150 W for 220 V ac supply of 60 Hz. Calculate
(i) the resistance of the bulb
(ii) the rms current through the bulb.

18. State Gauss' law in electrostatics. Using this law derive an expression for the electric field due to a uniformly changed infinite plane sheet.

19. Use Kirchhoff's rules to determine the value of the current I, flowing in the circuit shown in the figure.

$V = IR$ $P = I^2 R$ $\frac{V^2}{R^2} \times R$ $\frac{V^2}{R}$



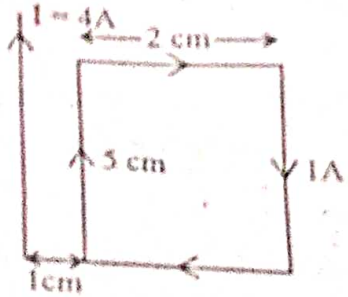
20. Two point charges 20μC and −4μC are separated by a distance of 80 cm in air.
    (i) Find the point on the line joining the charges, where the electric potential is zero.
    (ii) Also find the electrostatic potential energy of the system.

21. Calculate the de-Broglie wavelength of the electron orbiting in the n = 2 state of hydrogen atom.

SECTION-C

Answer the following questions— 3×7=21

22. A rectangular loop of wire of size 2 cm×5 cm carries a steady current of 1 A. A straight long wire carrying 4 A current is kept near the loop as shown in the figure. If the loop and the wire are coplanar, find



    (i) the torque acting on the loop and
    (ii) the magnitude and direction of the force on the loop due to the current carrying wire.

23. In a series LCR circuit connected across an ac source of variable frequency, obtain the expression for its impedance and draw a plot showing its variation with the frequency of the ac source.

24. (a) Define self inductance. Write its S.I. units.

(b) Derive an expression for self inductance of a long solenoid of length l, cross-sectional area A havine, N number of turns.

25. Depict the behaviour of magnetic field lines when

(i) a diamagnetic material and

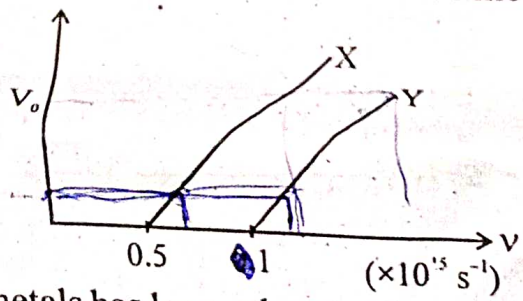
(ii) a paramagnetic material is placed in an external magnetic field. Mention briefly the properties of these materials which explain this distinguishing behaviour.

26. An electron and a photon each have a wavelength of 1.50 nm. Find :

(i) their momenta (ii) the energy of the photon and

(iii) kinetic energy of the electron

27. The following graph shows the variation of stopping potential V_0 with the frequency ν of the incident radiation for two photosensitive metals X and Y :



(i) Which of the metals has larger threshold wavelength ? Give reason.

(ii) Explain, giving reason, which metal gives out electrons, having larger kinetic energy, for the same wavelength of the incident radiation.

(iii) If the distance between the light source and metal X is halved, how will the kinetic energy of electrons emitted from it change? Give reason.

28. The total energy of an electron in the first excited state of the hydrogen atom is about –3.4 eV.

(a) What is the kinetic energy of the electron in this state ?

(b) What is the potential energy of the electron in this state ?

(c) Which of the answers above would change if the choice of the zero of potential energy is changed?

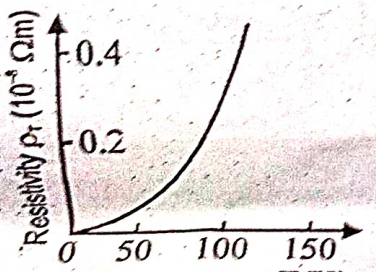
SECTION-D

Case Based Study Questions— 4×2=8

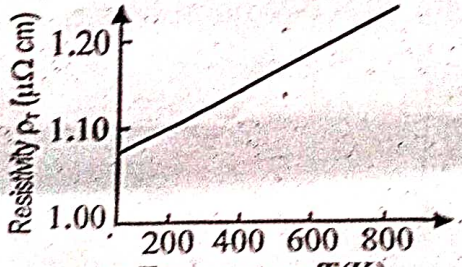
29. Case Study :

Read the following paragraph and answer the questions—

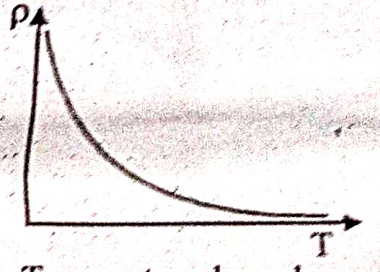
The resistance of a conductor at temperature t°C is given by $R_t = R_0(1+\alpha t)$ where R_t is the resistance at t°C, R_0 is the resistance at 0°C and α is the characteristics constants of the material of the conductor. Over a limited range of temperatures, that is not too large. The resistivity of a metallic conductor is approximately given by $\rho t = \rho_0(1+\alpha t)$ where α is the temperature coefficient of resistivity. Its unit is K^{-1} or $°C^{-1}$. For metals, α is positive i.e., resistance increases with rise in temperature. For insulators and semiconductors, α is negative i.e., resistance decreases with rise in temperature.



Resistivity ρ_T of copper as a function of temperature T



Resistivity ρ_T of nichrome as a function of temperature T



Temperature dependence of the resistivity of a typical semiconductor

(i) Fractional increase in resistivity per unit increase in temperature is defined as:

(a) resistivity (b) temperature coefficient of resistivity

(c) conductivity (d) drift velocity

(ii) The material whose resistivity is insensitive to temperature is :

(a) silicon (b) copper

(c) silver (d) nichrome

(iii) The temperature coefficient of the resistance of a wire is 0.00125 per °C. At 300 K its resistance is 1 ohm. The resistance of wire will be 2 ohms at :

$1 = \frac{0.00125}{300K} = 2 - 300K$

(a) 1154 K

(b) 1100 K

(c) 1400 K

(d) 1127 K

(iv) The temperature coefficient of resistance of an alloy used for making resistors is :

(a) small and positive

(b) small and negative

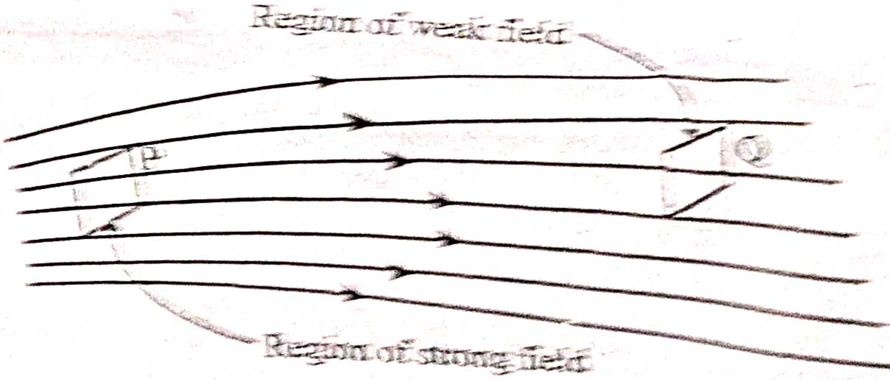
(c) large and positive

(d) large and negative

30. Case Study :

Read the following paragraph and answer the questions.

Electric field strength is proportional to the density of lines of force i.e., electric field strength at a point is proportional to the number of lines of force cutting a unit area element placed normal to the field at that point. As illustrated in given figure, the electric field at P is stronger than at Q.



(i) Electric lines of force about a positive point charge are :

(a) radially outwards

(b) circular clockwise

(c) radially inwards

(d) parallel straight lines

(ii) Which of the following is false for electric lines of force ?

(a) They always start from positive charge and terminate on negative charges.

(b) They are always perpendicular to the surface of a charged conductor.

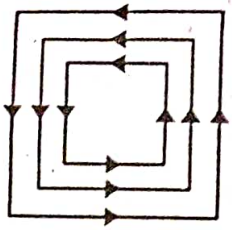
(c) They always form closed loops.

(d) They are parallel and equally spaced in a region of uniform electric field.

(iii) Which one of the following patterns of electric line of force is not possible in field due to stationary charges?

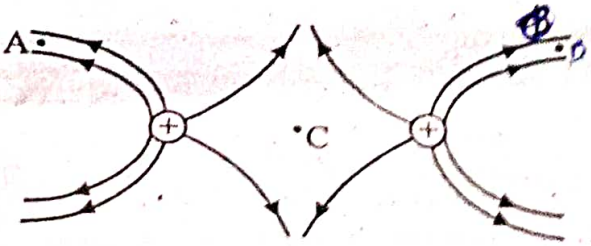
(a) 

(b) 

(c) 

(d) 

(iv) The figure below shows the electric field lines due to two positive charges. The magnitudes E_A, E_B and E_C of the electric fields at point A, B and C respectively are related as :



(a) $E_A > E_B > E_C$

(b) $E_A < E_B < E_C$

(c) $EA = EB > EC$

(d) $E_A > E_B = E_C$

SECTION-E

Answer the following questions— 5×3=15

31. (a) Draw a schematic diagram of a step-up transformer. Explain its working principle. Deduce the expression for the secondary to primary voltage in terms of the number of turns in the two coils. In an ideal transformer, how is this ratio related to the currents in the two coils? 3

(b) How is the large scale transmission of electric energy over long distances done with the use of transformers? 2

OR

(a) A series LCR circuit is connected to an a.c. source having voltage $v = v_m \sin \omega t$. Derive the expression for the instantaneous current I and its phase relaticinship to the applied voltage. Obtain the condition for resonance to occur. 3

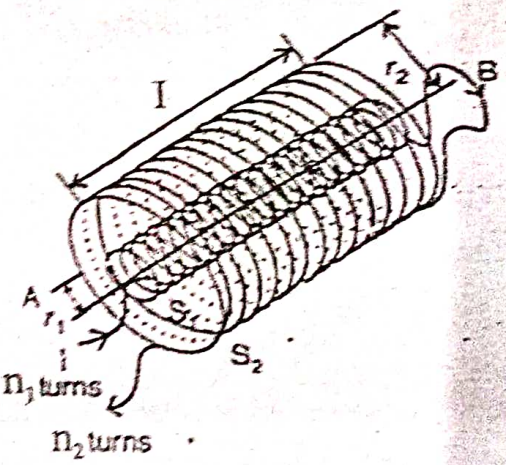
(b) Define 'power factor'. State the conditions under which it is : 2

(i) maximum and (ii) minimum

32. (a) Two long coaxial insulated solenoids, S_1 and S_2 of equal lengths are wound one over the other as shown in the figure. A steady current "I" flows through the inner solenoid S_1 to the other end B, which is connected to the outer solenoid S_2 through which the same current "I" flows in the opposite direction so as to come out at end A. If n_1 and n_2 are the number of turns per unit length, find the magnitude and direction of the net magnetic field at a point :

(i) inside on the axis and

(ii) outside the combined system. 2



(b) Draw the magnetic field lines due to a current passing through a long solenoid. Use Ampere's circuital law, to obtain the expression for the magnetic field due to the current I in a long solenoid having n number of turns per unit length. 3

OR

(a) Draw a schematic sketch of a moving coil galvanometer and describe its construction and working. 3

(b) "Increasing the current sensitivity of a galvanometer does not necessarily increase the voltage sensitivity." Justify this statement. 2

33: (a) Derive the expression for the electric potential at any point along the equatorial point of an electric dipole ? 1

(b) An electric dipole of length 4 cm, when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of $4\sqrt{3}$ Nm. Calculate the potential energy of the dipole, if it has charge ± 8nC. 2

(c) Calculate the amount of work done to dissociate a system of three charges 1μC. 1 μC and –4 μC placed on the vertices of an equilateral triangle of side 10 cm. 2

OR

(a) Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude 17×10^{-22} cm^2. What is E :

(i) in the outer region of the first plate 1

(ii) in the outer region of the second plate, and 1

(iii) between the plates ? 1

(b) Two capacitors of unknown capacitances C_1 and C_2 are connected first in series and then in parallel across a battery of 100 V. If the energy stored in the two combinations is 0.045 J and 0.25 J respectively, determine the value of C_1 and C_2. Also calculate the charge on each capacitor in parallel combination. 2