Paper - 9

Board's Question Paper (March - 2024)

Time : 1 Hour] **PART - A** **[Total Marks : 50**

❖ **Select the following questions with proper alternative and answer it :**

1) **If an electric charge 'q' is placed at the centre of a cube, then the flux associated with each surface of the cube is .....**

(A) $\frac{q}{\varepsilon_0}$ (B) $\frac{q}{6\varepsilon_0}$ (C) $\frac{q}{4\varepsilon_0}$ (D) $\frac{q}{2\varepsilon_0}$

2) **The dimensional formula of electric field is .....**

(A) $[M^1 L^1 T^{-3} A^{-1}]$ (B) $[M^1 L^2 T^{-3} A^{-1}]$

(C) $[M^1 L^1 T^{-2} A^{-1}]$ (D) $[M^0 L^1 T^{-3} A^{-1}]$

3) **Two identical conducting spheres A and B having charges $+q$ and $-q$ are kpet at 'd' distance apart experience coulombian force F between them. If 50 % of charge is transferred from sphere B to A, then the new coulombian force between them is .....**

(A) F (B) $\frac{F}{2}$ (C) $\frac{F}{4}$ (D) $\frac{2F}{3}$

4) **Three equal charge $+q$ each are placed at the three vertices of an equilateral triangle. The electric field at the centroid of the triangle is .....**

(A) $\frac{3kq}{r^2}$ (B) $\frac{kq}{r^2}$

(C) zero (D) $\frac{\sqrt{3}kq}{2r^2}$

5) **If two infinite plane sheets having same surface charge density σ are placed parallel to each other, then the electric field between the two sheet is .....**

(A) zero (B) $\frac{\sigma}{\varepsilon_0}$ (C) $\frac{\sigma}{2\varepsilon_0}$ (D) $\frac{2\sigma}{\varepsilon_0}$

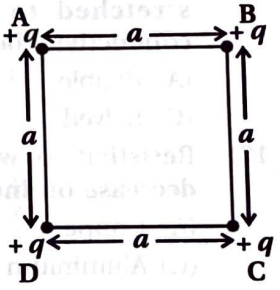
6) **As shown in figure charges $+q$ each are placed at the four vertices of a square. Then the coulombian force acting on charge placed at vertex D is .....**

(A) $\left(\sqrt{2}+\frac{1}{2}\right)\frac{kq^2}{a^2}$

(B) $\left(\sqrt{2}-\frac{1}{2}\right)\frac{kq^2}{a^2}$

(C) $\frac{\sqrt{2}kq^2}{a^2}$

(D) $\frac{kq^2}{2a^2}$



7) **Charge + Q is placed at the centre of a circular path of radius r. The work done to bring charge $+q$ from one end of the diameter to other end of the circular path in the electric field produced by charge + Q is .....**

(A) $\frac{kQq}{r}$ (B) $\frac{kQq}{2r}$ (C) zero (D) $\frac{2kQq}{r}$

8) **By keeping a conductor in an external electric field and from the result obtained by electrostatics, which of the following options is wrong ?**

(A) Inside a conductor electrostatic field is zero.

(B) At the surface of a charged conductor electric field must be perpendicular to the surface.

(C) The interior of the conductor have excess charge in static situation.

(D) Electrostatic potential is constant through out the volume of the conductor.

9) **A charged capacitor is disconnected from the battery and if the distance between the two plates of the capacitor is increased then .....**

(A) charge on plate will decrease.

(B) charge on plate will remain same.

(C) the potential difference between the two plates will decrease.

(D) capacitance of the capacitor will increase.

10) **Which of the following molecule is not polar ?**

(A) HCl (B) H_2O (C) NH_3 (D) H_2

11) If a 12 pF capacitor is connected to a 50 V battery, then the electrostatic energy stored in the capacitor is .....
(A) 1.5×10^{-12} J (B) 1.5×10^{-6} J
(C) 1.5×10^{-8} J (D) 3×10^{-8} J

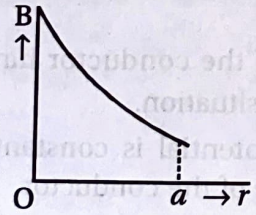
12) If a conducting wire of length L is uniformly stretched to double its length, then its conductivity becomes .....
(A) double (B) 4 times
(C) halved (D) remain same

13) Resistivity of which of the following substance decrease on increasing the temperature ?
(A) Copper (B) Silicon
(C) Aluminium (D) Nichrome

14) The storage battery of a car has an emf of 12 V. If the internal resistance of the battery is 0.6 Ω then the maximum current that can be drawn from the battery is .....
(A) 20 A (B) 25 A (C) 30 A (D) 72 A

15) If a battery of 12 V is connected across the diametrically end points A and B of a conducting ring of radius R and the current drawn from the battery is I, then the magnetic field produced at the centre of the ring due to the ring is .....
(A) zero (B) $\frac{\mu_0 I}{2R}$ (C) $\frac{\mu_0 I}{4\pi R}$ (D) $\frac{\mu_0 I}{R}$

16) Which of the following graph represents magnetic field (B) versus distance r from the centre of a long straight conducting wire of uniform cross sectional area carrying steady current I and radius a ?

(A)


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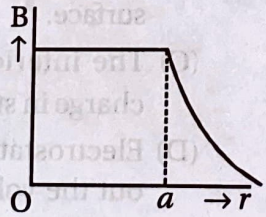

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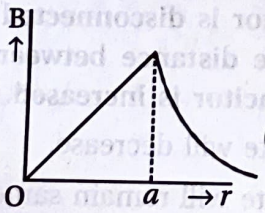
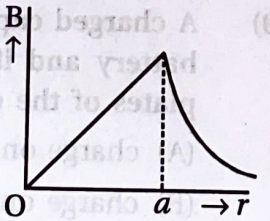


(D)


17) A closely wound solenoid 120 cm long has 4 laayers of windings of 400 turns each. The diameter of the solenoid is 1.8 cm. If the current carried is 8.0 A. Estimate the magnitude of B inside the solenoid near its centre.
(A) $5.12\pi \times 10^{-7}$ T (B) $5.12\pi \times 10^{-3}$ T
(C) $4.27\pi \times 10^{-3}$ T (D) $8\pi \times 10^{-3}$ T

18) A conducting ring of radius R and one turn is formed from a conducting wire of length L and on passing current I the obtained magnetic dipole moment is m. If this wire is then converted to a ring of two turns and on passing electric current I, the new magnetic dipole moment obtained is .....
(A) $\frac{m}{2}$ (B) $2m$ (C) $\frac{m}{4}$ (D) $4m$

19) A short bar magnet placed with its axis at 30° with a uniform external magnetic field of 0.25 T experiences a torque of magnitude 4.5×10^{-2} J. The magnitude of the magnetic moment of the magnet will be ..... $J T^{-1}$.
(A) 0.18 (B) 0.36 (C) 0.54 (D) 0.72

20) The flux associated with a closed loop is $\phi_{(t)} = 3t^2 + 2t + 5$ weber. If the resistance of the loop is 14 Ω, then the current induced in this coil in $t = 2$ sec is .....
(A) 1 A (B) 2 A (C) 1.5 A (D) 2.5 A

21) Current in a circuit falls from 5.0 A to 0.0 A in 0.1 s. If an average emf of 100 V induced then the value of self inductance of the circuit is .....
(A) 0.5 H (B) 1 H (C) 2 H (D) 4 H

22) Mutual inductance of a system of two coil does not depend on .....
(A) no. of turns of the coil.
(B) distance between two coil.
(C) the relative permeability of the medium within the coil.
(D) current passing through the coils.

23) A 1.0 m long metallic rod is rotated with an angular frequency 200 rad/s about an axis normal to the rod passing through its one end. The other end of the rod is in contact with a circular metallic ring. A constant and uniform magnetic field of 0.5 T parallel to the axis exist everywhere. The emf developed between the centre and the ring is .....
(A) 100 V (B) 200 V (C) 50 V (D) 400 V

24) From which of the following options the power factor of an A.C. circuit can be zero.

(A) R and L in series
(B) R and C in series
(C) L, C and R in series
(D) L and C in series

25) **An L-C-R series circuit is connected to an AC source of peak voltage 240 V. The phase difference between voltage and current of this circuit is 45° and resistance is 100 Ω, then the rms value of current through the circuit is .....**
(A) 5.25 A (B) 1.7 A (C) 3.5 A (D) 1.2 A

26) **Which of the following option represents Ampere-Maxwell Law ?**

(A) $\oint \vec{B} \cdot d\vec{l} = \mu_0 i_c + \mu_0 \frac{d\phi_E}{dt}$

(B) $\oint \vec{B} \cdot d\vec{l} = \mu_0 i_c + \varepsilon_0 \frac{d\phi_E}{dt}$

(C) $\oint \vec{B} \cdot d\vec{l} = \mu_0 i_c + \frac{d\phi_E}{dt}$

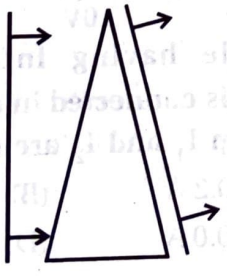
(D) $\oint \vec{B} \cdot d\vec{l} = \mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$

27) **Which of the following waves is used in speed gun to measure the speed of ball in cricket match ?**
(A) Radio wave (B) Microwave
(C) Infrared waves (D) Ultraviolet wave

28) **The speed of light in a medium of refractive index 1.25 is (Speed of light in vacuum is 3×10^8 ms^{-1})**
(A) 2.4×10^8 ms^{-1} (B) 2.0×10^8 ms^{-1}
(C) 1.5×10^8 ms^{-1} (D) 1.25×10^8 ms^{-1}

29) **A small telescope has an objective lens of focal length 140 cm and an eye piece of focal length 5 cm. The magnifying power of telescope for viewing distant object when the telescope is in normal adjustment is .....**
(A) 145 (B) 70 (C) 28 (D) 35

30) **Which of the following figure is correct on the basis of Huygens principle for refraction of a plane wave by a thin prism.**

(A)


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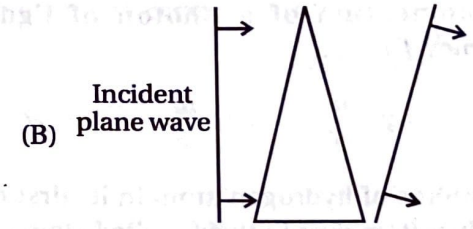
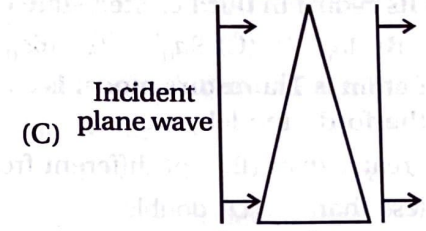


(C)


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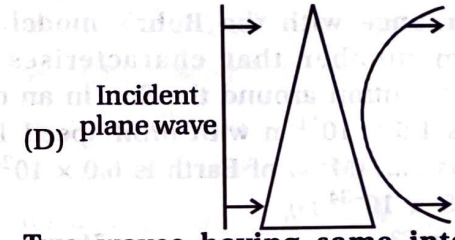


31) **Two waves having same intensity I_0 and originated from two non-coherent sources superpose at a point. The average intensity at the point is .....**
(A) I_0 (B) $2I_0$
(C) $3I_0$ (D) $4I_0$

32) **In the case of photoelectric effect, on increasing the frequency of incident light .....**
(A) photelectric current increases
(B) photoelectric current decreases
(C) stopping potential increases
(D) stopping potential decreases

33) **The photoelectric cut-off voltage in a certain experiment is 1.5 V. What is the maximum kinetic energy of photoelectrons emitted ?**
(A) 1.5 eV (B) 3.0 eV
(C) 1.5 J (D) 1.6×10^{-19} J

34) **If de-Broglie wavelength of a dust particle of mass 1.0×10^{-9} kg is 3×10^{-25} m, then the speed of the particle is .....**
($h = 6.625 \times 10^{-34}$ Js)
(A) 1.1 ms^{-1} (B) 1.0 kms^{-1}
(C) 1.2 kms^{-1} (D) 2.2 ms^{-1}

35) **Threshold frequency of which of the following metal does not lie in the ultraviolet region. (In case of photoelectric effect)**
(A) Zinc (B) Cadmium
(C) Magnesium (D) Sodium

36) The momentum of a photon of light of frequency f is .....

(A) $\frac{hc}{f}$ (B) $\frac{h}{cf}$ (C) $\frac{hf}{c}$ (D) hcf

37) If the radius of hydrogen atom in its first orbit is a_0, then its radius in third excited state is .....

(A) $3a_0$ (B) $4a_0$ (C) $9a_0$ (D) $16a_0$

38) The size of atom is Thomson's model is ..... the size in Rutherford's model.

(A) much greater than (B) not different from
(C) much less than (D) double

39) In accordance with the Bohr's model, the quantum number that characterises the Earth's revolution around the Sun in an orbit of radius 1.5×10^{11} m with orbit speed 1.5×10^4 m/s is ..... (Mass of Earth is 6.0×10^{24} kg, $h = 6.625 \times 10^{-34}$ Js)

(A) 2.6×10^{72} (B) 2.6×10^{74}
(C) 2.6×10^{39} (D) 2.6×10^{73}

40) Kinetic energy of electron in one of the orbit of hydrogen atom is x then its total energy is .....

(A) $-x$ (B) $-\frac{x}{2}$ (C) $-2x$ (D) $-\frac{x}{8}$

41) Choosing the correct option, complete the given nuclear fusion reaction that occurs in the Sun.

$_3^2H + _2^3H \rightarrow _2^4He + _1^1H + _1^1H +$ .....

(A) 0.42 MeV (B) 1.02 MeV
(C) 12.86 MeV (D) 5.49 MeV

42) The radius of nuclei of $_{13}^{27}Al$ is ..... ($R_0 = 1.2$ fm)

(A) 3.0×10^{-15} m (B) 3.6×10^{-15} m
(C) 3.2×10^{-14} m (D) 3.6×10^{-12} m

43) Which of the following element has maximum binding energy per uncleon ?

(A) Uranium (B) Lithium
(C) Tungsten (D) Iron

44) According to Einsteins mass-energy equivalent relation, the energy equivalent of 1 mg of substance is .....

(Speed of light in vacuum C = 3×10^8 m/s)

(A) 9×10^{13} J (B) 9×10^{10} J
(C) 9×10^{-13} J (D) 9×10^{-10} J

45) The atomic masses of two isotopes of an element are 34.98 u and 36.98 u and their relative abundance are 75.4 % and 24.6 % respectively, then the average atomic mass of the element is .....

(A) 34.51 u (B) 36.46 u
(C) 35.47 u (D) 35.99 u

46) In a p-type semiconductor, which of the following statements is true ?

(A) Electrons are majority charge carriers and trivalent atoms are the dopants.
(B) Electrons are minority charge carriers and pentavalent atoms are the dopants.
(C) Holes are minority carriers and pentavalent atoms are the dopants.
(D) Holes are majority carriers and trivalent atoms are the dopants.

47) When a forward bias is applied to a p-n junction it ..... .

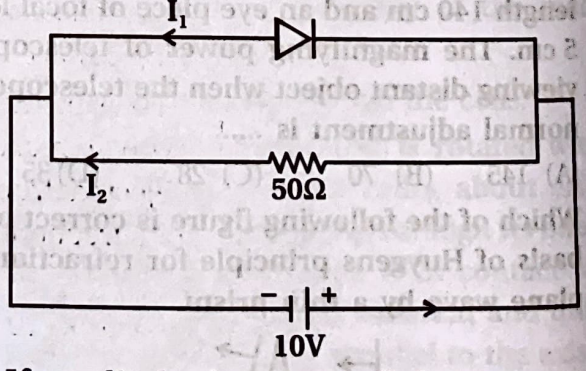
(A) raises the potential barrier
(B) reduces the majority carrier to zero
(C) lowers the potential barrier
(D) potential barrier remain same

48) What type of semiconductor is CdS ?

(A) Elemental (B) Organic
(C) Inorganic (D) Organic polymer

49) Which of the following substance have energy gap (E_g) more than 3 eV ?

(A) Metals (B) Alloys
(C) Semiconductor (D) Non-metals

50) 

If a diode having infinite reverse-bias resistance is connected in a circuit as shown in figure, then I_1 and I_2 are respectively .....

(A) 0.0 A; 0.2 A (B) 10.0 A; 0.0 A
(C) 0.2 A; 0.0 A (D) 0.0 A; 0.0 A

Time : 2 Hours] PART - B [Total Marks : 50

Section - A

❖ **Answer any 8 of the following given question 1 to 12 : (Each carries 2 marks)** [16]

1) Derive the formula for the torque acting on a dipole placed in a uniform external electric field.

2) An infinite line charge produces a field of 9×10^4 N/C at a distance of 2 cm. Calculate the linear charge density.

3) Define mobility and write its formula, unit and dimensional formula.

4) Write the characteristics of magnetic field lines.

5) Obtain the expression for the magnetic energy stored in a solenoid in terms of magnetic field B, area A and length l of the solenoid and hence obtain formula for magnetic energy per unit volume.

6) A 100 Ω resistor is connected to a 220 V, 50 Hz AC supply.
   (a) What is the rms value of current in the circuit ?
   (b) What is the net power consumed over a full cycle ?

7) Derive the relation between focal length (f) and radius of curvature (R) for a spherical convex mirror with the help of a geometrical diagram of reflection of incident ray on a convex spherical mirror.

8) Using Huygens principle, explain reflection of a plane wave by a plane reflecting surface.

9) Light of frequency 7.21×10^{14} Hz is incident on a metal surface. Electrons with a maximum speed of 6.0×10^5 m/s are ejected from the surface. What is the threshold frequency for photoemission of electrons ?
   ($h = 6.625 \times 10^{-34}$ Js, $e = 1.6 \times 10^{-19}$ C, $m = 9.1 \times 10^{-31}$ kg)

10) A hydrogen atom initially in the ground level absorbs a photon which excites it to the $n = 4$ level. Determine the wavelength and frequency of photon.
   ($h = 6.625 \times 10^{-34}$ Js, C = 3×10^8 m/s)

11) Write any two features of nuclear binding force.

12) Suppose a pure Si crystal has 5×10^{28} atom m^{-3}. It is doped by 1 ppm concentration of pentavalent As. Calculate the number of electrons and holes. Given that ($n = 1.5 \times 10^{16}$ m^{-3})

Section - B

❖ **Answer any 6 of the following given questions 13 to 21 : (Each carries 3 marks)** [18]

13) A spherical conductor of radius 12 cm has a charge of 1.6×10^{-7} C distributed uniformly on its surface. What is the electric field :
   (a) inside the sphere ?
   (b) just outside the sphere ?
   (c) at a point 18 cm from the centre of the sphere ?

14) Obtain the formula for equivalent emf and equivalent internal resistance of a series combination of two cells of emf ε_1 and ε_2 and internal resistance r_1 and r_2 respectively.

15) Obtain the formula for force acting between two parallel straight current carrying conductors and hence define one ampere.

16) A horizontal straight wire 10 m long extending from east to west is falling with a speed of 5.0 ms^{-1} at right angle to the horizontal component of the earth's magnetic field 3×10^{-5} Wb m^{-2}.
   (a) What is the instantaneous value of the emf induced in the wire ?
   (b) What is the direction of the emf ?
   (c) Which end of the wire is at the higher electrical potential ?

17) In actual transformers, small energy losses do occur. Give reason for it and how it can be reduced. (Any three)

18) (a) The radii of curvatures of the faces of a double convex lens are 10 cm and 15 cm. Its focal length is 12 cm. What is the refractive index of the material of lens ?
   (b) A convex lens of glass has 20 cm focal length in air. What is focal length in water ? (Refractive index of air-water is 1.33. Refractive index of air-glass = 1.5)

19) Discuss the intensity of transmitted light when a polaroid sheet is rotated between two crossed polaroids.

20) Summarise any three experimental features and observation described in the experimental study of photoelectric effect.

21) On the basis of Bohr's postulate obtain the formula for radius and total energy of electron in the n^{th} stable orbit for hydrogen atom.

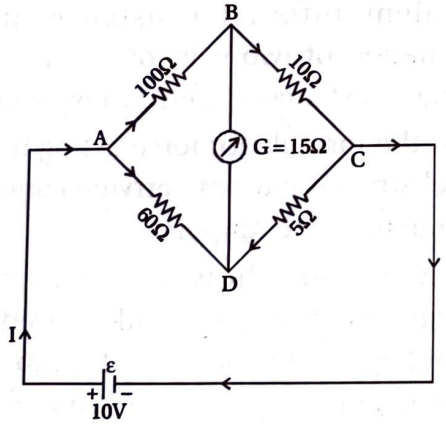
Section - C

❖ **Answer any 4 of the following given questions from 22 to 27 : (Each carries 4 marks)** [16]

22) Derive the formula for electric potential due to an electric dipole at a point having position vector $\vec{r}$ with respect to the mid-point of the dipole and discuss the electric potential on

(a) equator, (b) axis

23) As shown in figure, resistances are connected in the four arms of a Wheatstone bridge.



A galvanometer of 15 Ω resistance is conneceted across BD. Calculate the current through galvanometer when a potential difference of 10 V is maintained across AC.

24) A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series LCR circuit in which R = 3Ω, L = 25.48 mH and C = 796 μF. Find :

(a) the impedance of the circuit

(b) the phase difference between the voltage across the source and the current

(c) the power dissipated in the circuit and

(d) the power factor

25) Draw the ray diagram for the formation of image by a compound microscope and obtained the formula for magnification.

26) How long can an electric lamp of 100 W be kept glowing by fusion of 2.0 kg of deuterium ? Take the fusion reaction as :

$$_1^2H + _1^2H \rightarrow _2^3He + n + 3.27\ MeV$$

27) Explain full wave rectification with the help of proper circuit diagram and draw the wave form of input and output voltage.

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