Techno India Batanagar
Basic Science and Humanities

Model Questions

Subject Name: Physics **Subject Code:** PH 401

Multiple Choice Questions

1) The angle between $\hat{\jmath}$ and $2\hat{\imath} + 3\hat{\jmath}$ is
(a) $\cos^{-1}\left(\frac{13}{\sqrt{3}}\right)$ (b) $\cos^{-1}\left(\frac{3}{\sqrt{13}}\right)$ (c) $\text{Sin}^{-1}\left(\frac{13}{\sqrt{3}}\right)$ (d) $\text{Sin}^{-1}\left(\frac{3}{\sqrt{13}}\right)$

2) For two antiparallel collinear vectors $\vec{F}$ and $\vec{G}$ we can write (a)$\vec{F} \times \vec{G} = -\vec{F}\vec{G}$ (b)$\vec{F} \times \vec{G} = -\vec{G}\vec{F}$ (c) $\vec{F} \times \vec{G} = -1(d)\vec{F} \times \vec{G} = 0$

3) If electric field vector $\vec{E}$ and magnetic field vector $\vec{H}$are at right angles to each other, the wave propagates in the direction of
(a) $\vec{E} \times \vec{E}\vec{H}$ (b) $\vec{H}.\vec{E}$ (c) $\vec{E}.\vec{H}$ (d) $\vec{E} \times \vec{H}$

4) The Poisson's equation for electrostatic field is –
(a) $\nabla^2 V = 0$, (b) $\nabla^2 V = -\frac{\rho}{\epsilon_0}$, (c) $\nabla^2 \rho = -\frac{V}{\epsilon_0}$, (d) $\nabla^2 V = \frac{\rho}{\epsilon_0}$

5) If μ and σ are the permeability const. and conductivity of a medium, the skin depth δ is given by

(a) $\delta = \frac{2}{\mu\sigma\omega}$, (b) $\delta = \frac{1}{\mu\sigma\omega}$, (c) $\sqrt{\frac{2}{\mu\sigma\omega}}$ (d) None of these

6) The Laplace's equation for electrostatic field is –
(a) $\nabla^2 V = 0$, (b) $\nabla^2 V = -\frac{\rho}{\epsilon_0}$, (c) $\nabla^2 \rho = -\frac{V}{\epsilon_0}$, (d) $\nabla^2 V = \frac{\rho}{\epsilon_0}$

7) Electric field intensity and electric flux density in an isotropic medium is related by
(a)$\vec{D} = \epsilon^2 \vec{E}$, (b) $\vec{E} = \epsilon \vec{D}$, (c) $\vec{D} = \epsilon \vec{E}$, (d) $\vec{E} = -\epsilon \vec{D}$

8) If a solenoid carrying 3 mA current is 40m long and has 100 turns, what is the magnetic field at a distance of 4 m outside the solenoid? -(a) 400 T, (b) 120 T, (c) 33.3 T, (d) 0T

(9)What is the velocity (approx.) of an electromagnetic wave propagating through a medium with relative permittivity 4 and relative permeability 1 - (a) 1.7×10^8 m/s, (b) 1.5×10^8 m/s, (c) 1.2×10^8 m/s, (d) 5.1×10^8 m/s

(10) Average energy of an electron in metal at T = 0 K is

(a) $\frac{5}{2}\epsilon_F$, (b) $\frac{1}{2}\epsilon_F$, (c) $\frac{3}{5}\epsilon_F$ (d) None of these

Short answer type questions

11) Express physical entities like 'work done', 'power', 'magnetic flux' and 'Electric flux' in form of scalar product (or dot product)

12) Prove that $\vec{\nabla} \times (\vec{\nabla} \times \vec{\mathbf{F}}) = \vec{\nabla}(\vec{\nabla} \cdot \vec{\mathbf{F}}) - \vec{\nabla}^2\vec{\mathbf{F}}$ for any vector

13) Write down Gauss divergence theorem and Stoke's theorem.

14) What is electrostatic flux, electric potential and Write down the differential and integral forms of Gauss law of electrostatics in free space and dielectric medium

15) A very long cylindrical (of radius *a*) charge distribution proportional to the distance from the axis (*r*). Find the electric field both at *r > A and R < a*

16) Write down Laplace's equation in cylindrical coordinate system and use the equation to find out the potential inside a cylindrical capacitor

17) Write down Gauss's divergence theorem. Determine $\nabla^2\left(\frac{1}{r}\right)$, where 'r' is usual position vector

18) Derive Coulomb's theorem from Gauss's law of electrostatics. Calculate the magnetic field intensity along the axis of 2 m long solenoid carrying a current of 20 mA if it has 110 turns

19) Use Gauss law to find out electric field between infinite parallel plate capacitor carrying a charge density and separation check whether the potential *V(x,y)* satisfies the Laplace's equation

20) Define polarization vector$(\vec{p})$ and displacement vector$(\vec{D})$. Establish relationship between D, E and P.

21) Using Gauss divergence theorem and Stokes theorem, prove $\vec{\nabla}.(\vec{\nabla} \times \vec{A}) = 0$ for any vector A

22) Establish the relation $\vec{D} = \varepsilon_0 \vec{E} + \vec{P}$. What is Electric Displacement vector?

23) Rewrite the differential form of Gauss's Law in terms of displacement vector $(\vec{D})$.

24) Show the electronic polarizability is proportional to the atomic volume

25) Show that when a dielectric is placed in an electric field, the field within the dielectric becomes weaker.

26) State the Ampere's Law of Magnetostatics. Obtain its differential form from Integral form. Use this law to derive an expression for Magnetic Field due to a **straight infinite conductor** carrying current.

27) Deduce an expression of the force experienced by a current element placed in a Magnetic Field. Write Lorentz Force equation and Bio-Savart's law

28) Calculate the Magnetic Field along the axis and at centre of a current carrying circular coil

with n turns.

29) Calculate the Magnetic Field induction due to a wire carrying current I at a point P situated at R distance from it.

30) Show that is the magnetic vector potential associated with B, if $\vec{A} = \frac{1}{2}(\vec{B} \times \vec{r})$

31) Find out the magnetic vector corresponding to an electric vector of an electromagnetic field $\vec{E} = \vec{E}_{e^{i(kx-wt)}}$

32) Considering Maxwell's (electromagnetic field) equations, check whether $\vec{E} = Sin(5y - t)$and $\vec{B} = Sin(5y - t)$ construct a electromagnetic wave or not.

33) State polarization of monoatomic gas and show $\alpha_e = 4\pi\epsilon_o a^3$

34) Show that magnetic field due to a long straight wire independent of its length.

35) State Faraday's laws of electromagnetic induction, (b) What are the differences between conduction current and displacement current, (c) Why Classical Mechanics includes degrees of freedom and generalized coordinates ?

36) Find the skin depth at a frequency 0.8 MHz in copper wire with conductive. ity 76.4×10^6 mho.m^{-1} and magnetic permeability $4\pi\times10^{-7}$ henry.m^{-1}. 6.63e5m What is Poynting Vector?

37) Find out the value of $[\hat{x}, \widehat{p_x}]$, Give its physical significance.

38) What are Holonomic, conservative and Scleronomic constraint(s).Give examples

39) Show that $\vec{\nabla} \times (\vec{\nabla} \times \vec{B}) = -\nabla^2\vec{B} + \vec{\nabla}(\vec{\nabla}.\vec{B})$. When a vector is called to be irrotational?

40) Write down Maxwell's equations for good conductor.

41) Calculate the magnetic field intensity and magnetic field induction for a hollow cylinder of 2 cm radius just outside it if it carries 500 mA current.

43). Use Stoke's theorem to evaluate line integral $\oint \vec{F}.dr$ for a vector $\vec{F} = y\hat{\imath} + xz^3\hat{\jmath} - zy^3\hat{k}$ in a circle $x^2 + y^2 = 4$ and $z = -3$. Write down physical significance of Maxwell's equation$\nabla.\vec{B} = 0$.

43) State Ampere's circuital law and express mathematically (integral form). If a metallic spherical shell of radius 0.5 m carries electric charge of 2C, calculate the electric field at a point 4m from the centre, at the surface and inside the sphere.

44). Write down Maxwell's equations for static (time invariant) field. Using Maxwell's (electromagnetic field) equations show that light progressing through a charge free conducting medium behaves like an electromagnetic wave.

45) Show that $\vec{\nabla} \times (\vec{\nabla} \times \vec{B}) = -\nabla^2\vec{B} + \vec{\nabla}(\vec{\nabla}.\vec{B})$. When a vector is called to be irrotational?

46) Demonstrate the application of Laplace's equation to evaluate the potential inside a spherical

capacitor. If carbon atom has radius 0.064 nm, find its electrical polarizability

47) Check whether position and momentum operator commutes. Explain your result in context of Heisenberg's uncertainty principle. Define eigenvalue with example

48) Derive the Lagrangian and Hamiltonian (in one dimension) of a body of mass M falling freely under gravity. What are the advantages of generalized coordinates?

49) Find the eigenvalues of energy of energies of a particle in a one dimensional box of length d What is corresponding normalized wave function?

50) Draw the distribution of Bosons for different energy levels at low & high temperature. Consider a two Boson particle system each of which can be kept in states S1, S2 and S3. What are the possible states- show with equation and table.

51). Find the time period of a simple harmonic oscillator using Lagrangean method.

52) Write time-dependent Schrödinger equation and derive time-independent equation from it.

53) Find the energy and wave function of a particle inside the infinite potential well by using Schrödinger equation.

54) Write (a) Maxwell-Boltzmann, (b) Fermi-Dirac, and (c) Bose-Einstein distribution functions. (d) What is Fermi energy? Derive an expression for it.

55) Two particles have three different energy states. Find the possible arrangements according to (a) MB, (b) FD and (c) BE statistics.

56) (a) State differential form of Ampere's law, (b)Write Maxwell's equations with theirphysical significances. (c) Derive the Lagrangian and Hamilton's equations of motion for a free falling particle under the influence of gravity.

57)Derive Lagrangean equation of motion from the D'Alembert's Principle.

58)Find the expression of energy and wave function of a particle inside an infinite one dimensional potential well. Find the energy difference between 1st and 3rd levels.

59)Consider a two-particle system, each of which can exist in states e_1,e_2,e_3. What are the possible states, if the particles are (i) bosons, (ii) fermions and (iii) boltzon.

60) Use Stoke's theorem to evaluate line integral $\oint \vec{F}.dr$ for a vector $\vec{F} = y\hat{\imath} + xz^3\hat{\jmath} - zy^3\hat{k}$ in a circle $x^2 + y^2 = 4$ and $z = -3$. Write down physical significance of Maxwell's equation$\nabla.\vec{B} = 0$.

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