Class XII Session 2024-25

PHYSICS FULL SYLLABUS MOCK TEST – 04

Maximum Marks: 70 **Time allowed: 3 hours**

General Instructions:

1. There are 33 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
3. **Section A** contains **sixteen questions, twelve MCQ 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 questions of four marks each** and **Section E** contains **three long answer questions of five marks each.**
4. There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.
6. You may use the following values of physical constants where ever necessary

i. $c = 3 \times 10^8$ m/s

ii. $m_e = 9.1 \times 10^{-31}$ kg

iii. $m_p = 1.7 \times 10^{-27}$ kg

iv. $e = 1.6 \times 10^{-19}$ C

v. $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

vi. $h = 6.63 \times 10^{-34}$ J s

vii. $\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

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

SECTION – A

[16 × 1]

1. When a p-n diode is reverse biased, then

a) the height of the potential barrier is reduced b) the depletion region is increased

c) no current flows d) the depletion region is reduced

2. How many coulombs of electricity must pass through acidulated water to liberate 22.4 litres of hydrogen at N.T.P.?

a) 193000 C b) $1.6 \times 10^{-19} C$ c) 96500 C d) 19300 C

3. Which of the following is used in optical fibers?

a) Scattering b) Refraction c) Diffraction d) Total internal reflection

4. The arrangement for two magnetic poles of equal and opposite strengths separated by a finite distance is called:

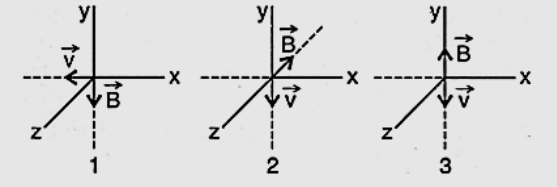
a) Magnetic dipole b) Magnetic current c) Magnetic field d) Magnetic pole

5. The dielectric constant K of an insulator will be –

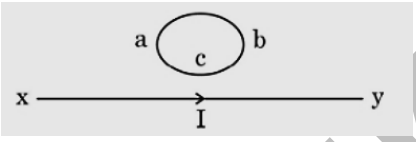
a) 0.4 b) 4 c) -4 d) 0

6. The following figure shows three situations when an electron with velocity $\vec{v}$ travels through a uniform magnetic Field $\vec{B}$. In each case, what is the direction of magnetic force on the electron?

a) -ve z-axis, -ve x-axis and zero
b) -ve z-axis, +ve x-axis and zero
c) +ve z-axis, -ve x-axis, +ve y-axis
d) +ve z-axis, +ve y-axis and zero



7. The direction of induced current in the loop abc is:
a) along abc if I is constant
b) along abc if I increase
c) along abc if I decrease
d) along acb if I increase



8. The universal property among all substances is

a) ferromagnetism b) non-magnetism c) diamagnetism d) paramagnetism

9. Phenomenon of bending of waves around corners of obstacle without a change in medium is called --------.

a) diffraction b) interference c) reflection d) refraction

10. The magnitude of the electric field due to a point charge object at a distance of 4.0 m is 9 N/C. From the same charged object the electric field of magnitude, $16\frac{N}{C}$ will be at a distance of

a) 3 m b) 1 m c) 6 m d) 2 m

11. The output of the given circuit in Figure.
a) would be like a half-wave rectifier with negative cycles in output
b) would be like a half-wave rectifier with positive cycles in output
c) would be like that of a full-wave rectifier
d) would be zero at all times

12. An equi-convex crown glass lens has a focal length 20 cm for violet rays. Here $\mu_v = 1.5$ & $\mu_r = 1.47$. Its focal length for red rays is

a) 24.85 cm b) 20.82 cm c) 21.28 cm. d) 22.85 cm

13. **Assertion (A):** If the frequency of the incident light on a metal surface is doubled, the kinetic energy of emitted electrons is more than doubled.
Reason (R): The metal will provide additional energy to the emitted photoelectron for light of higher frequency than that for lower frequency.
a) Bath A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

14. **Assertion (A):** Two equipotential surfaces cannot cut each other.
Reason (R): Two equipotential surfaces are parallel to each other.

a) Bath A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

15. **Assertion (A):** Colours are seen in thin layers of oil on the surface of the water.
Reason (R): White light is composed of several colours.
a) Bath A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

16. **Assertion:** An electric lamp is connected in series with a long solenoid of copper with air core and then connected to ac source. If an iron rod is inserted in solenoid, the lamp will become dim.
Reason: If an iron rod is inserted in solenoid, the inductance of solenoid increases.
a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
c) Assertion is correct statement but reason is wrong statement.
d) Assertion is wing statement but reason is correct statement.

SECTION – B

[05 × 2]

17. An e.m. wave is travelling in a medium with a velocity $v = v\,\hat{\imath}$. The electric field oscillations, of this e.m. wave, are along the y-axis.
a. Identify the direction in which the magnetic field oscillations are taking place, of the e.m. wave.
b. How are the magnitudes of the electric field and magnetic fields in the electromagnetic wave related to each other?

18. Two identical bars, one of paramagnetic material and other of diamagnetic material are kept in a uniform external magnetic field parallel to it. Draw diagrammatically the modifications in the magnetic field pattern in each case.

19. Describe briefly, with the help of a diagram, the role of the two important processes involved in the formation of a p-n junction.

20. An α-particle after passing through a potential difference of 2×10^6 V falls on a silver foil. The atomic number of silver is 47. Calculate (i) the kinetic energy of the α-particle at the time of falling on the foil (ii) the kinetic energy of the α-particle at a distance of 5×10^{-14} m from the nucleus and (iii) the shortest distance from the nucleus of silver to which the α-particle reaches.

21. The maximum torque acting on a coil of effective area 0.04 m^2 is 4×10^{-8} Nm when the current in it is 100 pA. Find the magnetic induction in which it is kept. [2]

OR

A long straight wire carrying a current of 30 A is placed in an external uniform magnetic field of 4.0×10^{-4} T parallel to the current. Find the magnitude of the resultant magnetic field at a point 2.0 cm away from the wire.

SECTION – C

[07 × 3]

22. In a Wheatstone bridge, $P = 1\Omega$, $Q = 2\Omega$, $R = 2\Omega$, $S = 3\Omega$ and $R_g = 4\Omega$. Find the current through the galvanometer in the unbalanced position of the bridge, when a battery of 2V and internal resistance 2Ω is used.

23. Draw the energy band diagrams (at $T > 0K$) for n-type and p-type semiconductors. Using diagram, explain why in n-type semiconductor the conduction band has most electrons from the donor impurities.

24. The energy flux of sunlight reaching the surface of the earth is 1.388×10^3 W/m^2. How many photons (nearly) per square metre are incident on the Earth per second? Assume that the photons in the sunlight have an average wavelength of 550 nm.

25. The radionuclide ^{11}C decays according to ${}^{11}_{6}C \rightarrow {}^{11}_{5}B + e^{+} + v : T_{1/2} = 20.3$ min. The maximum energy of the emitted positron is 0.960 MeV. Given the mass values: m $(\frac{11}{6}\text{C}) = 11.011434$ u and m $(\frac{11}{5}\text{B}) = 11.009305$ u, calculate Q and compare it with the maximum energy of the positron emitted.

26. The photon emitted during the de-excitation from the first excited level to the ground state of hydrogen atom is used to irradiate a photocathode of a photocell, in which stopping potential of 5 V is used. Calculate the work function of the cathode used.

27. In a Young's double experiment, the slits are 1.5 mm apart. When the slits are illuminated by a monochromatic light source and the screen is kept 1 m apart from the slits, width of 10 fringes is measured as 3.93 mm. Calculate the wavelength of light used. What will be the width of 10 fringes when the distance between the slits and the screen is increased by 0.5 m. The source of light used remains the same.

28. State Lenz's law. Give one example to illustrate this law. "The Lenz's law is a consequence of the principle of conservation of energy." Justify this statement.

OR

A metallic rod of length 1 and resistance R is rotated with a frequency v, with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius I, about an axis passing through the centre and perpendicular to the plane of the ring. A constant and uniform magnetic field B parallel to the axis is present everywhere.

i. Derive the expression for the induced emf and the current in the rod.

ii. Due to the presence of the current in the rod and of the magnetic field, find the expression for the magnitude an direction of the force acting on this rod.

iii. Hence obtain the expression for the power required to rotate the rod.

SECTION – D

[02 × 4]

29**. Case Study Based Question:**

Maxwell showed that the speed of an electromagnetic wave depends on the permeability and permittivity of the medium through which it travels. The speed of an electromagnetic wave in free space is given by $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$. The fact led Maxwell to predict that light is an electromagnetic wave. The emergence of the speed of light from purely electromagnetic considerations is the crowning achievement of Maxwell's electromagnetic theory. The speed of an electromagnetic wave in any medium of permeability μ and permittivity ε will be $\frac{c}{\sqrt{K \mu_r}}$ where K is the dielectric constant of the medium and μ_r is the relative permeability.

(a) The dimensions of $\frac{1}{2}\ \varepsilon_0\ E^2$ (ε_0: permittivity of free space; E = electric field) is

a) MLT^{-1} b) $M\ L^{-1}\ T^{-2}$ c) $M\ L^2\ T^{-2}$ d) $M\ L^2\ T^{-1}$

(b) Let $[\varepsilon_0]$ denote the dimensional formula of the permittivity of the vacuum. If M = mass, L = length, T = time and A = electric current, then

a) $[\varepsilon_0] = ML^2\ T^{-1}$ b) $[\varepsilon_0] = MLT^{-2}\ A^{-2}$

c) $[\varepsilon_0] = M^{-1}\ L^{-3}\ T^4\ A^2$ d) $[\varepsilon_0] = M^{-1}\ L^{-3}\ T^2\ A$

(c) An electromagnetic wave of frequency 3 MHz passes from vacuum into a dielectric medium with permittivity ε = 4 Then

a) wavelength is halved and the frequency remains unchanged.

b) wavelength and frequency both remain unchanged

c) wavelength is doubled and the frequency remains unchanged

d) wavelength is doubled and the frequency becomes half

OR

The electromagnetic waves travel with

a) the speed of light $c = 3 \times 10^8\ ms^{-1}$ in fluid medium.

b) the speed of light $c = 3 \times 10\ ms^{-1}$ in solid medium

c) the speed of light $c = 3 \times 10^8\ ms^{-1}$ in free space

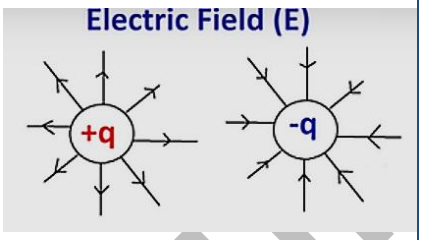
d) the same speed in all media

(d) Which of the following are not electromagnetic waves?

cosmic rays, γ-rays, β-rays, X-rays

a) β-rays b) X-rays c) γ-rays d) cosmic rays

Q30. **Case Study Based Question: Photoelectric effect**



Electric field intensity at any point is the strength of the electric field at that point. It is also defined as the force experienced by unit positive charge placed at that point. Electric Field Intensity is a vector quantity. It is denoted by E. When placed within the electric field, the test charge will experience an electric force - either attractive or repulsive.

(a) The Electric field at a point is

a) discontinuous only if there is a negative charge at that point

b) always continuous

c) continuous if there is charge at that point

d) continuous if there is no charge at that point

(b) A charge is distributed uniformly over a ring of radius a. Obtain an expression for the electric intensity E at a point on the axis of the ring. Hence the points at large distances from the ring, it behaves like a point charge is:

a) $E = \frac{1}{4\pi\varepsilon_0}.\frac{q}{x}$ b) $E = \frac{1}{2\pi\varepsilon_0}.\frac{Q}{x^2}$ c) $E = \frac{1}{4\pi\varepsilon_0}.\frac{q}{x^4}$ d) $E = \frac{1}{4\pi\varepsilon_0}.\frac{q}{x^2}$

(c) Force acting on an electron in a uniform electric field of 5×10^4 N/C is:

a) 8×10^{-15} N b) -7×10^{-15} N c) -8×10^{-15} d) 7×10^{-15}

(d) At a particular point, the electric field depends upon

a) source charge Q only b) both Q and q c) test charge q_0 only d) neither Q nor q

OR

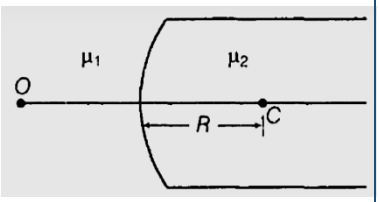
Four charges of the same magnitude and same sign are placed at the corners of a square, of each side 0.1 m. then electric field intensity at the centre of the square is:

a) 0.01 N/C b) 0.25 N/C c) zero d) 0.1 N/C

SECTION – E

[03 ×5]

31. Figure shows a convex spherical surface with centre of curvature C separating the two media of refractive indices μ_1 and μ_2. Draw a ray diagram showing the formation of the image of a point object O lying on the principal axis. Derive the relationship between the object and image distance in terms of refractive indices of the media and the radius of curvature R of the surface.



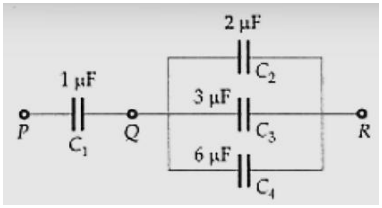
OR

a. Use Huygen's geometrical construction to show how a plane wavefront at t = 0 propagates and produces a wavefront at a later time.

b. Verify, using Huygen's principle, Snell's law of refraction of a plane wave propagating from a denser to a rarer medium.

c. Illustrate with the help of diagrams the action of i. convex lens and ii. concave mirror, on a plane wavefront incident on it.

32. In Fig. the energy stored in C_4 is 27 J. Calculate the total energy stored in the system.



OR

i. A. Why does the electric field inside a dielectric slab decrease when kept in an external electric field?

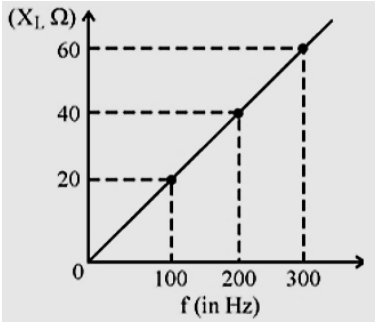
B. Derive an expression for the capacitance of a parallel plate capacitor filled with a medium of dielectric constant K.

ii. A charge q = 2 μC is placed at the centre of a sphere of radius 20 cm. What is the amount of work done in moving 4 μC from one point to another point on its surface?

iii. Write a relation for polarisation $\vec{P}$ of a dielectric material in the presence of an external electric field.

33. a. Show that an ideal inductor does not dissipate power in an ac circuit.

b. The variation of inductive reactance (X_L) of an inductor with the frequency (f) of the ac source of 100 V and variable frequency is shown in the fig.



i. Calculate the self-inductance of the inductor.

ii. When this inductor is used in series with a capacitor of unknown value and a resistor of 10Ω at 300 s^{-1}, maximum power dissipation occurs in the circuit. Calculate the capacitance of the capacitor.

OR

i. What do you understand by the sharpness of resonance in a series L-C-R circuit? Derive an expression for Q-factor of the circuit.

ii. Three electrical circuits having AC sources of variable frequency are shown in the figures. Initially, the current flowing in each of these is same. If the frequency of the applied AC source is increased, how will the current flowing in these circuits be affected? Give the reason for your answer.