Class XII Session 2024-25

PHYSICS FULL SYLLABUS MOCK TEST – 06

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

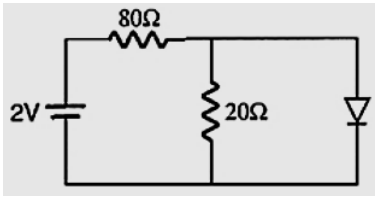
vii. $\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

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

SECTION – A

[16 × 1]

1. In the circuit shown, the current through the ideal diode is:



a) 100 mA

b) 20 mA

c) 25 mA

d) 75 mA

2. $m^2 V^{-1} s^{-1}$ is the SI unit of which of the following?

a) Potential gradient b) Mobility c) Drift velocity d) Resistivity

3. For a glass prism, the angle of minimum deviation will be smallest for the light of

a) blue colour b) yellow colour c) green colour d) red colour.

4. A bar-magnet of the pole-strength 2 Amp-m is kept in a magnetic field of induction 4×10^{-5} Wb/m^2 such that the axis of the magnet makes an angle 30° with the direction of the field. If the couple acting on the magnet is found to be 80×10^{-7} Nm, then the distance between the poles of the magnet is:

a) 20 cm b) 4 m c) 2 m d) 8 m

5. A proton is about 1840 times heavier than an electron. When it is accelerated by a potential difference of 1 kV, its kinetic energy will be:

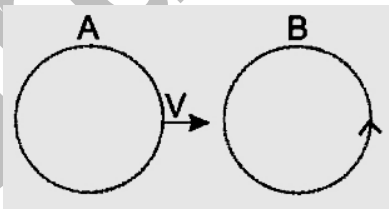
a) 920 keV b) $\frac{1}{1840}$keV c) 1 keV d) 1840 keV

6. An electron with velocity $\vec{v} = (v_x\,\hat{\imath} + v_y\hat{\jmath})$ moves through a magnetic field $\vec{B} = (B_x\,\hat{\imath} + B_y\hat{\jmath})$. The force $\vec{F}$ on the electron is : (e is the magnitude of its charge)

a) $e(v_x B_y - v_y B_x)\hat{k}$ b) $-e(v_x B_y - v_y B_x)\hat{k}$

c) $-e(v_x B_y + v_y B_x)\hat{k}$ d) $e(v_x B_y + v_y B_x)\hat{k}$

7. For MRI, a patient is slowly pushed in a time of 10 s within the coils of the magnet where magnetic field is B = 2.0 T. If the patient's trunk is 0.8 m in circumference, the induced emf around the patient's trunk is



a) there is a constant current in the counterclockwise direction in A.

b) there is a constant current in the clockwise direction in A.

c) there is a varying current in A.

d) there is no current in A.

8. A bar magnet having a magnetic moment of 2×10^4 JT^{-1} is free to rotate in a horizontal plane. A horizontal magnetic field B = 6×10^{-4} T exists in the space. The work done in taking the magnet slowly from a direction parallel to the field to a direction 60° from the field is

a) 0.6 J b) 12 J c) 2 J d) 6 J

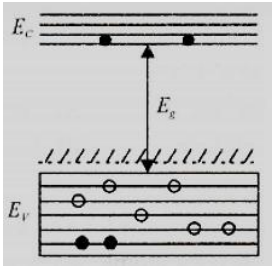
9. Phase difference between any two points of a wavefront is

a) π b) 0 c) π/4 d) π/2

10. When 10^{19} electrons are removed from a neutral metal plate, the electric charge on it is

a) -1.6 C b) 10^{+19} C c) +1.6 C d) 10^{-19} C

11. In the energy band diagram of a material as given below, the open circles and filled circles denote holes and electrons respectively. The material is a/an



a) insulator

b) metal

c) p-type semiconductor

d) n-type semiconductor

12. The minimum distance between an object and its real image formed by a convex lens of focal length f is:

a) 4f b) f c) 2f d) 3f

13. **Assertion (A):** When ultraviolet light is incident on a photocell, its stopping potential is V_0 and the maximum kinetic energy of the photoelectrons is K_{max}. When the ultraviolet light is replaced by X-rays, both V_0 and K_{max}. increase.
Reason (R): Photoelectrons are emitted with speeds ranging from zero to a maximum value because of the range of frequencies present in the incident light.
a) Both 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:** When a capacitor is filled completely with a metallic slab its capacity becomes very large.
Reason: Dielectric constant for metal is zero.
a) Both 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 and R is also false

15. **Assertion:** According to Huygen's principle, no backward wave-front is possible.
Reason: (R) Amplitude of secondary wavelet is proportional to $(1 + \cos \theta)$ where θ is the angle between the ray at the point of consideration and the direction of secondary wavelet.
a) Both 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 (A):** Faraday's laws are consequences of the conservation of energy.
Reason (R): In a purely resistive AC circuit, the current lags behind the emf in phase.
a) Both 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.

SECTION – B

[05 × 2]

17. Compare the following:

i. Wavelengths of the incident solar radiation absorbed by the earth's surface and the radiation re-radiated by the earth.

ii. Tanning effect produced on the skin by UV incident directly on the skin and that coming through glass window.

18. A sample of paramagnetic salt contains 2.0×10^{24} atomic dipoles each of dipole moment 1.5×10^{-23} J T^{-1}. The sample is placed under homogeneous magnetic field of 0.84 T and cooled to the

temperature of 4.2 K. The degree of magnetic saturation achieved is equal to 15%. What is the total dipole moment of the sample for a magnetic field of 0.98 T and a temperature of 2.8 K (assume Curie's law)?

19. Distinguish between intrinsic and extrinsic semiconductors. Although in an extrinsic semiconductor $n_e \neq n_h$, yet it is electrically neutral. Why?

20. Explain why the spectrum of hydrogen atom has many lines, although a hydrogen atom contains only one electron.

21. Answer the following:

a. Magnetic field lines can be entirely confined within the core of a toroid, but not within a straight solenoid. Why?

b. Does a bar magnet exert a torque on itself due to its own field? Justify your answer.

c. When an electron revolves around a nucleus, obtain the expression for the magnetic moment associated with it.

OR

a. It is not advisable to use a galvanometer as such to measure current directly. Why?

b. Why should the value of resistance connected in parallel to a galvanometer be low?

c. Is the reading shown by an ammeter in a circuit less than or more than the actual value of current flowing in the circuit? Why?

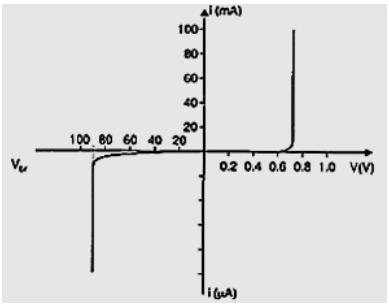
SECTION – C

[07 × 3]

22. a. Write the relationship between mobility and drift velocity in a current carrying conductor.

b. Two aluminium wires have their lengths in the ratio 2 : 3 and radii in the ratio 1 : 3. These are connected in parallel across a battery of emf E and of negligible internal resistance. Find the ratio of drift velocities of the electrons in the two wires.

23. The following figure shows the V-I characteristics of a semiconductor diode.



i. Identify the semiconductor diode used.

ii. Draw the circuit diagram to obtain the given characteristics of this device.

iii. Briefly explain how this diode can be used as a voltage regulator.

24. Write the basic features of the photon picture of electromagnetic radiation on which Einstein's photoelectric equation is based.

25. Calculate and compare the energy released by
a. fusion of 1.0 kg of hydrogen deep within Sun and
b. the fission of 1.0 kg of ^{235}U in a fission reactor.

26. An electron in a hydrogen atom makes transitions from orbits of higher energies to orbits of lower energies.
a. When will such transitions result in (a) Lyman (b) Balmer series?
b. Find the ratio of the longest wavelength in Lyman series to the shortest wavelength in Balmer series.

27. In a single slit diffraction experiment, a slit of width d is illuminated by red light of wavelength 650 nm. For what value of d will
i. the first minimum fall is at an angle of diffraction of 30°and
ii. the first maximum fall is at an angle of diffraction of 30°?

28. A coil of cross-sectional area A lies in a uniform magnetic field B with its plane perpendicular to the field. In this position the normal to the coil makes an angle of 0° with the field. The coil rotates at a uniform rate to complete one rotation in time T. Find the average induced emf in the coil during the interval when the coil rotates:
i. from 0° to 90°position
ii. from 90° to 180° position
iii. from 180° to 270° and
iv. from 270° to 360°

OR

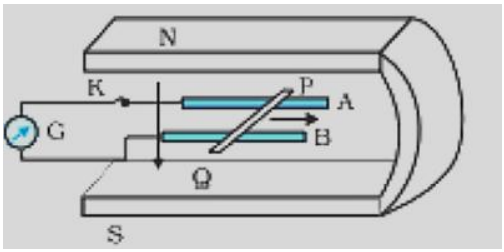


Figure shows a metallic rod PQ of length l, resting on the smooth horizontal rails AB positioned between the poles of a permanent magnet. The rails, the rod, and the magnetic field are in three mutually perpendicular directions. A galvanometer G connects the rails through a switch K. Assume the magnetic field to be uniform. Given the resistance of the closed-loop containing the rod is R.
i. Suppose K is open and the rod is moved with a speed v in the direction shown. Find the polarity and magnitude of induced emf.
ii. With K open and the rod moving uniformly, there is no net force on the electrons in the rod PQ even though they do experience a magnetic force due to the motion of the rod. Explain.
iii. What is the induced emf in the moving rod if the magnetic field is parallel to the rails instead of being perpendicular?

SECTION – D

[02 × 4]

29. **Case Study Based Question:**

An electromagnetic wave transports linear momentum as it travels through space. If an electromagnetic wave transfers a total energy U to a surface in time t, then total linear momentum delivered to the surface is $p = \frac{U}{c}$. When an electromagnetic wave falls on a surface, it exerts pressure on the surface. In 1903, the American scientists Nichols and Hull succeeded in measuring radiation pressures of visible light where other had failed, by making a detailed empirical analysis of the ubiquitous gas heating and ballistic effects.

(a) The pressure exerted by an electromagnetic wave of intensity I(W m^{-2}) on a non-reflecting surface is (c is the velocity of light)

a) $\frac{I}{c}$ b) $\frac{I}{c^2}$ c) Ic^2 d) Ic

(b) Light with an energy flux of 18 W/cm2 falls on a non-reflecting surface at normal incidence. The pressure exerted on the surface is:

a) 2 N/m^2 b) 6×10^{-4} N/m^2 c) 2×10^{-4} N/m^2 d) 6 N/m^2

(c) Radiation of intensity 0.5 W m^{-2} are striking a metal plate. The pressure on the plate is

a) 0.212×10^{-8} N m^{-2} b) 0.132×10^{-8} N m^{-2} c) 0.166×10^{-8} N m^{-2} d) 0.083×10^{-8} N m^{-2}

OR

The radiation pressure of the visible light is of the order of

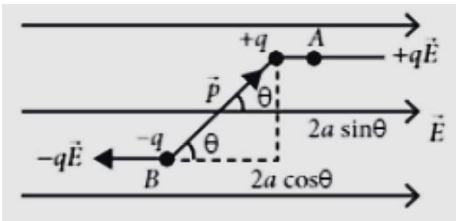
a) 10^{-4} N/m b) 10^{-6} N/m^2 c) 10^{-8} N d) 10^{-2} N m^2

(d) A point source of electromagnetic radiation has an average power output of 1500 W. The maximum value of electric field at a distance of 3 m from this source (in V m-1) is

a) 500 b) 500/3 c) 250/3 d) 100

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

When electric dipole is placed in uniform electric field, its two charges experience equal and opposite forces, which cancel each other and hence net force on electric dipole in uniform electric field is zero. However these forces are not collinear, so they give rise to some torque on the dipole. Since net force on electric dipole in uniform electric field is zero. so no work is done in moving the electric dipole in uniform electric field. However some work is done in rotating the dipole against the torque acting on it.



(a) The dipole moment of a dipole in a uniform external field $\vec{E}$ is $\vec{P}$. Then the torque $\vec{\tau}$ acting on the dipole is

a) $\vec{\tau} = 2(\vec{P} + \vec{E})$ b) $\vec{\tau} = (\vec{P}.\vec{E})$ c) $\vec{\tau} = (\vec{P} + \vec{E})$ d) $\vec{\tau} = (\vec{P} \times \vec{E})$

(b) An electric dipole consists of two opposite charges, each of magnitude 1.0 μC separated by a distance of 2.0 cm. The dipole is placed in an external field of 10^5 NC^{-1}. The maximum torque on the dipole is

a) 4×10^{-3} Nm b) 2×10^{-3} Nm c) 1×10^{-3} Nm d) 0.2×10^{-3} Nm

(c) Torque on a dipole in uniform electric field is minimum when θ is equal to

a) 0^o b) 90^o c) 180^o d) Both 0^o and 180^o

(d) When an electric dipole is held at an angle in a uniform electric field, the net force F and torque τ on the dipole are

a) $F = 0, \tau = 0$ b) $F \neq 0, \tau \neq 0$ c) $F \neq 0, \tau = 0$ (d) $F = 0, \tau \neq 0$

OR

An electric dipole of moment p is placed in an electric field of intensity E. The dipole acquires a position such that the axis of the dipole makes an angle θ with the direction of the field. Assuming that the potential energy of the dipole to be zero when $\theta = 90^o$, the torque and the potential energy of the dipole will respectively be

a) pE sin θ, −pE cosθ b) pE cos θ, −pE sinθ

c) pE sin θ, 2pE cos θ d) pE sin θ, −2pE cosθ

SECTION – E

[03 ×5]

31. i. Draw a ray diagram showing the image formation by a compound microscope. Obtain the expression for total magnification when the image is formed at infinity.

ii. How does the resolving power of a compound microscope get affected, when

1. focal length of the objective is decreased.

2. the wavelength of light is increased? Give reasons to justify your answer.

OR

i. Using Huygens's construction of secondary wavelets explains how a diffraction pattern is obtained on a screen due to a narrow slit on which a monochromatic beam of light is incident normally.

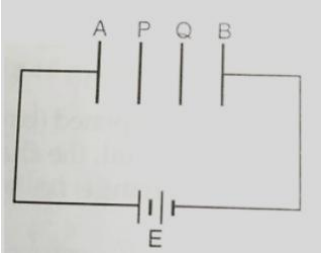
ii. Show that the angular width of first diffraction fringe is half that of the central fringe.

iii. Explain why the maxima at $\theta = (n + \frac{1}{2})\frac{\lambda}{a}$ become weaker and weaker with increasing n.

32. Two charged conducting spheres of radii a and b are connected to each other by a wire. What is the ratio of electric fields at the surfaces of the two spheres? Use the result obtained to explain why charge density on the sharp and pointed ends of a conductor is higher than on its flatter portions.

OR

Two parallel metal plates P and Q are inserted at equal distances into a plane capacitor as shown in fig. Plates A and B of the capacitor are connected to a battery of e.m.f. V.



a. What are the potentials of the four plates?

b. How will the potentials of plates P and Q and the intensities of the fields in each of the three spaces change after plates P and Q have been connected by a wire?

c. What will happen to the charges on plates A and B, when plates P and Q are connected with a wire?

d. Will there be charges on the plates P and Q after connecting them with a wire?

33. i. An alternating voltage $V = V_m \sin \omega t$ applied to a series L-C-R circuit derives a current given by $I = I_m \sin(\omega t - \phi)$. Deduce an expression for the average power dissipated over a cycle.

ii. For circuit used for transporting electric power, a low power factor implies large power loss in transmission. Explain.

OR

a. Draw graphs showing the variations of inductive reactance and capacitive reactance with the frequency of the applied ac source.

b. Draw the phasor diagram for a series RC circuit connected to an ac source.

c. An alternating voltage of 220 V is applied across a device X, a current of 0.25 A flows, which lag behind the applied voltage in phase by $\frac{\pi}{2}$ radian. If the same voltage is applied across another device Y, the same current flows but now it is in phase with the applied voltage.

i. Name the devices X and Y.

ii. Calculate the current flowing in the circuit when the same voltage is applied across the series combination of X and Y.