Class XII Session 2024-25

PHYSICS FULL SYLLABUS MOCK TEST – 08

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 middle of the depletion layer of reverse biased p-n junction, the:

a) potential is maximum b) potential is zero

c) electric field is zero d) electric field is maximum

2. Two bulbs each marked 100 W, 220 V are connected in series across 220 V supply. The power consumed by them, when lit, is

a) 220 W b) zero c) 100 W d) 50 W

3. In a compound microscope, maximum magnification is obtained when the final image

a) coincides with the objective b) is formed at the least distance of distinct vision

c) coincides with the object d) is formed at infinity

4. The magnetic moment (μ) of a revolving electron around the nucleus varies with principal quantum number n as

a) $\mu \propto n$ b) $\mu \propto \frac{1}{n}$ c) $\mu \propto \frac{1}{n^2}$ d) $\mu \propto n^2$

5. The capacitors, each of 4μF are to be connected in such a way that the effective capacitance of the combination is 6μF. This can be achieved by connecting

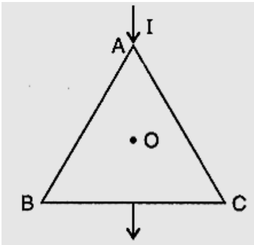
a) Two of them connected in parallel and the combination in series to the third.

b) Two of them connected in series and the combination in parallel to the third.

c) All three in series

d) All three in parallel

6. An equilateral triangle is made by uniform wires AB, BC, CA, A current I enters at A and leaves from the mid-point of BC. If the lengths of each side of the triangle is L, the magnetic field B at the centroid O of the triangle



a) $\frac{\mu_0}{4\pi}\left(\frac{4I}{L}\right)$

b) $\frac{\mu_0}{4\pi}\left(\frac{2I}{L}\right)$

c) $\frac{\mu_0}{2\pi}\left(\frac{4I}{L}\right)$

d) zero

7. A coil of wire of a certain radius has 100 turns and a self-inductance of 15 mH. The self-inductance of a second similar coil of 500 turns will be:

a) 15 mH b) 375 mH c) 45 mH d) 75 mH

8. Consider the two idealised systems: (i) a parallel plate capacitor with large plates and small separation and (ii) a long solenoid of length L >> R, radius of cross-section. In (i), E is ideally treated as a constant between plates and zero outside. In (ii), magnetic field is constant inside the solenoid and zero outside. These idealised assumptions, however, contradict fundamental laws as below:

a) case (ii) contradicts Gauss's law for magnetic fields.

b) case (i) contradicts Gauss's law for electrostatic fields.

c) case (ii) contradicts en $\oint H.d1 = I_{en}$

d) case (i) agrees with $\oint E.d1 = 0$

9. In Huygens' theory, light waves

a) are transverse waves and require no medium to travel.

b) are longitudinal waves and require a medium to travel.

c) are transverse waves and require a medium to travel.

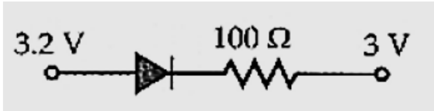
d) are longitudinal waves and require no medium to travel.

10. An electric dipole placed in a non-uniform electric field can experience

a) always a force and a torque. b) neither a force nor a torque.

c) a force but not a torque. d) a torque but not a force.

11. The current in the circuit shown in the figure considering ideal diode is



a) 200 A

b) 2×10^{-4} A

c) 20 A

d) 2×10^{-3} A

12. A microscope is focused on a mark. Then a glass slab of refractive index 1.5 and thickness 6 cm is placed on the mark. To get the mark again in focus the microscope should be moved

a) 9 cm upward b) 2 cm downward c) 4 cm upward d) 2 cm upward

13. **Assertion (A):** In the process of photoelectric emission, all emitted electrons have the same kinetic energy.
Reason (R): According to Einstein's equation $E_k = h\nu - \phi_0$.
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:** Two adjacent conductors of unequal dimensions, carrying the same positive charge have a potential difference between them.
Reason: The potential of a conductor depends upon the charge given to it.
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.

15. **Assertion:** To observe diffraction of light, the size of the obstacle/aperture should be of the order of 10^{-7} m.
Reason: (R) 10^{-7} is the order of the wavelength of visible 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.

16. **Assertion (A):** If the frequency of the applied AC is doubled, then the power factor of a series R-L circuit decreases.
Reason (R): Power factor of series R-L circuit is given by $\cos\phi = \frac{2R}{R^2 + \omega^2 L^2}$.
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. Poynting vectors $\vec{S}$ is defined as a vector whose magnitude is equal to the wave intensity and whose direction is along the direction of wave propogation. Mathematically, it is given by $\vec{S} = \frac{1}{\mu_0}\vec{E} \times \vec{B}$. . Show the nature of S vs t graph.

18. Distinguish between diamagnetic and ferromagnetic materials in terms of
i. susceptibility and ii. their behaviour in a non-uniform magnetic field

19. Determine the number density of donor atoms which have to be added to an intrinsic germanium semiconductor to produce an n-type semiconductor of conductivity 5 Ω^{-1} cm^{-1}, given that the mobility of electron in n-type Ge is 3900 cm^2 /Vs. Neglect the contribution of holes to conductivity.

20. An α -particle moving with initial kinetic energy K towards a nucleus of atomic number Z approaches a distance d at which it reverses its direction. Obtain the expression for the distance of closest approach d in terms of the kinetic energy of α-particle K.

21. A proton and an alpha particle having the same kinetic energy are, in turn, passed through a region of the uniform magnetic field, acting normal to the plane of the paper and travel in circular paths. Deduce the ratio of the radii of the circular paths described by them.

OR

Which one of the following will describe the smallest circle when projected with the same velocity v perpendicular to the magnetic field B: (i) α-particle, and (ii) β-particle?

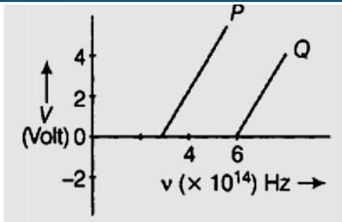
SECTION – C

[07 × 3]

22. A homogeneous poorly conducting medium of resistivity ρ fills up the space between two thin coaxial ideally conducting cylinders. The radii of the cylinders are equal to a and b with $a < b$, the length of each cylinder is l. Neglecting the edge effects, find the resistance of the medium between the cylinders.

23. Draw a circuit diagram of a transistor amplifier in CE configuration. Under what condition does the transistor act as an amplifier? Define the terms:
i. Input resistance and
ii. Current amplification factor. How are these determined using typical input and output characteristics?

24. In the study of a photoelectric effect, the graph between the stopping potential V and frequency υ of the incident radiation on two different metals P and Q is shown below.



i. Which one of the two metals has higher threshold frequency?

ii. Determine the work function of the metal which has greater value.

25. We are given the following atomic masses:

${}^{238}_{92}U = 238.05079$ u

${}^{4}_{2}He = 4.00260$ u

${}^{234}_{90}Th = 234.04363$ u

${}^{1}_{1}H = 1.00783$ u

${}^{237}_{91}Pa = 237.05121$ u

Here the symbol Pa is for the element protactinium (Z = 91).

i. Calculate the energy released during the alpha decay of ${}^{238}_{92}U$.

ii. Calculate the kinetic energy of the emitted α-particles.

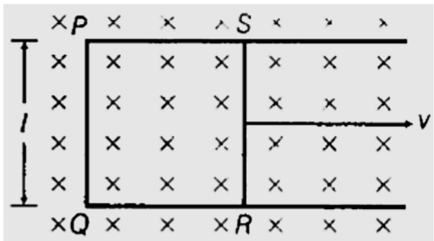
iii. Show that ${}^{238}_{92}U$ can not spontaneously emit a proton.

26. a. Using the Bohr's model, calculate the speed of the electron in a hydrogen atom in the n = 1, 2 and 3 levels.

b. Calculate the orbital period in each of these levels.

27. Define the term wavefront. State Huygen's principle. Consider a plane wavefront incident on a thin convex lens. Draw a proper diagram to show how the incident wavefront traverses through the lens and after refraction focusses on the focal point of the lens, giving the shape of the emergent wavefront.

28. Figure shows a rectangular conducting loop PQRS in which arm RS of length l is movable. The loop is kept in a uniform magnetic field B directed downward perpendicular to the plane of the loop. The arm RS is moved with a uniform speed v.



Deduce an expression for

i. the emf induced across the arm RS

ii. the external force required to move the arm and

iii. the power dissipated as heat.

OR

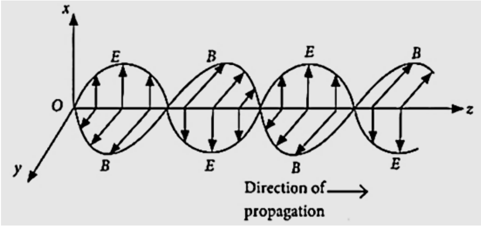
Define the term self-inductance of a solenoid. Obtain the expression for the magnetic energy stored in an inductor of self-inductance L to build up a current I through it.

SECTION – D

[02 × 4]

29. **Case Study Based Question:**

A stationary charge produces only an electrostatic field while a charge in uniform motion produces a magnetic field, that does not change with time. An oscillating charge is an example of accelerating charge. It produces an oscillating magnetic field, which in turn produces an oscillating electric fields and so on. The oscillating electric and magnetic fields regenerate each other as a wave which propagates through space.



(a) Magnetic field in a plane electromagnetic wave is given by $\vec{B} = B_0 \sin(kx + \omega t)\hat{j}$ T Expression for corresponding electric field will be (Where c is speed of light.)

a) $\vec{E} = B_0 c \sin(kx + wt)\hat{k}\ V/m$ b) $\vec{E} = -B_0 c \sin(kx - wt)\hat{k}\ V/m$

c) $\vec{E} = -B_0 c \sin(kx + wt)\hat{k}\ V/m$ d) $\vec{E} = \frac{B_0}{c} \sin(kx + wt)\hat{k}\ V/m$

(b) The electric field component of a monochromatic radiation is given by $\vec{E} = 2E_0\ \hat{\imath} \cos kz \cos \omega t$. Its magnetic field $\vec{B}$ is then given by

a) $-\frac{2E_0}{c}\hat{\jmath} \sin kz \sin \omega t$ b) $\frac{2E_0}{c}\hat{\jmath} \sin kz \sin \omega t$

c) $\frac{2E_0}{c}\hat{\jmath} \sin kz \cos \omega t$ d) $\frac{2E_0}{c}\hat{\jmath} \cos kz \cos \omega t$

(c) A plane em wave of frequency 25 MHz travels in a free space along x-direction. At a particular point in space and time, E = (6.3 $\hat{\jmath}$) V/m. What is magnetic field at that time?

a) 0.089 μT b) 0.124 Mt c) 0.021 μT d) 0.095 μT

OR

A plane electromagnetic wave travels in free space along x-axis. At a particular point in space, the electric field along y-axis is 9.3 V m^{-1}. The magnetic induction (B) along z-axis is

a) 3.1×10^{-8}T b) 3×10^{-5} T c) 3×10^{-6} T d) 9.3×10^{-6} T

(d) A plane electromagnetic wave travelling along the x-direction has a wavelength of 3 mm. The variation in the electric field occurs in the y-direction with an amplitude 66 V m^{-1}. The equations for the electric and magnetic fields as a function of x and t are respectively

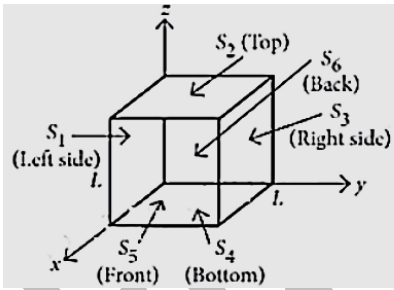
a) $E_y = 11 \cos 2\pi \times 10^{11}\ \left(t - \frac{x}{c}\right), B_y = 11 \times 10^{-7} \cos 2\pi \times 10^{11}\ \left(t - \frac{x}{c}\right);$

b) $E_y = 66 \cos 2\pi \times 10^{11}\ \left(t - \frac{x}{c}\right), B_z = 2.2 \times 10^{-7} \cos 2\pi \times 10^{11}\ \left(t - \frac{x}{c}\right);$

c) $E_x = 33 \cos \pi \times 10^{11}\ \left(t - \frac{x}{c}\right), B_x = 11 \times 10^{-7} \cos \pi \times 10^{11}\ \left(t - \frac{x}{c}\right);$

d) $E_y = 33 \cos \pi \times 10^{11} \left(t - \frac{x}{c}\right), B_z = 1.1 \times 10^{-7} \cos \pi \times 10^{11} \left(t - \frac{x}{c}\right)$

Q30. **Case Study Based Question:**



Net electric flux through a cube is the sum of fluxes through its six faces. Consider a cube as shown in figure, having sides of length L = 10.0 cm. The electric field is uniform, has a magnitude E = 4.00×10^3 NC^{-1} and is parallel to the xy plane at an angle of 37^o measured from the +x -axis towards the +y -axis.

(a) Electric flux passing through surface S_6 is

a) -24 Nm^2 C^{-1} b) 32 Nm^2 C^{-1} c) -32 Nm^2 C^{-1} d) 24 Nm^2 C^{-1}

(b) Electric flux passing through surface S_1 is

a) -32 Nm^2 C^{-1} b) -24 Nm^2 C^{-1} c) 32 Nm^2 C^{-1} d) 24 Nm^2 C^{-1}

(c) The surfaces that have zero flux are

a) S_2 and S_4 b) S_3 and S_6 c) S_1 and S_2 d) S_1 and S_3

(d) The total net electric flux through all faces of the cube is

a) 24 Nm^2 C^{-1} b) 8 Nm^2 C^{-1} c) -8 Nm^2 C^{-1} d) Zero

OR

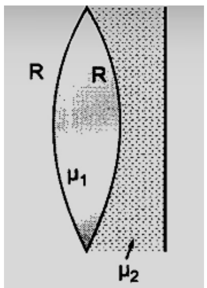
The dimensional formula of surface integral $\oint \vec{E} \cdot d\vec{S}$ of an electric field is

a) $[M^{-1}L^3T^{-3}A]$ b) $[M L^2T^{-2}A^{-1}]$ c) $[ML^3T^{-3}A^{-1}]$ d) $[ML^{-3}T^{-3}A^{-1}]$

SECTION – E

[03 ×5]

31. A biconvex lens with its two faces of equal radius of curvature R is made of a transparent medium of refractive index μ_1. It is kept in contact with a medium of refractive index μ_2 as shown in the figure.



a. Find the equivalent focal length of the combination.

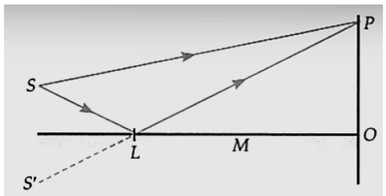
b. Obtain the condition when this combination acts as a diverging lens.

c. Draw the ray diagram for the case $\mu_1 > \frac{(\mu_2 + 1)}{2}$, when the object is kept far away from the lens. Point out the nature of the image formed by the system.

OR

Figure shows an outline of Lloyd's mirror experiment. M is a plane mirror; S is a narrow slit illuminated by some source of light (not shown) and S' is the image of S in M. M, S and S' are in a plane perpendicular to the paper. O is the line of intersection of the mirror and the screen.

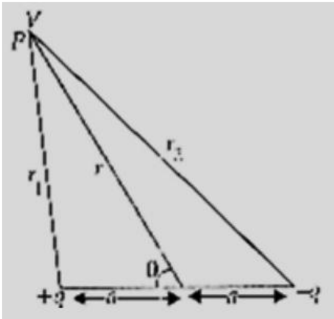
a. What is the origin of fringes observed on the screen?



b. Why is the slit S placed so as to have very oblique angle of incidence of light striking the mirror?

c. The two path lengths PS and PS' are equal when P coincides with O. Yet the fringe at O is found in the experiment to be dark not bright. What does this observation imply?

32. Derive an expression for potential due to a dipole for distances large compared to the size of the dipole. How is the potential due to dipole different from that due to a single charge?



OR

Two point charges q and -q are located at points (0, 0, - a) and (0, 0, a) respectively.

i. Find the electrostatic potential at (0, 0, z) and (x, y, 0).

ii. How much work is done in moving a small test charge from the point (5, 0, 0) to (-7, 0, 0) along the X-axis?

iii. How would your answer change if the path of the test charge between the same points is not along the x-axis but along any other random path?

iv. If the above point charges are now placed in the same positions in a uniform external electric field $\vec{E}$, what would be the potential energy of the charge system in its orientation of unstable equilibrium? Justify your answer in each case.

33. a. Draw the diagram of a device which is used to decrease high ac voltage into a low ac voltage and state its working principle. Write four sources of energy loss in this device.

b. A small town with a demand of 1200 kW of electric power at 220 V is situated 20 km away from an electric plant generating power at 440 V. The resistance of the two-wire line carrying power is 0.5Ω per km. The town gets the power from the line through a 4000-220 V step-down transformer at a sub-station in the town. Estimate the line power loss in the form of heat

OR

i. With the help of a diagram, explain the principle and working of a device which produces current that reverses its direction after regular intervals of time.

ii. If a charged capacitor C is short-circuited through an inductor L, the charge and current in the circuit oscillate simple harmonically.

a. In what form the capacitor and the inductor store energy?

b. Write two reasons due to which the oscillations become damped.