Class XII Session 2024-25

PHYSICS FULL SYLLABUS MOCK TEST – 02

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. The cations and anions are arranged in alternate form in

a) ionic crystal b) semiconductor crystal

c) covalent crystal d) metallic crystal

2. Current density of a conductor is

a) Is always zero

b) the net charge flowing through the area

c) measure of the flow of electric charge in amperes per unit area of cross-section

d) the net charge flowing through the area per unit time

3. The focal length of a concave mirror is f. An object is placed at a distance x from the focus. The magnification is

a) $\frac{f}{(f+x)}$ b) $\frac{(f+x)}{f}$ c) $\frac{f}{x}$ d) $\frac{x}{f}$

4. A magnet of magnetic moment M is suspended in a uniform magnetic field B. The maximum value of torque acting on the magnet is

a) zero b) MB c) 2MB d) MB

5. A parallel plate capacitor of plate area A has a charge Q. The force on each plate of the capacitor is

a) $\frac{2q^2}{\varepsilon_0 A}$ b) zero c) $\frac{q^2}{\varepsilon_0 A}$ d) $\frac{q^2}{2\,\varepsilon_0 A}$

6. An electron is travelling along the X-direction. It encounters a magnetic field in the Y-direction. Its subsequent motion will be:

a) a circle in the YZ-plane b) straight line along the X-direction

c) a circle in the XZ-plane d) a circle in the XY-plane

7. A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from 0 to 20 A in 0.5 s, change of flux linkage with the other coil is

a) 45 Wb b) 35 Wb c) 30 Wb d) 40 Wb

8. An aeroplane having a wingspan of 35m files due north with the speed of 90 m/s, given $B = 4 \times 10^{-5}$ T. The potential difference between the tips of the wings will be

a) 0.126 V b) 1.26 V c) 0.013 V d) 12.6 V

9. The shape of the wavefront of the portion of the wavefront of light from a distant star intercepted by the earth is

a) plane b) spherical c) conical d) hyperboloid

10. If an electron is accelerated by 8.8×10^{14} m/s², then electric field required for acceleration is (given specific charge of the electron = 1.76×10^{11} Ckg^{-1})

a) 52 V cm^{-1} b) 50 V cm^{-1} c) 54 V cm^{-1} d) 56 V cm^{-1}

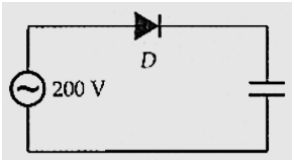
11. In the circuit given in the figure, an ac. source of 200 V is connected through a diode D to a capacitor. The potential difference across the capacitor will be

a) 283 V

b) 100 V

c) 310 V

d) 200 V



12 Green light of wavelength 5,460 Å is incident on an air-glass interface. If the refractive index of glass is 1. 5, the wavelength of light in glass would be (Given that the velocity of light in air, $c = 3 \times 10^{-8}$ m s^{-1})

a) 6731 Å b) 3,640 Å c) 5, 460 Å d) 4,861 Å

For Questions 13 to 16, two statements are given -one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

13. **Assertion (A):** The photoelectrons produced by a monochromatic light beam incident on a metal surface, have a spread in their kinetic energies.

Reason (R): The work function of the metal varies as a function of depth from the surface.
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:** For a charged particle moving from point P to point Q, the net work done by an electrostatic field on the particle is independent of the path connecting point P to point Q.
Reason: The net work done by a conservative force on an object moving along a closed loop is zero.
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 wrong statement but reason is correct statement.

15. **Assertion (A)**: Light added to light can produce darkness.
Reason (R): When two coherent light waves interfere, there is darkness at position of destructive interference.
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.

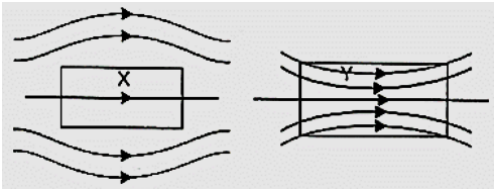
16. **Assertion (A):** A step-up transformer cannot be used as a step-down transformer.
Reason (R): A transformer works only in one direction.
a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

SECTION – B

[05 × 2]

17. A light beam travelling in the x-direction is described by the electric field: $E_y = 270 \sin \omega \left(t - \frac{x}{c}\right)$. An electron is constrained to move along the y-direction with a speed of 2.0×10^7 ms^{-1}. Find the maximum electric force and maximum magnetic force on the electron.

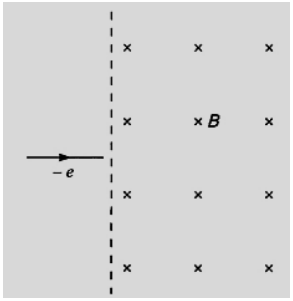
18. A uniform magnetic field gets modified as shown below, when two specimens X and Y are placed in it.
i. Identify the two specimens X and Y.
ii. State the reason for the behaviour of the field lines in X and Y.



19. Explain the formation of potential barrier and depletion region in a p-n junction diode. What is effect of applying forward bias on the width of depletion region?

20. If the short series limit of the Balmer series for hydrogen is 3646 Å, calculate the atomic number of the element which gives X-ray wavelengths down to 1.0 Å. Identify the element.

21. a. An electron moving horizontally with a velocity of 4×10^4 m/s enters a region of uniform magnetic field of 10^{-5} T acting vertically upward as shown in the figure. Draw its trajectory and find out the time it takes to come out of the region of magnetic field.



b. A straight wire of mass 200 g and length 1.5 m carries a current of 2 A. It is suspended in mid-air by a uniform magnetic field B. What is the magnitude of the magnetic field?

OR

What information would you wish to know about the galvanometer before converting it into an ammeter or voltmeter?

SECTION – C

[07 × 3]

22. Two cells of EMFs 1 V, 2 V and internal resistance 2Ω and 1 Ω respectively are connected in
i. series,
ii. parallel.
What should be the external resistance in the circuit so that the current through the resistance be the same in the two cases? In which case, more heat is generated in the cells?

23. i. Differentiate between three segments of a transistor on the basis of their size and level of doping.
ii. When is a transistor said to be in active state?
iii. Draw a plot of transfer characteristic V_0 vs. V_1 and show which portion of the characteristic is used in amplification and why?
iv. Draw the circuit diagram of the base bias transistor amplifier in CE configuration and briefly explain its working.

24. Photoelectrons are emitted from a metal surface when illuminated with UV light of wavelength 330 nm. The minimum amount of energy required to emit the electrons from the surface is 3.5×10^{-19} J. Calculate:

a. the energy of the incident radiation, and

b. the kinetic energy of the photoelectron.

25. a. Differentiate between nuclear fission and nuclear fusion.

b. Deuterium undergoes fusion as per the reaction:

$_1^2H + {}_1^2H \rightarrow {}_2^3H + {}_0^1n + 3.27\ MeV$

Find the duration for which an electric bulb of 500 W can be kept glowing by the fusion of 100 g of deuterium.

26. Show that the radius of the orbit in hydrogen atom varies as n^2, where n is the principal quantum number of the atom.

27. A beam of light consisting of two wavelengths, 650 nm and 520 nm, are used to obtain interference fringes in a Young's double slit experiment.

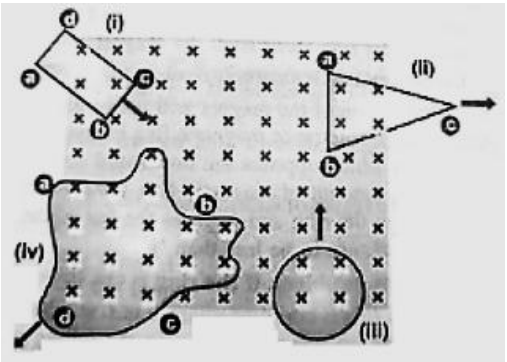
a. Find the distance of the third bright fringe on the screen from the central maximum for wavelength 650 nm.

b. What is the least distance from the central maximum where the bright fringes due to both the wavelengths coincide?

28. Define mutual inductance between a pair of coils. Derive an expression for the mutual inductance of two long coaxial solenoids of the same length wound one over the other.

OR

The figure below shows planer loops of different shapes moving out of or into a region of the magnetic field which is directed normal to the plane of the loops away from the reader. Determine the direction of induced current in each loop using Lenz's law. Check if you would obtain the same answers by considering the magnetic force on the charge inside the moving loops.



SECTION – D

[02 × 4]

29. **Case Study Based Question: Microwave oven:**

The spectrum of electromagnetic radiation contains a part known as microwaves. These waves have frequency and energy smaller than visible light and wavelength larger than it. What is the principle of a microwave oven and how does it work? Our objective is to cook food or warm it up. All food items such as fruit, vegetables, meat, cereals, etc., contain water as a constituent. Now, what does it mean when we say that a certain object has become warmer? When the temperature of a body rises, the energy of the random motion of atoms and molecules increases and the molecules travel or vibrate or rotate with higher energies. The frequency of rotation of water molecules is about 2.45 gigahertz (GHz). If water receives microwaves of this frequency, its molecules absorb this radiation, which is equivalent to heating up water. These molecules share this energy with neighbouring food molecules, heating up the food. One should use porcelain vessels and non-metal containers in a microwave oven because of the danger of getting a shock from accumulated electric charges. Metals may also melt from heating. The porcelain container remains unaffected and cool, because its large molecules vibrate and rotate with much smaller frequencies, and thus cannot absorb microwaves. Hence, they do not get eaten up. Thus, the basic principle of a microwave oven is to generate microwave radiation of appropriate frequency in the working space of the oven where we keep food. This way energy is not wasted in heating up the vessel. In the conventional heating method, the vessel on the burner gets heated first and then the food inside gets heated because of transfer of energy from the vessel. In the microwave oven, on the other hand, energy is directly delivered to water molecules which is shared by the entire food.

(i) As compared to visible light microwave has frequency and energy

a) Frequency is less but energy is more b) less than visible light

c) more than visible light d) equal to visible light

(ii) When the temperature of a body rises

a) the energy of the random motion of atoms and molecules decreases.

b) the energy of the random motion of atoms and molecules remains same.

c) the energy of the random motion of atoms and molecules increases

d) the random motion of atoms and molecules becomes streamlined.

(iii) The frequency of rotation of water molecules is about

a) 2.45 THz b) 2.45 kHz c) 2.45 MHz d) 2.45 GHz

OR

In the microwave oven

a) Energy is directly delivered to the food grains.

b) The vessel gets heated first and then the water molecules collect heat from the body of the vessel

c) Energy is directly delivered to water molecules which is shared by the entire food

d) The vessel gets heated first, and then the food grains insideIf this electron of charge

(d) Why should one use porcelain vessels and non-metal containers in a microwave oven?

a) Because it will prevent the food items to become hot

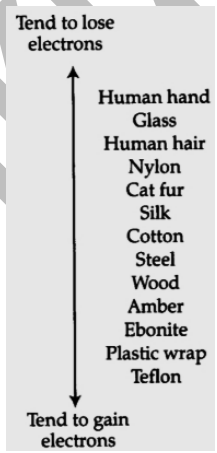
b) Because it will get too much hot

c) Because of the danger of getting a shock from accumulated electric charges

d) Because it may crack due to high frequency

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

The triboelectric series is a list that ranks materials according to their tendency to gain or lose electrons. The process of electron transfer as a result of two objects coming into contact with one another and then separating is called triboelectric charging. During such an interaction, one of the two objects will always gain electrons (becoming negatively charged) and the other object will lose electrons (becoming positively charged). The relative position of the two objects on the triboelectric series will define which object gains electrons and which object loses electrons. In triboelectric series, materials are ranked from high to low in terms of the tendency for the material to lose electron. If an object high up on this list (Glass, for example) is rubbed with an object low down on the list (Teflon, for example), the glass will lose electrons to the teflon. The glass will, in this case, become positively charged and the teflon will become negatively charged. Materials in the middle of the list (steel and wood, for example) are items those do not have a strong tendency to give up or accept electrons



(a) Materials in the upper position have _____ tendency to become positively charged.

a) no b) medium c) high d) low

(b) Name two materials which do not have a strong tendency to give up or accept electrons.

a) Steel, wood b) Plastic wrap, Teflon c) Ebonite, Nylon d) Nylon, cat fur

(c) If human hair is rubbed with amber, how those will be charged?

a) Hair will be negatively charged, Amber will be positively charged.

b) Both positive

c) Hair will be positively charged, Amber will be negatively charged.

d) Both negative

(d) Triboelectric charging is the process of electron transfer between two objects

a) By contact b) Without contact c) By anyone of these d) By none of these

OR

The object which loses electron becomes _____ charged and the object gains electron becomes _____ charged.

a) positively, positively b) negatively, positively

c) negatively, negatively d) positively, negatively

SECTION – E

31. A compound microscope consists of an objective lens of focal length 2.0 cm and an eyepiece of focal length 6.25 cm separated by a distance of 15 cm. How far from the objective should an object be placed in order to obtain the final image at [03 ×5]

a. the least distance of distinct vision (25 cm), and

b. at infinity? What is the magnifying power of the microscope in each case?

OR

When a parallel beam of a monochromatic source of light of wavelength λ is incident on a single slit of width a, show how the diffraction pattern is formed at the screen by the interference of the wavelets from the slit. Show that, besides the central maxima at θ = 0, secondary maxima are observed at θ = $\left(n+\frac{1}{2}\right)\frac{\lambda}{a}$ and the minima at $\theta = \frac{n\lambda}{a}$. Why do secondary maxima get weaker in intensity with increasing n?

32. A parallel plate capacitor is charged by a battery. After some time the battery is disconnected and a dielectric slab with its thickness equal to the plate separation is inserted between the plates. What change, in any will take place in

i. charge on the plates

ii. electric field intensity between the plates

iii. the capacitance of the capacitor,

iv. a potential difference between the plates and

v. the energy stored in the capacitor? Justify your answer in each case.

OR

Derive an expression for the electric potential at a point due to an electric dipole. Mention the contrasting features of electric potential of a dipole at a point as compared to that due to a single charge.

33. i. Prove that an ideal capacitor in an ac circuit does not dissipate power.

ii. An inductor of 200 mH, a capacitor of 400 μf, and a resistor of 10 Ω are connected in series to ac source of 50 V of variable frequency. Calculate the

a. the angular frequency at which maximum power dissipation occurs in the circuit and the corresponding value of the effective current and

b. value of Q-factor in the circuit.

OR

In the following circuit, calculate:

i. the capacitance of the capacitor, if the power factor of the circuit is unity,

ii. the Q-factor of this circuit. What is the significance of the Q-factor in ac circuit? Given the angular frequency of the ac source to be 100 rad/s. Calculate the average power dissipated in the circuit.