No. of Printed Pages : 12

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FAS / Physics / XII / Half Yearly Examination / 2024-25

Time : 3 hrs.] **[M.M. : 70**

General Instructions :

1. *The question paper contains five sections, which carry a total of 33 questions.*
2. *All questions are compulsory.*
3. *Section A-Q 1-16 are MCQ/ assertion–reason questions carrying 1 mark each.*
4. *Section B-Q 17-21 are short answer questions carrying 2 marks each.*
5. *Section C-Q 22-28 are long answer questions carrying 3 marks each.*
6. *Section D-Q 29-30 are case study based MCQs carrying 4 marks each*
7. *Section E-Q 31-33 are long answer questions carrying 5 marks each.*
8. *You may use the following physical constants wherever necessary.*

$c=3\times10^{8}$ m/s

$h=6.63\times10^{-34}$ Js

$e=1.6\times10^{-19}$ C

$\mu_0=4\pi\times10^{-7}$ TmA^{-1}

$\varepsilon_0=8.854\times10^{-12}$ C^2 N m^{-2}

$1/(4\pi\varepsilon_0)=9\times10^{9}$ Nm^2 C^{-2}

Mass of electron$=9.1\times10^{-31}$ kg

Mass of neutron$=1.675\times10^{-27}$ kg

Mass of proton$=1.673\times10^{-27}$ kg

Avogadro's number$=6.023\times10^{+23}$

Boltzmann constant$=1.38\times10^{-23}$ JK^{-1}

SECTION-A

1. A positively charged particle is moving along +x-axis. It enters in a uniform electric field directed along +Y-axis. The trajectory of particle will be :

(a) Circle

(b) Straight line directed along + X-axis

(P.T.O.)

(c) Straight line directed along + Y-axis

(d) Parabola

2. An electric dipole of dipole moment 2×10^{-8} C-m in a uniform electric field experiences a maximum torque equal to 6×10^{-1} Nm. The magnitude of electric field is :

(a) 2.2×10^{3} N/C (b) 1.2×10^{4} N/C

(c) 3.0×10^{7} N/C (d) 4.2×10^{3} N/C

3. On moving along + X-axis potential increases at a constant rate. It means that the electric field is :

(a) Uniform and along -X-axis (b) Non-uniform and along +X- axis

(c) Uniform and along -Y- axis (d) Non- uniform and along +Y-axis

4. Capacitance of a capacitor increases after filling it with a dielectric because :

(i) Electric field between capacitor plates get decreased due to dielectric

(ii) Electric potential between capacitor plates get decreased due to dielectric

(iii) The dielectric material gets polarised

(iv) The capacitor now has more charge on it.

Out of these reasons the correct reason/s is/are :

(a) Only (iii) (b) (i) and (ii) only

(c) (i), (ii) and (iii) only (d) All of these

5. Two cells of emf's 3V and 5V have internal resistances 0.1Ω and 0.5 Ω are connected in parallel. The emf and internal resistance of equivalent cell are :

(a) 3.2 V, 0.08 Ω (b) 8 V, 0.6 Ω

(c) 2V, 0.08 Ω (d) 2V, 0.6 Ω

6. In a balanced Wheatstone bridge :

(i) Ratio of resistances of adjacent arms is same

(ii) Potential difference across galvanometer is zero

(iii) Current in each of the two branches is the same

(iv) Ratio of currents in two branches is the same as that of resistances.

Out of the above facts, the true ones are :

(a) Only (i) (b) Only (ii)

(c) (i) and (iii) (d) (i), (ii) and (iv)

7. An ammeter of resistance 0.81 Ω reads up to 1 A. The value of the required shunt to increase the range to 10 A is :

(a) 0.9 Ω (b) 0.09 Ω

(c) 0.03 Ω (d) 0.3 Ω

8. A circular copper loop of radius R is moved in a uniform magnetic field with its plane being always perpendicular to the direction of magnetic field. If constant velocity of loop is v, the motional emf across t he diameter of loop parallel to velocity v is :

(a) BRv (b) 2BRv

(c) 4BRv (d) Zero

9. The large-scale transmission of electrical energy over long distances is done with the use of transformers. The voltage output of the generator is stepped-up because of : 3

(a) Increase of current

(b) Reduction of current and voltage both

(c) Power loss is cut down

(d) Reduction of voltage

10. If the electric field (E) and magnetic field (B) components of an electromagnetic wave at a certain time and location are drawn on a plane of paper such that the E vector points downwards along the negative Y- axis while B vector points leftwards along ~~positive~~ negative X- axis. The direction of the propagation of the electromagnetic wave is :

(a) Perpendicular to E and B and out of plane of the paper

(b) Perpendicular to E and B and into the plane of the paper

(c) Parallel and in the same direction as E

(d) Parallel and in the same direction as B

11. A metal coin is at the bottom of a beaker filled with a liquid of refractive index 4/3 to 6 cm height. To an observer looking from above the surface of liquid, the coin will appear at a depth of :

(a) 1.5 cm (b) 6.75 cm

(c) 4.5 cm (d) 7.5 cm

12. A ray of light is passed through a prism at different angles of incidence. As the angle of incidence is increased from a very low value, the angle of deviation :

(a) Increases (b) Decreases and then increases

(c) Increases then decreases (d) Decreases

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 :

(a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) If Assertion is true but Reason is false.

(d) If both Assertion and Reason are false.

13. Assertion (A) : The diamagnetic materials are repelled in the magnetic field.
Reason (R) : Diamagnetic materials get strongly magnetised in a magnetic field in the opposite direction.

14. Assertion (A) : The induced emf always exists if the magnetic field is changing.
Reason (R) : The induced emf is equal to the rate of change of magnetic flux.

15. Assertion (A) : The output power of a transformer is always less than the input power.
Reason (R) : The transformer suffers energy losses in various ways.

16. Assertion (A) : Propagation of light through an optical fibre is due to total internal reflection taking place at the core-cladding interface.
Reason (R) : Refractive index of the material of the cladding of the optical fibre is greater than that of the core.

SECTION - B

17. (a) Two point charges are placed at a fixed distance between them in different media. Plot the force vs dielectric constant graph.

(b) Draw the electric field lines of two thick metallic concentric spherical shells having charges q and 2q on inner and outer shells respectively.

18. Obtain the expression for emf of two different cells connected in parallel combination with each other.

19. Distinguish between diamagnetic & feromagnetic materials based on :
(i) Magnetic Susceptibility
(ii) Behaviour inside non-uniform magnetic field

20. A coil is rotated in a uniform magnetic field with constant angular velocity. Find the expression for magnetic flux through the coil at any instant.

21. Define displacement current and obtain the expression for it.

OR

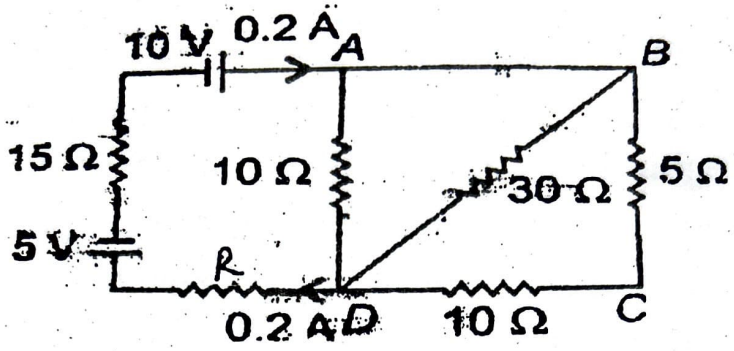
21. The equation for an em wave is $E=2\times10^{-3}\sin 2\pi(6t\times10^{16}+2y\times10^{8})$, where all the quantities are in SI units. Write the equation of the magnetic field of the same em wave. Also find its frequency and wavelength.

SECTION- C

22. Charges (+q) and (–2q) are placed at the vertices B and C of an equilateral triangle ABC of side 'a'. Obtain the expression for (i) the magnitude and (ii) the direction of the electric field at vertex A due to these two charges.

23. Charges (+5μC) and (–2μC) are placed at the points A and B of a straight line AB of distance '5 cm'. A uniform electric field of 5×10^7 N/C exists along this line from A to B. Obtain the potential energy of this system if potential at A is zero.

24. Calculate the value of resistance R in the circuit shown in the figure below so that the current in the circuit is 0.2 A. What would be the potential difference between points A and D ?



25. Two circular loops A and B each of radius 3 m, are placed co-axially at a distance of 4 m. They carry currents of 3 A and 2 A in opposite directions respectively. Find the net magnetic field at the centre of loop A.

26. (a) Define mutual inductance and write its SI units.

(b) Two coplanar circular loops, one of small radius r and other of larger radius R. such that R>>r, are placed eoaxially with the coinciding centres. Obtain the mutual inductance of the arrangement.

OR

26. (a) State Lenz law for electromagnetic induction.

(b) Obtain the expression for energy and energy density in a solenoid.

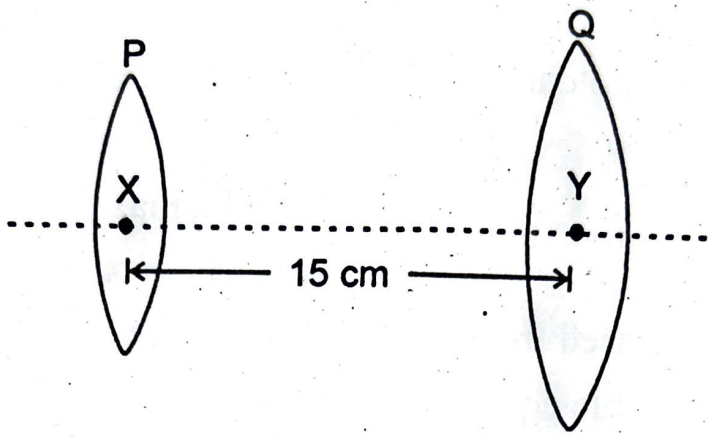
27. (a) Draw graphs showing the variations of inductive reactance and capacitive reactance with frequency of applied ac source.

(b) When an alternating voltage V is applied across a device X, a current I flows which lags behind the applied voltage in phase by $\pi/2$ 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. Name the devices X and Y.

28. Draw the ray diagram when the final image is formed at least distance of distinct vision by a compound microscope. Also derive the expression for its magnifying power in this condition.

OR

Two convex lenses P and Q of an astronomical telescope having focal lengths 4 cm and 16 cm respectively are arranged as shown in figure.



(i) Which one will you select to use as the objective lens and why ?

(ii) What should be the change in the distance between the lenses to have the telescope in its normal adjustment position ?

(iii) Calculate the magnifying power of the telescope in its normal adjustment.

SECTION- D

Case Study Based Questions :

29. Read the following paragraph and answer the questions that follow :

A magnetic dipole when kept in a uniform magnetic field, experiences a torque that tends to rotate it. The magnitude of torque depends upon the strength of the magnetic field, the pole strength and its orientation in the magnetic field. It is observed that if the angle of orientation is increased w.r.t, magnetic field, the torque as well as potential energy increase. The torque becomes maximum when the dipole becomes perpendicular to the magnetic field while its potential energy becomes maximum when the dipole gets aligned opposite to the direction of the magnetic field. The dipole has two equilibrium orientations in a uniform magnetic field, one of which refers to stable equilibrium position while the other refers to unstable equilibrium position.

If B Tesla is the strength of uniform magnetic field and mA m^2 is the dipole moment of dipole then :

(i) The stable equilibrium position of dipole refers to the orientation of :

(a) 0° (b) 90°

(c) 180° (d) 60°

(ii) The torque and potential energy respectively at stable equilibrium position are :

(a) max, min (b) min, max

(c) min, min (d) max, max

(iii) If dipole is released from any orientation, it :

(a) comes to stable equilibrium position :

(b) comes to unstable equilibrium position

(c) does not show any change in orientation

(d) oscillates about a stable equilibrium position.

OR

If the dipole is slightly displaced from its unstable equilibrium orientation, it :

(a) loses energy

(b) gains energy

(c) first loses then gains energy

(d) Its energy remains constant

(iv) The work done in rotating the dipole in Joules from stable to unstable equilibrium position is :

(a) mB (b) 2 mB

(c) –mB (d) –2mB

30. Read the following paragraph and answer the questions that follow :

Types of Lenses and their combination

A convex or converging lens is thicker at the centre than at the edges. It converges a beam of light on refraction through it. It has a real focus. Convex

lens is of three types: Double convex lens, Piano convex lens and Concavo-convex lens. Concave lens is thinner at the centre than at the edges. It diverges a beam of light on refraction through it. It has a virtual focus. Concave lenses are of three types: Double concave lens. Piano concave lens and Convexo-concave lens. When two thin lenses of focal lengths f1 and f2 are placed in contact with each other along their common principal axis, then the two lens system is regarded as a single lens of focal length f and is given by :

$1 / f = 1/ f_1 + 1/f_2$

If several thin lenses of focal length $f_1, f_2, ... f_n$ are placed in contact, then the effective focal length of the combination is given by :

$1 / f = 1 / f, + 1 /f_2 + ...+ 1/ f_n$

and in terms of power, we can write

$P = P_1 + P_2 + ... + P_n$

The value of focal length and power of a lens must be used with proper sign consideration.

(i) Two thin lenses are kept coaxially in contact with each other and the focal length of the combination is +80 cm. If the focal length of one lens is +20 cm. the focal length of the other would be :

(a) –26.7 cm (b) 60 cm

(c) 80 cm (d) 30 cm

(ii) A spherical air bubble is embedded in a piece of glass. For a ray of light passing through the bubble, it behaves like a :

(a) Converging lens (b) diverging lens

(c) mirror (d) thin plane sheet of glass

(iii) Lens generally used in magnifying glass is :

(a) Single bi-concave lens (b) single bi-convcx lens

(c) Combination of convex lens and concave lens

(d) Plano-concave lens

(iv) The magnification of an image by a convex lens is positive only when the object is placed :

(a) At its focus F
(b) between F and 2F
(c) at 2F
(d) between F and the optical centre.

OR

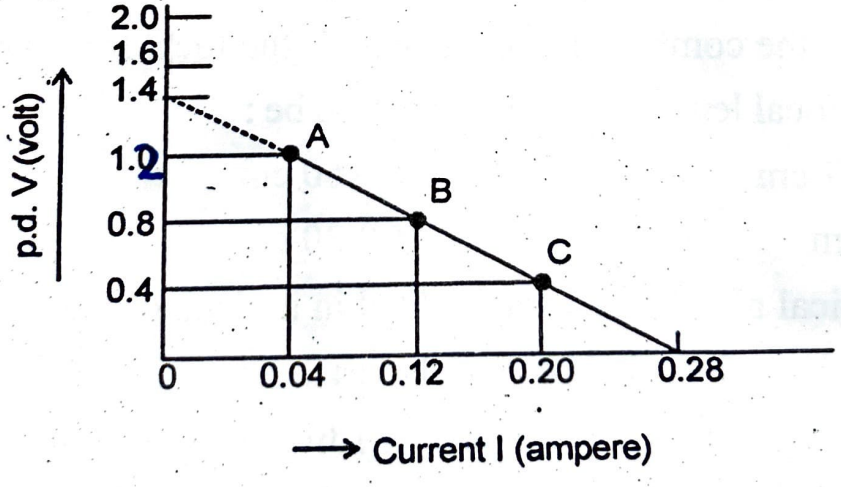
A convex lens of 20 cm focal length forms a real image which is three times magnified. The distance of the object from the lens is :

(a) 13.33 cm
(b) 14 cm
(c) 26.66 cm
(d) 25 cm

SECTION-E

31. (i) Two heating elements of different resistances when operated at a constant supply of voltage V, consume powers P_1 and P_2 respectively. Deduce the expressions for the power of their combination when they are, in turn, connected in (a) series and (b) parallel across the same voltage supply.

(ii) From the graph of V and I of a battery, given below, calculate the emf and internal resistance of the battery.



OR

31. (i) State Kirchhoffs laws.

(ii) Plot the graph of resistivity of a semiconductor Vs temperature and also justify it.

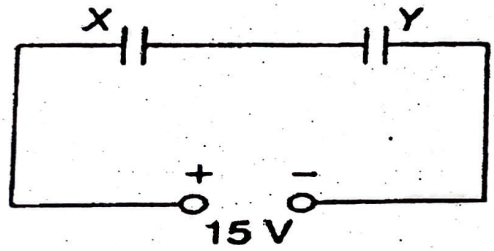
(iii) Two nichrome wires are connected in scries with a battery. The lengths of the wires are in the ratio 1 : 2 whereas their resistances are in the ratio 2 : 1 Find the ratio of drift velocities of free electrons in them.

32. (i) Derive an expression for the capacitance of a parallel plate capacitor with air present between the two plates.

(ii) Two parallel plate capacitors *X* and Y have the same area of plates and separation between them, X has air between the plates while Y contains a dielectric medium of K=4. They are connected as shown in the figure.

(a) Calculate the capacitance of each capacitor if the equivalent capacitance of the combination is 4 μF.

(b) Estimate the ratio of electrostatic energy stored in X and Y.



OR

32. (i) A dielectric slab of thickness 't' is kept between the plates of a parallel plate capacitor with plate separation 'd' (t<d). Derive the expression for the capacitance of the capacitor.

(ii) A capacitor of 200 pF is charged by a 300 V battery. The battery is then disconnected and the charged capacitor is connected to another uncharged capacitor of 100 pF. Calculate the difference between the final energy stored in the combined system and the initial energy stored in the single capacitor.

33. (i) State and prove Ampere's circuital law.

(ii) A uniform magnetic field of 1.5 T exists in a cylindrical region of radius 10.0 cm. and its direction is parallel to the axis along east to west. A wire carrying current of 7.0 A in the north to south direction passes through this

region. What is the magnitude and direction of force on the wire if the wire intersects the axis ?

OR

(i) Obtain the magnetic force on the unit length of two infinitely long parallel current carrying straight conductors and hence define 1 Ampere.

(ii) A rectangular loop of wire of size 4 cm × 10 cm carries a steady current of 2 A. A straight long wire carrying 5 A current is kept near the loop as shown. If the loop and the wire are coplanar, find the magnitude and direction of force on the loop due to current carrying wire.