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SAMPLE PAPER - 04

Class: XII

MM: 70

Subject: Physics

Time: 3 Hrs

General Instruction:-

- (xix) All questions are compulsory. There are 33 questions in all.
- (xx) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
- (xxi) Section A contains ten very short answer questions and four assertion reasoning MCQs of 1 mark each, Section B has two case based questions of 4 marks each, Section C contains nine short answer questions of 2 marks each, Section D contains five short answer questions of 3 marks each and Section E contains three long answer questions of 5 marks each.
- (xxii) There is no overall choice. However internal choice is provided. You have to attempt only one of the choices in such questions.
- (xxiii) Use of calculators is not permitted. However, you may use log tables, if necessary.
- (xxiv) You may use the following physical constant where ever necessary:

$$\text{Gravitational constant } G = 6.6 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$$

$$\text{Gas constant } R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$$

$$\text{Mass of electron} = 9.110 \times 10^{-31} \text{ kg}$$

$$\text{Mechanical equivalent of heat} = 4.185 \text{ J cal}^{-1}$$

$$\text{Standard atmospheric pressure} = 1.013 \times 10^5 \text{ Pa}$$

$$\text{Absolute zero (0 K)} = -273.15^\circ \text{C}$$

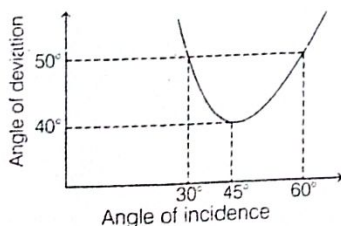
$$\text{Acceleration due to gravity} = 9.8 \text{ ms}^{-2}$$

in such questions.

SECTION-A

All questions are compulsory. In case of internal choices, attempt anyone of them.

- Two long straight wires are set parallel to each other. Each carries a current in the same direction and the separation between them is $2r$. Find out the intensity of the magnetic field mid-way between them.
- When the voltage drop across a p - n junction diode is increased from 0.65 V to 0.70 V, the change in the diode current is 5 mA. What is the dynamic resistance of diode?
- What are the dark lines seen in the solar spectrum called?
- Draw the graphs that shows in a pure resistor, the voltage and current are in phase?
- A plot of angle of deviation D versus angle of incidence, for a triangular prism is shown below



Calculate the angle of incidence for which the light ray travels parallel to the base.

Or

A slit of size 0.15 cm is placed at 2.1 m from a screen. On illuminating it by a light of wavelength 5×10^{-5} cm, calculate the width of central maxima.

6. When an electron jumps from the orbit $n = 2$ to $n = 4$, then calculate the wavelength of the radiations absorbed. (R is Rydberg's constant)

Or

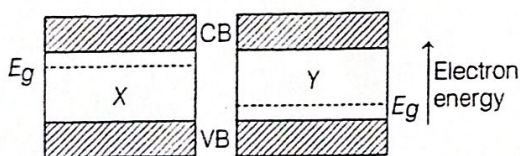
Two nuclei have mass numbers in the ratio 125 : 216, what is the ratio of their radii?

7. 2m long wire is moved with a velocity 1 ms^{-1} in a magnetic field of intensity 0.5 Wbm^{-2} in a direction perpendicular to the field. What is the value of emf induced?

Or

If an AC main supply is given to be 220 V, then what would be the average emf during a positive half-cycle?

8. Write the formula for kinetic mass of a moving photon.
9. The energy band diagrams for two semiconductor samples of silicon are as shown below



What will you infer from the above diagrams?

10. What is the angle of refraction made by a ray of light inside a prism, i.e. an equilateral glass prism in the minimum deviation?

Or

Two monochromatic light waves of same amplitudes of $2A$ interfering at a point have a phase difference of 60° . What is the relation between intensity and amplitude?

For question numbers 11, 12, 13 and 14, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

- (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.

11. **Assertion** A charge particle is released from rest in magnetic field, then it will move in a circular path.

Reason Work done by magnetic field is not zero.

12. **Assertion** Resonance phenomenon is exhibited by a circuit only, if both L and C are present in the circuit.

Reason Voltage across L and C cancel each other and the current amplitude is V_m/R , the total source voltage appearing across R cause resonance.

- 13 **Assertion** Heinrich Hertz observed that high voltage spark across detector loop were enhanced when the emitter plate was illuminated by UV-light.

Reason Light shining on the metal surface facilitate the escape of free electrons.

- 14 **Assertion** The applied voltage (in forward bias of a $p-n$ junction) mostly drops across the depletion region and the voltage drop across the p -side and n -side of the junction is negligible.

Reason Resistance of depletion region is large compared to resistance of n or p -side.

SECTION-B

Questions 15 and 16 are case study based questions and are compulsory. Attempt any 4 sub parts from each question. Each question carries 1 mark.

Microscope

15. The instruments like microscope, telescope, etc., which are used to assist the eye in viewing an object are known as optical instruments.

Microscope is used to see very small object. It forms a large image of closed and minute objects.

There are of two types; simple microscope and compound microscope

Simple microscope consists of a single convex lens (converging lens) of small focal length. In this type of microscope, when an object is at a distance less than the focal length of the lens, the image obtained is virtual, erect and magnified.

On the other hand, compound microscope consists of two convex lenses coaxially separated by some distance. The lens nearer to the object is called the objective. The lens through which the final image is viewed is called the eyepiece.

(i) Which one of the following statements is incorrect?

- (a) A simple magnifier or microscope is a converging lens of small focal length.
- (b) For microscope the magnification in case of image formed at infinity is one more than the magnification when image is at the near point.
- (c) For larger magnifications, one uses two lenses, one compounding the effect of the other. This is known as a compound microscope.
- (d) The lens nearest the object is called objective and the lens near eye is called eyepiece.

(ii) In order to increase the angular magnification of a simple microscope, one should increase

- (a) the object size
- (b) the aperture of the lens
- (c) the focal length of the lens
- (d) the power of the lens

(iii) The image formed by an objective of a compound microscope is

- (a) virtual and diminished
- (b) real and diminished
- (c) real and enlarged
- (d) virtual and enlarged

(iv) For realistic focal length, a simple microscope has a limited maximum magnification

- (a) greater than 9
- (b) lesser than 9
- (c) equal to 9
- (d) Both (b) and (c)

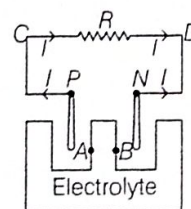
(v) A compound microscope has an objective with magnification 20, an eyepiece with magnification 12.5 and a tube length of 20 cm, then the magnification of this microscope is

- (a) 200
- (b) 250
- (c) 100
- (d) 150

EMF of a Cell

16. An electric cell is a source of energy that maintains a continuous flow of charge in a circuit. It changes chemical energy into electrical energy. It has two electrodes, positive electrode (PA) and negative electrode (NB) as shown below.

Electric cell has to do some work in maintaining the current through a circuit. The work done by the cell in moving unit positive charge through the whole circuit (including the cell) is called the **electromotive force (emf)** of the cell.



(i) When two electrodes (positive and negative) of a cell are immersed in an electrolytic solution, the charges are exchanged between

- (a) positive electrode and electrolyte only
- (b) negative electrode and electrolyte only
- (c) Both electrodes and electrolytes
- (d) directly between two electrodes

(ii) The current flowing in the cell is

(a) $I = \frac{\epsilon}{R+r}$ (b) $I = \frac{R+r}{\epsilon}$
 (c) $I = \frac{R}{\epsilon}$ (d) $I = r/\epsilon$

(iii) The maximum current that can be drawn from a cell is for

- (a) $R = \text{infinity}$
 (b) $R = \text{finite non-zero resistance}$
 (c) $R = 0$ (d) $R = r$

(iv) When R is infinite, then potential difference V between P and N is

- (a) ϵ (b) 2ϵ (c) $\epsilon/2$ (d) $\epsilon/4$

(v) For the given circuit, if the cell has an emf of 2V and the internal resistance of this cell is 0.1Ω , it is connected to resistance of 3.9Ω , the voltage across the cell will be

- (a) 1.95 V (b) 1.5 V
 (c) 2 V (d) 1.8 V

SECTION-C

All questions are compulsory. In case of internal choices, attempt anyone.

17. What is the difference between the values of potential difference across the two terminals of a cell in an open circuit and closed circuit?

Or

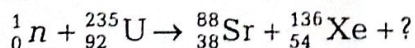
First a set of n equal resistors of R each are connected in series to a battery of emf E and internal resistance R , a current I is observed to flow. Then, the n resistors are connected in parallel to the same battery. It is observed that the current is increased 10 times. What is the value of n ?

18. (i) Define one tesla using the expression of the magnetic force acting on a particle of charge q moving with velocity v in a magnetic field B .
 (ii) Is it possible to decrease or increase the range of given voltmeter? Explain.

Or

Two identical magnets with a length 100 cm are arranged freely with their like poles facing in a vertical glass tube. The upper magnet hangs in air above the lower one so that the distance between the nearest poles of the magnet is 3 mm. If the pole strength of the pole of these magnets is 6.64 A-m, then determine the force between the two magnets.

19. Complete the following fission reaction and how do we calculate the amount of energy it releases?



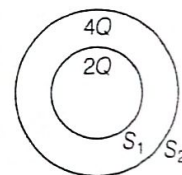
20. A ray of light is normally incident on one face of an equilateral prism. Trace the course of the ray through the prism and emerging from it. ($\mu_g = 3/2$)

21. Identify the electromagnetic waves whose wavelengths vary as

- (i) $10^{-12} \text{ m} < \lambda < 10^{-8} \text{ m}$ (ii) $10^3 \text{ m} < \lambda < 10^1 \text{ m}$

Write one use for each.

22. Consider two hollow concentric spheres S_1 and S_2 enclosing charges $2Q$ and $4Q$ respectively as shown in the figure.



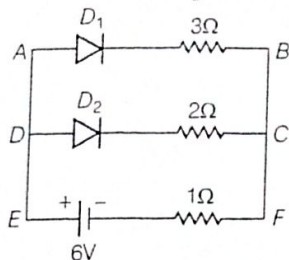
- (i) Find out the ratio of the electric flux through them.
 (ii) How will the electric flux through the sphere S_1 changes, if a medium of dielectric constant ϵ_r is introduced in the space inside S_1 in place of air. Deduce the necessary expression.

23. Suppose a pure Si crystal has 5×10^{28} atoms m^{-3} . It is doped by 1 ppm concentration of pentavalent. Calculate the number of electrons and holes. Given that, $n_i = 1.5 \times 10^{16} \text{ m}^{-3}$.

Or

Assuming that the two identical diodes D_1 and D_2 are used in the electric circuit as shown in the figure are ideal. Find out th

value of current flowing through $1\ \Omega$ resistor.



24. Answer the following questions.

- (i) In any AC circuit, is the applied instantaneous voltage equal to the algebraic sum of instantaneous voltage across the series elements of the circuit? Is the same true for rms voltage?

- (ii) An applied voltage signal consists of superposition of a DC voltage and an AC voltage of high frequency. The circuit consists of an inductor and a capacitor in series. Show that the DC signal will appear across C (capacitor) and the AC signal across L (inductance).

25. An AC input signal of frequency 60 Hz is rectified by
(i) half-wave (ii) and full wave rectifier.

Draw the output waveform and write the output frequency in each case.

SECTION-D

All questions are compulsory. In case of internal choices, attempt anyone.

26. A neutron of mass (m) = 1.66×10^{-27} kg having energy (E) = 8.28×10^{-21} J at 127°C is moving in a waveform, then its de-Broglie wavelength can be calculated as.

[given, Boltzmann constant,

$$k = 1.38 \times 10^{-23} \text{ J mol}^{-1} \text{ K}^{-1}$$

and Planck's constant, $h = 6.63 \times 10^{-34}$ J-s.]

$$\begin{aligned} \lambda &= \frac{h}{\sqrt{2mE}} \\ &= \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 1.66 \times 10^{-27} \times 8.28 \times 10^{-21}}} \\ \lambda &= 1.264 \times 10^{-10} \text{ m} \\ &= 1.264 \text{ \AA} \end{aligned}$$

If the energy of neutron will not be given, then suggest an alternative method to find the wavelength.

27. (i) If ϵ_0 & μ_0 are the electric permittivity & magnetic permeability of free space and ϵ & μ are the corresponding quantities in the medium. Find the index of refraction of the medium in terms of above parameter.
(ii) An electromagnetic wave is travelling in vacuum with a speed of 3×10^8 m/s. Find the velocity in a medium having relative electric permittivity and magnetic permeability 2 and 1, respectively.

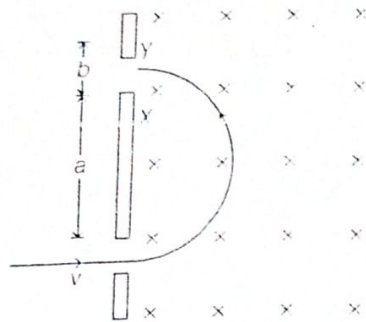
28. (i) A charged particle is free to move in an electric field. Will it always move along the line of force?
(ii) Two point charges of unknown magnitudes and signs are placed at a distance apart. The electric field is zero at a point, not between the charges but on the line joining them. Write two essential conditions for this to happen.

Or

A parallel plate capacitor of capacitance C is charged to a potential V by a battery. Without disconnecting the battery, the distance between the plates is tripled and a dielectric medium of $K = 10$ is introduced between the plates of the capacitor. Explain giving reasons, how will the following be affected

- (i) capacitance of the capacitor,
(ii) charge on the capacitor and
(iii) energy density of the capacitor.

29. A beam of equally charged particles after being accelerated through a voltage V enters into a magnetic field B as shown in figure. It is found that all the particles hit the plate between X and Y , then what is the ratio between the masses of the heaviest and lightest particles of the beam?



Or

A current carrying loop consists of 3 identical quarter circles of radius R , lying in the positive quadrants of the

x - y , y - z and z - x planes with their centres at the origin, joined together. Find the direction and magnitude of B at the origin.

30. (i) When four hydrogen nuclei combine to form a helium nucleus, estimate the amount of energy in MeV released in this process of fusion. (Neglect the masses of electrons and neutrinos). Given, mass of ${}^1_1\text{H} = 1.007825 \text{ u}$ and mass of helium nucleus = 4.002603 u .
- (ii) What is the longest wavelength photon that can ionize a hydrogen atom in its ground state? Specify the type of radiation.

SECTION-E

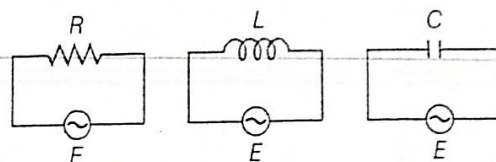
All questions are compulsory. In case of internal choices, attempt anyone.

31. (i) A rod of length l is moved horizontally with a uniform velocity v in a direction perpendicular to its length through a region in which a uniform magnetic field is acting vertically downward. Derive the expression for the emf induced across the ends of the rod. How does one understand this motional emf by involving the Lorentz force acting on the free charge carriers of the conductor? Explain.
- (ii) With the help of a neatly drawn labelled diagram, prove that the magnitude of motional emf e is given by $e = Blv$, where l is the length of a metallic rod and v is the velocity with which it is pulled in a transverse magnetic field B .

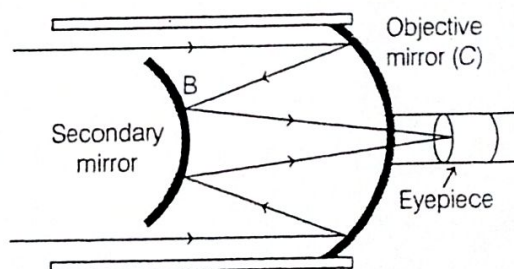
Or

- (i) When an AC source is connected to an ideal inductor, show that the average power supplied by the source over a complete cycle is zero.
- (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, then how will the current flowing in these circuits be affected?

Give the reason for your answer.



32. (i) Double convex lenses are to be manufactured from a glass of refractive index 1.55 with both faces of the same radius of curvature. What is the radius of curvature required, if the focal length is 30 cm?
- (ii) A Cassegrain telescope (reflecting telescope) uses two mirrors as shown in figure below. Such a telescope is built with the mirrors 20 mm apart. If the radius of curvature of the large mirror is 220 mm and of the small mirror is 140 mm, then where will be the final image of an object at infinity?



Or

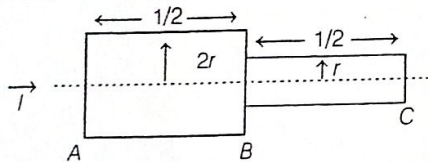
(i) In a single slit diffraction experiment, a slit of width d is illuminated by red light of wavelength 650 nm . For what value of d will

- (a) the first minimum fall is at an angle of diffraction of 60° and
 (b) the first maximum fall is at an angle of diffraction of 60° ?

(ii) In Young's double slit experiment, the two slits 0.15 mm apart are illuminated by monochromatic light of wavelength 450 nm . The screen is 1.0 m away from the slits.

- (a) Find the distance of the second
 I. bright fringe
 II. and dark fringe from the central maxima.
 (b) How will the fringe pattern change, if the screen is moved away from the slits?

33. (i) Two bars of radii r and $2r$ are kept in contact as shown in the figure. An electric current I is passed through the bars. Find the ratio of heat produced in bars AB and BC .



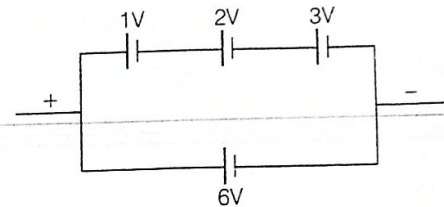
(ii) Two conducting wires A and B of same diameter but different materials are

joined in series across a battery. If the number density of electrons in A is that in B , find the ratio of drift velocity of electrons in the two wires.

(iii) A secondary cell after a long use has an emf of 1.9 V and a large internal resistance of 380Ω . What maximum current can be drawn from the cell? Could the cell drive the starting motor of a car?

Or

(i) Find the emf of the battery shown in the figure:



(ii) In the circuit given E_1 and E_2 are two cells of emfs 4 V and 6 V respectively, having negligible internal resistances. Applying Kirchhoff's laws of electrical networks, find the values of I_1 and I_2 .

