2024 III 04 **0930** **Seat No.** | | | | | |

Time : 3 Hours **PHYSICS**

Subject Code

H	4	7	0	2

Total No. of Questions : 35 (Printed Pages : 12) **Maximum Marks : 70**

INSTRUCTIONS : (*i*) *All* questions are compulsory.

(*ii*) This question paper has *four* sections.

(*iii*) Section A contains **14** questions of *one* mark each. Section B contains **10** questions of *two* marks each. Section C contains **8** questions of *three* marks each. Section D contains **3** questions of *four* marks each.

(*iv*) There is no overall choice. However, internal choices have been provided in one question of *three* marks and three questions of *four* marks weightage. You have to attempt only *one* of the choices in such questions.

(*v*) Use of calculators is not permitted. However, you may ask for mathematical tables.

(*vi*) You may use the following values of physical constants wherever necessary :

$h = 6.63 \times 10^{-34}$ Js

$\pi = 3.14$

$e = 1.6 \times 10^{-19}$ C

$c = 3 \times 10^{8}$ ms^{-1}

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

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^{9}$ Nm^{2}C^{-2}

$\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}

$m_e = 9.1 \times 10^{-31}$ kg

Section A

Directions for Q.1–Q.7 :

Select and write the most appropriate options from those given below each question.

1. Rutherford's alpha particle scattering experiment was responsible for the discovery of : 1

   - Nucleus
   - Electron
   - Helium
   - Neutrino

2. Which of the following gives the polarity of the induced emf ? 1

   - Biot-Savart Law
   - Lenz's Law
   - Ampere's circuital law
   - Fleming's right hand rule

3. In AC generator, if the rotational velocity of armature is doubled, the induced emf will : 1

   - become half
   - become double
   - become zero
   - remains unchanged

4. The oscillating electric and magnetic field vectors of an electromagnetic wave are oriented along : 1

   - the same direction but differ in phase by 90^{o}
   - the same direction and are in phase
   - mutually perpendicular direction and are in phase
   - mutually perpendicular direction and differ in phase by 90^{o}

5. The generation of energy in the sun is mainly due to : 1

- Fission of heavy nuclei
- Fission of light nuclei
- Fusion of heavy nuclei
- Fusion of light nuclei

6. The frequencies of X-rays, gamma rays and ultra violet rays are a, b and c respectively, then : 1

- $a < b,\ b > c$
- $a > b,\ b < c$
- $a > b,\ b > c$
- $a < b,\ b < c$

7. A lens of power +2 dioptre is placed in contact with a lens of power –1 dioptre. The combination will behave like : 1

- A convergent lens of focal length 50 cm
- A divergent lens of focal length 100 cm
- A convergent lens of focal length 100 cm
- A convergent lens of focal length 200 cm

Direction for Q.8–Q.14

Answer the following :

8. Why microwaves are considered suitable for radar systems used in aircraft navigation ? 1

9. What is Bohr's quantisation condition for the angular momentum of an electron in the second orbit ? 1

10. Why is it necessary to introduce a cylindrical soft iron core inside the coil of a galvanometer ? 1

11. Why do we prefer steel for making permanent magnets ? 1

12. If the horizontal and vertical components of earth's magnetic field are equal at a place, find the angle of dip. 1

13. What is the ratio of de-Broglie wavelength associated with two electron beams A and B accelerated through 25 V and 36 V respectively ? 1

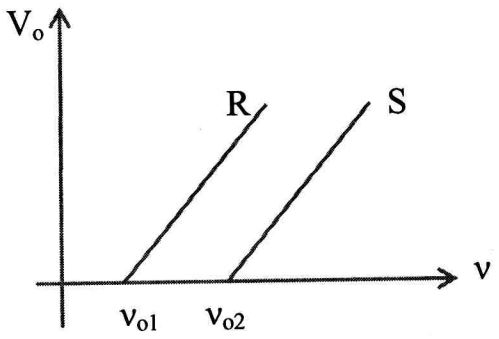
14. In an ideal transformer, number of turns in the primary and secondary are 200 and 1000 respectively. If the input voltage is 200 V, what will be its output voltage ? 1

Section B

15. Graph shows the variation of stopping potential (V_o) with frequency (υ) for two photosensitive metals 'R' and 'S'. 2

(*i*) Which metal has smaller threshold wavelength ?

(*ii*) The distance between the light source and metal is doubled, how will the stopping potential change ?



16. A nucleus ${}^{m}_{n}X$ emits one alpha particle and one positron. What will be the mass number and atomic number of the product nucleus ? 2

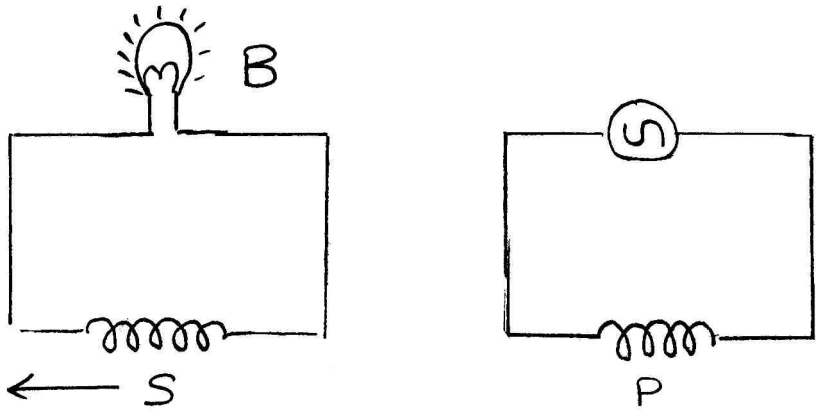
17. Calculate the shortest wavelength present in the Balmer series of spectral line. ($R = 1.097 \times 10^{-7}\ m^{-1}$) 2

18. A spherical shell of radius 8 cm has a charge of 1.6×10^{-7} C, distributed uniformly over its surface. What is the electric field at a point 12 cm from the center of the shell ? 2

19. A coil 'S' is connected to low voltage bulb 'B' and placed near coil 'P' as shown in figure : 2

(*i*) Give reason why the bulb lights up.

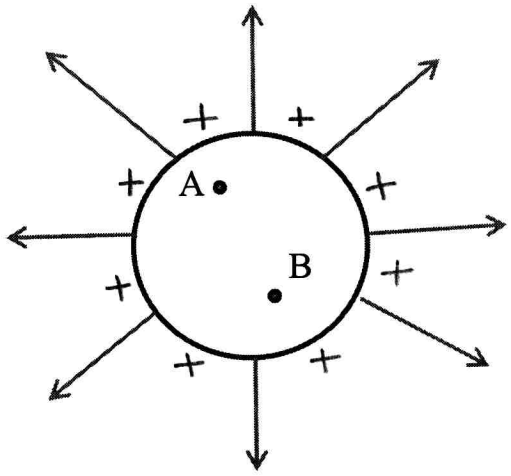
(*ii*) Bulb gets dimmer if the coil 'S' is moved slowly toward left.



20. A metallic spherical shell is charged to potential +50 V : 2

(*i*) What is the potential difference between points A and B ?

(*ii*) Why is the electric field always perpendicular to the surface of the charged conductor ?

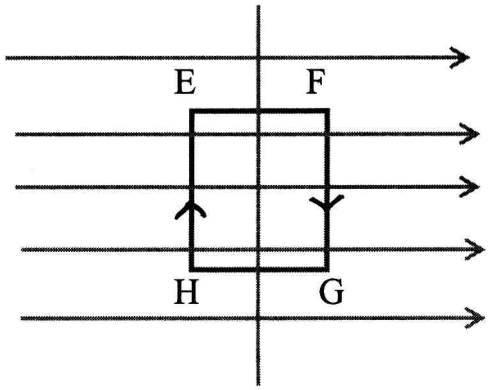


21. Two bars 'L' and 'M' are made from different materials are placed in a non-uniform magnetic field. Bar 'L' tends to move slightly from weaker to the stronger field region, while bar 'M' tends to move from stronger to weaker field region. What is the nature of the magnetic materials used for making of these two bars ? What is their susceptibility ? 2

22. A rectangular current carrying loop EFGH (parallel to the plane of the paper) is kept in a uniform magnetic field as shown in figure : 2

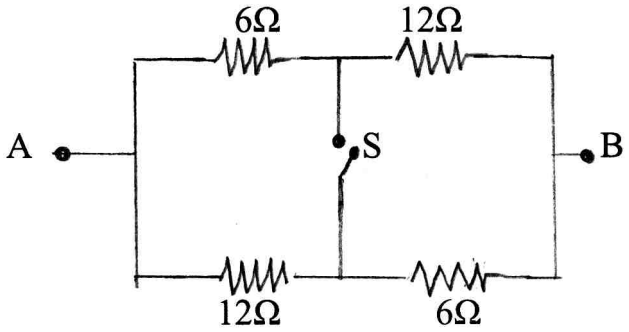
(*i*) What is the direction of the magnetic moment of the current loop ?

(*ii*) When is the torque acting on the loop zero ?



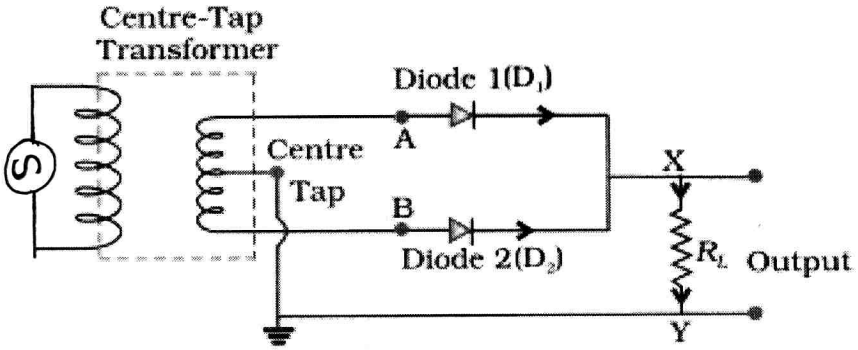
23. Using Huygen's principle, derive the laws of refraction for a plane wave propagating from a rarer to denser medium. Draw the necessary ray diagram. 2

24. Find the effective resistance of the network shown below between the points A and B when the switch is open and closed. 2



Section C

25.



(*i*) Identify the above circuit. 3

(*ii*) Which property of the diode is utilized in working of the above circuit ?

(*iii*) Draw input and output waveforms for above circuit.

26. In Young's double slit experiment : 3

(*i*) What is the effect on the fringe width if the separation between the slits is increased ?

(*ii*) What is the path difference, when two light waves coming from two slits form third minimum ?

(*iii*) Why steady interference pattern is not observed when two slits are illuminated with two separate sources ?

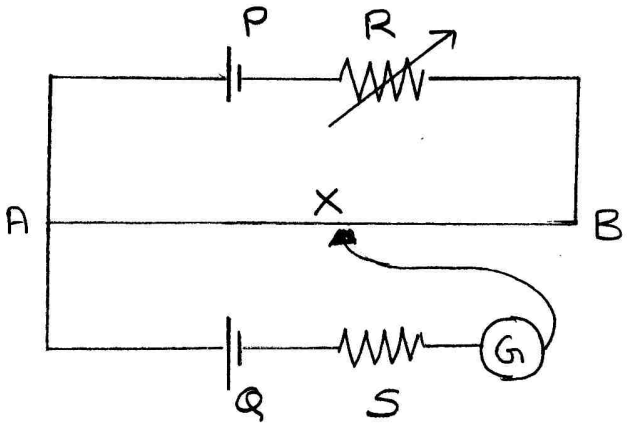
27. An object placed 12 cm to the left of a diverging lens of focal length –6 cm. A converging lens with focal length of 12 cm is placed at a distance '*d*' to the right of the diverging lens. Find the distance '*d*' that corresponds to a final image at infinity. 3

28. In a potentiometer circuit shown, the balance point is at X. Towards which end, A or B the balance point will shift when : 3

(*i*) Resistance 'R' is increased, keeping all parameters unchanged.

(*ii*) Resistance 'S' is increased keeping 'R' constant.

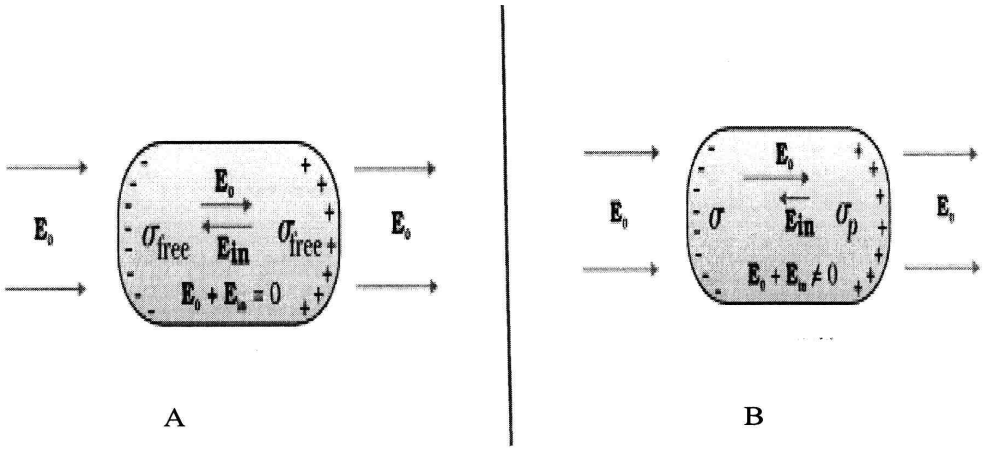
(*iii*) Cell 'P' is replaced by another cell whose emf is lower than that of cell 'Q'.



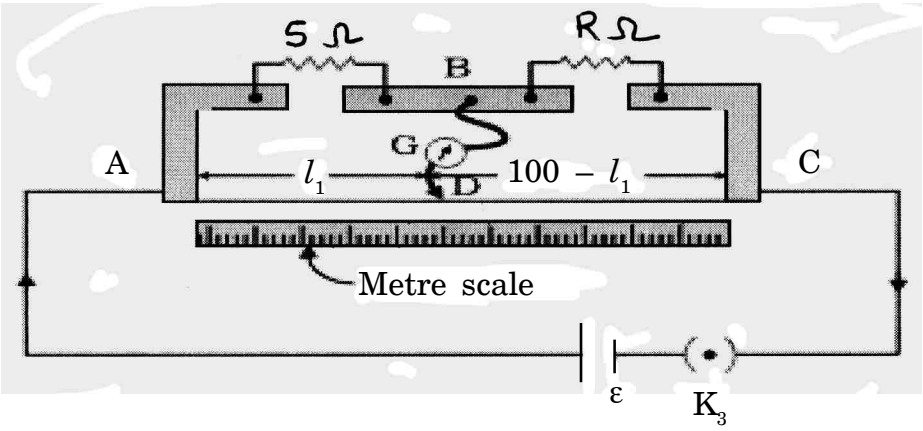
29. Two slabs 'A' and 'B' made of certain material is placed inside a region of a uniform electric field E_0 as shown in figure. 3

(*i*) Identify nature of the slabs 'A' and 'B'.

(*ii*) What is the total electric dipole moment of the slab 'B' in the absence of external field ?



30. In a meter bridge experiment, resistances 5 Ω and R Ω are connected in the left and right gap respectively. The balance point is obtained at a distance l_1 from A as shown in figure. When the resistance 'R' is shunted with equal resistance, the new balance point is at 1.6 l_1. Calculate the value resistance R and length l_1. 3



31. With the help of neat diagram, derive an expression for the electric field at any point on the equatorial line of an electric dipole. 3

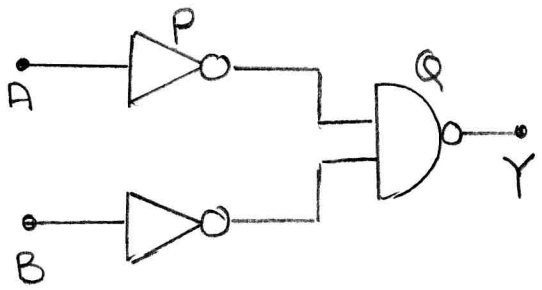
32. Derive an expression for the magnetic field due to a circular current carrying loop, at a point along its axis. Draw the necessary diagram. 3

Or

Show that the force per unit length between two parallel current carrying wires is inversely proportional to the distance between them. Draw the necessary diagram. 3

Section D

33. Identify the logic gates marked P and Q. Rewrite the truth table with output Y for input conditions shown in the truth table for the combination of logic gates and identify the logic operation carried out by the combination of gates. 4



A	B	Y
0	0	
0	1	
1	0	
1	1	

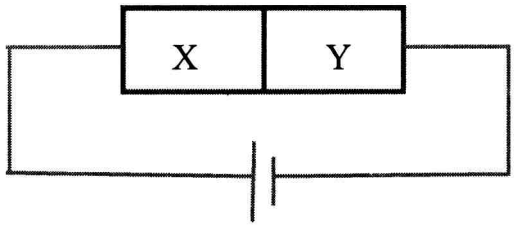
Or

A semiconductor X is made by doping a germanium crystal with indium. A second semiconductor Y is made by doping germanium with arsenic. The two are joined end to end and connected to a battery as shown : 4

(*i*) Identify the semiconductors X and Y obtained after doping.

(*ii*) Identify the biasing and draw VI characteristics.

(*iii*) If the polarity of the source is reversed, how will the width of the depletion region change ?



34. Derive an expression for the ac current, when an ac source is applied across a pure inductor. Draw the necessary phasor diagram. 4

What is the average power supplied to an inductor over one complete cycle of the ac source ?

Or

Derive an expression for the ac current, when an ac source is applied across a pure capacitor. Draw the necessary phasor diagram.

What is the average power supplied to a capacitor over one complete cycle of the ac source ? 4

35. With the help of a neat ray diagram, derive an expression for the refractive index of the material of a prism. Hence obtain the angle of minimum deviation of a thin prism. 4

Or

With the help of a neat ray diagram, derive the relationship between the object distance, image distance and focal length of a concave mirror. Also deduce the formula for linear magnification. 4