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Time : 3 Hours

PHYSICS

Subject Code

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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 :

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

$$\pi = 3.14$$

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

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

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2 \text{N}^{-1} \text{m}^{-2}$$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2 \text{C}^{-2}$$

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

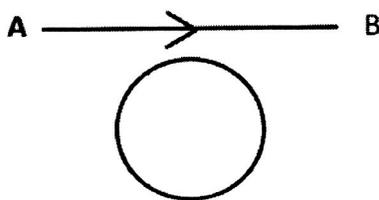
$$m_e = 9.1 \times 10^{-31} \text{ kg}$$

Section A

1. A spherical conducting shell of radius R has a charge $+q$ units. 1

The electric field due to the shell at a point :

- Inside is zero and varies as r^{-1} outside it
 - Inside is constant and varies as r^{-1} outside it
 - Inside is zero and varies as r^{-2} outside it
 - Inside is constant and varies as r^{-2} outside it
2. A straight current carrying wire kept in a uniform magnetic field will experience a maximum force when it is : 1
- perpendicular to the magnetic field
 - parallel to the magnetic field
 - at an angle of 45° to the magnetic field
 - at an angle of 60° to the magnetic field
3. A current starts flowing from A to B as shown in the figure : 1



The direction of the induced current in the loop is :

- Clockwise
- Anticlockwise
- No current is induced
- Dependent on the radius of the loop

4. The magnetic field in a plane electromagnetic wave is given by : 1

$$B_y = 2 \times 10^{-7} \sin (0.5 \times 10^3 x + 3.14 \times 10^{11} t) \text{ Tesla}$$

What is the frequency of the wave ?

- 50 GHz
- 50 MHz
- 0.5 GHz
- 5 MHz

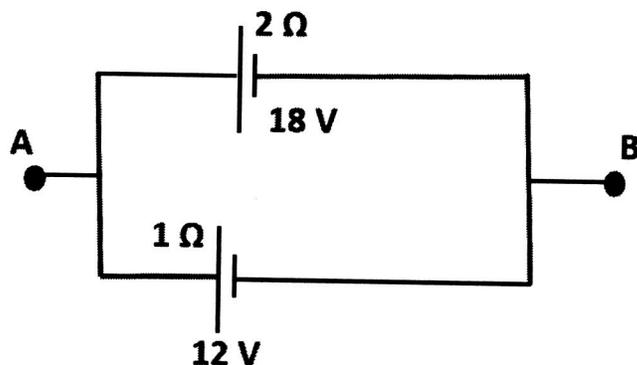
5. If the velocity of the electron increases, then its de Broglie wavelength : 1

- Increases
- Decreases
- Remains same
- Cannot be predicted

6. The volume of a nucleus with mass number A is proportional to : 1

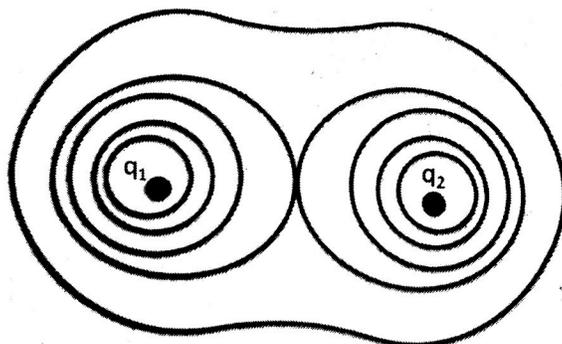
- $A^{1/2}$
- $A^{1/3}$
- A^3
- A

7. Two batteries, one of emf 18 volts and internal resistance 2Ω and the other of emf 12 volts and internal resistance 1Ω , are connected as shown : 1



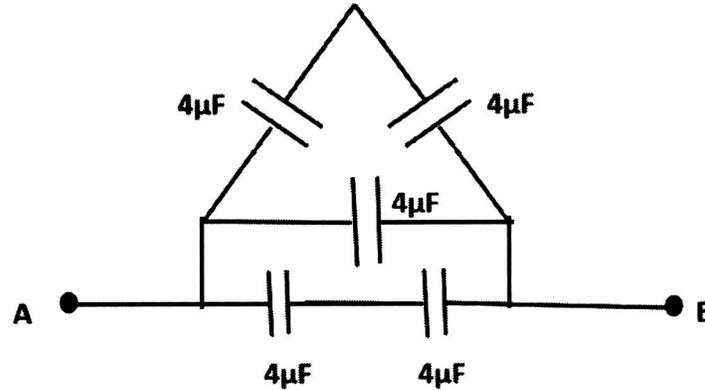
What will be the potential difference across the points A and B ?

- 30 volt
 - 18 volt
 - 15 volt
 - 14 volt
8. The refractive indices of glass and water with respect to air are $3/2$ and $4/3$ respectively. What will be the refractive index of glass with respect to water ? 1
9. Figure below shows the equipotential surfaces for two charges q_1 and q_2 . Identify the nature of charges q_1 and q_2 . 1



10. What is the force experienced by : 1
- (i) A stationary charge in a magnetic field ?
- (ii) A charge moving with a velocity v parallel to the magnetic field ?

11. What is the equivalent capacitance between A and B ? 1



12. What is the critical angle for a material of refractive index $\sqrt{2}$? 1
13. Why is electric power transmission from power stations to sub-stations near consumers done at high voltages ? 1
14. Distinguish between a semiconductor and an insulator based on their energy gap. 1

Section B

15. A spherical Gaussian surface of radius R encloses a positive charge Q . What happens to the net electric flux through the surface in the following cases ? 2
- (a) The shape of the Gaussian surface is changed into a cuboid with side $2R$.
- (b) The charge is doubled.

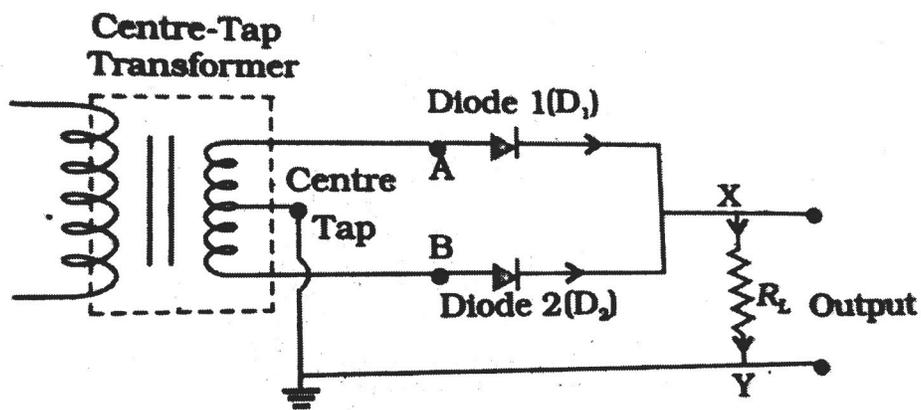
16. How are X-rays produced ? Give *one* use of X-rays. 2
17. An erect image 3 times the size of the object is obtained with a concave mirror of radius of curvature 36 cm. What is the position of the object ? 2
18. A and B are two copper wires of same length and have diameters 0.3 mm and 3.0 mm respectively. 2
- (a) Which wire will have higher resistance ?
- (b) Which wire will have lower resistivity ?
- (c) What happens to the resistivity of the wire A when it is heated ?
- (d) How does resistivity depend on the number of free electrons per unit volume ?
19. Two concentric circular loops A and B of radii 3 meters and 5 meters carry currents 3 A and 2 A respectively in opposite directions. Find the magnitude of the net magnetic field at the centre of the coils. 2
20. A series LCR circuit is made by taking $R = 100\Omega$, $L = \frac{2}{\pi}$ H, and $C = \frac{100}{\pi}$ μF . This series combination is connected across an AC source of 220 V, 50 Hz. Calculate the impedance of the circuit. 2

21. If a plane wavefront is incident on a convex lens, what will be the shape of the refracted wavefront ? 2

Which principle is used to predict the shape of the refracted wavefront ?

22. Distinguish between nuclear fission and nuclear fusion based on the binding energy per nucleon of the nuclei undergoing these reactions. 2

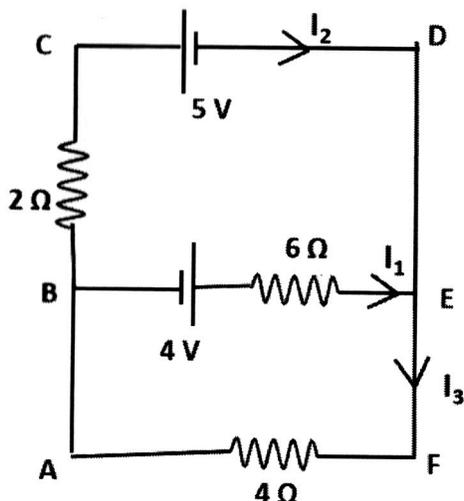
23. 2



- (a) Identify the above circuit.
- (b) What is the function of the above circuit ?
24. Using ampere's circuital law in magnetism, derive an expression for the intensity of magnetic field due to a straight current carrying wire. 2

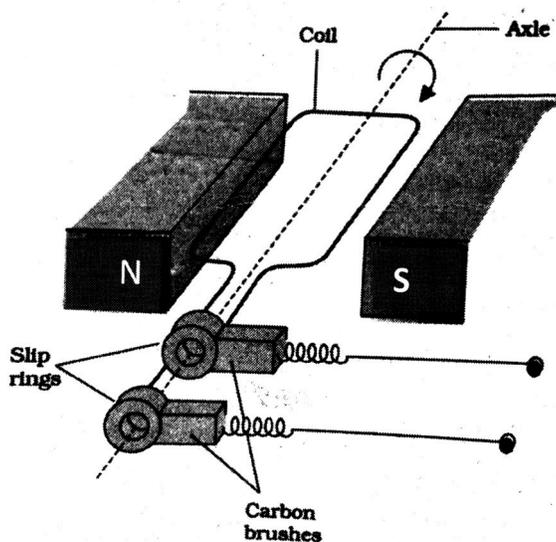
Section C

25. Using Kirchoff's rules, in the network shown in figure, find the currents I_1 , I_2 and I_3 : 3



26. Derive an expression for the intensity of electric field for points on the equatorial plane of an electric dipole. Draw the necessary diagram. 3

27. 3



- (a) Identify the device in the above figure.
- (b) How does it work ?
- (c) At which position of the coil will the EMF be maximum ?

28. When three materials A, B, and C are placed in an external magnetic field B_0 : 3

(i) In material A, the individual atomic dipole moments are aligned in the same direction as B_0 .

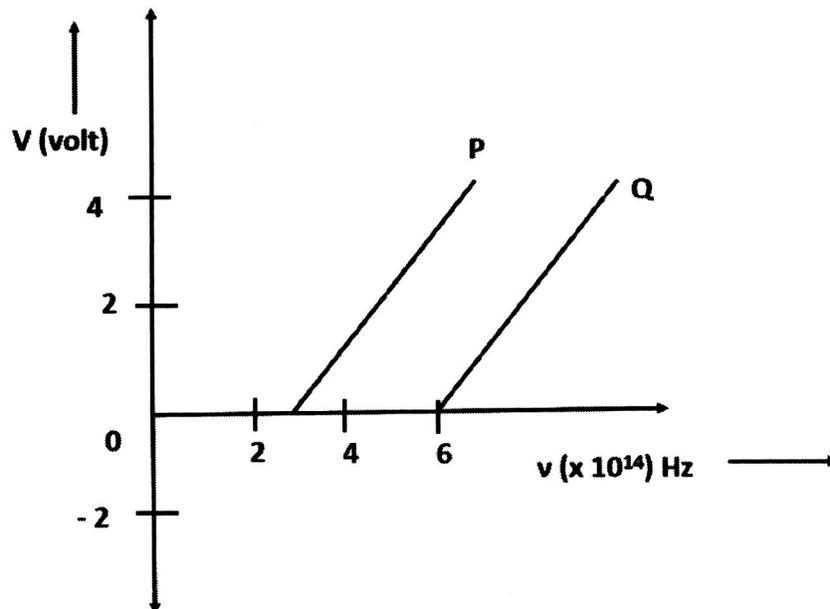
(ii) Material B, develops a net magnetic moment in the direction opposite to that of B_0 .

(iii) In material C, the domain oriented in the direction of B_0 grow in size.

Identify the materials A, B, and C.

Explain what would happen to the magnetic field lines inside these materials when placed in an external uniform field B_0 .

29. The figure shows the graph between the stopping potential V , and the frequency ν of the incident radiation for two different metals P and Q emitting photo electrons : 3



- (a) How can the value of Planck's constant be found out from the graph ?
- (b) Which metal will emit photo electrons with higher kinetic energy ?
Why ?
30. Monochromatic light of wavelength 589 nm is incident from air on a water surface. What are the wavelength, frequency, and speed of : 3
- (i) Reflected light
- (ii) Refracted light.
31. In an atom an electron revolving around the nucleus has kinetic energy equal to 'K'. What will be its potential energy and total energy in terms of the kinetic energy 'K' ? Why is the total energy of an electron revolving around the nucleus always negative ? 3
32. Derive an expression for the current when an alternating EMF is connected to a pure resistor. Also, obtain an expression for the average power. Draw the phasor diagram. 3

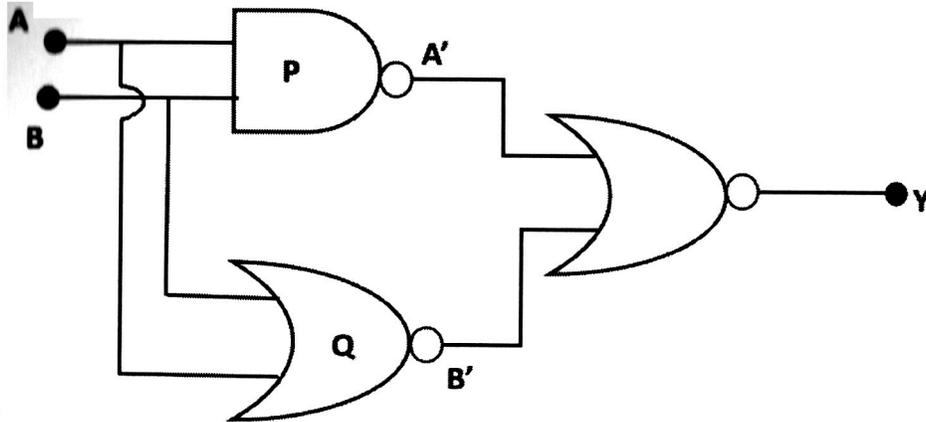
Or

Derive an expression for the current when an alternating EMF is connected to an ideal capacitor. Draw the phasor diagram. 3

Section D

33. In the figure shown below :

4



- (a) Identify the gates P and Q.
- (b) Write the truth table for inputs A and B and output Y.
- (c) Identify the logic operation carried out with the combination of gates.

Or

How can you convert a NAND gate into a :

4

- (i) NOT gate
- (ii) AND gate
- (iii) OR gate

Write the necessary truth tables and draw the necessary diagrams.

34. Derive an expression for the capacitance of a parallel plate capacitor. 4

State *one* method of increasing the capacitance of this capacitor.

Or

Derive an expression for the potential due to a point charge. Draw the necessary diagram. Write an expression for the potential due to an electric dipole.

4

35. Assuming the expression for refraction at a spherical surface, derive the Lens maker's formula. Also, derive the thin lens formula. Draw the necessary diagrams. 4

Or

With the help of a neat ray diagram, derive an expression for the refractive index of the material of a prism. Hence obtain an expression for the deviation produced by a thin prism.