HS/XII/Sc/Ph/18

2 0 1 8

PHYSICS

Full Marks : 70

Time : 3 hours

The figures in the margin indicate full marks for the questions

General Instructions :

(i) All questions are compulsory.

(ii) All the answers are to be written in the Answer Script.

(iii) There is no overall choice. However, internal choices have been provided in two questions of *two* marks, two questions of *three* marks and one question of *five* marks.

(iv) Use of non-programmable ordinary scientific calculator and/or logarithmic table is allowed.

(v) Use of Mobile Phones, Pagers and such other electronic gadgets is not allowed in the Examination Hall.

(2)

(vi) Use the following values of physical constants wherever necessary :

Speed of light in vacuum, $c = 3 \times 10^8 \, \text{m s}^{-1}$

Planck's constant, $h = 6 \cdot 63 \times 10^{-34}$ J-s

Permittivity of free space,

$$\varepsilon_0 = 8 \cdot 86 \times 10^{-12} \, \text{C}^2 \, \text{N}^{-1} \, \text{m}^{-2}$$

Permeability of free space, $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

Mass of electron, $m_e = 9 \cdot 11 \times 10^{-31}$ kg

Mass of proton, $m_p = 1 \cdot 67 \times 10^{-27}$ kg

Electronic charge, $e = 1 \cdot 6 \times 10^{-19}$ C

GROUP—A

(Multiple choice type questions)

Choose and write the correct option for the following :

½×8=4

1. A given charge situated at a certain distance from an electric dipole of very small length along its axial line experiences a force F. If the distance of the charge is doubled, the force on the charge will become

(a) $2F$

(b) $F/2$

(c) $F/4$

(d) $F/8$

2. A 700 pF capacitor is charged by a 50 V battery. How much electrostatic energy is stored by it?

(a) $6 \cdot 7 \times 10^{-7}$ J

(b) $8 \cdot 75 \times 10^{-7}$ J

(c) $13 \cdot 6 \times 10^{-9}$ J

(d) $17 \cdot 0 \times 10^{-8}$ J

3. Which of the following quantities does not change when a resistor is heated by passing current through it?
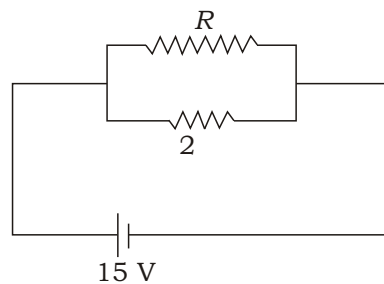
(a) Resistance

(b) Resistivity

(c) Drift velocity

(d) Number of free electrons

4. If in the following circuit, power dissipated is 150 W, then R is

(a) 2

(b) 6

(c) 5

(d) 4

5. If the number of turns, area and current through a coil are *n, A* and *I* respectively, then its magnetic moment is

(a) $n^2 IA$

(b) nIA^2

(c) nIA

(d) $nI^2 A$

6. The magnetic field at the centre of a circular coil of radius 5 cm carrying a current of 1 A is 1·256 T. If the radius is made 10 cm, then the magnetic field at the centre of the loop carrying same current is

(a) 0·628 T

(b) 2·512 T

(c) 5·024 T

(d) 0·314 T

7. Which of the following phenomena is used in optical fibres?

(a) Total internal reflection

(b) Scattering

(c) Diffraction

(d) Dispersion

8. The refractive index of the material of an equilateral prism is $\sqrt{3}$. What is the angle of minimum deviation?

 (a) 45°

 (b) 60°

 (c) 37°

 (d) 30°
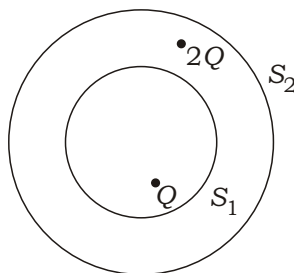
GROUP—B

(Very short answer type questions)

Answer the following questions in *one* sentence/step each :   1×8=8

9. What is the direction of electric field with respect to an equipotential surface?   1

10. S_1 and S_2 are two parallel concentric spheres enclosing charges Q and $2Q$ respectively as shown in the figure below. What is the ratio of electric flux through S_1 and S_2?   1

11. State Kirchhoff's voltage law.   1

12. The potential difference across a given wire is increased. What happens to the drift velocity of the free electrons? 1

13. The equation of an alternating current is $I = 50\sin100\,t$. Find the frequency. 1

14. Write the following radiations in the ascending order of their wavelengths : 1

Microwaves, Ultraviolet rays, Gamma rays, Infrared rays

15. You are given two convex lenses of focal lengths 10 cm and 60 cm. To make a telescope, which of the two lenses will you use as object lens and which one as eye lens? 1

16. Green light ejects electron from a certain photo-sensitive surface, but yellow light does not. What will happen in case of red and violet light? ½+½=1

GROUP—C

(Short answer type–I questions)

Answer the following questions within *30* words each :
2×8=16

17. Obtain an expression for the torque on an electric dipole placed in a uniform electric field. 2

18. Derive Ohm's law from the expressions of drift velocity and current. 2

(7)

19.   *Either*

Calculate the force per unit length between two parallel long straight wires 2 cm apart in air, each carrying a current of 4 A.   2

Or

Horizontal and vertical components of earth's magnetic field at a place are 0·22 tesla and 0·38 tesla respectively. Find the resultant intensity of earth's magnetic field at the place.   2

20. Find the root mean square value of current through a capacitor of capacitance 10 F, when connected to an a.c. source of 110 volt at 50 cycles/sec supply. What is its reactance?   2

21.   *Either*

State Lenz's law and show that it is in accordance with the law of conservation of energy.   1+1=2

Or

What are eddy currents? Write its two applications.

1+1=2

22. State two applications each of X-rays and radio waves.   1+1=2

23. Draw the energy-level diagram of hydrogen atom. Show the Lyman series and Pfund series in the diagram.   1+1=2

24. *(a)* What is amplitude modulation?   1

*(b)* Name the different types of wave propagation.   1

GROUP—D

(Short answer type–II questions)

Answer the following questions within *30* to *40* words each : 3×9=27

25. Using Gauss's theorem in electrostatics, derive an expression for electric field at a point due to an infinitely long line of charge having a uniform charge density. 3

26. The circuit shown in the figure below contains a battery *B*, a rheostat Rh and identical lamps *P* and *Q*. What will happen to the brightness of the lamps if the resistance through the rheostat is increased? Give reasons. 3
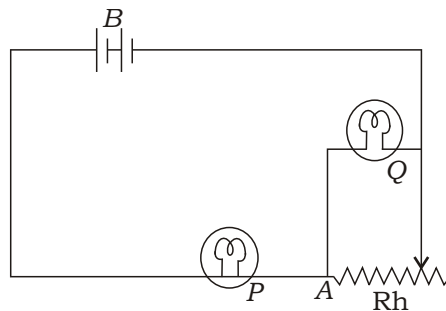
27. *Either*

Obtain an expression for the average power of an a.c. circuit. 3

Or

What is meant by self-inductance of a coil? Obtain an expression for the self-inductance of a long solenoid. 3

(9)

28. Derive an expression for the magnifying power of an astronomical telescope in normal adjustment.   3

29.   *Either*

Show that the de Broglie wavelength of an electron accelerated through a potential difference of V volts is $\dfrac{h}{\sqrt{2\,meV}}$.   3

                    Or

Define work function and threshold frequency of a metal. Write Einstein's photoelectric equation in terms of stopping potential, frequency of incident radiation and threshold frequency of a metal.   1+1+1=3

30. What is half-life of a radioactive nucleus? Show that half-life is inversely proportional to the decay constant of the radioactive sample.   1+2=3

31. Find the binding energy per nucleon of an -particle in MeV. (Take, 1 a.m.u. 931 5 MeV) Given—

   mass of -particle   4 00150 a.m.u.
   mass of proton   1 00728 a.m.u.
   mass of neutron   1 00867 a.m.u.   3

32. *(a)* Draw a neat diagram showing forward biasing of a *p-n* junction.   1

   (b) With the help of a circuit diagram, show how a Zener diode can be used as a voltage regulator.   2

33. What is demodulation? Draw a circuit for using a junction diode as a demodulator. Why is demodulation necessary?   1+1+1=3

(10)

GROUP—E

#### (Long answer type questions)

Answer the following questions in *70* to *80* words each :

5×3=15

34. Using Biot-Savart law, find an expression for the magnetic field at a point on the axis of a circular current-carrying loop. Hence find the expression for the magnetic field at its centre.   4+1=5

35.   *Either*

State Snell's law of refraction. A spherical surface of radius of curvature R separates a rarer and a denser medium as shown in the figure below :
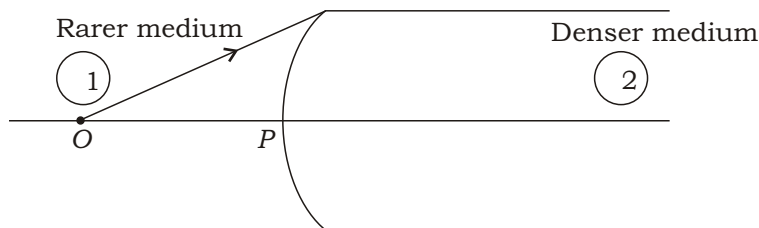
Complete the path of the ray of light, showing the formation of a real image. Derive the relation connecting object distance u, image distance v, radius of curvature R and the refractive indices $_1$ and $_2$ of the two media.   1+1+3=5
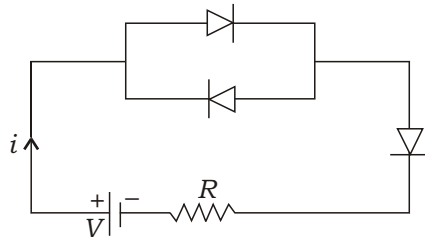
Or

What are coherent sources? Define interference of light. Obtain the condition for constructive and destructive interference of light.   1+1+3=5

36. *(a)* Discuss the working of a photodiode. Why a photodiode is operated in reverse bias mode?

$$3+1=4$$

(b) Find the current i in the circuit given below :

Given, forward resistance of the diode is r_f 1 , R 2 and V 10 volts. 1

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