

Total No. of Printed Pages—11

HS/XII/Sc/Ph/19

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PHYSICS

(Theory)

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, $h = 6.63 \times 10^{-34} \text{ J-s}$

Permittivity of free space,

$$\epsilon_0 = 8.86 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$$

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

Mass of electron, $m_e = 9.11 \times 10^{-31} \text{ kg}$

Mass of proton, $m_p = 1.67 \times 10^{-27} \text{ kg}$

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

GROUP—A

(Multiple choice type questions)

Choose and write the correct option for the following :

$$\frac{1}{2} \times 8 = 4$$

1. The force between two equal point charges separated by a certain distance is F . If the distance between them is doubled and their individual charges are also doubled, then the force between them is

(a) F

(b) $2F$

(c) $F/2$

(d) $F/4$

(3)

- 2.** An electric dipole of dipole moment $\vec{p}$ is placed in a uniform electric field of strength $\vec{E}$. If θ is the angle between the positive direction of $\vec{p}$ and $\vec{E}$, then potential energy of the dipole is largest when θ is

(a) 0°

(b) 90°

(c) 180°

(d) 45°

- 3.** A charged particle of mass m and charge q moves along a circular path with a velocity v perpendicular to a magnetic field $\vec{B}$. The radius of the circular path is

(a) $\frac{mv}{qB}$

(b) $\frac{mB}{qv}$

(c) $\frac{mq}{vB}$

(d) $\frac{qv}{mB}$

4. To convert a galvanometer into a voltmeter, we must connect a
- (a) high resistance in parallel with the galvanometer
 - (b) high resistance in series with the galvanometer
 - (c) low resistance in parallel with the galvanometer
 - (d) low resistance in series with the galvanometer
5. A step-up transformer operates on a 230 V line and supplies current of 2 A to a load. The ratio of the primary and secondary windings is 1 : 25. The current in the primary coil is
- (a) 12.5 A
 - (b) 15 A
 - (c) 25 A
 - (d) 50 A
6. When current changes from 2A to 2A in 0.05 s, an e.m.f. of 8 V is induced in a coil. The coefficient of self-induction of the coil is
- (a) 0.8 H
 - (b) 0.4 H
 - (c) 0.1 H
 - (d) 0.2 H

(5)

7. The displacements of interfering light waves are $y_1 = 4 \sin t$ and $y_2 = 3 \sin(t/2)$. The amplitude of the resultant wave is

- (a) 5
- (b) 7
- (c) 1
- (d) 0

8. The slits in Young's experiment have widths in the ratio 1:16. The ratio of maxima and minima in the interference pattern is

- (a) 1:16
- (b) 1:4
- (c) 5:3
- (d) 25:9

GROUP—B

(Very short answer type questions)

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

9. Using an expression for drift velocity, show that the mobility of free electron is directly proportional to its relaxation time. 1
10. A wire of resistance 1000 and length l is increased to twice its original length. Calculate its new resistance. 1

(6)

- 11.** Name the electromagnetic radiation which is used—
(a) to kill cancerous cells in human;
(b) to produce dehydrated fruits. $\frac{1}{2} + \frac{1}{2} = 1$
- 12.** What is carrier wave? 1
- 13.** What is diffraction of light? 1
- 14.** What is the effect of intensity of incident light on photoelectric current? 1
- 15.** Mention one practical application of logic gates. 1
- 16.** Why VHF, UHF and microwaves cannot be transmitted by sky wave propagation? 1

GROUP—C

(Short answer type-I questions)

Answer the following questions within 30 words each
wherever applicable : $2 \times 8 = 16$

- 17.** *Either*
Use Gauss's theorem to derive an expression for electric field due to a uniformly charged spherical shell at a point outside the shell. 2
- Or*
- Derive an expression for energy stored in a charged capacitor. 2

(7)

18. Write down the condition of resonance in series L - C - R circuit and hence find an expression for the resonant frequency. $\frac{1}{2} + 1\frac{1}{2} = 2$

19. An alternating source of e.m.f. $E = E_0 \sin t$ is applied to a circuit containing a capacitor only. Show that the current leads the e.m.f. by $\pi/2$ radian. 2

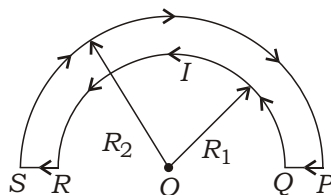
20. Using supplied value of μ_0 and ϵ_0 , find the speed of electromagnetic waves in vacuum. 2

21. *Either*

Two parallel wires carrying current in the same direction attract each other while two beams of electrons travelling in the same direction repel each other. Explain why. 2

Or

The wire loop $PQRSP$ formed by joining two semi-circular wires of radii R_1 and R_2 carries a current I as shown in the figure below. Find the magnitude of magnetic field at O . 2



22. (a) What are isotones? 1

(b) A A_1 A_2 A_3

The mass number and atomic number of A are 180 and 72 respectively. What are these numbers for A_3 ? 1

23. A semiconductor has equal electron and hole concentration $6 \times 10^8 \text{ m}^{-3}$. On doping with a certain impurity, electron concentration increases to $9 \times 10^{12} \text{ m}^{-3}$. Calculate the new hole concentration. Also identify the new semiconductor. $1\frac{1}{2} + \frac{1}{2} = 2$

24. What is the basic principle of a rectifier? Draw a neat circuit diagram of a full-wave rectifier circuit. $1 + 1 = 2$

GROUP—D

(Short answer type-II questions)

Answer the following questions within 30 to 40 words each wherever applicable : $3 \times 9 = 27$

25. What is drift velocity of electrons? Show that electric current flowing through a conductor is directly proportional to the drift velocity. $1 + 2 = 3$

26. *Either*

Derive an expression for coefficient of mutual induction for two long solenoids. 3

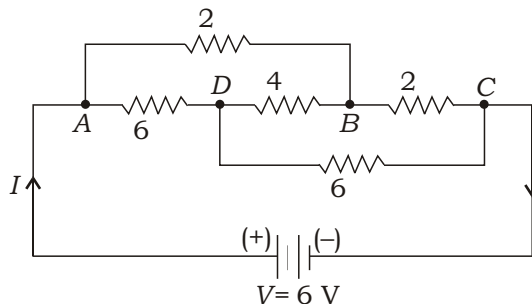
Or

With the help of a phasor diagram, find an expression for impedance (Z) in a series L - C - R circuit. 3

(9)

27. (a) Why do we prefer potentiometer to compare the e.m.f.s of cells than a voltmeter? 1

(b) Find I in the following circuit :



[Assume negligible internal resistance of the cell.] 2

28. (a) Derive de Broglie wave equation for material particles. 2

(b) Why does photoelectric emission not take place if the frequency of incident radiation is less than threshold frequency? 1

29. State radioactive decay law. Derive the relation $N = N_0 e^{-\lambda t}$, where symbols have their usual meanings. 1+2=3

30. *Either*

Using Huygens' principle, establish the laws of reflection. 3

Or

Find an expression for combined focal length of two thin coaxial convex lenses placed in contact. 3

(10)

- 31.** (a) State the postulates of Bohr's theory of hydrogen atom. 2
- (b) Name the series of hydrogen spectrum lying in ultraviolet and visible region. $\frac{1}{2} + \frac{1}{2} = 1$
- 32.** With the help of labelled circuit diagram, explain the working of a transistor as an amplifier using *n-p-n* transistor in CE configuration. $1 + 2 = 3$
- 33.** (a) Obtain an expression for the coverage range in space wave propagation in terms of height of the antenna. 2
- (b) What is modulation factor? 1

GROUP—E

(Long answer type questions)

Answer the following questions in 70 to 80 words each wherever applicable : $5 \times 3 = 15$

- 34.** Derive an expression for the electric potential at any point at a distance r from the centre of an electric dipole. Hence find the potential if the point lies on (i) axial line and (ii) equatorial line. $4 + \frac{1}{2} + \frac{1}{2} = 5$

- 35.** Describe the principle and working of a moving-coil galvanometer and hence show that the deflection of the coil is directly proportional to the current flowing through it. What is the effect of the radial magnetic field in a moving-coil galvanometer? 1+3+1=5

- 36.** *Either*

Derive lens maker formula for a thin convex lens. 5

Or

With the help of a neat diagram, explain the working of a compound microscope. Obtain an expression for its magnifying power when the final image is formed at least distance of distinct vision. 2+3=5

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