

Total No. of Printed Pages—11

HS/XII/Sc/Ph/NC/21

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PHYSICS

(Theory)

(New Course)

Full Marks : 70

Time : 3 hours

The figures in the margin indicate full marks for the questions

General Instructions :

- (i) There are **31** questions in all. All questions are compulsory.
- (ii) This question paper has four Sections : Section—A (Part—I & Part—II), Section—B, Section—C and Section—D.
- (iii) Section—A (Part—I) contains five multiple choice questions of 1 mark each and Section—A (Part—II) contains five questions of 1 mark each. Section—B contains nine questions of 2 marks each, Section—C contains nine questions of 3 marks each and Section—D contains three questions of 5 marks each.
- (iv) There is no overall choice. However, internal choices have been provided in three questions of 1 mark, five questions of 2 marks, five questions of 3 marks and all three questions of 5 marks weightage. You have to attempt only one of the choices in such questions.

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(v) You may use the following values of physical constants, wherever necessary :

$$c = 3 \times 10^8 \text{ m/s}$$

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

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

$$\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$$

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

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

$$\text{Mass of neutron} = 1.675 \times 10^{-27} \text{ kg}$$

$$\text{Mass of proton} = 1.673 \times 10^{-27} \text{ kg}$$

$$\text{Avogadro's number} = 6.023 \times 10^{23} \text{ per gram mole}$$

$$\text{Boltzmann constant} = 1.38 \times 10^{-23} \text{ J K}^{-1}$$

SECTION—A

PART—I

(Multiple choice type questions)

Choose the correct option from the following :

1×5=5

1. A soap bubble is given some charge. Its radius

(A) increases

(B) increases if the charge is positive

(C) decreases if the charge is negative

(D) is not affected

1

(3)

2. Drift velocity of free electrons, when current passes through the conductor, is of the order of
- (A) 10 mm/s
 - (B) 10 m/s
 - (C) 10 km/s
 - (D) 10^6 m/s
- 1
3. A charged particle is projected along the magnetic field line. Magnetic force on the particle is
- (A) perpendicular to the velocity only
 - (B) perpendicular to the magnetic field only
 - (C) perpendicular to both the velocity and magnetic field
 - (D) zero
- 1
4. The energy of a photon of wavelength λ is
- (A) $hc\lambda$
 - (B) hc/λ
 - (C) $h\lambda/c^2$
 - (D) $h\lambda$
- 1
5. The energy required to remove an electron from the $n = 2$ state of hydrogen atom is
- (A) 27.2 eV
 - (B) 13.6 eV
 - (C) 6.8 eV
 - (D) 3.4 eV
- 1

(4)

PART—II

(Very short answer type questions)

Answer each of the following questions in 1 sentence/step :
1×5=5

6. *Either*
What is the cause of internal resistance of a cell? 1
Or
Why is a slide wire bridge also called meter bridge? 1
7. Induced e.m.f. is sometimes known as back e.m.f.
Why? 1
8. *Either*
Draw a ray diagram to show that a totally reflecting prism deviates a ray through 180° . 1
Or
Draw the ray diagram showing the formation of primary rainbow with the total internal reflection and refraction of a ray of light inside a water drop. 1
9. *Either*
Calculate the frequency associated with a photon of energy 3.3×10^{-20} J. 1
Or
The threshold frequency of a material is 2×10^{14} Hz.
What is its work function? 1
10. What would happen, if the electrons in an atom were stationary? 1

(5)

SECTION—B

(Short answer type-I questions)

Answer each of the following questions within 20 to 30 words,
wherever applicable : 2×9=18

- 11.** Calculate the resistivity of the material of a wire 1.0 m long, 0.4 mm in diameter and having a resistance of 2.0 Ω . 2

12. *Either*

Using Ampere's circuital theorem, calculate the magnetic field due to an infinitely long wire carrying a current I . 2

Or

Write an expression for the force per unit length between two infinitely long straight parallel current carrying wires. Hence define 1 ampere. 1+1=2

13. *Either*

What are eddy currents and how can they be minimised? 1+1=2

Or

What is a transformer? State its principle. 1+1=2

- 14.** Name the part of the electromagnetic spectrum whose wavelength lies in the range 10^{-10} m. Give its one use. 1+1=2

(6)

- 15.** *Either*
The amplitude of the magnetic field of a harmonic electromagnetic wave in vacuum is $B_0 = 510$ nT. What is the amplitude of the electric field part of the wave? 2
Or
Electromagnetic waves travel in a medium with a speed of 2×10^8 m/s. The relative permeability of the medium is 1. Find the relative permittivity. 2
- 16.** *Either*
What are the conditions necessary for total internal reflection to take place? 2
Or
State the assumptions on which Huygens' principle of secondary wavelets is based. 2
- 17.** *Either*
Prove that the nuclear density is same for all nuclei and is independent of its mass number A . 2
Or
Define atomic mass unit (a.m.u.). Show that $1 \text{ a.m.u.} = 931 \text{ MeV}$. $\frac{1}{2} + 1\frac{1}{2} = 2$
- 18.** Differentiate between intrinsic and extrinsic semi-conductors. 2
- 19.** With the help of a circuit diagram, explain the use of junction diode as a half-wave rectifier. 1+1=2

(7)

SECTION—C

(Short answer type-II questions)

Answer each of the following questions within 30 to 40 words,
wherever applicable : 3×9=27

20.

Either

Deduce the expression for the electric potential due to a point charge. 3

Or

Obtain the expression for the electric field at any point on the axial line of an electric dipole. 3

21. State and explain Kirchhoff's laws. 3

22.

Either

Apply Biot-Savart law to derive an expression for the magnetic field at the centre of a current carrying circular loop. 3

Or

Derive an expression for the magnetic dipole moment of an electron revolving around a nucleus. 3

23. (a) Why are pole pieces of a magnet within a galvanometer made concave? 1

(b) Name the elements of earth's magnetic field. 1

(c) Write the expression for Lorentz force. 1

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24. *Either*

For a concave lens, show that $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$, the symbols having their usual meanings. 3

Or

Derive the laws of reflection of light on the basis of Huygens' wave theory of light. 3

25. *Either*

Refractive indices of water and glass are $\frac{4}{3}$ and $\frac{3}{2}$ respectively. A ray of light travelling in water is incident on the water-glass interface at 30° . Calculate the angle of refraction. 3

Or

A ray of light suffers minimum deviation while passing through a prism of refractive index 1.5 and refracting angle 60° . Calculate—(a) the angle of deviation and (b) the angle of incidence. $2+1=3$

26. A metal has a threshold wavelength of 6000 \AA . Calculate—

(a) threshold frequency;

(b) the work function. $1\frac{1}{2}+1\frac{1}{2}=3$

27. Differentiate between nuclear fission and nuclear fusion with examples. 3

(9)

28.

Either

What is meant by the term 'doping'? Mention the various methods of doping and explain them in brief.

1+2=3

Or

What is dark current? Explain the working principle of a photodiode. Give two important uses of photodiodes.

1+1+1=3

SECTION—D

(Long answer type questions)

Answer each of the following questions within 70 to 80 words, wherever applicable :

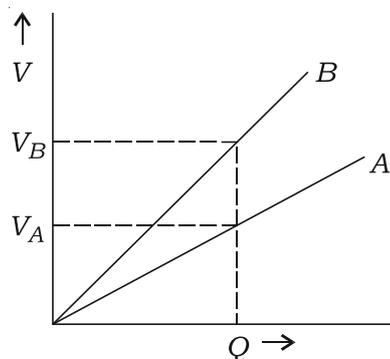
5×3=15

29.

Either

(a) Obtain the expression for the energy stored in a charged parallel-plate capacitor. 2

(b) The graph shows the variation of voltage V across the plates of two capacitors A and B versus increase of charge Q stored on them. Which of the two capacitors has higher capacitance? Give reason for your answer : 2



(10)

- (c) Explain the meaning of the statement “electric charge is quantised”. 1

Or

- (a) Obtain the expression for the capacitance of a parallel-plate capacitor when the space between the plates is filled with a medium of dielectric constant k . 3
- (b) Why two electric lines of force cannot intersect each other? 1
- (c) What does $q_1 + q_2 = 0$ signify in electrostatics? 1

30.

Either

- (a) Define r.m.s. value or virtual value of an alternating current. Derive a relation between r.m.s. value and its peak value. 1+3=4
- (b) An electrical device has the following ratings printed on it :
- 60 W, 220 V, 50 Hz.
- What is the meaning of these numbers? 1

Or

Using the phasor diagram, derive an expression for the impedance of a series LCR circuit. What is the resonant condition in series LCR circuit? 4+1=5

(11)

31.

Either

Obtain an expression for the refractive index of the material of the prism in terms of the angle of the prism and the angle of minimum deviation.

5

Or

Show that the fringe width is given by

$$\beta = \frac{D\lambda}{d}$$

where D is the distance between the source and the screen, λ is the wavelength of light and d is the distance between the two sources.

5

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