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.

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

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

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

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

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

$\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ $C^2$ $N^{-1}$ $m^{-2}$

$m_e = 9{\cdot}1 \times 10^{-31}$ kg

Mass of neutron = $1{\cdot}675 \times 10^{-27}$ kg

Mass of proton = $1{\cdot}673 \times 10^{-27}$ kg

Avogadro's number = $6{\cdot}023 \times 10^{23}$ per gram mole

Boltzmann constant = $1{\cdot}38 \times 10^{-23}$ 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

**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 $\lambda$ is

(A) $hc\lambda$

(B) $hc / \lambda$

(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

## 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 $3{\cdot}3\times10^{-20}$ J. 1

*Or*

The threshold frequency of a material is $2\times10^{14}$ Hz. What is its work function? 1

**10.** What would happen, if the electrons in an atom were stationary? 1

## 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

**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 $2 \times 10^8$ 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 a.m.u. = 931 MeV. ½+1½=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

## 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

**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 4/3 and 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 Å. Calculate—

*(a)* threshold frequency;

*(b)* the work function. 1½+1½=3

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

**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

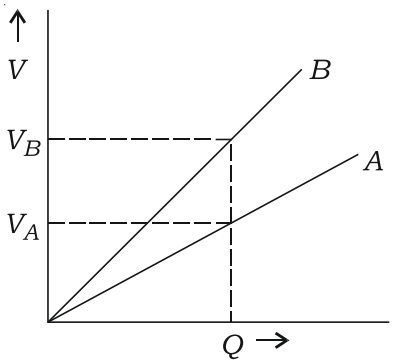
( Long answer type questions )

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



*(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

**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, $\lambda$ is the wavelength of light and $d$ is the distance between the two sources. 5

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