

Total No. of Printed Pages—11

**HS/XII/Sc/Ph/22**

**2 0 2 2**

**PHYSICS**

**( Theory )**

*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 one question of 1 mark, three questions of 2 marks, six 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 :

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

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

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

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

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

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

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

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

SECTION—A

PART—I

( Multiple choice type questions )

Choose the correct option from the following : 1×5=5

1. For sustained interference of light, we must have
- (A) two real monochromatic sources of same wavelength
  - (B) two real white sources
  - (C) two virtual sources obtained from a single monochromatic source
  - (D) two virtual white sources

1

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2. In terms of susceptibility  $\chi$ , a material is diamagnetic if

- (A)  $\chi$  is negative
- (B)  $\chi$  is positive and small
- (C)  $\chi$  is large and positive
- (D)  $\chi$  is zero

1

3. The work function of cesium is 2.14 eV. The threshold frequency for cesium is

- (A)  $8.15 \times 10^{13}$  Hz
- (B)  $5.16 \times 10^{14}$  Hz
- (C)  $7.12 \times 10^{12}$  Hz
- (D)  $9.16 \times 10^{15}$  Hz

1

4. Optical fibres are based on the phenomenon of

- (A) reflection
- (B) refraction
- (C) dispersion
- (D) total internal reflection

1

5. The magnitude of induced e.m.f. in a coil of inductance 1 mH in which a current is changing from 0.1 A to 2.1 A in 0.01 sec is

- (A) 0.02 V
- (B) 0.2 V
- (C) 2 V
- (D) 20 V

1

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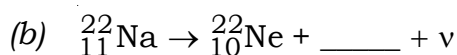
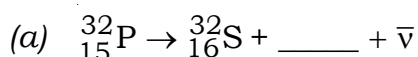
PART—II

( Very short answer type questions )

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

6. The resistance of a given carbon resistor is  $2.4 \times 10^6 \Omega \pm 5\%$ . What is the sequence of colours on the resistor? 1

7. Complete the following nuclear reaction :  $\frac{1}{2} + \frac{1}{2} = 1$



8. In passing through a refracting prism, which component colour of white light bends the most? Write the equation for the speed of electromagnetic waves in terms of  $\epsilon_0$  and  $\mu_0$ . 1

9. What is an LED? 1

10. *Either*

Unpolarized light is incident on a plane glass surface of  $\mu = 1.5$ . What should be the angle of incidence so that the reflected and refracted rays are perpendicular to each other? 1

*Or*

Two slits are made 1 mm apart and the screen is placed 1 m away.

What is the fringe separation when light of wavelength 500 nm is used? 1

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SECTION—B

( Short answer type-I questions )

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

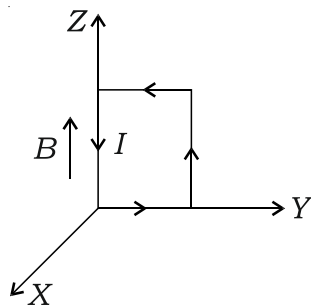
11. State Biot-Savart law. Write the equation in vector form. 1+1=2

12. *Either*

A uniform magnetic field of 3000 G is established along the positive Z-direction.

A rectangular loop of side 10 cm and 5 cm carries a current of 12 A.

What is the torque acting on the loop shown in the figure? (Use  $1\text{ G} = 10^{-4}\text{ T}$ ) 2



*Or*

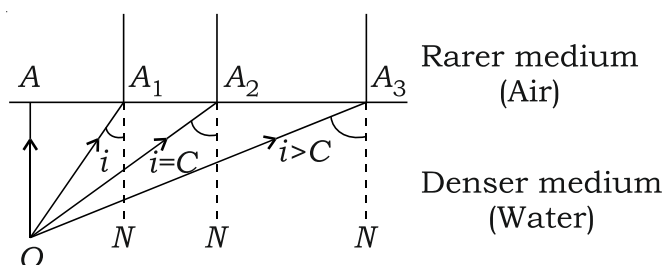
Consider a uniform electric field  $E = 3 \times 10^3\text{ NC}^{-1}$ , acting along x-axis.

- (a) What is the flux through a square of side 10 cm whose plane is parallel to Y-Z plane?

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- (b) What is the flux through the same square if the normal to its plane makes a  $60^\circ$  angle with the  $x$ -axis? 1+1=2

13. Complete the ray diagram for the incident rays  $OA$ ,  $OA_1$ ,  $OA_2$ ,  $OA_3$ . 2



14. *Either*
- Define half-life of a radioactive substance.  
Write the expression for it. 1+1=2
- Or*
- What is mass defect?  
Write the expression for the mass defect of a nucleus of mass  $M$ , mass number  $A$  and atomic number  $Z$ . 1+1=2
15. What are polar and non-polar dielectrics? 1+1=2
16. Explain briefly the blue colour of the sky on the basis of Rayleigh scattering. 2
17. Define the terms magnetic declination and inclination or dip. 1+1=2

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18. How are X-rays generated? What is the wavelength range of X-rays? Mention one use of X-rays.  $1 + \frac{1}{2} + \frac{1}{2} = 2$

19. *Either*

Draw a properly labelled diagram showing the main components of an AC generator. 2

*Or*

What are Eddy currents? How can they be minimised?  $1 + 1 = 2$

### SECTION—C

( Short answer type—II questions )

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

20. *Either*

Derive an expression for the mutual inductance of two long co-axial solenoids. 3

*Or*

State Lenz's law.

Show that Lenz's law is a consequence of law of conservation of energy.  $1 + 2 = 3$

21. *Either*

What are extrinsic semiconductors? Citing suitable examples, explain how *p*-type and *n*-type semiconductors are obtained.  $1 + 1 + 1 = 3$

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Or

Explain the terms depletion layer and potential barrier for a  $p$ - $n$  junction diode.

What happens to the width of the depletion layer when the junction is under forward bias and reverse bias?

1+1+1=3

22.

Either

With suitable circuit diagram, derive the required expression for the value of shunt, to convert a galvanometer into an ammeter.

A galvanometer of resistance  $10\ \Omega$  gives full-scale deflection for a current of 4 mA. How can it be converted into an ammeter of range 0 to 5 A?

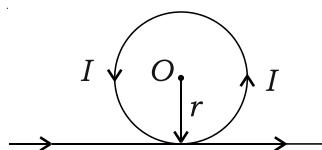
2+1=3

Or

State Ampere's circuital law.

A part of infinite long wire carrying current  $I$  is bent into a circle of radius  $r$  as shown in the figure. Calculate the magnetic field at the centre of the circular loop.

1+2=3



23.

Either

Obtain an expression for the torque on a rectangular loop placed in a uniform magnetic field.

3

Or

Obtain an expression for the magnetic dipole moment of a revolving electron.

3



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24. Prove that

$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

when refraction takes place for a ray of light travelling from rarer medium to denser medium at a convex spherical refracting surface.

( $n_1$  and  $n_2$  are the refractive indices of rarer and denser medium)

3

25.

*Either*

What is resonance in a series LCR circuit?

Write an expression for the resonant frequency for the same circuit. Also draw a resonance curve in LCR circuit for at least two different values of resistance  $R$ . 1+1+1=3

*Or*

What is a transformer? Explain the theory and working of a transformer. 1+2=3

26.

*Either*

What is a rectifier? Explain with circuit diagram the working of a full-wave rectifier. 1+2=3

*Or*

Explain with circuit diagram, how a Zener diode can function as a voltage regulator. 1+2=3

27. Deduce the equation for the torque acting on an electric dipole, placed in a uniform electric field. 3

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**28.** With regards to the study of photoelectric effect, explain the following terms briefly :

(a) Work function

(b) Cut-off or stopping potential

Also draw a graph showing variation of photoelectric current with collector plate potential for incident radiation of different frequency but same intensity.

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*

State Huygen's principle for wave theory of light. Using Huygen's principle, derive the laws of refraction for plane waves.

2+3=5

*Or*

What are coherent sources? Establish the conditions for constructive and destructive super position of waves emitted by coherent sources.

1+4=5

**30.**

*Either*

State Gauss's law.

Using Gauss's law, derive the equation for the electric field intensity at a point due to an infinitely long straight uniformly charged wire.

1+4=5

*Or*

Derive the equation for the electric field intensity at a point on the equatorial line of a short electric dipole. Also write the equation in vector form.

4+1=5

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31.

*Either*

State Bohr's postulates for hydrogen atom.

Using Bohr's postulate, derive the expression for the energy of an electron in any orbit of the hydrogen atom.

2+3=5

*Or*

Draw the energy-level diagram for the hydrogen atom.

Using equation for the energy of an electron in the  $n$ th orbit of hydrogen atom, calculate the energy required to excite an electron from ground state to—

(a) first excited state;

(b) second excited state.

Also find the value of the kinetic energy and potential energy of the electron in the first excited state. 2+2+1=5

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