

Total No. of Printed Pages—11

**HS/XII/Sc/Ph/NC/20**

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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 two questions of 2 marks, three 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 :

$$c = 3 \times 10^8 \text{ m s}^{-1}$$

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

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

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

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

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

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

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

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

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

SECTION—A

PART—I

( Multiple choice type questions )

Choose the correct option from the following :

1×5=5

1. The flux in a coil of 50 turns changes from 0.3 Wb to 0.5 Wb in 8 seconds. The induced e.m.f. in the coil is
- (A) 10 volts
- (B) 0.6 volt
- (C) -12 volts
- (D) -1.25 volts

1

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2. Lenz's law is a consequence of
- (A) Ohm's law
  - (B) back e.m.f. due to current
  - (C) law of conservation of energy
  - (D) law of conservation of charge 1
3. When light travels from an optically rarer medium to an optically denser medium, the velocity of light decreases because of change in
- (A) frequency
  - (B) wavelength
  - (C) amplitude
  - (D) phase 1
4. To demonstrate the phenomenon of interference, we require
- (A) two sources which emit radiations of same frequency
  - (B) two sources which emit radiations of different wavelengths
  - (C) two sources which emit radiations of nearly the same frequency
  - (D) two sources which emit radiations of the same frequency and have a definite phase relationship 1

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5. A conductor of radius  $r$  and length  $l$  has resistance  $10 \Omega$ . The conductor is stretched in such a way that its volume is maintained constant and its length is increased by 10% of its original length. The resistance of the stretched conductor is
- (A)  $8 \Omega$
- (B)  $100 \Omega$
- (C)  $12.10 \Omega$
- (D)  $20 \Omega$  1

PART—II

( Very short answer type questions )

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

6. The magnetic susceptibility of a substance is  $-1.66 \times 10^{-5}$ . Name the type of magnetic substance it represents. 1
7. Write the following radiations in the ascending order of their frequencies : 1  
Microwaves, Ultraviolet rays, X-rays and Infrared rays
8. How does the maximum kinetic energy of electron emitted vary with work function of the metal? 1

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9. The radius of the innermost electron orbit of hydrogen atom is  $5.3 \times 10^{-11}$  m. What are the radii of the  $n = 2$  and  $n = 3$  orbits ? 1
10. A power transmission line feeds input power at 2300 V to a step-down transformer with its primary windings having 4000 turns. What should be the number of turns in the secondary in order to get an output power at 230 V? 1

SECTION—B

( Short answer type-I questions )

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

11. *Either*

When resistances are connected in series, the effective resistance increases. Why? 2

*Or*

What are carbon resistors? A carbon resistor is marked in coloured bands in the sequence Blue, Green, Orange and Gold. What is the resistance and tolerance value of the resistor? 2

12. Write the relation of e.m.f. of a cell and its internal resistance. What is the condition under which the potential difference between the terminals of the cell and its e.m.f. are equal? 2

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13. What is inductive reactance? Show how a purely inductive circuit offers zero resistance to direct current. 2

14. *Either*

Show that the effective power of two thin lenses in contact is the sum of the power of each lens. 2

*Or*

Derive the relation between critical angle and refractive index. 2

15. What is the effect on interference fringes in Young's double-slit experiment due to the following operations? 2

(a) Separation between the slits is increased

(b) The (monochromatic) source is replaced by another (monochromatic) source of shorter wavelength

16. How is nuclear radius related to the mass number? Obtain approximately the ratio of nuclear radii of gold isotope  ${}_{79}\text{Au}^{197}$  and silver isotope  ${}_{47}\text{Ag}^{107}$ . 2

17. (a) In the hypothetical fission reaction



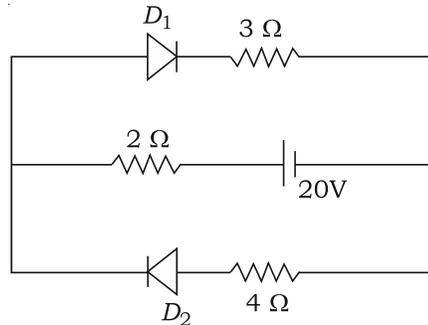
what are the values of  $a$  and  $b$ ?

(b) What is a chain reaction? 2

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18. From the given circuit, find the value of current flowing through the  $2\ \Omega$  resistor. Assume that  $D_1$  and  $D_2$  are two ideal diodes :

2



19. What is  $V-I$  characteristic of a  $p-n$  junction diode? Draw the  $V-I$  characteristics of a diode in—

(a) forward bias;

(b) reverse bias.

$\frac{1}{2} + 1\frac{1}{2} = 2$

### 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. Three capacitors of capacitances  $2\ \mu\text{F}$ ,  $3\ \mu\text{F}$  and  $4\ \mu\text{F}$  are connected in parallel.

(a) What is the total capacitance of the combination?

(b) Determine the charge on each capacitor if the combination is connected to a  $100\ \text{V}$  supply.

3

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**21.** What is the relationship between current and magnetic moment of a current-carrying circular loop? Use the expression to derive the magnetic dipole moment of a revolving electron. 3

**22.** *Either*

(a) A closed loop is held stationary in the magnetic field between the north and south poles of two permanent magnets held fixed. Can we hope to generate current in the loop by using very strong magnets?

(b) A closed loop moves normal to a constant electric field between the plates of a large capacitor. Is current induced in the loop—

(i) when it is wholly inside the region between the capacitor plates;

(ii) when it is partially outside the plates of the capacitor? 3

*Or*

Describe the principle and working of a transformer. 3

**23.** How are electromagnetic waves produced? Find the wavelength of electromagnetic waves of frequency  $5 \times 10^{19}$  Hz in free space. Give its two applications. 1+1+1=3

**24.** (a) Plot a graph showing the variation of photoelectric current with anode potential for two light beams of same wavelength but different intensities.

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- (b) The work function of cesium metal is 2.14 eV. When light of frequency  $6 \times 10^{14}$  Hz is incident on the metal surface, photoemission of electron occurs. What is the maximum kinetic energy of the emitted electron? 1+2=3

**25.** *Either*

- (a) From the law of radioactive decay, show that the total rate of decay,  $R = R_0 e^{-\lambda t}$ , where the symbols have their usual meanings.
- (b) Derive the relationship between half-life of a radioactive substance and its decay constant. 2+1=3

*Or*

Derive the expression for the total energy of an electron in the  $n$ th orbit of hydrogen atom. 3

**26.** *Either*

Name the device which is used as voltage regulator. Draw the necessary circuit diagram and explain its working. 3

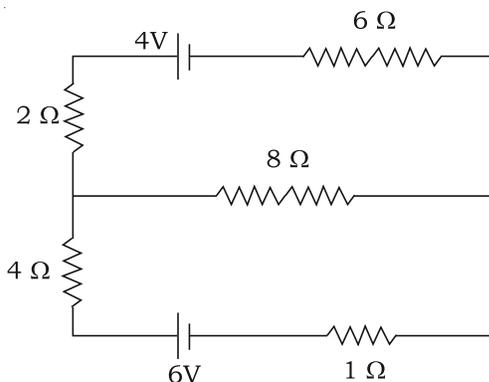
*Or*

With circuit diagram, distinguish between LED and photodiode. What is dark current? 2+1=3

- 27.** (a) Why do we prefer an objective of large aperture in a telescope?
- (b) A small telescope has an objective lens of focal length 144 cm and an eyepiece of focal length 6.0 cm. What is the magnifying power of the telescope? 2+1=3

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28. From the following circuit, using Kirchhoff's rule, find the current that flows through the  $8\ \Omega$  resistor : 3



SECTION—D

( Long answer type questions )

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

29. *Either*

With the help of a labelled diagram, state the underlying principle of a cyclotron. Explain clearly how it works to accelerate the charged particles. Is there an upper limit on the energy acquired by the particle? Give reason.

$1 + 2 + 2 = 5$

*Or*

Derive the torque on a rectangular current-carrying loop placed in a uniform magnetic field. Draw suitable figures. Write one application of this principle.  $4 + \frac{1}{2} + \frac{1}{2} = 5$

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30.

*Either*

- (a) State Gauss's law. Calculate the flux due to 1 C of positive charge.
- (b) Use Gauss's law to obtain the expression for the electric field due to a uniformly charged infinite plane sheet. 2+3=5

*Or*

- (a) Distinguish between polar and non-polar dielectrics.
- (b) A dielectric slab of thickness  $t$  is inserted between the plates of a parallel-plate capacitor separated by distance  $d$  ( $t < d$ ). Obtain the capacitance of this capacitor. 2+3=5

31.

*Either*

What is an unpolarized light? Explain with the help of a suitable diagram how an unpolarized light can be polarized by reflection from a transparent medium. Write the expression for Brewster's angle in terms of refractive index of denser medium. 1+3+1=5

*Or*

Draw a ray diagram to show the refraction of light through a glass prism. Hence, obtain the relation for angle of deviation in terms of angle of incidence, angle of emergence and angle of prism. What is the refractive index of the material of the prism? 1+2+2=5

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