Total No. of Printed Pages—11

HS/XII/Sc/Ph/25

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PHYSICS

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 and Part—II), Section—B, Section—C and Section—D.

(iii) Section—A (Part—I) contains five multiple choice type questions of *1* mark each and Section—A (Part—II) contains five very short answer type 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, four questions of *2* marks, five questions of *3* marks and all the 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 :

c = 3 10^{8} m/s

h = 6 63 10^{-34} J-s

e = 1 6 10^{-19} C

$_{0}$ = 4 10^{-7} T m A $^{-1}$

$_{0}$ 8 854 10^{-12} C^{2} N $^{-1}$ m $^{-2}$

m_e = 9 1 10^{-31} kg

Mass of neutron = 1 675 10^{-27} kg

Mass of proton = 1 673 10^{-27} kg

Avogadro's number = 6 023 10^{23} per gram mole

Boltzmann constant = 1 38 10^{-23} J K $^{-1}$

SECTION—A

PART—I

(Multiple choice type questions)

Choose and write the correct option for the following : 1×5=5

1. The capacitance of a parallel-plate capacitor with air in between the plates is C. If an oil of dielectric constant k 2 is put between the plates, then the capacitance will become

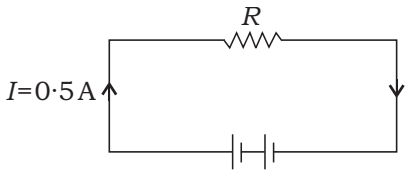
(a) C

(b) $2C$

(c) $C/2$

(d) $C/4$ 1

2.



In the circuit shown above, each cell has an e.m.f. of 2 V and an internal resistance of 1 . The current flowing through the circuit is 0·5 A. The resistance of the resistor R is

(a) 6

(b) 4

(c) 8

(d) 2 1

3. The magnetic field at the centre of a circular coil of radius 5 cm carrying a current of 1 A is 1·256 T. If the radius is made 10 cm, then the magnetic field at the centre of the loop carrying same current will be

(a) 2·512 T

(b) 0·628 T

(c) 5·024 T

(d) 0·314 T 1

4. Monochromatic light of wavelength 4500 Å is incident on a clean metal surface of work function 2·3 eV. The maximum kinetic energy of the ejected photoelectrons is 0·5 eV. Then the energy of the incident photon is

(a) 1·8 eV

(b) 2·8 eV

(c) 11·5 eV

(d) 12·5 eV 1

5. A nucleus ${}_{Z}X^{A}$ has mass represented by $M(A, Z)$. If M_p and M_n denote the mass of proton and neutron respectively and $B\ E$, the binding energy in MeV, then

(a) $B\ E\quad M(A, Z)\quad ZM_p\quad (A\quad Z)\,M_n$

(b) $B\ E\quad [ZM_p\quad AM_n\quad M(A, Z)]C^2$

(c) $B\ E\quad [Z\quad M_p\quad (A\quad Z)\,M_n\quad M(A, Z)]C^2$

(d) $B\ E\quad [M(A, Z)\quad ZM_p\quad (A\quad Z)\,M_n]C^2$ 1

PART—II

(Very short answer type questions)

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

6. *Either*

The specific resistances of copper, silver and constantan are $1\ 78\quad 10^{\ 6}$ -cm, $1\quad 10^{\ 6}$ -cm and $4\ 8\quad 10^{\ 6}$ -cm respectively, which is the best conductor and why? 1

Or

In which way, the cells should be combined to get maximum current, when the external resistance is very high compared to the total internal resistance of the cells? 1

7. *Either*

The equation of an alternating current is $I\quad 50\sin 100t$. Find the frequency. 1

Or

A 100 hertz alternating current is flowing in a 14 mH coil. Find its reactance. 1

8. What is the de Broglie wavelength associated with an electron, when accelerated through a potential difference of 100 volt? 1

9. *Either*

You are given two convex lenses of focal lengths 10 cm and 60 cm. To make a telescope, which of the two lenses will you use as object lens and which one as an eye lens? 1

Or

A convex lens is immersed in water. How is power of the lens affected? 1

10. The energy of the electron of H-atom is ground state is –13·6 eV. What will be the energy of the electron in n 3 orbit? 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. *Either*

A parallel-plate capacitor is made of two foils, each of surface area 2 m^2, separated by paper 7 10 ^{5} m thick. What is its capacitance? (Take k 3 5 for paper) 2

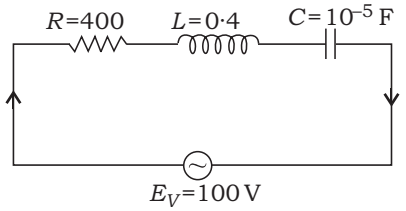
Or

An electric dipole consists of two opposite charges of magnitude 1 C each, separated by a distance of 3 cm. The dipole is placed in a uniform electric field of 4 10^5 N/C. Find the maximum torque on the dipole. 2

12. Write down the condition of resonance in series *L-C-R* circuit and hence find an expression for the resonant frequency. ½+1½=2

13. *Either*

An *L-C-R* series circuit is connected to an AC source as shown in the figure below :



If 1000 radian/sec, then find the impedance of the circuit. 2

Or

Find the root mean square value of current through a capacitor of capacitance 10 F, when connected to an AC source of 110 volts at 50 cycles/sec supply. What is its reactance? 2

14. Which waves are used in radar system? Give their frequency range and mention the source of their production. 2

15. Find the wavelength of electromagnetic waves of frequency 5 10^{19} Hz in free space. Identify the type of electromagnetic waves. Give one application of it. 1+½+½=2

16. *Either*

Write down the conditions for constructive and destructive interference in terms of path difference of two coherent light waves. 1+1=2

Or

What is critical angle? Derive the relation between the critical angle and the refractive index of the denser medium relative to the rarer medium. 1+1=2

17. *Either*

According to Rutherford's model of atom, what is 'impact parameter'? Write down the relation between the impact parameter and scattering angle. 1+1=2

Or

In hydrogen atom, an electron undergoes transition from third excited state to the second excited state and then to the first excited state. Identify the spectral series to which these transitions belong. Find out the ratio of the wavelength of the emitted radiations in the two cases. 1+1=2

18. What are extrinsic semiconductors? Name the types of extrinsic semiconductor obtained when germanium is doped with *(a)* arsenic and *(b)* gallium. 1+½+½=2

19. Define the term 'potential barrier'. How does the thickness of depletion region change when *p-n* junction is reverse biased? 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. Using Gauss' theorem, derive an expression for electric field intensity at a point due to an infinite plane sheet of charge. 3

21. *Either*

Deduce a relation between the drift velocity and current flowing through a conductor. Using the magnitude of drift velocity in the relation, show that

$$R \quad \frac{ml}{nAe^2}$$

where the symbols have their usual meanings. 1+2=3

Or

Apply Kirchhoff's laws to obtain the condition of balance of a Wheatstone bridge. 3

22. *Either*

Obtain an expression for the torque acting on a rectangular current loop, when placed inclined at an angle with the direction of a magnetic field. 3

Or

Using Ampere's circuital law, find an expression for the magnetic field at a point well inside straight solenoid carrying current. 3

23. *Either*

What is meant by self-inductance of a coil? Obtain an expression for the self-inductance of a long solenoid. 1+2=3

Or

What are diamagnetic and ferromagnetic substances? Write about the magnetic susceptibility of diamagnetic and ferromagnetic substances. 1+1+½+½=3

24. Draw a labelled ray diagram to show the image formation at least distance of distinct vision due to a compound microscope and hence obtain an expression for its magnifying power. 1+2=3

25. *Either*

Define the term 'threshold frequency' in relation to photoelectric effect. Explain the variation of photoelectric current with *(a)* the intensity of incident radiation and *(b)* the frequency of incident radiation. 1+1+1=3

Or

Using the postulates of Bohr's atomic model, find an expression for the radius of the *n*th stationary orbit of hydrogen atom. 3

26. Calculate the binding energy per nucleon for $_{30}Zn^{64}$ in MeV. (Take 1 a.m.u. 931 MeV)
Given,

m_p 1·007825 a.m.u., m_n 1·008665 a.m.u.,
mass of $_{30}Zn^{64}$ 63·9423 a.m.u. 3

27. *Either*

What is an optical fibre? Explain the principle of its working. Mention two of its applications. 1+1+1=3

Or

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

28. What is a rectifier? With the help of a labelled circuit diagram, explain half-wave rectification using semi-conductor diode. 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*

What is dipole moment of an electric dipole? What is the net charge on an electric dipole? State SI unit of dipole moment of an electric dipole. Derive an expression for the electric field intensity at a point on the equatorial line of an electric dipole. 1+1+3=5

Or

Two point charges q and q separated by a short distance $2a$ are placed in free space at points A and B respectively. Derive an expression for the electric potential at a point P whose distance from the centre O of the line AB is r and OP makes an angle , with the electric dipole moment $\vec{p}$. Hence find the potential if P lies on *(a)* axial line and *(b)* equatorial line. 3+1+1=5

30. *Either*

State Biot-Savart law. Using this law, find an expression for the magnetic field at a point P which is at a distance x, on the axis of a circular current-carrying loop of radius R. Also find the magnetic field if point P lies at the centre of the loop. 1+3+1=5

Or

An AC voltage $v \quad v_0 \sin \quad t$ is applied across a pure inductor of inductance L. Show mathematically that the current flowing through it lags behind the applied voltage by a phase angle of $/2$. Explain the term 'inductive reactance' and show that a pure inductor acts as a conductor for DC. 3+1+1=5

31. *Either*

Derive lens maker formula for a thin convex lens. 5

Or

State Huygens' principle for wave theory of light. Using Huygens' principle, derive the laws of reflection for plane waves. 2+3=5

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