Series : X4YZW

SET ~ 5

रोल नं.
Roll No.

प्रश्न–पत्र कोड
Q.P. Code **55(B)**

परीक्षार्थी प्रश्न–पत्र कोड को उत्तर–पुस्तिका के मुख–पृष्ठ पर अवश्य लिखें ।
Candidates must write the Q.P. Code on the title page of the answer-book.

भौतिक विज्ञान (सैद्धान्तिक)
(केवल दृष्टिबाधित परीक्षार्थियों के लिए)

PHYSICS (Theory)
(FOR VISUALLY IMPAIRED CANDIDATES ONLY)

निर्धारित समय : 3 घण्टे | *अधिकतम अंक : 70*

Time allowed : 3 hours | *Maximum Marks : 70*

नोट / NOTE ~

(I) कृपया जाँच कर लें कि इस प्रश्न–पत्र में मुद्रित पृष्ठ **23** हैं ।
Please check that this question paper contains **23** printed pages.

(II) कृपया जाँच कर लें कि इस प्रश्न–पत्र में **33** प्रश्न हैं ।
Please check that this question paper contains **33** questions.

(III) प्रश्न–पत्र में दाहिने हाथ की ओर दिए गए प्रश्न–पत्र कोड को परीक्षार्थी उत्तर–पुस्तिका के मुख–पृष्ठ पर लिखें ।
Q.P. Code given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.

(IV) **कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, उत्तर–पुस्तिका में यथा स्थान पर प्रश्न का क्रमांक अवश्य लिखें ।**
Please write down the serial number of the question in the answer-book at the given place before attempting it.

(V) इस प्रश्न–पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है । प्रश्न–पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जाएगा । 10.15 बजे से 10.30 बजे तक परीक्षार्थी केवल प्रश्न–पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर–पुस्तिका पर कोई उत्तर नहीं लिखेंगे ।
15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the candidates will read the question paper only and will not write any answer on the answer-book during this period.

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General Instructions :

Read the following instructions very carefully and follow them :

(i) *This question paper contains **33** questions. **All** questions are compulsory.*

(ii) *This question paper is divided into **five** sections – **Sections A, B, C, D** and **E**.*

(iii) *In **Section A :** Question numbers **1** to **16** are Multiple Choice (MCQ), Assertion and Reasoning type questions. Each question carries **1** mark.*

(iv) *In **Section B :** Question numbers **17** to **21** are Very Short Answer (VSA) type questions. Each question carries **2** marks.*

(v) *In **Section C :** Question numbers **22** to **28** are Short Answer (SA) type questions. Each question carries **3** marks.*

(vi) *In **Section D :** Question numbers **29** and **30** are Case Study-Based questions. Each question carries **4** marks.*

(vii) *In **Section E :** Question numbers **31** to **33** are Long Answer (LA) type questions. Each question carries **5** marks.*

(viii) *There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the Sections except Section **A**.*

(ix) *Use of calculators is **NOT** allowed.*

You may use the following values of physical constants wherever necessary :

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

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

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

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

$\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

Mass of electron (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's constant = 1.38×10^{-23} J K^{-1}

SECTION – A

1. A charge of $-1\ \mu C$ on a body represents 1

(A) loss of 6.25×10^{12} electrons by the body.

(B) gain of 6.25×10^{12} electrons by the body.

(C) gain of 1.6×10^{13} electrons by the body.

(D) loss of 1.6×10^{13} electrons by the body.

2. The resistance of a wire at 20 °C is 50 Ω. When it is heated to 120 °C, the resistance becomes 51 Ω. The temperature coefficient of resistance of the material of the wire is 1

(A) $2 \times 10^{-4}\ °C^{-1}$ (B) $1 \times 10^{-4}\ °C^{-1}$

(C) $5 \times 10^{-4}\ °C^{-1}$ (D) $1 \times 10^{-3}\ °C^{-1}$

3. A particle of mass m and charge q moving with a velocity $\vec{V}$ at right angle to a magnetic field $\vec{B}$, experiences a force $\vec{F}$. Another particle of mass 2 m and charge 2q enters the same field $\vec{B}$ with a velocity $\frac{\vec{V}}{2}$, in the same direction. This particle will experience a force 1

(A) $4\vec{F}$ (B) $2\vec{F}$

(C) $\vec{F}$ (D) $\frac{\vec{F}}{2}$

4. A 5.0 cm long wire carrying 1.0 A current is kept in a region in which a uniform magnetic field of 0.3 T is applied perpendicular to the length of the wire. The magnitude of the force acting on the wire is – 1

(A) zero (B) 0.45 N

(C) 0.03 N (D) 0.015 N

5. A step up transformer – 1

(A) decreases the current to transmit power over short distances with minimum loss.

(B) increases the current to transmit power over short distances with minimum loss.

(C) increases the voltage to transmit power over short distances with minimum loss.

(D) increases the voltage to transmit power over long distances with minimum loss.

6. The magnetic flux through a loop changes from 3.6 Wb to 1.6 Wb in 0.4 s. The magnitude of the induced emf in the loop is – 1

(A) 5 V (B) 2.5 V

(C) 1.5 V (D) 0.5 V

7. The electromagnetic radiation used to kill germs in water purifiers is 1

(A) Ultraviolet rays (B) Infrared waves

(C) Visible rays (D) γ-rays

8. Two thin lenses of focal lengths +40 cm and –20 cm and placed coaxially in contact. An object is placed at infinity, in front of the combination. The image formed by the combination will lie – 1

(A) at a distance of 60 cm, in front of the combination.

(B) at a distance of 40 cm, in front of the combination.

(C) at a distance of 20 cm, behind the combination.

(D) at infinity

9. The de-Broglie wavelengths associated with an electron (mass m_e) and a proton (mass m_p) moving with the same velocity are λ_e and λ_p respectively. The value of (λ_e/λ_p) is – 1

(A) $\sqrt{\frac{m_p}{m_e}}$ (B) $\frac{m_p}{m_e}$

(C) $\frac{m_e}{m_p}$ (D) $\sqrt{\frac{m_e}{m_p}}$

10. Which one out of the following transitions of an electron in Bohr's model of hydrogen atom will emit a photon with the greatest frequency ? 1

(A) $n = 3$ to $n = 1$ (B) $n = 3$ to $n = 2$
(C) $n = 4$ to $n = 3$ (D) $n = 4$ to $n = 2$

11. The general purpose diode is normally used in – 1

(A) beyond cut-in voltage region
(B) before cut-in voltage region.
(C) beyond the reverse saturation current region.
(D) before the reverse saturation current region.

12. Which of the following impurity atoms when doped in silicon, would produce a p-type semiconductor ? 1

(A) Phosphorus (B) Arsenic
(C) Antimony (D) Boron

Note : For question numbers **13** to **16**, two statements are given – one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below :

(A) If both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(B) If both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(C) If Assertion (A) is true, but Reason (R) is false.
(D) If both Assertion (A) and Reason (R) are false.

13. **Assertion (A) :** Only a continuous change of magnetic flux will maintain an induced emf in a coil. 1

Reason (R) : An induced current has a direction such that the magnetic field due to the current opposes the change in the magnetic field that induces the current.

14. **Assertion (A) :** At resonance the impedance of a series LCR circuit is Z = R. **1**

Reason (R) : $Z = \sqrt{R^2 + (X_C - X_L)^2}$ and at resonance the inductive reactance (X_L) is equal to the capacitive reactance (X_C).

15. **Assertion (A) :** When two coherent sources in Young's double-slit experiment (YDSE) are infinitely close to each other, interference pattern is observed on a screen. **1**

Reason (R) : The fringe width in YDSE does not depend on separation between the two slits.

16. **Assertion (A) :** A photon behaves as a particle. **1**

Reason (R) : A photon possesses both energy and momentum.

SECTION – B

17. A 20.0 cm long wire is connected across an ideal battery of 4 V. The drift velocity of conduction electrons in the wire is 0.8 mm/s. Calculate the relaxation time of the electrons. **2**

18. (a) The real image of an object is formed at a distance twice the distance of the object from a concave mirror of focal length 10 cm. Find the distance between the object and the image. **2**

OR

(b) An object is placed 1.50 m in front of a lens of power 4.0 D. Find the nature and position of the image formed. **2**

19. Light of wavelength 700 nm is incident normally on a slit of width 0.2 mm. Find the angular width of the central maximum on a screen placed at a distance of 1 m from the slit. **2**

20. The total energy of an electron in the hydrogen atom in the ground state is –13.6 eV. Find : **2**
    (a) the potential energy of the electron.
    (b) the kinetic energy of the electron.
    (c) the ratio of the magnitude of the total energy to the kinetic energy of the electron.

21. When the voltage across a p-n junction diode is increased from 0.90 V to 0.95 V, the diode current changes by 0.005 A. Find the dynamic resistance of the diode. **2**

SECTION – C

22. (a) Define the terms 'emf' and 'terminal voltage' of a cell. Can the terminal voltage of a cell ever exceed its emf ? Explain. **3**

OR

(b) Define the term current density. Write its SI unit. Derive the equivalent form of Ohm's law $\vec{j} = \sigma\vec{E}$. **3**

23. (a) Write one point of similarity and one point of difference between magnetic field and the electrostatic field. **3**

(b) A wire of length l is first bent into a circular loop and then into a circular coil of two turns. For the same current passing through them, find the ratio of the magnetic fields at their centres.

24. (a) State the conditions under which total internal reflection occurs. **3**

(b) A glass slab 3.0 cm thick, is placed over a dark ink dot. Find the height through which the image of the dot is raised. The refractive index of the glass is 1.5.

25. (a) Explain how the reactance of a capacitor and that of an inductor change with the frequency of ac source. **3**

(b) An ideal inductor of self-inductance 0.5 H is connected to an ac source of peak voltage 314 V and frequency 50 Hz. Calculate the peak value of current in the circuit.

26. (a) Write two characteristics of electromagnetic waves. **3**

(b) What is meant by 'displacement current' ? Explain briefly how is displacement current set up during charging of a capacitor in a circuit.

27. State postulates of Bohr model of hydrogen atom. Using Bohr's second postulate, show that the circumference of n^{th} orbit in hydrogen atom is n times the de Broglie wavelength associated with the electron revolving in it. **3**

28. (a) Define the term 'resistivity of a material'. 3

(b) Explain briefly how is the resistivity of (i) a metal and (ii) a semiconductor affected with the rise of temperature. Justify your answer.

SECTION – D

Question Numbers **29** and **30** are Case-Study based questions. Read the following paragraphs and answer the questions that follow :

29. A power supply is connected across the two plates of a capacitor. Consequently, one plate becomes positively charged and the other plate becomes negatively charged. Thus a uniform electric field is established between the two plates. If a charged particle is released between these two plates, it experiences a force. The potential difference between the plates affects its charge and the energy stored in the capacitor. $4 \times 1 = 4$

(i) A proton and an electron are released from rest in the space between the two plates of a charged capacitor. Assume that the proton and the electron do not interact with each other. The acceleration of the proton compared with that of the electron is 1

(A) same in both magnitude and direction.
(B) same in magnitude but in opposite direction.
(C) greater in magnitude and opposite in direction.
(D) lesser in magnitude but in opposite direction.

(ii) An electron is released between the two parallel plates of a charged capacitor. Which of the following statements is incorrect ? 1

(A) The electric field between the plates is directed from the positively charged plate to the negatively charged plate.
(B) The magnitude of electric field is the same at all points between the plates.
(C) The acceleration of the electrons will be constant between the plates.
(D) The potential increases in the direction of the electric field between the plates.

(iii) The potential difference between the two plates of a capacitor is V. An electron of mass m and charge – e is released from rest near the negative plate. The maximum speed gained by the electron is 1

(A) 2 eVm (B) $\sqrt{\frac{em}{2V}}$ (C) $\sqrt{\frac{2eV}{m}}$ (D) $\sqrt{\frac{2me}{V}}$

(iv) (a) The electric field between two parallel plates of a charged capacitor is 200 V/m. The plates are 5 mm apart. The potential difference between the two plates is 1

(A) 20 V (B) 10 V

(C) 5.0 V (D) 1.0 V

OR

(b) A proton is located at a point between the above plates. The force acting on the proton is 1

(A) 1.6×10^{-19} N (B) 2×10^{9} N

(C) 3.2×10^{-17} N (D) 4×10^{9} N

30. A photon is a quantum of energy. The energy of a photon depends on its frequency (ν). When light of suitable frequency is incident on a metal surface, photo-electrons are emitted from the surface. The minimum frequency is called threshold frequency (ν_o) and the minimum energy required to emit an electron is called the work function (ϕ_o) of that metal. The energy of an incident photon is utilised in two ways (i) liberating the electron and (ii) the remaining energy is given to the ejected electron as its kinetic energy i.e. $h\nu = \phi_o + K.E.$ $4 \times 1 = 4$

(i) The packet of electromagnetic energy is called – 1

(A) Photon (B) Neutron

(C) Molecule (D) Quark

(ii) A photon has energy 3.3×10^{-19} J. Its momentum is – 1

(A) 9.9×10^{-11} kg.m/s (B) 9.9×10^{-26} kg.m/s

(C) 1.1×10^{-27} kg.m/s (D) 3.3×10^{-25} kg.m/s

(iii) Monochromatic light of frequency 5.0×10^{14} Hz is produced by a source. The power emitted is 3.315 mW. The number of photons emitted per second, on an average, by the source is – 1

(A) 5.0×10^{14} (B) 6.0×10^{15}

(C) 1.0×10^{16} (D) 2.0×10^{17}

(iv) (a) The work function of a metal is 2.14 eV. When light of frequency 6×10^{14} Hz is incident on the metal surface, photoemission of electrons occurs. The maximum kinetic energy of the emitted electrons is – 1

(A) 0.34×10^{-18} J (B) 0.40×10^{-17} J

(C) 0.51×10^{-18} J (D) 0.55×10^{-19} J

OR

(b) The work function of a metal is 2.21 eV. The threshold frequency for the metal is 1

(A) 2.1×10^{13} Hz (B) 3.2×10^{13} Hz

(C) 5.3×10^{14} Hz (D) 4.1×10^{15} Hz

SECTION – E

31. (a) (A) Two points charges q_1 and q_2 in air are located at $\vec{r}_1$ and $\vec{r}_2$ respectively in a region of uniform external field $\vec{E}$. Obtain an expression for the electrostatic potential energy of the system.

(B) The coulomb force between two point charges is 1.5×10^{-4} N. How will this force be affected in the following situations :

(i) the distance between the charges is doubled.

(ii) the magnitude of each charge is doubled but the distance between the charges remains the same. 5

OR

(b) (A) Differentiate between the electrostatic force and the gravitational force between two charged particles.

(B) A potential difference of 480 V is applied between two large horizontal plates, kept one above the other, 3.0 cm apart. A charged particle of mass 4×10^{-11} kg, when released at rest between the plates, remains stationary in the region. If the upper plate is at positive potential, find

(i) nature of the charge on the particle

(ii) the magnitude of the charge on the particle. **5**

32. (a) (A) When a current passes through a conductor it produces a magnetic field.

(i) State the right-hand thumb rule that gives the direction of the magnetic field.

(ii) How does the magnetic field vary with the distance from the conductor ?

(iii) Name the factors (other than the distance) which affect the magnitude of the magnetic field.

(B) Explain how a magnetic dipole in a uniform magnetic field attains (i) stable equilibrium (ii) unstable equilibrium. **5**

OR

(b) (A) A particle of mass m and charge q is moving with velocity v in a circular path under the influence of a uniform magnetic field $\vec{B}$. Explain how will the path followed be affected when

(i) the strength of magnetic field is decreased.

(ii) the velocity of the particle is decreased.

(iii) the velocity of charged particle is such that one of its component is perpendicular to B and another component is parallel to $\vec{B}$.

(iv) an electric field is applied in such a way that electrostatic force balances the magnetic force on the charged particle.

(v) the magnetic field is suddenly removed.

In each of the above cases, other factors remain the same.

(B) Derive an expression for torque acting as a rectangular loop carrying a steady current when placed in a uniform magnetic field. 5

33. (a) (A) In Young's double slit experiment, the two slits are 0.15 mm apart. The slits are illuminated by a monochromatic light and an interference pattern is obtained a screen kept 3.0 m away from the slits. The distance between first and eighth minima is 8.0 cm. Find the wavelength of the light used.

(B) Two coherent waves of amplitude A_1 and A_2 are used in an interference experiment. Derive expression for the ratio of minimum and maximum intensities of light obtained in the interference pattern. 5

OR

(b) (A) A ray of light is incident at an angle of incidence, $\frac{A}{2}$ on face AB of a prism ABC of angle of prism A. The ray emerges normally from the opposite face AC. If the refractive index of the material of the prism be n, find the relation between A and n.

(B) The focal length of a convex lens of refractive index 1.5 is 20 cm. Find the focal length of this lens when immersed in a liquid of refractive index 1.25. 5