

Maharashtra HSC BOARD QUESTION PAPER 2023

Physics

Time: 3 Hrs.

Max. Marks: 70

General Instructions:

The question paper is divided into **four** sections:

- (1) **Section A:** Q. No. 1 contains **Ten multiple choice type** of questions carrying **One mark** each.
Q. No. 2 contains **Eight very short answer type** of questions carrying **One mark** each.
- (2) **Section B:** Q. No. 3 to Q. No. 14 contain **Twelve short answer type** of questions carrying **Two marks** each.
(Attempt **any Eight**).
- (3) **Section C:** Q. No. 15 to Q. No. 26 contain **Twelve short answer type** of questions carrying **Three marks** each.
(Attempt **any Eight**).
- (4) **Section D:** Q. No. 27 to Q. No. 31 contain **Five long answer type** of questions carrying **Four marks** each.
(Attempt **any Three**).
- (5) Use of the log table is allowed. Use of calculator is **not** allowed.
- (6) Figures to the right indicate full marks.
- (7) For each multiple choice type of question, it is mandatory to write the correct answer along with its alphabet. e.g., (a)...../(b)...../(c)...../(d)..... No marks(s) shall be given, if ONLY the correct answer or the alphabet of the correct answer is written. Only the first attempt will be considered for evaluation.
- (8) **Physical Constants:**
 - (i) $h = 6.63 \times 10^{-34}$ Js
 - (ii) $c = 3 \times 10^8$ m/s
 - (iii) $\pi = 3.142$
 - (iv) $g = 9.8$ m/s²
 - (v) $\epsilon_0 = 8.85 \times 10^{-12}$ C² / Nm²
 - (vi) $\mu_0 = 4\pi \times 10^{-7}$ Wb / A-m

SECTION – A

Q.1. Select and write the correct answers for the following multiple choice type of questions: [10]

- i. If 'n' is the number of molecules per unit volume and 'd' is the diameter of the molecules, the mean free path ' λ ' of molecules is
 - (A) $\sqrt{\frac{2}{\pi nd}}$
 - (B) $\frac{1}{2 \pi nd^2}$
 - (C) $\frac{1}{\sqrt{2} \pi nd^2}$
 - (D) $\frac{1}{\sqrt{2} \pi nd}$
- ii. The first law of thermodynamics is consistent with the law of conservation of _____.
 - (A) momentum
 - (B) energy
 - (C) mass
 - (D) velocity
- iii. $Y = \overline{A + B}$ is the Boolean expression for _____.
 - (A) OR - gate
 - (B) AND - gate
 - (C) NOR - gate
 - (D) NAND - gate
- iv. The property of light which remains unchanged when it travels from one medium to another is _____.
 - (A) velocity
 - (B) wavelength
 - (C) amplitude
 - (D) frequency
- v. If a circular coil of 100 turns with a cross-sectional area of 1 m² is kept with its plane perpendicular to the magnetic field of 1 T, the magnetic flux linked with the coil will be _____.
 - (A) 1 Wb
 - (B) 50 Wb
 - (C) 100 Wb
 - (D) 200 Wb
- vi. If ' θ ' represents the angle of contact made by a liquid which completely wets the surface of the container then _____.
 - (A) $\theta = 0$
 - (B) $0 < \theta < \frac{\pi}{2}$
 - (C) $\theta = \frac{\pi}{2}$
 - (D) $\frac{\pi}{2} < \theta < \pi$

- vii. The LED emits visible light when its _____.
 (A) junction is reverse biased (B) depletion region widens
 (C) holes and electrons recombine (D) junction becomes hot
- viii. Soft iron is used to make the core of transformer because of its _____.
 (A) low coercivity and low retentivity (B) low coercivity and high retentivity
 (C) high coercivity and high retentivity (D) high coercivity and low retentivity
- ix. If the maximum kinetic energy of emitted electrons in photoelectric effect is 2eV, the stopping potential will be _____.
 (A) 0.5 V (B) 1.0 V (C) 1.5 V (D) 2.0 V
- x. The radius of eighth orbit of electron in H-atom will be more than that of fourth orbit by a factor of _____.
 (A) 2 (B) 4 (C) 8 (D) 16

Q.2. Answer the following questions:

[8]

- i. What is the value of resistance for an ideal voltmeter?
- ii. What is the value of force on a closed circuit in a magnetic field?
- iii. What is the average value of alternating current over a complete cycle?
- iv. An electron is accelerated through a potential difference of 100 volt. Calculate de-Broglie wavelength in nm.
- v. If friction is made zero for a road, can a vehicle move safely on this road?
- vi. State the formula giving relation between electric field intensity and potential gradient.
- vii. Calculate the velocity of a particle performing S.H.M. after 1 second, if its displacement is given by $x = 5 \sin \left(\frac{\pi t}{3} \right)$ m.
- viii. Write the mathematical formula for Bohr magneton for an electron revolving in n^{th} orbit.

SECTION – B

Attempt any EIGHT questions of the following:

[16]

- Q.3.** Define coefficient of viscosity. State its formula and S.I. units.
- Q.4.** Obtain an expression for magnetic induction of a toroid of 'N' turns about an axis passing through its centre and perpendicular to its plane.
- Q.5.** State and prove principle of conservation of angular momentum.
- Q.6.** Obtain an expression for equivalent capacitance of two capacitors C_1 and C_2 connected in series.
- Q.7.** Explain, why the equivalent inductance of two coils connected in parallel is less than the inductance of either of the coils.
- Q.8.** How will you convert a moving coil galvanometer into an ammeter?
- Q.9.** A 100 Ω resistor is connected to a 220 V, 50 Hz supply.
Calculate:
 i. r.m.s. value of current and
 ii. net power consumed over the full cycle
- Q.10.** A bar magnet of mass 120 g in the form of a rectangular parallelepiped, has dimensions $l = 40$ mm, $b = 100$ mm and $h = 80$ mm, with its dimension 'h' vertical, the magnet performs angular oscillations in the plane of the magnetic field with period π seconds. If the magnetic moment is 3.4 Am^2 , determine the influencing magnetic field.

- Q.11.** Distinguish between free vibrations and forced vibrations (Two points).
- Q.12.** Compare the rate of loss of heat from a metal sphere at 827°C with rate of loss of heat from the same at 427°C , if the temperature of surrounding is 27°C .
- Q.13.** An ideal mono-atomic gas is adiabatically compressed so that its final temperature is twice its initial temperature. Calculate the ratio of final pressure to its initial pressure.
- Q.14.** Disintegration rate of a radio-active sample is 10^{10} per hour at 20 hours from the start. It reduces to 5×10^9 per hour after 30 hours. Calculate the decay constant.

SECTION – C

Attempt any EIGHT questions of the following:

[24]

- Q.15.** Derive laws of reflection of light using Huygens' principle.
- Q.16.** State postulates of Bohr's atomic model.
- Q.17.** Define and state unit and dimensions of :
- Magnetization
 - Magnetic susceptibility
- Q.18.** With neat labelled circuit diagram, describe an experiment to study the characteristics of photoelectric effect.
- Q.19.** Explain the use of potentiometer to determine internal resistance of a cell.
- Q.20.** Explain the working of n-p-n transistor in common base configuration.
- Q.21.** State the differential equation of linear S.H.M. Hence, obtain expression for :
- acceleration
 - velocity
- Q.22.** Two tuning forks of frequencies 320 Hz and 340 Hz are sounded together to produce sound wave. The velocity of sound in air is 326.4 m/s. Calculate the difference in wavelengths of these waves.
- Q.23.** In a biprism experiment, the fringes are observed in the focal plane of the eye-piece at a distance of 1.2 m from the slit. The distance between the central bright band and the 20th bright band is 0.4 cm. When a convex lens is placed between the biprism and the eye-piece, 90 cm from the eye-piece, the distance between the two virtual magnified images is found to be 0.9 cm. Determine the wavelength of light used.
- Q.24.** Calculate the current flowing through two long parallel wires carrying equal currents and separated by a distance of 1.35 cm experiencing a force per unit length of $4.76 \times 10^{-2} \text{ N/m}$.
- Q.25.** An alternating voltage given by $e = 140 \sin (314.2 t)$ is connected across a pure resistor of 50Ω . Calculate :
- the frequency of the source
 - the r.m.s current through the resistor
- Q.26.** An electric dipole consists of two opposite charges each of magnitude $1 \mu\text{C}$, separated by 2 cm. The dipole is placed in an external electric field of 10^5 N/C . Calculate the :
- maximum torque experienced by the dipole and
 - work done by the external field to turn the dipole through 180° .

SECTION – D

Attempt any **THREE** questions of the following:

[12]

Q.27. On the basis of kinetic theory of gases obtain an expression for pressure exerted by gas molecules enclosed in a container on its walls.

Q.28.

- i. Derive an expression for energy stored in the magnetic field in terms of induced current.
- ii. A wire 5 m long is supported horizontally at a height of 15 m along east-west direction. When it is about to hit the ground, calculate the average e.m.f. induced in it. ($g = 10 \text{ m/s}^2$)

Q.29.

- i. Derive an expression for the work done during an isothermal process.
- ii. 104 J of work is done on certain volume of a gas. If the gas releases 125 kJ of heat, calculate the change in internal energy of the gas.

Q.30.

- i. Obtain the relation between surface energy and surface tension.
- ii. Calculate the work done in blowing a soap bubble to a radius of 1 cm. The surface tension of soap solution is $2.5 \times 10^{-2} \text{ N/m}$.

Q.31. Derive expressions for linear velocity at lowest position, mid-way position and the top-most position for a particle revolving in a vertical circle, if it has to just complete circular motion without string slackening at top.