Newton's Academy

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/s^2

(v) $\epsilon_0 = 8.85 \times 10^{-12}$ C^2 / Nm^2

(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 m^2 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 :

i. Magnetization

ii. 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 :

i. acceleration

ii. 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 4.76×10^{-2} N/m.

Q.25. An alternating voltage given by e = 140 sin (314.2 t) is connected across a pure resistor of 50 Ω.

Calculate :

i. the frequency of the source

ii. the r.m.s current through the resistor

Q.26. An electric dipole consists of two opposite charges each of magnitude 1 μC, separated by 2 cm. The dipole is placed in an external electric field of 10^5 N/C.

Calculate the :

i. maximum torque experienced by the dipole and

ii. 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. ($g = 10\ m/s^2$)

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 2.5×10^{-2} 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.