Board Question Paper: October 2014
Physics

Time: 3 Hours **Total Marks: 70**

Note:

i. All questions are compulsory.
ii. Neat diagrams must be drawn wherever necessary.
iii. Figures to the right indicate full marks.
iv. Use of only logarithmic table is allowed.
v. All symbols have their usual meaning unless otherwise stated.

SECTION – I

Q.1. Attempt any THREE: **[9]**

i. Draw a diagram showing all components of forces acting on a vehicle moving on a curved banked road. Write the necessary equation for maximum safety speed and state the significance of each term involved in it.

ii. Explain Maxwell distribution of molecular speed with necessary graph.

iii. Find the total energy and binding energy of an artificial satellite of mass 800 kg orbiting at a height of 1800 km above the surface of the earth.
($G = 6.67 \times 10^{-11}$ S.I. units, Radius of earth : R = 6400 km, Mass of earth : $M = 6 \times 10^{24}$ kg)

iv. Wavelengths of two notes in the air are $\left(\frac{70}{153}\right)$ m and $\left(\frac{70}{157}\right)$ m . Each of these notes produces 8 beats per second with a tuning fork of fixed frequency. Find the velocity of sound in the air and frequency of the tuning fork.

Q.2. Attempt any SIX: **[12]**

i. Draw a diagram showing different stages (cases) of projection for artificial satellite.

ii. State the law of conservation of angular momentun and explain with a suitable example.

iii. Define the angle of contact and state its any 'two' characteristics.

iv. With a neat and labelled diagram, explain Ferry's perfectly black body.

v. A stone of mass 5 kg, tied to one end of a rope of length 0.8 m, is whirled in a vertical circle. Find the minimum velocity at the highest point and at the midway point. ($g = 9.8$ m/s^2)

vi. The maximum velocity of a particle performing linear S.H.M. is 0.16 m/s. If its maximum acceleration is 0.64 m/s^2, calculate its period.

vii. Water rises to a height 3.2 cm in a glass capillary tube. Find the height to which the same water will rise in another glass capillary having half area of cross section.

viii. A 36 cm long sonometer wire vibrates with frequency of 280 Hz in fundamental mode, when it is under tension of 24.5 N. Calculate linear density of the material of wire.

Q.3. Select and write the most appropriate answer from the given alternatives for each sub-questions: **[7]**

i. A thin wire of length L and uniform linear mass density ρ is bent into a circular coil. Moment of inertia of the coil about tangential axis in its plane is _____.

(A) $\frac{3\rho L^2}{8\pi^2}$ (B) $\frac{8\pi^2}{3\rho L^3}$

(C) $\frac{3\rho L^3}{8\pi^2}$ (D) $\frac{8\pi}{3\rho L^2}$

ii. The average displacement over a period of S.H.M. is _____.
(A = amplitude of S.H.M.)

(A) 0 (B) A

(C) 2A (D) 4A

iii. In which of the following substances, surface tension increases with increase in temperature?

(A) Copper (B) Molten copper

(C) Iron (D) Molten iron

iv. The ratio of diameters of two wires of the same material and length is n : 1. If the same load is applied to both the wires then increase in the length of the thin wire is (n > 1) _____.

(A) $n^{1/4}$ times (B) $n^{1/2}$ times

(C) n times (D) n^2 times

v. The co-efficient of reflection of an opaque body is 0.16. Its co-efficient of emission is _____.

(A) 0.94 (B) 0.84

(C) 0.74 (D) 0.64

vi. Let velocity of a sound wave be 'v' and 'ω' be angular velocity. The propagation constant of the wave is _____.

(A) $\sqrt{\frac{\omega}{v}}$ (B) $\sqrt{\frac{v}{\omega}}$

(C) $\frac{\omega}{v}$ (D) $\frac{v}{\omega}$

vii. The value of end correction for an open organ pipe of radius 'r' is _____.

(A) 0.3 r (B) 0.6 r

(C) 0.9 r (D) 1.2 r

Q.4. Distinguish between forced vibrations and resonance. Draw neat, labelled diagrams for the modes of vibration of a stretched string in second harmonic and third harmonic.

The area of the upper face of a rectangular block is 0.5 m × 0.5 m and the lower face is fixed. The height of the block is 1 cm. A shearing force applied at the top face produces a displacement of 0.015 mm. Find the strain and shearing force.
(Modulus of rigidity : $\eta = 4.5 \times 10^{10}$ N/m^2) **[7]**

OR

Q.4. Define phase of S.H.M. Show variation of displacement, velocity and acceleration with phase for a particle performing linear S.H.M. graphically, when it starts from extreme position.

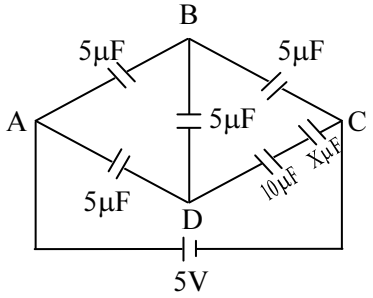
A body starts rotating from rest. Due to a couple of 20 Nm it completes 60 revolutions in one minute. Find the moment of inertia of the body. **[7]**

SECTION – II

Q.5. Attempt any THREE: **[9]**

i. In a biprism experiment, a slit is illuminated by a light of wavelength 4800 Å. The distance between the slit and biprism is 15 cm and the distance between the biprism and eyepiece is 85 cm. If the distance between virtual sources is 3 mm, determine the distance between 4^{th} bright band on one side and 4^{th} dark band on the other side of the central bright band.

ii. Six capacitors of capacities 5, 5, 5, 5, 10 and X μF are connected as shown in the network given below.
Find:
a. The value of X if the network is balanced, and
b. the resultant capacitance between A and C.



iii. Show that the current flowing through a moving coil galvanometer is directly proportional to the angle of deflection of coil.

iv. Explain the formation of energy band diagram in case of conductor and semiconductor.

Q.6. Attempt any SIX: **[12]**

i. Draw a neat labelled diagram showing the plane of vibration and plane of polarisation for polarised light.

ii. State the conditions to get steady interference pattern.

iii. In a hydrogen atom, an electron carrying charge 'e' revolves in an orbit of radius 'r' with speed 'v'. Obtain an expression for the magnitude of magnetic moment of a revolving electron.

iv. Draw a neat, labelled block diagram for a generalised communication system.

v. A red light of wavelength 6400 Å in air has wavelength 4000 Å in glass. If the wavelength of violet light in air is 4400 Å, find its wavelength in glass.
(Assume that $\mu_r \approx \mu_v$)

vi. The magnetic moment of a magnet of dimensions 5 cm × 2.5 cm × 1.25 cm is 3 Am^2. Calculate the intensity of magnetization.

vii. An A.C. circuit consists of inductor of inductance 125 mH connected in parallel with a capacitor of capacity 50 μF. Determine the resonant frequency.

viii. Calculate the de Broglie wavelength of an electron moving with $1/3^{rd}$ of the speed of light in vacuum.
(Neglect relativistic effect)
(Planck's constant : $h = 6.63 \times 10^{-34}$ Js,
Mass of electron : $m = 9.11 \times 10^{-28}$ g)

Q.7. Select and write the most appropriate answer from the given alternatives for each sub-questions **[7]**

i. If numerical aperture of a microscope is increased, then its _____.
(A) resolving power decreases (B) limit of resolution decreases
(C) resolving power remains constant (D) limit of resolution increases

ii. A solenoid of length 1.5 m and 4 cm in diameter possesses 10 turns per metre. A current of 5 A is flowing through it. The magnetic induction at a point inside the solenoid along the axis is _____. ($\mu_0 = 4\pi \times 10^{-7}$ Wb/Am)

(A) $\pi \times 10^{-5}$ T (B) $2\pi \times 10^{-5}$ T

(C) $3\pi \times 10^{-5}$ T (D) $4\pi \times 10^{-5}$ T

iii. Kirchhoff's voltage law and current law are respectively in accordance with the conservation of _____.

(A) charge and momentum (B) charge and energy

(C) energy and charge (D) energy and momentum

iv. When radiations of wavelength λ_1 and λ_2 are incident on certain photosensitive material, the energies of electron ejected are E_1 and E_2 respectively, such that $E_1 > E_2$. Then Planck's constant 'h' is _____. (c = velocity of light)

(A) $\frac{(E_1 - E_2)(\lambda_1 - \lambda_2)}{c(\lambda_1 \cdot \lambda_2)}$ (B) $\frac{(E_1 - E_2)\lambda_1 c}{(\lambda_1 - \lambda_2)\lambda_2}$

(C) $\frac{(E_1 - E_2)\lambda_1\lambda_2}{c(\lambda_2 - \lambda_1)}$ (D) $\frac{(\lambda_2 - \lambda_1)c}{(E_1 - E_2)\lambda_1 \cdot \lambda_2}$

v. Colour of light emitted by LED depends upon _____.

(A) its forward bias

(B) its reverse bias

(C) the band gap of the material of semiconductor

(D) its size

vi. Line of sight propagation is also called as _____ propagation.

(A) sky wave (B) ground wave

(C) sound wave (D) space wave

vii. Two parallel plates separated by distance d are kept at potential difference V volt. A charge q of mass m enters in parallel plates with some velocity. The acceleration of the charged particle will be _____.

(A) $\frac{qV}{dm}$ (B) $\frac{dm}{qV}$

(C) $\frac{qm}{dV}$ (D) $\frac{dV}{qm}$

Q.8. Explain the phenomenon of self induction and mutual induction. Define coefficient of self induction and mutual induction. Write the SI unit and dimensions of coefficient of self induction.

A potentiometer wire has a length of 4 m and a resistance of 5 Ω. What resistance should be connected in series with a potentiometer wire and a cell of e.m.f. 2 V having internal resistance 1 Ω to get a potential gradient of 10^{-3} V/cm? **[7]**

OR

Q.8. Derive an expression for the total energy of electron in 'n' th Bohr orbit. Hence show that energy of the electron is inversely proportional to the square of principal quantum number. Also define binding energy.

The photoelectric threshold wavelength of a metal is 230 nm. Determine the maximum kinetic energy in joule and in eV of the ejected electron for the metal surface when it is exposed to a radiation of wavelength 180 nm.
(Planck's constant : $h = 6.63 \times 10^{-34}$ Js,
Velocity of light : $c = 3 \times 10^8$ m/s.) **[7]**