Board Question Paper: October 2013
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. Derive an expression for the period of motion of a simple pendulum.
On which factors does it depend?

A ballet dancer spins about a vertical axis at 2.5π rad/s with his both arms outstretched. With the arms folded, the moment of inertia about the same axis of rotation changes by 25%. Calculate the new speed of rotation in r.p.m.   **[7]**

OR

Q.1. Draw neat labelled diagrams for modes of vibration of an air column in a pipe when it is
    a.   open at both ends,
    b.   closed at one end.
Hence derive an expression for fundamental frequency in each case.

A soap bubble of radius 12 cm is blown. Surface tension of soap solution is 30 dyne/cm. Calculate the work done in blowing the soap bubble.   **[7]**

Q.2. **Attempt any THREE:**   **[9]**
    i.   In a conical pendulum, a string of length 120 cm is fixed at rigid support and carries a mass of 150 g at its free end. If the mass is revolved in a horizontal circle of radius 0.2 m around a vertical axis, calculate tension in the string (g = 9.8 m/s^2)

    ii.   Explain the behaviour of metal wire under increasing load.

    iii.   Derive an expression for one dimensional simple harmonic progressive wave travelling in the direction of positive X-axis. Express it in 'two' different forms.

    iv.   The kinetic energy of nitrogen per unit mass at 300 K is 2.5×10^6 J/kg. Find the kinetic energy of 4 kg oxygen at 600 K. (Molecular weight of nitrogen = 28, Molecular weight of oxygen = 32)

Q.3. **Attempt any SIX:**   **[12]**
    i.   A racing car completes 5 rounds of a circular track in 2 minutes. Find the radius of the track if the car has uniform centripetal acceleration of π^2 m/s^2.

    ii.   A body weighs 4.0 kg-wt on the surface of the Earth. What will be its weight on the surface of a plant whose mass is $\frac{1}{8}$th of the mass of the Earth and radius half $\left(\frac{1}{2}\right)$ of that of the Earth?

iii. Define radius of gyration. Explain its physical significance.

iv. A body of mass 1 kg is made to oscillate on a spring of force constant 16 N/m. Calculate:
a. Angular frequency,   b. frequency of vibration.

v. Show that the surface tension of a liquid is numerically equal to the surface energy per unit area.

vi. Explain black body radiation spectrum in terms of wavelength.

vii. 'g' is the acceleration due to gravity on the surface of the Earth and 'R' is the radius of the Earth.
Show that acceleration due to gravity at height 'h' above the surface of the Earth is

$$g_h = g\left(\frac{R}{R+h}\right)^2$$

viii. In Melde's experiment, the number of loops on a string changes from 7 to 5 by the addition of 0.015 kgwt. Find the initial tension applied to the string.

Q.4. **Select and write the most appropriate answer from the given alternatives for each sub-questions:**   **[7]**

i. A planet is revolving around a star in a circular orbit of radius R with a period T. If the gravitational force between the planet and the star is proportional to $R^{\frac{-3}{2}}$, then

(A) $T^2 \propto R^{\frac{5}{2}}$

(B) $T^2 \propto R^{\frac{-7}{2}}$

(C) $T^2 \propto R^{\frac{3}{2}}$

(D) $T^2 \propto R^4$

ii. If 'L' is the angular momentum and 'I' is the moment of inertia of a rotating body, then $\frac{L^2}{2I}$ represents its _____.

(A) rotational P.E.

(B) total energy

(C) rotational K.E.

(D) translational K.E.

iii. A particle executing linear S.H.M. has velocities v_1 and v_2 at distances x_1 and x_2 respectively from the mean position. The angular velocity of the particle is _____.

(A) $\sqrt{\dfrac{x_1^2 - x_2^2}{v_2^2 - v_1^2}}$

(B) $\sqrt{\dfrac{v_2^2 - v_1^2}{x_1^2 - x_2^2}}$

(C) $\sqrt{\dfrac{x_1^2 + x_2^2}{v_2^2 + v_1^2}}$

(D) $\sqrt{\dfrac{v_2^2 + v_1^2}{x_2^2 + x_1^2}}$

iv. A metal rod having coefficient of linear expansion (α) and Young's modulus (Y) is heated to raise the temperature by $\Delta\theta$. The stress exerted by the rod is _____.

(A) $\dfrac{Y\alpha}{\Delta\theta}$

(B) $\dfrac{Y\Delta\theta}{\alpha}$

(C) $Y\alpha\Delta\theta$

(D) $\dfrac{\alpha\Delta\theta}{Y}$

v. A big drop of radius R is formed from 1000 droplets of water. The radius of a droplet will be _____.

(A) 10 R

(B) $\dfrac{R}{10}$

(C) $\dfrac{R}{100}$

(D) $\dfrac{R}{1000}$

vi. Apparent frequency of the sound heard by a listener is less than the actual frequency of sound emitted by source. In this case _____.
   (A) listener moves towards source.
   (B) source moves towards listener.
   (C) listener moves away from the source.
   (D) source and listener move towards each other.

vii. The substance which allows heat radiations to pass through is _____.
   (A) iron   (B) water vapour
   (C) wood   (D) dry air

SECTION – II

Q.5. Obtain an expression for the induced e.m.f. in a coil rotating with uniform angular velocity in uniform magnetic field. Plot a graph of variation of induced e.m.f. against phase ($\theta = \omega t$) over one cycle.

The energy density at a point in a medium of dielectric constant 6 is 26.55×10^6 J/m^3. Calculate electric field intensity at that point. ($\varepsilon_0 = 8.85 \times 10^{-12}$ SI units).   **[7]**

OR

Q.5. Write notes on –
   a. Nuclear fission   b. Nuclear fusion

A galvanometer has a resistance of 16 Ω. It shows full scale deflection, when a current of 20 mA is passed through it. The only shunt resistance available is 0.06 Ω which is not appropriate to convert a galvanometer into an ammeter. How much resistance should be connected in series with the coil of galvanometer, so that the range of ammeter is 8 A?   **[7]**

Q.6. Attempt any THREE: **[9]**
   i. Draw a well labelled diagram of photoelectric cell.
   Explain the observations made by Hertz and Lenard about the phenomenon of photoelectric emission.

   ii. Explain the working of transistor as a switch.

   iii. The refractive indices of water for red and violet colours are 1.325 and 1.334 respectively. Find the difference between the velocities of rays for these two colours in water.
   ($c = 3 \times 10^8$ m/s)

   iv. In Young's experiment, the ratio of intensity at the maxima and minima in an interference pattern is 36 : 9. What will be the ratio of the intensities of two interfering waves?

Q.7. Attempt any SIX: **[12]**
   i. Explain the principle of potentiometer.

   ii. What is –
   a. magnetization   and   b. magnetic intensity?

   iii. What do you mean by polar molecules and non-polar molecules? Give 'one' example each.

   iv. The minimum angular separation between two stars is 4×10^{-6} rad, if telescope is used to observe them with an objective of aperture 16 cm. Find the wavelength of light used.

   v. Explain the need for modulation related to the size of antenna (aerial).

   vi. Four resistances 4 Ω, 8 Ω, X Ω and 6 Ω are connected in a series so as to form Wheatstone's network. If the network is balanced, find the value of 'X'.

   vii. The magnetic susceptibility of annealed iron at saturation is 4224. Find the permeability of annealed iron at saturation. ($\mu_0 = 4\pi \times 10^{-7}$ SI unit)

Q.8. **Select and write the most appropriate answer from the given alternatives for each sub-questions:** **[7]**

i. A ray of light passes from a vacuum to a medium of refractive index (μ). The angle of incidence is found to be twice the angle of refraction. The angle of incidence is _____.

(A) $\cos^{-1}\left(\dfrac{\mu}{2}\right)$ 　　　　　　　　(B) $\cos^{-1}(\mu)$

(C) $2\cos^{-1}\left(\dfrac{\mu}{2}\right)$ 　　　　　　(D) $2\sin^{-1}\left(\dfrac{\mu}{2}\right)$

ii. The fringes produced in diffraction pattern are of _____.
(A) equal width with same intensity
(B) unequal width with varying intensity
(C) equal intensity
(D) equal width with varying intensity

iii. If 'R' is the radius of dees and 'B' be the magnetic field of induction in which positive charges (q) of mass (m) escape from the cyclotron, then its maximum speed (v_{max}) is _____.

(A) $\dfrac{qR}{Bm}$ 　　　　　　　　(B) $\dfrac{qm}{BR}$

(C) $\dfrac{qBR}{m}$ 　　　　　　　　(D) $\dfrac{m}{qBR}$

iv. The number of photoelectrons emitted _____.
(A) varies inversely with frequency
(B) varies directly with frequency
(C) varies inversely with intensity
(D) varies directly with intensity

v. The width of depletion region of p-n junction diode is _____.
(A) 0.5 nm to 1 nm 　　　　　　(B) 5 nm to 10 nm
(C) 50 nm to 500 nm 　　　　　(D) 500 nm to 1000 nm

vi. A device that converts one form of energy into another form is termed as _____.
(A) transducer 　　　　　　　　(B) transmitter
(C) amplifier 　　　　　　　　　(D) receiver

vii. A transformer converts 240 V AC to 60 V AC. The secondary has 75 turns. The number of turns in primary are _____.
(A) 600 　　　　　　　　　　(B) 500
(C) 400 　　　　　　　　　　(D) 300