HSC Maharashtra Board question paper: March 2013

Note:

i. All question are compulsory

ii. Neat diagrams must be drawn wherever necessary.

iii. Figure to the right indicate full marks.

iv. Use of logarithmic table is allowed.

v. All symbols have their usual meaning unless otherwise stated.

PHYSICS: SECTION – I

Q. 1. Select and write the most appropriate answer from the given alternatives for each sub-question: [7]

i. The moment of inertia of a thin uniform rod of mass M and length L, about an axis passing through a point, midway between the centre and one end, perpendicular to its length is ______.

(A) $\frac{48}{7}ML^2$ (B) $\frac{7}{48}ML^2$ (C) $\frac{1}{48}ML^2$ (D) $\frac{1}{16}ML^2$

ii. ‘n’ droplets of equal size of radius r coalesce to form a bigger drop of radius R. The energy liberated is equal to _______. (T = Surface tension of water)

(A) $4\pi R^2T[n^{\frac{1}{3}}-1]$ (B) $4\pi r^2T[n^{\frac{1}{3}}-1]$

(C) $4\pi R^2T[n^{\frac{2}{3}}-1]$ (D) $4\pi r^2T[n^{\frac{2}{3}}-1]$

iii. The buckling of a beam is found to be more if _______.

(A) the breadth of the beam is large.

(B) the beam material has large value of Young’s modulus.

(C) the length of the beam is small.

(D) the depth of the beam is small.

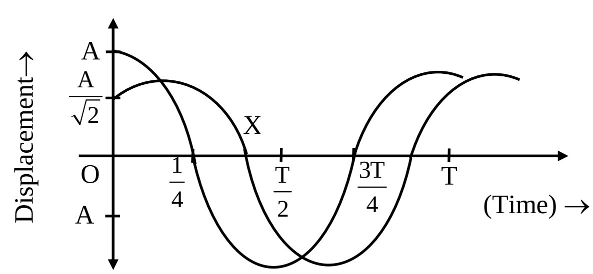
iv. When a transverse wave on a string is reflected from the free end, the phase change produced is _______.

(A) zero rad (B) $\frac{\pi}{2}$ rad (C) $\frac{3\pi}{4}$ rad (D) π rad

v. The number of degrees of freedom for a rigid diatomic molecule is _______.

(A) 3 (B) 5 (C) 6 (D) 7

vi. Two particles perform linear simple harmonic motion along the same path of length 2A and period T as shown in the graph below. The phase difference between them is _______.



(A) zero rad (B) $\frac{\pi}{4}$ rad (C) $\frac{\pi}{2}$ rad (D) $\frac{3\pi}{4}$ rad

vii. The light from the Sun is found to have a maximum intensity near the wavelength of 470 nm. Assuming the surface of the Sun as a black body, the temperature of the Sun is _______.
[Wien's constant $b = 2.898 \times 10^{-3}$ mK]
(A) 5800 K (B) 6050 K (C) 6166 K (D) 6500 K

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

i. State Kepler's law of orbit and law of equal areas.

ii. A car of mass. 1500 Kg rounds a curve of radius 250m at 90 Km/hour. Calculate the centripetal force acting on it.

iii. Draw a neat labelled diagram for Ferry's perfectly black body.

iv. A mass M attached to a spring oscillates with a period of 2 seconds. If the mass is increased by 2 Kg, the period increases by 1 second. Find the initial mass, assuming that Hooke's law is obeyed.

v. Differentiate between free and forced vibrations.

vi. The surface tension of water at 0°C is 75.5 dyne/cm. Find surface tension of water at 25°C. [α for water = 0.0021/°C]

vii. Derive the relation between surface tension and surface energy per unit area.

viii. A wheel of moment of inertia 1 Kgm^2 is rotating at a speed of 40 rad/s. Due to friction on the axis, the wheel comes to rest in 10 minutes. Calculate the angular momentum of the wheel, two minutes before it comes to rest.

Q. 3. Attempt any THREE: **[9]**

(i) A particle of mass m, just completes the vertical circular motion. Derive the expression for the difference in tensions at the highest and the lowest points.

(ii) The Earth is rotating with angular velocity ω about its own axis. R is the radius of the Earth. If $R\omega^2 = 0.03386 m/s^2$, calculate the weight of a body of mass 100 gram at lattitude 25°. ($g = 9.8 m/s^2$)

(iii) Derive an expression for kinetic energy, when a rigid body is rolling on a horizontal surface without slipping. Hence find kinetic energy for a solid sphere.

(iv) A steel wire of diameter 1×10^{-3} m is stretched by a force of 20 N. Calculate the strain energy per unit volume. (Y steel $= 2 \times 10^{11} N/m^2$)

Q. 4. Define an ideal simple pendulum. Show that, under certain conditions, simple pendulum performs linear simple harmonic motion. **[7]**

A train blows a whistle of frequency 640 Hz in air. Find the difference in apparent frequencies of the whistle for a stationary observer, when the train moves towards and away from the observer with the speed of 72 Km/hour. [Speed of sound in air = 340 m/s.]

OR

With a neat labelled diagram, show that all harmonics are present in an air column contained in a pipe open at both the ends. Define end correction.

Calculate the kinetic energy of 10 gram of Argon molecules at 127°C.
[Universal gas constant R = 8320 J/k mole K, Atomic weight of Argon = 40]