

# HSC Maharashtra Board question paper: March 2013

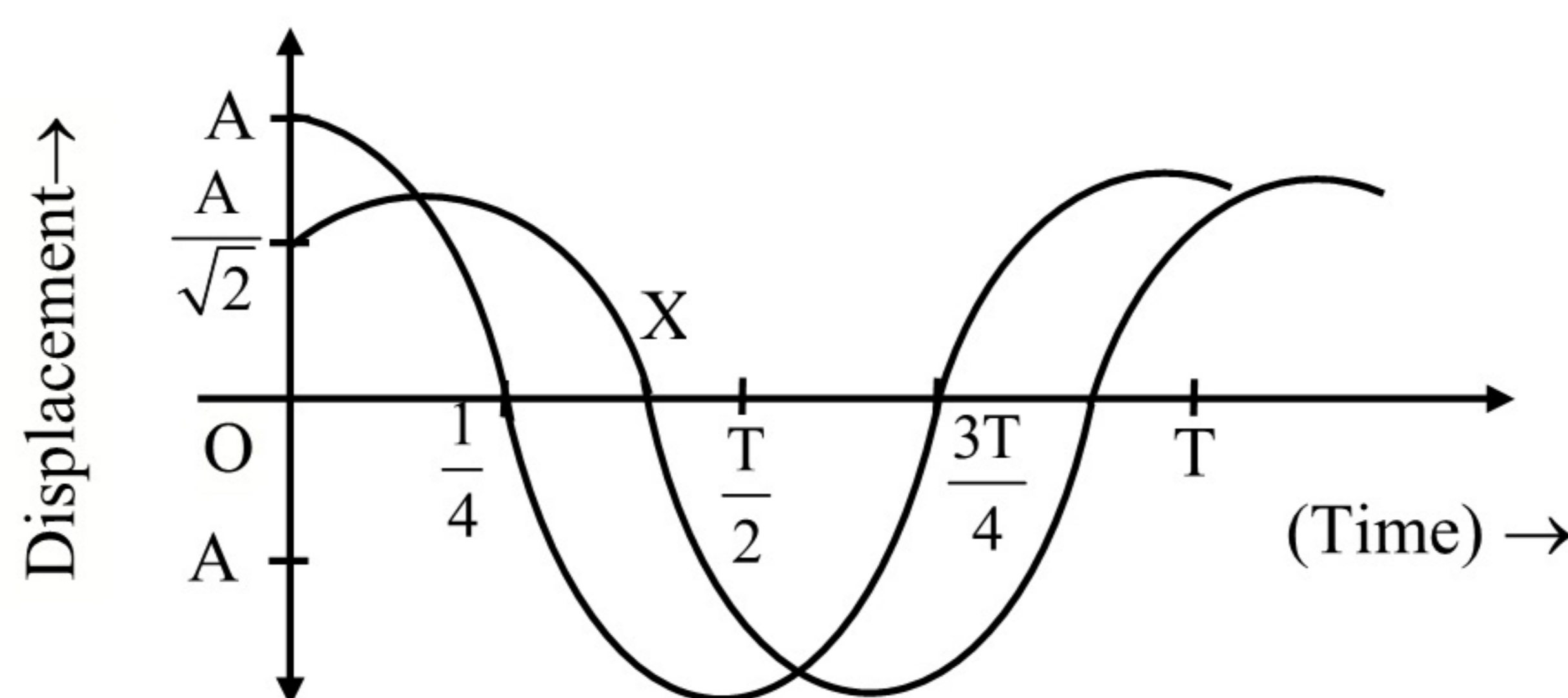
## Note:

- All question are compulsory
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- Figure to the right indicate full marks.
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## PHYSICS: SECTION – I

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

- 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)  $\frac{1}{16}ML^2$
- ' $n$ ' 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)  $4\pi R^2 T [n^{\frac{1}{3}} - 1]$  (B)  $4\pi r^2 T [n^{\frac{1}{3}} - 1]$   
(C)  $4\pi R^2 T [n^{\frac{2}{3}} - 1]$  (D)  $4\pi r^2 T [n^{\frac{2}{3}} - 1]$
- 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.
- 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)  $\pi$  rad
- The number of degrees of freedom for a rigid diatomic molecule is \_\_\_\_\_.  
(A) 3 (B) 5 (C) 6 (D) 7
- 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  $b = 2.898 \times 10^{-3} \text{ mK}$ ]

- (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  $0^\circ\text{C}$  is 75.5 dyne/cm. Find surface tension of water at  $25^\circ\text{C}$ . [ $\alpha$  for water =  $0.0021/^\circ\text{C}$ ]
- vii. Derive the relation between surface tension and surface energy per unit area.
- viii. A wheel of moment of inertia  $1 \text{ Kg m}^2$  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  $\omega$  about its own axis. R is the radius of the Earth. If  $R\omega^2 = 0.03386 \text{ m/s}^2$ , calculate the weight of a body of mass 100 gram at latitude  $25^\circ$ . ( $g = 9.8 \text{ m/s}^2$ )
- (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  $1 \times 10^{-3} \text{ m}$  is stretched by a force of 20 N. Calculate the strain energy per unit volume. ( $Y_{\text{steel}} = 2 \times 10^{11} \text{ N/m}^2$ )

**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  $127^\circ\text{C}$ .

[Universal gas constant  $R = 8320 \text{ J/k mole K}$ , Atomic weight of Argon = 40]

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## PHYSICS: SECTION – II

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

- i. In the diffraction pattern due to a single slit of width 'd' with incident light of wavelength ' $\lambda$ ', at an angle of diffraction ' $\theta$ ', the condition for first minimum is \_\_\_\_\_.  
(A)  $\lambda \sin \theta = d$  (B)  $d \cos \theta = \lambda$   
(C)  $d \sin \theta = \lambda$  (D)  $\lambda \cos \theta = d$
- ii. Kirchhoff's junction law is equivalent to \_\_\_\_\_.  
(A) conservation of energy  
(B) conservation of charge  
(C) conservation of electric potential  
(D) conservation of electric flux
- iii. let 'p' and 'E' denote the linear momentum and energy of emitted photon respectively. If the wavelength of incident radiation is increased \_\_\_\_\_.  
(A) both p and E increase  
(B) p increases and E decreases  
(C) p decreases and E increases  
(D) both p and E decrease
- iv. The nuclei having same number of protons but different number of neutrons are called \_\_\_\_\_.  
(A) isobars (B)  $\alpha$  - particles  
(C) isotopes (D)  $\gamma$  - particles
- v. In case of transistor oscillator, to obtain sustained oscillations, the product of voltage gain without feedback and feedback factor should be \_\_\_\_\_.  
(A) zero (B) less than 1  
(C) one (D) infinity
- vi. The process of regaining of information from carrier wave at the receiver is called \_\_\_\_\_.  
(A) modulation (B) transmission  
(C) propagation (D) demodulation
- vii. Reactance of a coil is  $157 \Omega$ . On connecting the coil across a source of frequency 100 Hz, the current lags behind e.m.f. by  $45^\circ$ . The inductance of the coil is \_\_\_\_\_.  
(A) 0.25 H (B) 0.5 H  
(C) 4 H (D) 314 H

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

- i. Draw a neat labelled diagram of a parallel plate capacitor completely filled with dielectric.
- ii. A point is situated at 7cm and 7.2 cm from two coherent sources. Find the nature of illumination at the point if wavelength of light is  $4000\text{\AA}$ .
- iii. Obtain the expression for current sensitivity of moving coil galvanometer.
- iv. In a cyclotron, magnetic field of  $3.5\text{ Wb/m}^2$  is used to accelerate protons. What should be the time interval in which the electric field between the Dees be reversed?  
(Mass of proton =  $1.67 \times 10^{-27}\text{ Kg}$ , Charge on proton =  $1.6 \times 10^{-19}\text{ C}$ ).
- v. Define magnetization. State its formula and S.I. unit.
- vi. Electrostatic energy of  $3.5 \times 10^{-4}\text{ J}$  is stored in a capacitor at 700 V. What is the charge on the capacitor?
- vii. What is space wave propagation? State its three components.
- viii. Find the value of energy of electron in eV in the third Bohr orbit of hydrogen atom.  
(Rydberg's constant ( $R$ ) =  $1.097 \times 10^7\text{ m}^{-1}$ ,  
Planck's constant ( $h$ ) =  $6.63 \times 10^{-34}\text{ J-s}$ ,  
Velocity of light in air ( $c$ ) =  $3 \times 10^8\text{ m/s}$ .)

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

- i. With the help of neat labelled circuit diagram explain the working of half wave rectifier using semiconductor diode. Draw the input and output waveforms.
- ii. A cell balances against a length of 200 cm on a potentiometer wire, when it is shunted by a resistance of  $8\Omega$ . The balancing length reduces by 40 cm, when it is shunted by a resistance of  $4\Omega$ . Calculate the balancing length when the cell is in open circuit. Also calculate the internal resistance of the cell.
- iii. State the law of radioactive decay. Hence derive the expression  $N = N_0 e^{-\lambda t}$  where symbols have their usual meanings.
- iv. The photoelectric work function for a metal is 4.2 eV. If the stopping potential is 3V, find the threshold wavelength and maximum kinetic energy of emitted electrons.  
(Velocity of light in air =  $3 \times 10^8\text{ m/s}$ ,  
Planck's constant =  $6.63 \times 10^{-34}\text{ J-s}$ ,  
Charge on electron =  $1.6 \times 10^{-19}\text{ C}$ )

**Q.4. State Faraday's laws of electromagnetic induction and Lenz's law.** [7]

Prove theoretically, the relation between e.m.f. induced and rate of change of magnetic flux in a coil moving in a uniform magnetic field.

A circular coil of 250 turns and diameter 18 cm carries a current of 12A. What is the magnitude of magnetic moment associated with the coil?

**OR**

On the basis of Huygens' wave theory of light prove that velocity of light in a rarer medium is greater than velocity of light in a denser medium.

In Young's experiment the ratio of intensity at the maxima and minima in the interference pattern is 36:16. What is the ratio of the widths of the two slits?