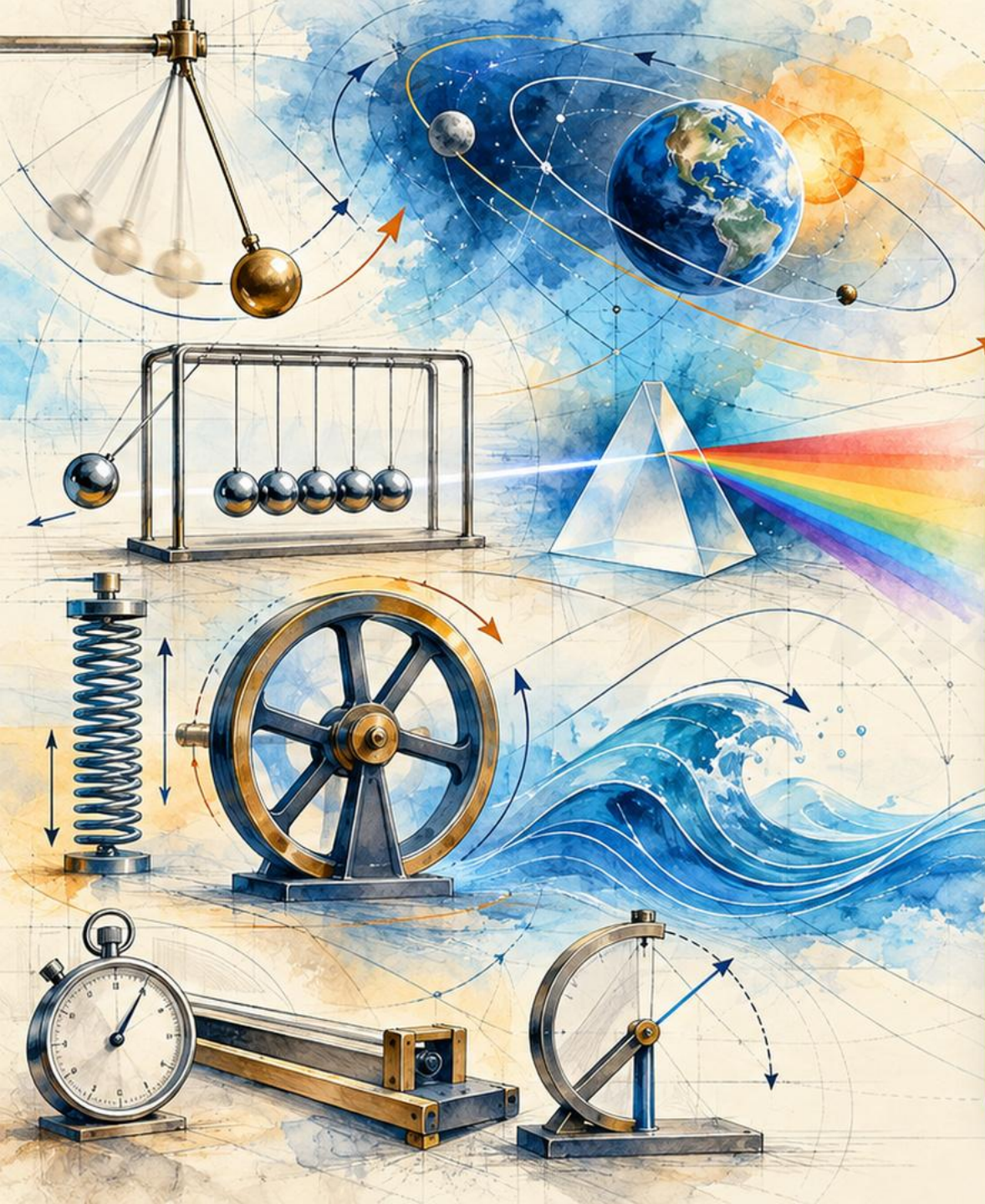




PHYSICS • CLASS 11

13

CHAPTER

Oscillations

NCERT SOLUTIONS

EXERCISE SOLUTION: QUESTION 13.1

Which of the following motions are periodic?

(a) A swimmer completes one return trip across a river and back.

Answer:

Not periodic as stated. One return trip does not establish motion repeating at equal time intervals.

(b) A freely suspended bar magnet is displaced from its north-south direction and released.

Answer:

Periodic in the ideal undamped model. It oscillates about the north-south equilibrium direction and repeats its motion.

(c) A hydrogen molecule rotates about its centre of mass.

Answer:

Periodic in the ideal uniform-rotation model. Its orientation repeats after a revolution.

(d) An arrow is released from a bow.

Answer:

Not periodic. Its flight does not repeatedly return through the same motion at equal time intervals.

EXERCISE SOLUTION: QUESTION 13.2

Identify nearly simple harmonic motion (SHM) and periodic motion that is not SHM in the following cases.

(a) Rotation of Earth about its axis.

Answer: Periodic, but the rotation itself is not SHM. It is not a to-and-fro displacement with acceleration proportional and opposite to that displacement.

(b) An oscillating mercury column in a U-tube.

Answer: Nearly SHM for a uniform tube with damping neglected. The liquid-level difference provides a restoring force proportional to displacement.

$$a = -\omega^2 x$$

(c) A ball bearing released slightly above the lowest point of a smooth curved bowl.

Answer: Nearly SHM for small displacements about the stable lowest point. The restoring force is approximately proportional to displacement.

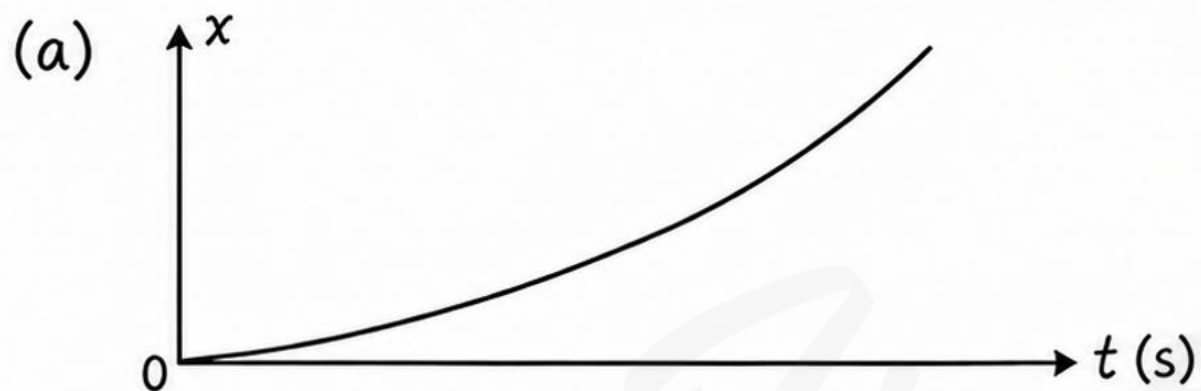
$$a = -\omega^2 x$$

(d) General vibrations of a polyatomic molecule about equilibrium.

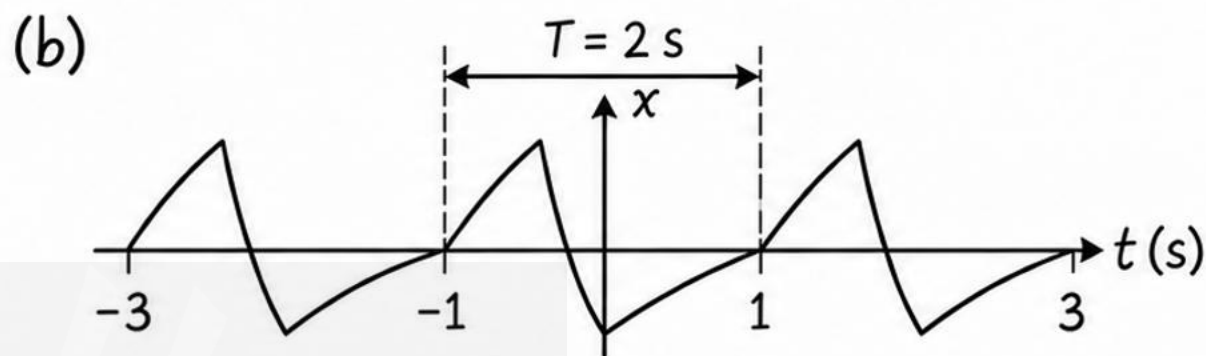
Answer: Generally not a single SHM: several normal-mode oscillations combine. In the textbook's periodic idealisation, classify this as periodic but not SHM. Exact repetition requires the component periods to share a common period.

EXERCISE SOLUTION: QUESTION 13.3

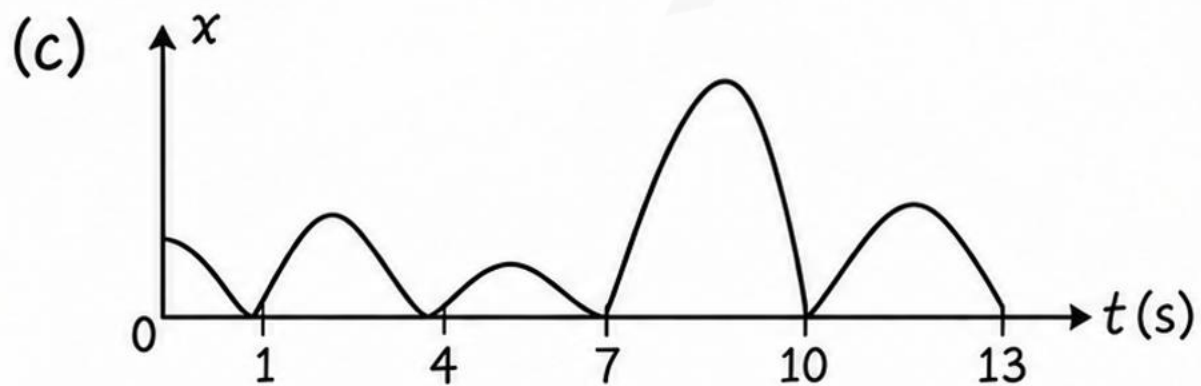
For the four displacement–time plots, identify periodic motion and state its period.



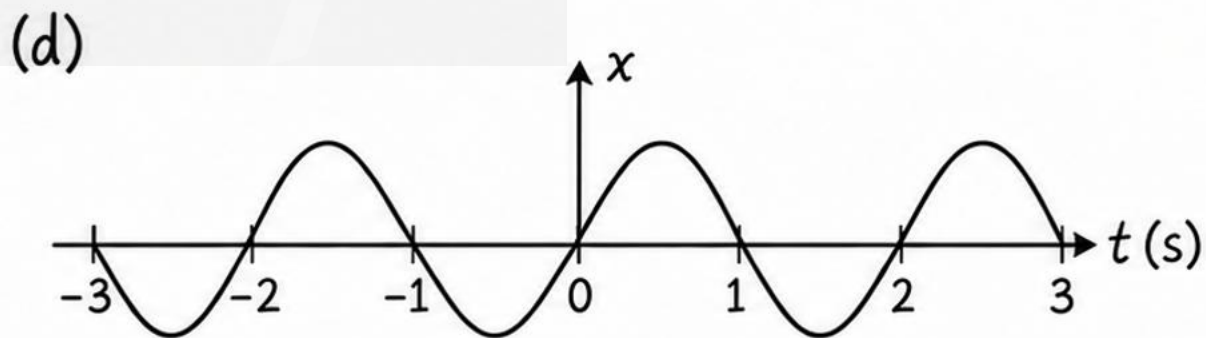
Not periodic: the motion does not repeat.



Periodic, but not sinusoidal.
Period = 2 s.



Not periodic. Repeated zeros alone do not make the whole motion repeat.



Periodic and sinusoidal.
Period = 2 s.

EXERCISE SOLUTION: QUESTION 13.4 (a-c)

Classify each time function as SHM, periodic but not SHM, or non-periodic. Give the period when it exists. Here ω is a positive constant.

$$(a) \quad x = \sin \omega t - \cos \omega t = \sqrt{2} \sin\left(\omega t - \frac{\pi}{4}\right)$$

$$T = \frac{2\pi}{\omega}.$$

Answer: This is one sinusoidal function with a fixed angular frequency, so it represents SHM.

$$(b) \quad x = \sin^3 \omega t = \frac{3}{4} \sin \omega t - \frac{1}{4} \sin 3\omega t$$

$$T = \frac{2\pi}{\omega}.$$

Answer: Periodic but not SHM. It contains two different angular frequencies, so it is not a single sinusoid.

$$(c) \quad x = 3 \cos\left(\frac{\pi}{4} - 2\omega t\right) = 3 \cos\left(2\omega t - \frac{\pi}{4}\right)$$

Angular frequency = 2ω .

Answer: SHM. Cosine is an even function, so reversing its argument does not change the motion.

$$T = \frac{2\pi}{2\omega} = \frac{\pi}{\omega}.$$



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