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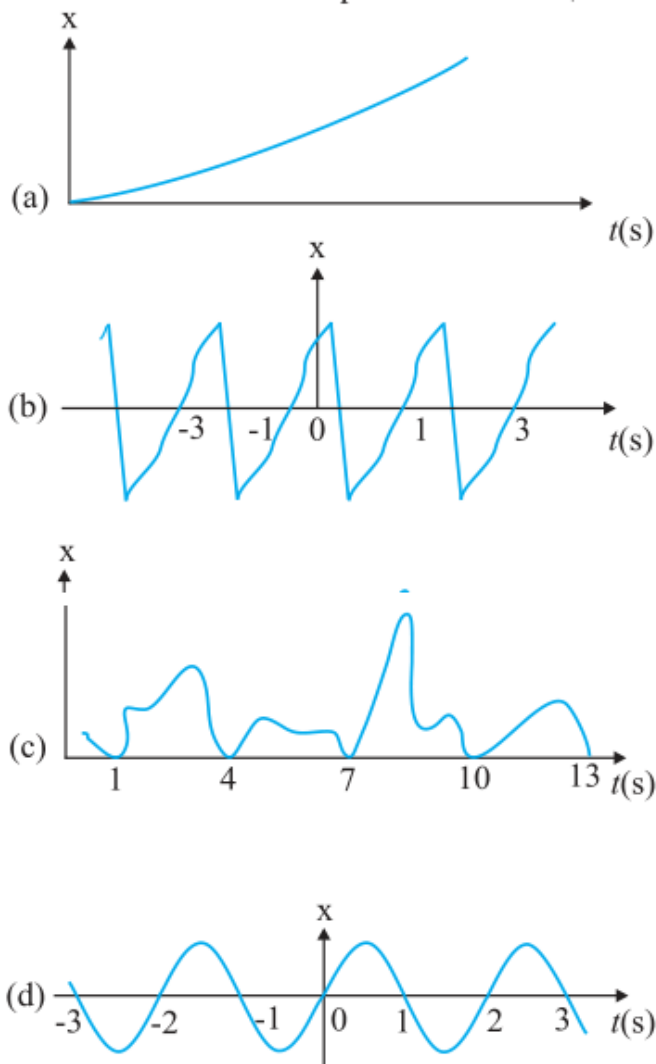
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NCERT Class 11 Physics Solutions: Chapter 14 – Oscillations-Part 2

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Question 14.3:

Figure depicts four $x-t$ plots for linear motion of a particle. Which of the plots represent periodic motion? What is the period of motion (in case of periodic motion) ?



Answer:

(b) and (d) Are periodic

Explanation:

(a)

It is not a periodic motion. This represents a unidirectional, linear uniform motion. There is no repetition of motion in this case.

(b)

In this case, the motion of the particle repeats itself after $2s$. Hence, it is a periodic motion, having a period of $2s$.

(c)

It is not a periodic motion. This is because the particle repeats the motion in one position only. For a periodic motion, the entire motion of the particle must be repeated in equal intervals of time.

(d)

In this case, the motion of the particle repeats itself after $2s$. Hence, it is a periodic motion, having a period of $2s$.

Question 14.4:

Which of the following functions of time represent,

- (a) Simple harmonic,
- (b) Periodic but not simple harmonic, and
- (c) Non-periodic motion?

Give period for each case of periodic motion (ω is any positive constant) :

(a) $\sin \omega t - \cos \omega t$

(b) $\sin^3 \omega t$

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

(d) $\cos \omega t + \cos 3\omega t + \cos 5\omega t$

(e) $\exp(-\omega^2 t^2)$

(f) $1 + \omega t + \omega^2 t^2$

Answer:

(a) : Simple harmonic motion

Explanation:

The given function is:

$$\begin{aligned} & \sin \omega t - \cos \omega t \\ &= \sqrt{2} \left[\frac{1}{\sqrt{2}} \sin \omega t - \frac{1}{\sqrt{2}} \cos \omega t \right] \\ &= \sqrt{2} \left[\sin \omega t \times \cos \frac{\pi}{4} - \cos \omega t \times \sin \frac{\pi}{4} \right] \\ &= \sqrt{2} \sin \left(\omega t - \frac{\pi}{4} \right) \end{aligned}$$

This function represents SHM as it can be written in the form:

$$a \sin(\omega t + \phi)$$

Its period is: $\frac{2\pi}{\omega}$

(b) :

Periodic, but not Simple harmonic motion

Explanation:

The given function is:

$$\begin{aligned} & \sin^3 \omega t \\ &= \frac{1}{2} [3 \sin \omega t - \sin 3\omega t] \end{aligned}$$

The terms $\sin \omega t$ and $\sin 3\omega t$ individually represent simple harmonic motion.

However, the superposition of two simple harmonic motion is periodic and not simple harmonic.

(c) :

Simple harmonic motion.

Explanation:

The given function is:

$$\begin{aligned} & 3 \cos \left[\frac{\pi}{4} - 2\omega t \right] \\ &= 3 \cos \left[2\omega t - \frac{\pi}{4} \right] \end{aligned}$$

This function represents simple harmonic motion because it can be written in the form:

$$a \cos(\omega t + \phi)$$

Its period is: $\frac{2\pi}{2\omega} = \frac{\pi}{\omega}$

(d) : Periodic, but not simple harmonic motion

Explanation:

The given function is $\cos \omega t + \cos 3\omega t + \cos 5\omega t$. Each individual cosine function represents simple harmonic motion. However, the superposition of three simple harmonic motions is periodic, but not simple harmonic.

(e) : Non-periodic motion

Explanation:

The given function $\exp(-\omega^2 t^2)$ is an exponential function. Exponential functions do not repeat themselves. Therefore, it is a non-periodic motion.

(f) :

The given function $1 + \omega t + \omega^2 t^2$ is non-periodic.