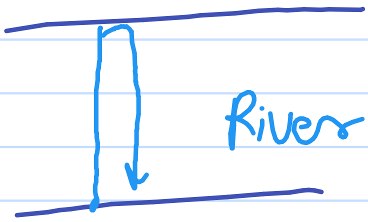
Exercise CH14.

- **Answer the following Questions.** [F

1. Which of the following examples represent periodic motion ?
   (a) A swimmer completing one (return) trip from one bank of a river to the other and back.
   (b) A freely suspended bar magnet displaced from its N-S direction and released.
   (c) A hydrogen molecule rotating about its center of mass.
   (d) An arrow released from a bow.

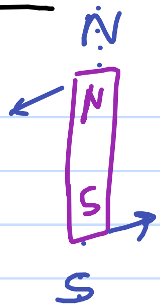
a).



T ≠ same.

Non periodic.

(b).



oscillate

⇒ ઝોલો

⇒ periodic ✓.

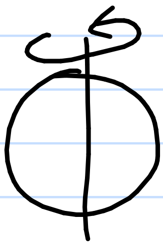
(c) rot^n ⇒ periodic ✓

(d) Arrow ⟶

$\boxed{\text{(b), (c) Ans.}}$

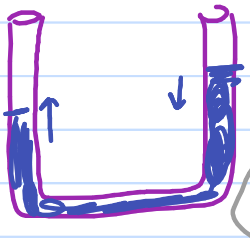
2. Which of the following examples represent (nearly) simple harmonic motion and which represent periodic but not simple harmonic motion ?
   ✓ (a) the rotation of earth about its axis.
   ✓ (b) motion of an oscillating mercury column in a U-tube.
   ✓ (c) motion of a ball bearing inside a smooth curved bowl, when released from a point slightly above the lower most point.
   ✓ (d) general vibrations of a polyatomic molecule about its equilibrium position.

1)



periodic ✓

SHM ✗

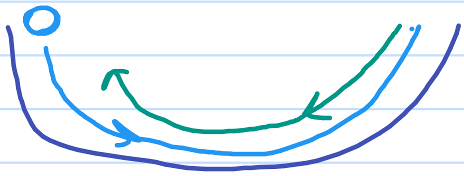


SHM ✓

Periodic ✓

any thing which SHM ⇒ periodic

3)



SHM ✓

periodic ✓

d). polyatomic → many atoms.

means all atoms have different f ⇒ differ. T.

Periodic ✓

SHM ✗

1) circular motion → ઘડી ✓ Fan

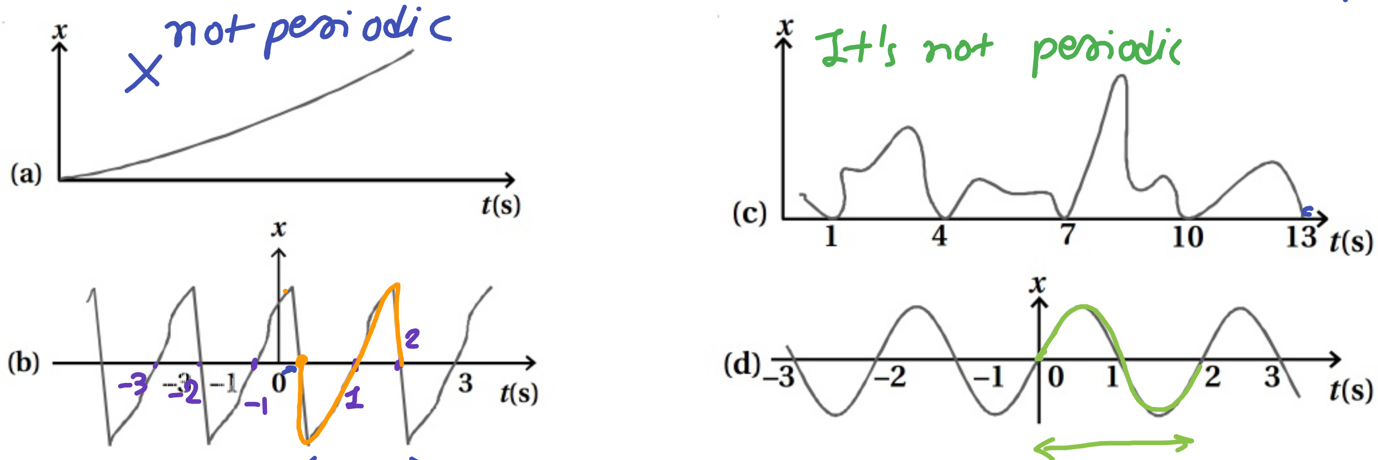
2) pendulum ✓

SHM ⟶ Periodic m

T = const, oscillate

T = const; (may be oscillate or not)

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) ? $T = ?$



(a) × not periodic

(b) $T = (2-0) = \underline{2s}$.

(c) It's not periodic

(d) $T = 2s$. Yes it's periodic.

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④. a). $\sin\omega t - \cos\omega t$

method ① $\rightarrow \left[\times \frac{\sqrt{2}}{\sqrt{2}}\right]$

$= \sqrt{2}\left[\frac{1}{\sqrt{2}}\sin\omega t - \frac{1}{\sqrt{2}}\cos\omega t\right]$

$= \sqrt{2}\left[\sin\omega t \cdot \cos\frac{\pi}{4} - \cos\omega t \cdot \sin\frac{\pi}{4}\right]$

$\left(\because \frac{1}{\sqrt{2}} = \sin\frac{\pi}{4} = \cos\frac{\pi}{4}\right)$

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

It's periodic because it's sine f^n which is periodic, SHM, with

$A = \sqrt{2}$

$T = \frac{2\pi}{(\omega)}$

$\phi = -\frac{\pi}{4}$ or $\left(2\pi - \frac{\pi}{4}\right) = \frac{8\pi - \pi}{4} = \frac{7\pi}{4}$

b) $\sin^3\omega t$

$\left(\because \sin 3\theta = 3\sin\theta - 4\sin^3\theta\right)$

$\sin 3\theta - 3\sin\theta = -4\sin^3\theta$

$\therefore (3\sin\theta - \sin 3\theta) = 4\sin^3\theta$

$\therefore \boxed{\frac{1}{4}[3\sin\theta - \sin 3\theta] = \sin^3\theta}$

$\sin^3(\omega t) = \frac{1}{4}[3\sin\omega t - \sin 3\omega t]$

periodic + SHM   periodic + SHM

but overall it's only periodic Not SHM.

$T_1 = \frac{2\pi}{\omega}$, $T_2 = \frac{2\pi}{3\omega}$

so it's not SHM.

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

(It's a cosine f^n which is periodic + SHM)

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

$(\because \cos(-\theta) = \cos\theta)$

$\therefore \; 3\cos\left[2\omega t - \frac{\pi}{4}\right]$

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

$\phi = -\frac{\pi}{4} = \frac{7\pi}{4}$

d) exponential f^n is not a periodic f^n

e) $1 + \omega t + \omega^2 t^2$

non periodic

No sine, cos funct.

solve

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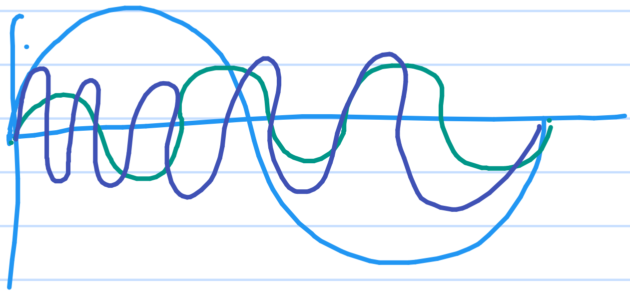
d) $\cos\omega t + \cos 3\omega t + \cos 5\omega t$

Here: $T_1 = \frac{2\pi}{\omega}$

$T_2 = \frac{2\pi}{3\omega}$

$T_3 = \frac{2\pi}{5\omega}$



Here: all have difference $T \Rightarrow$ diffnt ω.

→ so it's periodic but not SHM.

→ $\boxed{T = \frac{2\pi}{\omega}}$