🎯 Topic: Simple Harmonic Motion (SHM)

✅ A - Aim

To understand the behavior of objects undergoing **Simple Harmonic Motion**, their equations, and the role of restoring forces, amplitude, and energy conservation in oscillatory motion.

💡 C - Concept

- SHM is a **type of periodic motion** in which the **restoring force is directly proportional to the displacement** from the equilibrium position and acts in the opposite direction.
- Common examples: **pendulum**, **spring-mass system**, **vibrating tuning fork**.

⚙️ H - How it works

- When an object is displaced from its mean position, a **restoring force** acts to bring it back.
- This leads to **oscillations** about the equilibrium position.
- The object moves back and forth in a regular **sine wave pattern**.

🧮 E - Equations/Formulas

1. **Displacement**:
   x(t)=Asin(ωt+ϕ)x(t) = A \sin(\omega t + \phi)x(t)=Asin(ωt+ϕ) or x(t)=Acos(ωt+ϕ)x(t) = A \cos(\omega t + \phi)x(t)=Acos(ωt+ϕ)
2. **Velocity**:
   v(t)=dxdt=ωAcos(ωt+ϕ)v(t) = \frac{dx}{dt} = \omega A \cos(\omega t +

\phi)v(t)=dtdx=ωAcos(ωt+ϕ)

3. **Acceleration**:
   a(t)=−ω2xa(t) = -\omega^2 xa(t)=−ω2x

4. **Restoring Force**:
   F=−kxF = -k xF=−kx

5. **Time Period**:
   T=2πmkT = 2\pi \sqrt{\frac{m}{k}}T=2πkm (for spring-mass system)

6. **Energy in SHM**:
   - Total Energy: E=12kA2E = \frac{1}{2}kA^2E=21kA2
   - Kinetic Energy: KE=12mv2KE = \frac{1}{2}mv^2KE=21mv2
   - Potential Energy: PE=12kx2PE = \frac{1}{2}kx^2PE=21kx2

🔢 S - Steps to solve problems

1. Identify known quantities: A,m,k,x,ωA, m, k, x, \omegaA,m,k,x,ω, etc.
2. Choose the right formula based on what's asked (e.g., displacement, energy).
3. Substitute values into the formula.
4. Ensure units are correct (SI units).
5. Check if the answer makes physical sense (e.g., oscillatory behavior).

📘 E - Example

Q: A 0.2 kg mass is attached to a spring with k=200 N/mk = 200 \, N/mk=200N/m. Find the time period of oscillation.

Sol:
T=2πmk=2π0.2200=2π0.001≈0.2 sT = 2\pi \sqrt{\frac{m}{k}} = 2\pi \sqrt{\frac{0.2}{200}} = 2\pi \sqrt{0.001} ≈ 0.2 \, sT=2πkm=2π2000.2=2π0.001≈0.2s