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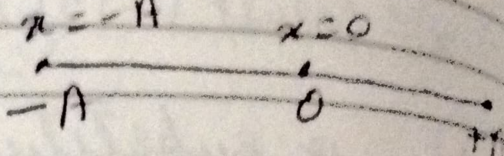
ENERGY IN S.H.M



Consider a system at rest at its position of equilibrium when it is displaced from this position, it acquires potential energy.

when the system is released, it beings to move with a velocity thus acquiring kenetic energy.

→ For a particle in SHM the kenetic energy (KE) is given by

T or $K.E = \frac{1}{2} m V^2$, but $V = \omega\sqrt{A^2 - x^2}$

So $K.E = \frac{1}{2} m \left(\omega\sqrt{A^2-x^2}\right)^2$

$= \frac{1}{2} \omega^2 m (A^2 - x^2)$

$$\boxed{K.E = \frac{1}{2} m\omega^2 (A^2 - x^2)}$$

(1) At mean position $x = 0$

$\boxed{K.E = \frac{1}{2} m\omega^2 A^2}$ maximum K.E

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(i) At extreme position $x \pm A$

$$K.E = \frac{1}{2} m\omega^2 (A^2 - A^2) = 0$$

$$\boxed{K.E = 0}$$

$\therefore x = A \sin(\omega t + \phi)$

$$\therefore K.E = \frac{1}{2} m\omega^2 (A^2 - A^2 \sin(\omega t + \phi))$$

$$K.E = \frac{1}{2} m\omega^2 A^2 (1 - \sin^2(\omega t + \phi))$$

or $\boxed{K.E = \frac{1}{2} m\omega^2 A^2 \cos^2(\omega t + \phi)}$

Potential energy →

Let the workdone for small displacement (dx) of the particle be given by

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$$dW = F dx$$

As the applied force must be opposite to the restoring force

$$F = -m\omega^2 x \quad \text{so}$$

$$dW = m\omega^2 x dx$$

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Then the total work done in displacement of particle from $x = 0$ to $x = x$ is obtained by integrating

$$\int dW = \int_0^x m\omega^2 x\,dx$$

$$W = m\omega^2 \int_0^x x\,dx$$

$$W = m\omega^2 \left[\frac{x^2}{2}\right]_0^x$$

$$W = m\omega^2 \frac{1}{2}(x^2 - 0^2)$$

$$\cancel{W = m\omega^2 \frac{1}{2}}$$

$$\boxed{W = \frac{1}{2} m\omega^2 x^2}$$

Potential energy of particle is given by

$$U = \frac{1}{2} m\omega^2 x^2$$

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or $\boxed{U = \frac{1}{2} kx^2}$