Acceleration in S.H.M.

The acceleration of the particle executing S.H.M. at any instant, is defined as the rate of change of its velocity at that instant. So acceleration $A = \frac{dv}{dt} = \frac{d}{dt}(a\omega \cos \omega t)$

$$A = -\omega^2 a \sin \omega t \quad \text{.....(i)}$$

$$A = -\omega^2 y \quad \text{.....(ii)}$$ [As $y = a \sin \omega t$]

Important points

(i) In S.H.M. as $|\text{Acceleration}| = \omega^2 y$ is not constant. So equations of translatory motion cannot be applied.

(ii) In S.H.M. acceleration is maximum at extreme position.

From equation (i) $|A_{\max}| = \omega^2 a$ when $|\sin \omega t| = \text{maximum} = 1$ i.e. At $t = \frac{T}{4}$ or $\omega t = \frac{\pi}{2}$

From equation (ii) $|A_{\max}| = \omega^2 a$ when $y = a$

(iii) In S.H.M. acceleration is minimum at mean position

From equation (i) $A_{\min} = 0$ when $\sin \omega t = 0$ i.e. At $t = 0$ or $t = \frac{T}{2}$ or $\omega t = \pi$

From equation (ii) $A_{\min} = 0$ when $y = 0$

(iv) Acceleration is always directed towards the mean position and so is always opposite to displacement

i.e. $A \propto -y$