



(ii)  $\frac{1}{2} \frac{d}{dt} \left( \frac{1}{2} m v^2 \right) = \frac{1}{2} m v \frac{dv}{dt} = \frac{1}{2} m v a$

Since  $a = \frac{dv}{dt}$ , we can write  $\frac{1}{2} m v a = \frac{1}{2} m v \frac{dv}{dt}$ . This is the power delivered to the particle. The work done by the force is the integral of power over time:  $W = \int P dt = \int \frac{1}{2} m v \frac{dv}{dt} dt = \frac{1}{2} m \int v dv = \frac{1}{4} m v^2$ .

Therefore, the work done by the force is  $\frac{1}{4} m v^2$ . This is half of the kinetic energy  $\frac{1}{2} m v^2$ . The other half of the kinetic energy is stored in the spring as potential energy.

The total energy of the system is  $\frac{1}{2} m v^2 + \frac{1}{4} m v^2 = \frac{3}{4} m v^2$ .

$$\frac{1}{2} m v^2 = \frac{1}{2} m \omega^2 A^2 \sin^2 \omega t$$
$$\frac{1}{4} m v^2 = \frac{1}{4} m \omega^2 A^2 \sin^2 \omega t$$

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The total energy of the system is  $\frac{3}{4} m \omega^2 A^2 \sin^2 \omega t$ . The average total energy over one cycle is  $\frac{3}{8} m \omega^2 A^2$ .