

Exemplar Problems :-

(1) The motion of a particle of mass m is given by $x=0$ for $t < 0$, $x(t) = A \sin 4\pi t$ for $0 < t < \frac{1}{4}$ s. and $x=0$ for $t > \frac{1}{4}$ s. ($A > 0$)

Which of the following statements is true?

(A) The force at $t = \frac{1}{8}$ s on the particle is $-16\pi^2 Am$.

(B) The particle is acted upon by an impulse of magnitude $4\pi^2 Am$ at $t=0$ and $t = \frac{1}{4}$ s.

(C) The particle is not acted upon by any force.

(D) The particle is not acted upon by a constant force.

(E) There is no impulse acting on the particle.

Ans :- (A), (B), (D)

Since force is a function of time, hence it is not constant.

$$\text{At } t = \frac{1}{8} \text{ s,}$$

$$\begin{aligned} \Rightarrow F &= m \frac{d^2x}{dt^2} \Big|_{t=\frac{1}{8}} = m \cdot A \cdot 4\pi \frac{d(\cos 4\pi t)}{dt} \Big|_{t=\frac{1}{8}} \\ &= 4\pi mA (-\sin 4\pi t) 4\pi \Big|_{t=\frac{1}{8}} \end{aligned}$$

$$\Rightarrow F = -16\pi^2 Am \sin\left[4\pi\left(\frac{1}{8}\right)\right] = -16\pi^2 Am$$

Now, Since impulse is change in momentum
given by $\vec{I} = \vec{F}t$

$$\text{Hence } \vec{I} = -16\pi^2 Am \cdot \frac{1}{4} = -4\pi^2 Am.$$