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PHYS - 230 LAB

QUIZ #2

~~The acceleration~~

Ans:- Given that acceleration of a particle moving along the x-axis is given by :-

$$a(t) = At^2 + Bt + C$$

(a) A & v(t) are in s & ms^{-1}, hence a(t) is in its S.I. unit, i.e, ms^{-2}.

(b) Given that :- $A = 24, B = 6, C = -2$

$$\therefore a(t) = 24t^2 + 6t - 2$$

(c) Given that :- Initial ($t=0$) velocity of particle = 0

We know :- $a(t) = \frac{dv(t)}{dt}$

$$\therefore v(t) = \int a(t)\,dt$$

$$v(t) = 24\int t^2\,dt + 6\int t\,dt - 2\int dt + C$$

$$v(t) = \frac{24t^3}{3_1} + \frac{6t^2}{2_1} - 2t + C$$

$$\therefore v(t) = 8t^3 + 3t^2 - 2t + C$$

P.T.O

Given :- $v(0) = 0$

$\therefore 8(0) + 3(0) - 2(0) + C = 0$

$\therefore C = 0$

$\therefore v(t) = 8t^3 + 3t^2 - 2t$

Again, Set the time (s) t' : $v(t') = 0$

$\therefore v(t') = 8t'^3 + 3t'^2 - 2t' = 0$

or, $t'(8t'^2 + 3t' - 2) = 0$

$t' = 0$ (Initial condition)

$$\therefore t' = \frac{-3 \pm \sqrt{9 - 4 \times 8 \times -2}}{2 \times 8}$$

$$= \frac{-3 \pm \sqrt{9 + 64}}{16}$$

$$t' = \frac{-3 \pm 8.544}{16}$$

$t' = \{0.3475, -0.7215\}$

Ignoring the '-' sign t', we get :- $t' = 0.3475$

Hence, the particle has zero velocity at t' $= \{0s, 0.3475s\}$

B.T.O

(a) When $t = 0$, we have $x(t) = x(0) = 0$.

Also we know: $x(t) = \int v(t)\,dt \quad \left[\because \frac{d(x(t))}{dt} = v(t)\right]$

$$\therefore x(t) = 8\int t^3\,dt + 3\int t^2\,dt - 2\int t\,dt + C$$

$$= \frac{8}{4}t^4 + \frac{3}{3}t^3 - \frac{2}{2}t^2 + C$$

$$= 2t^4 + t^3 - t^2 + C$$

$$x(0) = 0 = 0 + 0 - 0 + C$$

$$\therefore C = 0$$

Hence, $x(t) = 2t^4 + t^3 - t^2$

Let at time (s) t': $x(t') = 0$

$$\therefore 0 = 2t'^4 + t'^3 - t'^2$$

or, $t'^2(2t'^2 + t' - 1) = 0$

$\therefore t' = 0$ (Initial condition)

or, $2t'^2 + t' - 1 = 0$

$$t' = \frac{-1 \pm \sqrt{1 - 4\times 2\times -1}}{2\times 2}$$

$$= \frac{-1 \pm \sqrt{1+8}}{4} \quad (3) \qquad = \frac{-1 \pm \sqrt{9}}{4}$$

$$= \frac{-1 \pm 3}{4} = \frac{2}{4}1 \text{ or } -\frac{4}{4}1$$

$$= \frac{1}{2}\text{s or } -1\text{s}$$

Ignoring $-t'$s, we get :-

$$t' = 0.5\text{ s}$$

$$a(t') = a(0.5\text{s})$$

$$= 24(0.5\text{s})^2 + 6(0.5\text{s}) - 2$$

$$= 7\text{ ms}^{-2}$$

Hence, (i) Acceleration at $t = 0.5\text{ s} \overset{a(0.5s)}{=} 7\text{ ms}^{-2}$

(iii) Acceleration at $t = 0\text{ s} \overset{a(0s)}{=} -2\text{ ms}^{-2}$