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MATRIC NO; 19/ENG06/064
DEPT; MECHANICAL
COURSE; ENG 234 (MECHANICS)

Question 1

A particle travels along a straight line with a velocity of $v = (4t - 3t^2)$ m/s where t is in seconds, Determine the position of the particle when $t = 4s$, $s = 0$ when $t = 0$

Solution

$$V = \frac{ds}{dt}$$

$$4t - 3t^2 = \frac{ds}{dt}$$

$$\int ds = \int (4t - 3t^2)\,dt$$

$$S(t) = \frac{4t^2}{2} - \frac{3t^3}{3} + C$$

$$S(t) = 2t^2 - t^3 + C$$

at $s = 0$ $t = 0$

$$0 = 2(0)^2 - 0^3 + C$$

$$C = 0$$

$$\therefore \quad S(t) = 2t^2 - t^3$$

at $t = 4s$

$$S(4) = 2(4)^2 - 4^3$$

$$S(4) = 32 - 64$$

$$S(4) = -32m \quad (\leftarrow)$$

(The negative sign denotes that it is in the negative x direction)

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Question 2; A particle travels along a straight line with a speed $v = (0.5t^3 - 8t)$ m/s where t is in seconds. Determine the acceleration of the particle when $t = 2s$

Solution

$$a = \frac{dv}{dt}$$

and $$v = \frac{ds}{dt}$$

$$a = \frac{d(0.5t^3 - 8t)}{dt}$$

$$a = (1.5t^2 - 8) \ m/s^2$$

$$a = (1.5(2)^2 - 8)$$

$$a = (4 \times 1.5) - 8$$

$$a = 6 - 8 = -2 \ m/s^2 \leftarrow$$

The negative sign shows it is decelerating

$\therefore a = 2 \ m/s^2$

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Question 3

A particle moves along a straight line such that its acceleration is $a = (4t^2 - 2)\,m/s^2$, where t is in seconds. When $t = 0$, the particle is located 2m to the left of the origin and when $t = 2s$, it is 20m to the left of the origine. Determine the position of the particle when $t = 4s$

Solution

$$a = \frac{dv}{dt} \quad \text{and} \quad V = \frac{ds}{dt}$$

$$4t^2 - 2 = \frac{dv}{dt}$$

$$\int dv = \int (4t^2 - 2)\,dt$$

$$v = \frac{4t^3}{3} - 2t + c_1$$

and $$v = \frac{ds}{dt}$$

$$\frac{4t^3}{3} - 2t + C_1 = \frac{ds}{dt}$$

$$\int ds = \int \left(\frac{4t^3}{3} - 2t + C_1\right) dt$$

$$s = \frac{4t^4}{12} - \frac{2t^2}{2} + C_1t + C_2 = \frac{1}{3}t^4 - t^2 + C_1t + C_2$$

When $t = 0$ $S =$ 2m to the left

$$-2 = \frac{4(0)^4}{12} - \frac{2(0)^2}{2} + C_1(0) + C_2$$

$$\therefore C_2 = -2$$

Question 3 cont'd

when $t = 2$ $S =$ 20m to the left

$$-20 = \frac{4(2)^4}{12} - \frac{2(2)^2}{2} + c_1(2) - 2$$

$$-20 = \frac{16}{3} - 4 + 2c_1 - 2$$

$$2c_1 = -19.3333$$

$$c_1 = \frac{-19.3333}{2} = -9.67$$

$$\therefore \quad S = \frac{4t^4}{12} - t^2 + (-9.67t) - 2$$

$$S(t) = \frac{t^4}{3} - t^2 - 9.67t - 2 \longrightarrow \text{~~General~~ Particular solution}$$

$$S(4) = \frac{4^4}{3} - 4^2 - 9.67(4) - 2$$

$$S(4) = \frac{256}{3} - 16 - 38.68 - 2$$

$$S(4) = 28.653M \approx 28.7M$$

$S(4) = 28.7M \longrightarrow$ In the positive x direction

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Question 4

A particle travels along a straight line with a velocity of $V = (20 - 0.05s^2)$ m/s where s is in meters. Determine the acceleration of the particle at $S = 15$m

Solution

$$V = \frac{ds}{dt} \quad \text{and} \quad a = \frac{dv}{dt}$$

$$dt = \frac{ds}{V} \quad \text{and} \quad dt = \frac{dv}{a}$$

$V = 20 - 0.05S^2$; It is a function of displacement

$$\therefore \frac{ds}{v} = \frac{dv}{a}$$

$$a = \frac{v\,dv}{ds}$$

$$V(15) = 20 - 0.05(15)^2$$

$$V(15) = 8.75 \text{ m/s}$$

$$V = 20 - 0.05S^2$$

$$\frac{dv}{ds} = 0 - 0.1S$$

$$\therefore \left.\frac{dv}{ds}\right|_{s=15} = -0.1(15) = -1.5\,\frac{m}{s} \times \frac{1}{m} = -1.5\,S^{-1}$$

$$a = 8.75\,\frac{m}{s} \times -1.5\,\frac{1}{s}$$

$$a = -13.125 \text{ m/s}^2$$

The negative sign shows it is decelerating

$\therefore a = 13.125$ m/s²