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Computer Engineering
Course: Eng 234

i) A particle travels along 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 = 4 s. s = 0 when t = 0.

Solution

$$v = (4t - 3t^2) \text{ m/s}$$

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

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

$$\int ds = \int_0^4 (4t - 3t^2)\, dt$$

$$S = \left[\frac{4t^2}{2} - \frac{3t^3}{3}\right]_0^4$$

$$S = \left[2t^2 - t^3\right]_0^4$$

$$\therefore S = \left[2t^2 - 4^3\right]^4 - \left[2t^2 - t^3\right]^0$$

$$S = 2(4)^2 - (4)^3 - [0]$$

$$S = 32 - 64$$

$$S = -32\text{ m} \qquad \therefore S = 32\text{m left of the origin}$$

∴ This means that the position of the particle is to the left of the origin

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

$$v = (0.5t^3 - 8t) \text{ m/s}, \quad t = 2s, \quad a = ?$$

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

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

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

$\therefore$ at $t = 2s$

$$= 1.5(2)^2 - 8 = (1.5 \times 4) - 8$$

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

$\therefore$ this implies that the particle is ~~accelerating~~ decelerating

3) A particle moves along a straight line such that it's 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. Determine the position of the particle when $t = 4s$.

Solution

$$a = (4t^2 - 2)$$

$$a = \frac{dv}{dt} = (4t^2 2)$$

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

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

$$V = \left(\frac{4t^3}{3} - 2t + C_1\right) m/s$$

$$\therefore v = \frac{ds}{dt} = \left(\frac{4t^3}{3} - 2t + C_1\right) m/s$$

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

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

$$S = \left(\frac{4}{3} \times \frac{1}{4} - \frac{2t^2}{2} + C_1 t + C_2\right) m$$

$$S = \frac{1}{3}t^4 - t^2 + C_1 \cancel{t} + C_2$$

At $= t = 0, \quad S = -2m$

$$= S = \frac{1}{3}t^4 - t^2 + C_1 t + C_2$$

$$-2 = \frac{1}{3}(0)^4 - (0)^2 + C_1(0) + C_2$$

$$\therefore C_2 = -2$$

At $t = 2, \; S = -20m$

$$S = \frac{1}{3}t^4 - t^2 + C_1 t - 2$$

$$-20 = \frac{1}{3}(2)^4 - (2)^2 + C_1(2) - 2$$

$$-20 = \frac{16}{3} - 4 + 2C_1 - 2$$

$$-20 = -\frac{2}{3} + 2C_1$$

$$2C_1 = -19.33$$

$$C_1 = \frac{-19.33}{2} = -9.67$$

$\therefore C_1 = -9.67$

$C_2 = -2$

$\therefore S = \frac{1}{3}t^4 - t^2 + C_1 t + C_2$

$S = \frac{1}{3}t^4 - t^2 - 9.67t - 2$

At $t = 4s \therefore S = ?$

$S = \frac{1}{3}(4)^4 - (4)^2 - 9.67(4) = 2$

$S = \frac{256}{3} - 16 - 38.668 - 2$

$S = \frac{25}{3} - 56.666.8$

$S = 28.667m$

$\therefore$ This position of the particle is $28.67m$

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

Solution

$v = (20 - 0.05s^2)$

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

$= \frac{dv}{ds} \times v$

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

$\frac{dv}{s} = -0.15$

$\therefore a = (20 - 0.05s^2)(-0.15)$

At $S = 15m$

$a = (20 - 0.05(15)^2)(-0.1(15))$

$a = (20 - 11.25)(-1.5)$

$a = (8.75)(-1.5)$

$a = -13.125 m/s^2$

$a = -13.13 m/s^2$

$\therefore$ The acceleration of the particle at $S = 18m$ is due $-13.125 m/s^2$ which implies that the particle is decelerating