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18/ENG05/011
MECHATRONICS ENG
ENG 234 Assignment

① $v = (4t - 3t^2)\,m/s$ $\quad t=0,\ s=0,\ t=4$

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

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

Integrating both sides at $t=4$, $t=0$

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

$$s = 2t^2 - t^3 + c \Big|_0^4$$

$$s = \left[2[4]^2 - [4]^3 + c\right] - \left[4(0)^2 - 0^3 + c\right]$$

$$s = 32 - 64 - 0$$

$$s = -32\,m$$

The negative sign shows that the position of the particle is 32m left of the origin.

② $(v = 0.5t^3 - 8t)\,m/s$

$a = ?$ when $t = 2$

$$a = \frac{dv}{dt}, \quad \frac{dv}{dt} = (1.5t^2 - 8)\,m/s^2$$

$a = (1.5t^2 - 8)\,m/s^2$, but at $t = 2$ seconds

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

$\Rightarrow 6 - 8 \Rightarrow -2\,m/s^2$

This means that the particle is undergoing deceleration.

3) $a = (4t^2 - 2)\ m/s^2$

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

$\int dv = \int 4t^2 - 2\,dt$ [integrating both sides]

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

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

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

Integrating both sides

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

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

At $t = 0$ $s = -2$

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

$C_2 = -2m$

At $t = 2s$ $s = -20$

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

$-20 = -16/3 - 4 + 2C_1 - 2$

$-20 = -2/3 + 2C_1$

$2C_1 = -20 + 2/3$

$2C_1 = -19.33$

$C_1 = -19.33/2 = -9.67$

$C_1 = 9.67$, $C_2 = -2$

$\therefore \quad s = \frac{1}{3}t^4 - t^2 - 9.67t - 2$

At $t = 4s$

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

$s = \frac{256}{3} - 16 - 56.68$

$s = 28.67 m$

④ $v = (20 - 0.05s^2)\ m/s$

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

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

$\frac{dv}{ds} = -0.1s$

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

at $s = 15m$

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

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

$a = (8.75)(-1.5)$

$a = -13.125\ m/s^2$

The acceleration at $s = 15m$ is $-13.125\ m/s$

∴ The particle is decelerating