MIE100S – Winter 2017
Tutorial Problem 01a

A freighter is moving at 4 m/s. After the engines are shut off, it decelerates proportionally with the square of the velocity: i.e. $a=-kv^2$. If it takes 10 minutes to reduce its speed to 2 m/s find the distance travelled in those 10 minutes and its speed as a function of time during the interval.

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Tutorial Problem 01a-Solution

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a = dv/dt

therefore, $dv/v^2 = -kdt$ and $v = 1 / (kt + C)$

Since it takes 10 minutes to reduce speed to 2 m/s, and v(t=0) = 4m/s

C = ¼ , and k = 1 / (4*10*60) = 1 / (2400)

Therefore v = 1 / ((1/2400)* t + ¼)

To get distance travelled, must integrate again

V = ds/dt

Therefore, ds = 1 / ((1/2400)* t + ¼) dt

Or s = 2400 * ln ((1/2400)*t + 0.25) + C

Since s = 0 at t = 0, C = 3327

S(t=600s) = 1663 m

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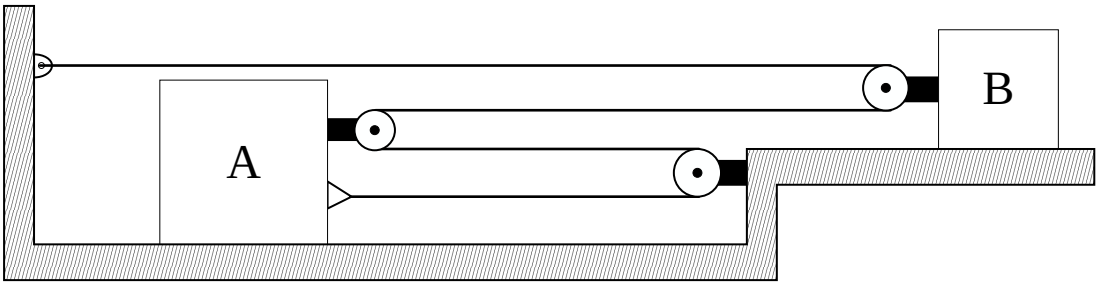
Tutorial Problem 01b

At the instant shown, slider block B is moving with a constant acceleration, and its speed is 180 mm/s. After slider block A is moved 240 mm to the right, its velocity is 60 mm/s.

a) Determine the accelerations of *A* and *B.*
b) Determine the velocity and the change in position of slider block B after 4 s.



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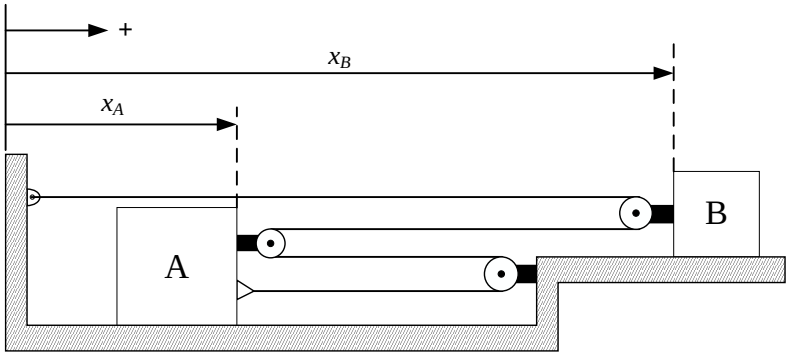
Tutorial Problem 01b-Solution



a)

From the diagram:

$$x_B + (x_B - x_A) - 2x_A = \text{constant}$$

$$2x_B - 3x_A = \text{Constant} \Rightarrow 2v_B - 3v_A = 0$$

$$2a_B - 3a_A = 0$$

If Block A moves to the right at $t = 0$:

$$2v_B - 3(v_A)_0 = 0 \Rightarrow 2(0.18) = 3(v_A)_0 \Rightarrow (v_A)_0 = 0.12 \text{ m/s}$$

$$a_B = \text{Constant} \Rightarrow a_A = \text{Constant}$$

$$v_A^2 = (v_A)_0^2 + 2a_A \underbrace{(x_A - (x_A)_0)}_{240 \text{ mm}}$$

$$0.06^2 = 0.12^2 + 2a_A(0.24) \Rightarrow a_A = -0.0225 \text{ m/s}^2$$

$$\boxed{a_A = 0.0225 \text{ m/s}^2 \leftarrow}$$

$$2a_B - 3a_A = 0 \Rightarrow a_B = \frac{3}{2} a_A = \boxed{0.03375 \text{ m/s}^2 \leftarrow}$$

b) $v_B = (v_B)_0 + a_B t \quad \text{at} \quad t = 4s$

$v_B = 0.18 + (-0.03375)(4) \Rightarrow \boxed{v_B = 0.045 \text{ m/s}}$

$x_B - (x_B)_0 = (v_B)_0 t + \frac{1}{2} a_B t^2$

$\Delta x_B = (0.18)(4) + (\frac{1}{2})(-0.03375)(4)^2$

$\boxed{\Delta x_B = 0.45 \text{ m}}$