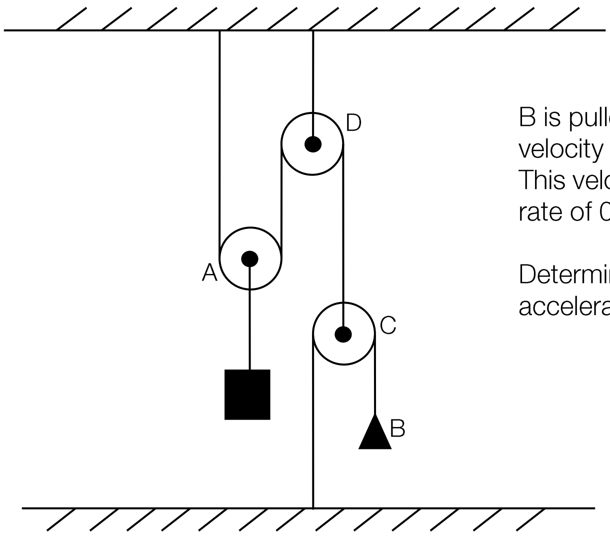
RMIT UNIVERSITY

WORKED SOLUTIONS

ENDY2.1 BLOCKS & PULLEYS

Question

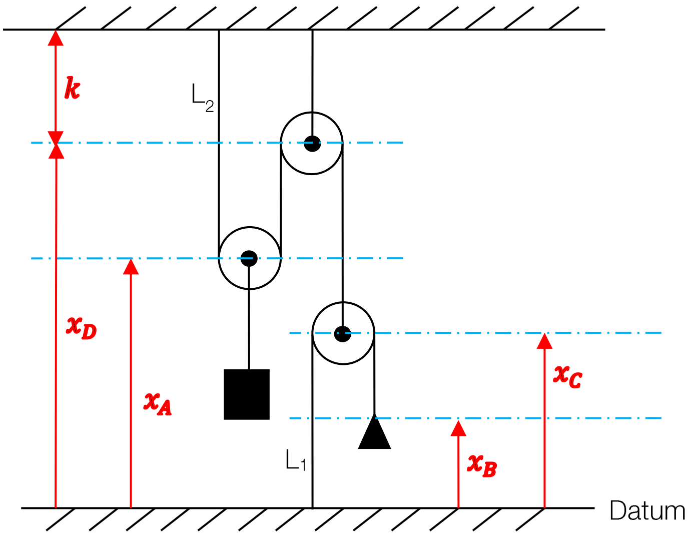


B is pulled downwards with a velocity of 1.2 ms^{-1}.
This velocity is decreasing at a rate of 0.6 ms^{-2}.

Determine the velocity and acceleration of A.

Worked Solution

Measure the position of all blocks from a common datum, and dimension on drawing.
These dimensions are position vectors and direction is important.
Let ↑ = +ve.



$$\dot{x}_B = -1.2\ ms^{-1}$$

$$\ddot{x}_B = 0.6\ ms^{-2}$$

Determine the length of the two ropes in terms of the position vectors.

Eq$^{\underline{n}}$ 1. $L_1 = 2x_C - x_B$

Eq$^{\underline{n}}$ 2. $L_2 = 2(x_D - x_A) + (x_D - x_C) + k = -2x_A - x_C + 3x_D + k$

From our diagram above we note that L_1, L_2, x_D and k are all constants.

Differentiate both sides of the equations above with respect to time.

Eq$^{\underline{n}}$ 1.
$$\frac{d}{dt}(L_1) = \frac{d}{dt}(2x_C - x_B)$$
$$0 = 2\dot{x_C} - \dot{x_B}$$
$$\dot{x_C} = \frac{\dot{x_B}}{2} = \frac{-1.2}{2} = -0.6\ ms^{-1}$$

Eq$^{\underline{n}}$ 2.
$$\frac{d}{dt}(L_2) = \frac{d}{dt}(-2x_A - x_C + 3x_D + k)$$
$$0 = -2\dot{x_A} - \dot{x_C} + 3(0)$$
$$\dot{x_A} = \frac{-\dot{x}_C}{2} = \frac{-(-0.6)}{2} = 0.3\ ms^{-1}$$

Differentiating again yields:
$$0 = 2\ddot{x_C} - \ddot{x_B}$$
$$\ddot{x_C} = \frac{\ddot{x_B}}{2} = \frac{0.6}{2} = 0.3\ ms^{-2}$$

$$0 = -2\ddot{x_A} - \ddot{x_C} + 3(0)$$
$$\ddot{x_A} = \frac{-\ddot{x}_C}{2} = \frac{-(0.3)}{2} = -0.15\ ms^{-2}$$

∴ velocity of A $= \dot{x_A} = 0.3\ ms^{-1}$

∴ acceleration of A $= \ddot{x_A} = -0.15\ ms^{-2}$