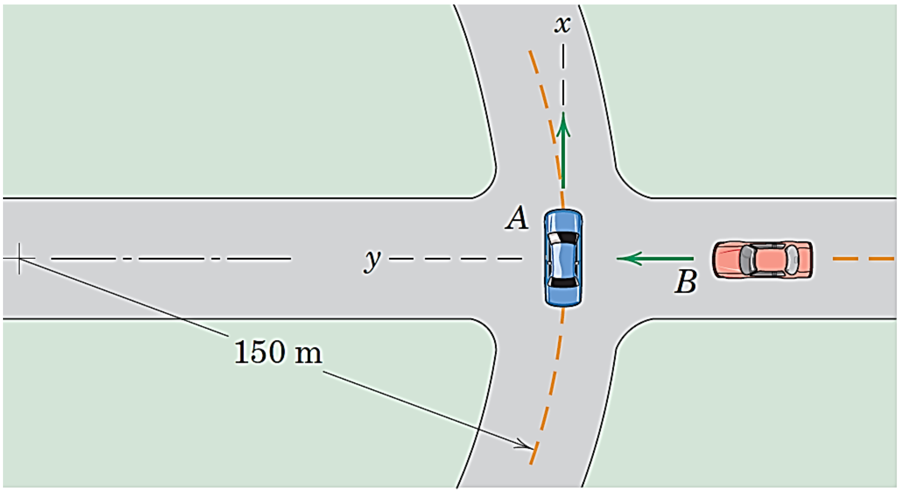
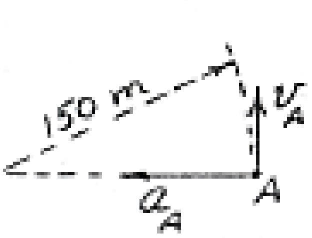
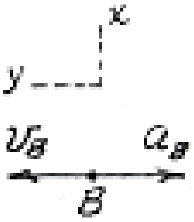
PROBLEM 2/183

Car A rounds a curve of 150-m radius at a constant speed of 54 km/h. At the instant represented, car B is moving at 81 km/h but is slowing down at the rate of 3 m/s^2. Determine the velocity and acceleration of car A as observed from car B.



2/183 $v_A = 54/3.6 = 15 \text{ m/s}$, $v_B = 81/3.6 = 22.5 \text{ m/s}$

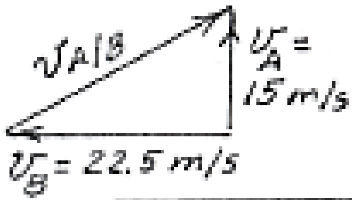




$$a_A = \frac{v_A^2}{\rho} = \frac{15^2}{150} = 1.5 \text{ m/s}^2$$

$$a_B = 3 \text{ m/s}^2$$

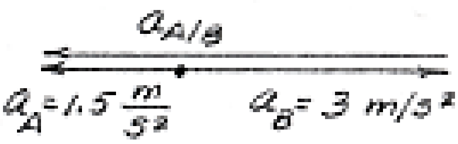
$\underline{v}_A = \underline{v}_B + \underline{v}_{A/B}$



$$v_{A/B} = \sqrt{(22.5)^2 + (15)^2} = 27.0 \text{ m/s}$$

$$\underline{v}_{A/B} = 15\underline{i} - 22.5\underline{j} \text{ m/s}$$

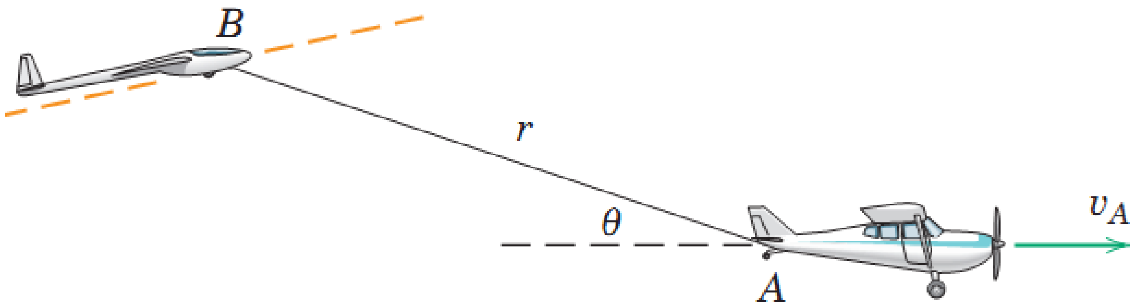
$\underline{a}_A = \underline{a}_B + \underline{a}_{A/B}$



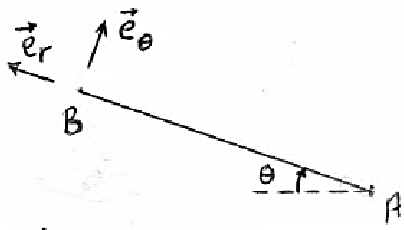
$$\underline{a}_{A/B} = 4.5\underline{j} \text{ m/s}^2$$

PROBLEM 2/196

Airplane A is flying horizontally with a constant speed of 200 km/h and is towing the glider B, which is gaining altitude. If the tow cable has a length $r = 60$ m and θ is increasing at the constant rate of 5 degrees per second, determine the magnitudes of the velocity $\mathbf{v}$ and acceleration $\mathbf{a}$ of the glider for the instant when $\theta = 15°$.

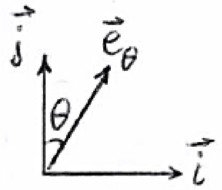


Solution:



$\vec{v}_B = \vec{v}_A + \vec{v}_{B/A}$, $\vec{v}_A = \frac{200}{3.6}\,\vec{\imath} = 55.6\,\vec{\imath}$ m/s

Since r is constant, we have $\dot{r} = 0$ and $\ddot{r} = 0$.



$\vec{v}_{B/A} = \dot{r}\vec{e}_r + r\dot{\theta}\vec{e}_\theta = r\dot{\theta}\vec{e}_\theta = 60\left(5\frac{\pi}{180}\right)\vec{e}_\theta = 5.24\vec{e}_\theta$ m/s

$\vec{e}_\theta = \sin 15^o\ \vec{\imath} + \cos 15^o\ \vec{\jmath} = 0.259\,\vec{\imath} + 0.966\,\vec{\jmath}$

$\vec{v}_{B/A} = 5.24\,(0.259\,\vec{\imath} + 0.966\,\vec{\jmath}) = 1.36\,\vec{\imath} + 5.06\,\vec{\jmath}$

$\vec{v}_B = 55.56\,\vec{\imath} + 1.36\,\vec{\imath} + 5.06\,\vec{\jmath} = 56.92\,\vec{\imath} + 5.06\,\vec{\jmath}$ m/s $\Rightarrow$ $v_B = 57.14$ m/s

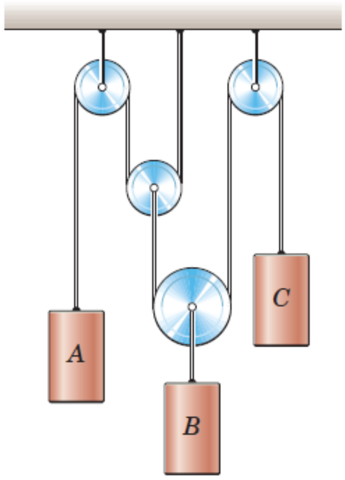
$\vec{a}_B = \vec{a}_A + \vec{a}_{B/A}$, $\vec{a}_A = 0$

$\vec{a}_{B/A} = (\ddot{r} - r\dot{\theta}^2)\vec{e}_r + (2\dot{r}\dot{\theta} + r\ddot{\theta})\vec{e}_\theta = -r\dot{\theta}^2\vec{e}_r = -60\left(5\frac{\pi}{180}\right)^2\vec{e}_r = 0.457\vec{e}_r$ m/s^2

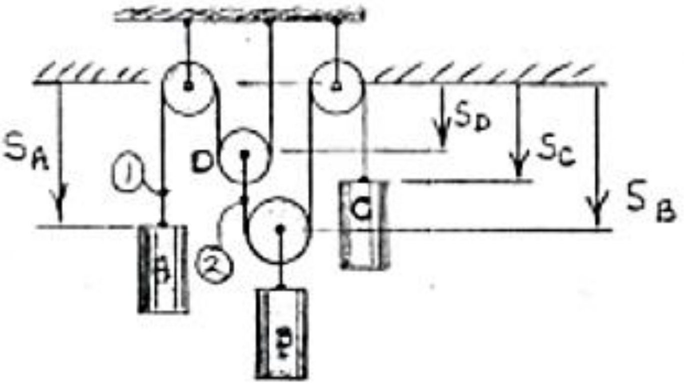
$\vec{a}_B = \vec{a}_{B/A} = 0.457\vec{e}_r$ m/s^2 $\Rightarrow$ $a_B = 0.457$ m/s^2

PROBLEM 2/215

Determine the relationship which governs the velocities of the three cylinders. Express all velocities as positive down. How many degrees of freedom are present?



2/215



The two cable lengths are

$$\begin{cases} L_1 = s_A + 2s_D + \text{constants} \\ L_2 = (s_B - s_D) + s_B + s_C + \text{constants} \\ = 2s_B + s_C - s_D + \text{constants} \end{cases}$$

Differentiate with respect to time:

$$\begin{cases} 0 = v_A + 2v_D & (1) \\ 0 = 2v_B + v_C - v_D & (2) \end{cases}$$

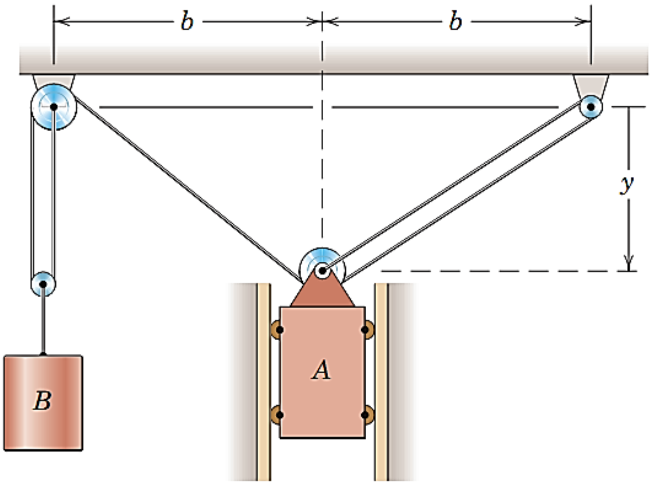
Eliminate v_D between (1) & (2)

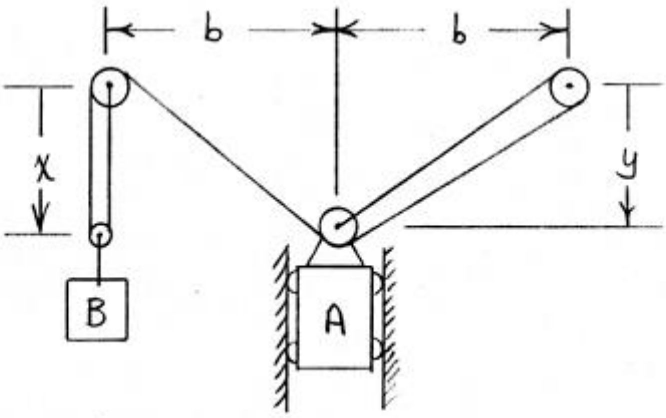
$$\underline{v_A + 4v_B + 2v_C = 0}$$

<u>Two degrees of freedom.</u>

PROBLEM 2/216

Neglect the diameters of the small pulleys and establish the relationship between the velocity of A and the velocity of B for a given value of y.





The total length of the cable is

$$L = 2x + 3\sqrt{y^2+b^2} + \text{constant}$$

Differentiate to obtain

$$\dot{L} = 0 = 2\dot{x} + 3\frac{y\dot{y}}{\sqrt{y^2+b^2}}$$

With $\dot{x} = v_B$ & $\dot{y} = v_A$, we have

$$v_B = -\frac{3y}{2\sqrt{y^2+b^2}}v_A$$