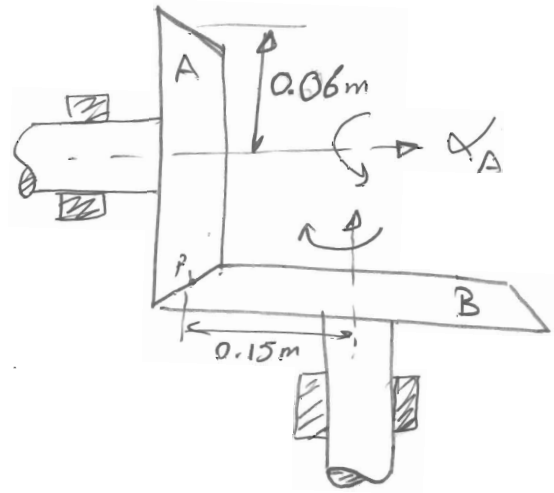
16-5

A starts from rest

$\Rightarrow (w_A)_0 = (w_B)_0 = 0$

$\alpha_A = 2$ rad/s (constant)

Determine $t$ when $w_B = 50$ rad/s




$$(a_P)_t^A = (a_P)_t^B$$

$$\alpha_A r_A = \alpha_B r_B$$

$$\Rightarrow \alpha_B = \alpha_A \frac{r_A}{r_B} = 2 \times \frac{0.06}{0.15} = 0.8 \text{ rad/s}$$

$$w_B = (w_B)_0 + \alpha_B t \Rightarrow t = \frac{w_B - (w_B)_0}{\alpha_B} = \frac{50-0}{0.8} = 62.5$$

16-18

Starting from rest $s = 0$;

$\alpha_A = (6\theta_A)$ rad/s$^2$ c.c.w

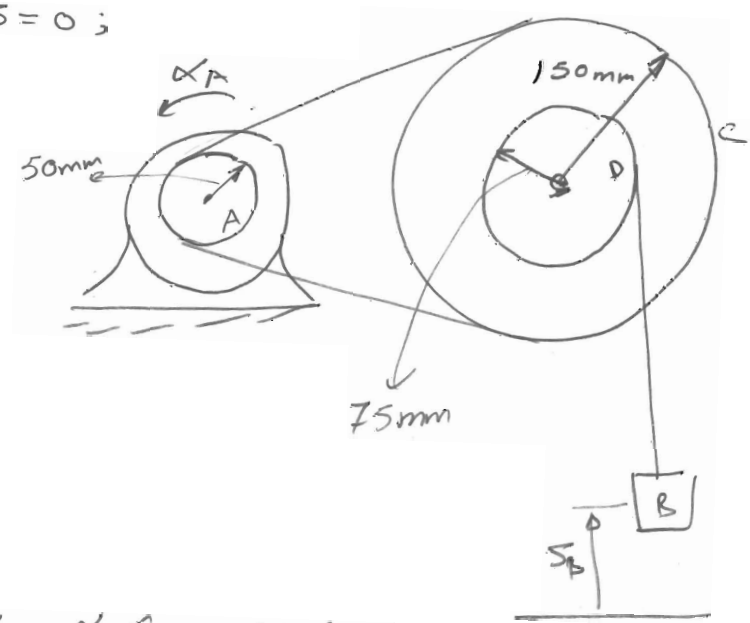
Determine $v_B$ when

$\Delta s_B = 6$m ↑

Starting from rest

$\Rightarrow (w_A)_0 = (w_C)_0 = (w_D)_0 = 0$

$(v_B)_0 = 0$




$$\alpha_A r_A = \alpha_C r_C \Rightarrow \alpha_C = \alpha_A \frac{r_A}{r_C} = 6\theta_A \left(\frac{r_A}{r_C}\right)$$

$$\theta_A r_A = \theta_C r_C \Rightarrow \theta_A = \theta_C \frac{r_C}{r_A}$$

$$\Rightarrow \alpha_C = 6\theta_C \left(\frac{r_C}{r_A}\right)\left(\frac{r_A}{r_C}\right)$$

$$\alpha_C = 6\theta_C$$

$$\alpha_D = \alpha_C \; ; \; \theta_D = \theta_C \Rightarrow \alpha_D = 6\theta_D$$

$a_B = \alpha_D r_D = 6\theta_D r_D$ ;

$s_B = r_D \theta_D$

$\Rightarrow a_B = 6 s_B$ .

$$v_B \, dv_B = a_B \, ds_B$$

$$\int_{(v_B)_0=0}^{v_B} v_B \, dv_B = \int_0^{s_B} 6 s_B \, ds_B$$

$$\frac{v_B^2}{2} = 3 s_B^2 \Longrightarrow v_B = \sqrt{6}\, s_B = \sqrt{6}\,(6) = 14.70 \text{ m/s}$$

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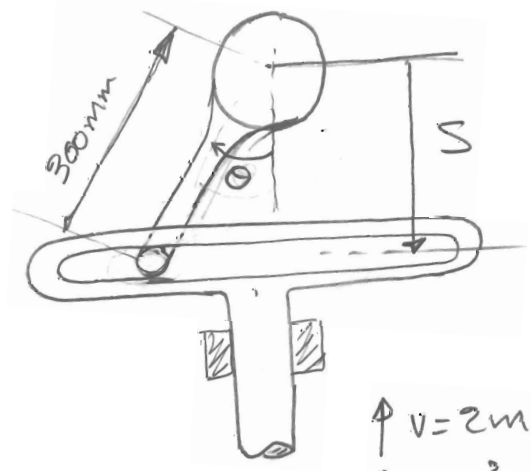
16-39

at $\theta = 50^\circ \Rightarrow$ $v = 2$ m/s ↑
$a = 3$ m/s² ↑

Determine $\omega$ & $\alpha$ ?




↑ v = 2 m/s
↑ a = 3 m/s²

From the figure

$s = 0.3 \cos\theta$

$\frac{ds}{dt} = -0.3 \sin\theta \, \dot{\theta}$

$-2 = -0.3 \sin\theta \, \dot{\theta}$ (v in the opposite direction of the increase of s)

$\omega = \dot{\theta} = \frac{2}{0.3 \sin\theta}$ at $\theta = 50^\circ \Rightarrow \omega = \frac{2}{0.3 \sin(50)} = 8.703$ rad/s

C.W

$\frac{d^2 s}{dt^2} = -3 = -0.3 \cos\theta \, \dot{\theta}^2 - 0.3 \sin\theta \, \ddot{\theta}$

$\Rightarrow \alpha = \ddot{\theta} = \frac{3 - 0.3 \cos\theta \, \dot{\theta}^2}{0.3 \sin\theta}$

at $\theta = 50^\circ \Rightarrow \alpha = \frac{3 - 0.3 \cos(50)(8.703)^2}{0.3 \sin(50)} = -50.5$ rad/s²

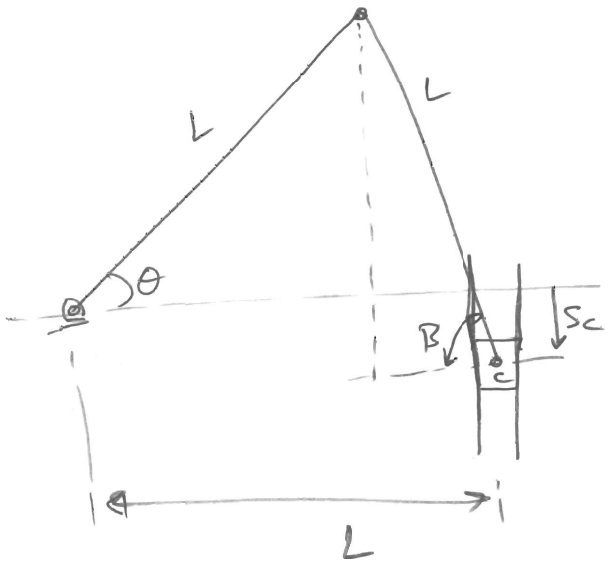
C.W

$= 50.5$ rad/s² C.C.W

16-45

$w$ = constant

Determine $V_c$ & $a_c$ when $\theta = 60^\circ$




$L\cos\theta + L\cos\beta = L$

$\cos\theta + \cos\beta = 1$ ---①

$s_c = L\sin\beta - L\sin\theta$

$s_c = L(\sin\beta - \sin\theta)$ --②

Derive ① & ② with respect to time

$\Rightarrow -\sin\beta\,\dot{\beta} - \sin\theta\,\dot{\theta} = 0$

$\Rightarrow \dot{\beta} = \frac{-\sin\theta}{\sin\beta}\dot{\theta} = \frac{-\sin\theta}{\sin\beta}\,w$

$V_c = L(\cos\beta\,\dot{\beta} - \cos\theta\,\dot{\theta})$

at $\theta = 60^\circ$

$\Rightarrow$ from① $\Rightarrow \beta = \cos^{-1}(1-\cos(60)) = 60^\circ$ $\quad \therefore \beta = \theta$

$\Rightarrow \dot{\beta} = -w$

$\Rightarrow V_c = L(\cos 60(-w) - \cos 60\, w) = -wL \downarrow = \underline{wL\uparrow}$

Derive another time

$\cos\beta\,\ddot{\beta}^2 + \sin\beta\,\ddot{\beta} + \cos\theta\,\dot{\theta}^2 + \sin\theta\,\ddot{\theta} = 0$ ---③

$a_c = L(-\sin\beta\,\dot{\beta}^2 + \cos\beta\,\ddot{\beta} + \sin\theta\,\dot{\theta}^2 - \cos\theta\,\ddot{\theta})$ --④

at $\theta = 60^\circ$ ; $\beta = 60^\circ$

$\Rightarrow$ From (3) $\ddot{\beta} = \frac{-w^2}{\sin(60)}$

From (4) $a_c = L\left(\cos(60)\left(\frac{-w^2}{\sin(60)}\right)\right)$

$$a_c = -\frac{Lw^2}{\tan 60} = -0.5774\,Lw^2 \downarrow$$

$$= 0.5774\,Lw^2 \uparrow$$

16-51

$\omega_w = 8$ rad/s

Determine $\vec{V}_A$ when $\begin{cases} \theta = 30^\circ \\ \phi = 60^\circ \end{cases}$

Location of AB when $\theta = [0, 30, 60]$

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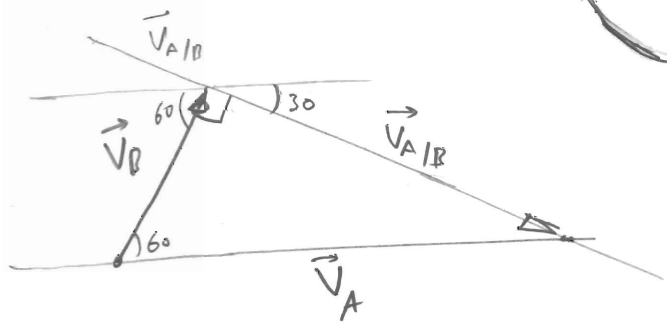
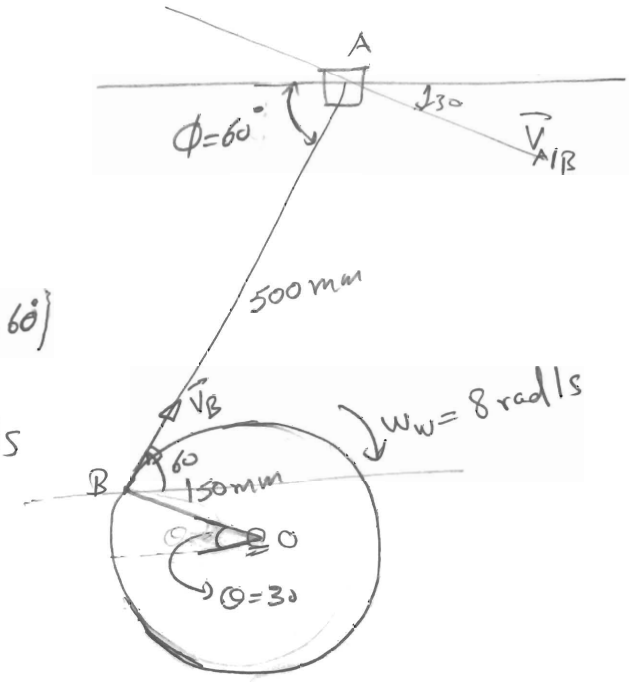
$V_B = \omega_w r_{OB} = 8(0.15) = 1.2$ m/s

$\vec{V}_A = \vec{V}_B + \vec{V}_{A/B}$




$\Rightarrow \dfrac{V_A}{\sin 90} = \dfrac{V_B}{\sin 30} \Rightarrow V_A = \dfrac{V_B}{\sin 30} = \dfrac{1.2}{\sin 30} = 2.4$ m/s $\longrightarrow$