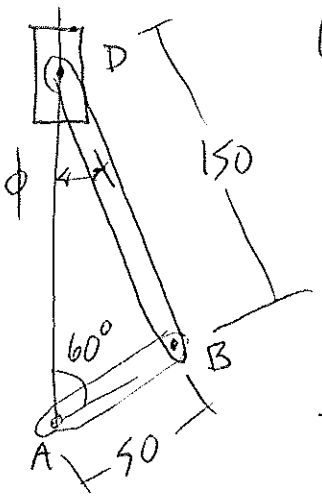
PROB. 15-125



$$\omega_{AB} = \left(900 \frac{REV}{MIN}\right)\left(\frac{MIN}{60\,S}\right)\left(\frac{2\pi}{REV}\right) = 94.25 \frac{RAD}{S} \circlearrowright$$

$\alpha_{AB} = 0$ FIND $\vec{a}_D$

VELOCITY

$$\vec{v}_B = \vec{v}_A^{\,0} + \omega_{AB}\hat{k} \times \vec{r}_{B/A}$$

$$\vec{r}_{B/A} = (50 \cdot \sin 60^\circ)\hat{i} + (50 \cdot \cos 60^\circ)\hat{j}$$

$$\vec{r}_{B/A} = (43.30)\hat{i} + (25.0)\hat{j}\ mm = (0.0433)\hat{i} + (0.025)\hat{j}\ m$$

$$\vec{v}_B = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & -94.25 \\ 0.0433 & 0.025 & 0 \end{vmatrix}$$

$$= [0 - (-94.25)(0.025)]\hat{i} - [0 - (-94.25)(0.0433)]\hat{j}$$

$$\vec{v}_B = (2.356)\hat{i} + (-4.081)\hat{j}\ \frac{m}{s}$$

$$\vec{v}_D = \vec{v}_B + \omega_{BD}\hat{k} \times \vec{r}_{D/B}$$

$$\phi = \sin^{-1}\left(\frac{43.3}{150}\right) = 16.78^\circ$$

$$\cos 16.78^\circ = \frac{y}{150}, \quad y = 150 \cdot \cos 16.78^\circ = 143.6\ mm = 0.1436\ m$$

$$\vec{r}_{D/B} = (-0.0433)\hat{i} + (0.1436)\hat{j}\ m$$

$$\omega_{BD}\hat{k} \times \vec{r}_{D/B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \omega_{BD} \\ -0.0433 & 0.1436 & 0 \end{vmatrix}$$

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$$\omega_{BD}\hat{k} \times \vec{r}_{D/B} = [0-(\omega_{BD})(0.1436)]\hat{i} - [0-(\omega_{BD})(-0.0433)]\hat{j}$$

$$= (-0.1436\,\omega_{BD})\hat{i} + (-0.0433\,\omega_{BD})\hat{j}$$

$$\vec{v}_D = (2.356)\hat{i} + (-4.081)\hat{j} + (-0.1436\,\omega_{BD})\hat{i}$$

$$+ (-0.0433\,\omega_{BD})\hat{j}$$

$$\vec{v}_D = (2.356 - 0.1436\,\omega_{BD})\hat{i} + (-4.081 - 0.0433\,\omega_{BD})\hat{j}$$

$$v_{Dx} = 0 = 2.356 - 0.1436\,\omega_{BD} \Rightarrow \omega_{BD} = 16.41 \ \frac{RAD}{s}\ \circlearrowright$$

ACCELERATION

$$\vec{a}_B = \cancel{\vec{a}_A}^{\,0} + \cancel{\alpha_{AB}\hat{k} \times \vec{r}_{B/A}}^{\,0} - \omega_{AB}^2\,\vec{r}_{B/A}$$

$$\vec{a}_B = -(-94.25)^2[(0.0433)\hat{i} + (0.025)\hat{j}]$$

$$\vec{a}_B = (-384.6)\hat{i} + (-222.1)\hat{j} \ \frac{m}{s^2}$$

$$\vec{a}_D = \vec{a}_B + \alpha_{BD}\hat{k} \times \vec{r}_{D/B} - \omega_{BD}^2\,\vec{r}_{D/B}$$

$$\alpha_{BD}\hat{k} \times \vec{r}_{D/B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \alpha_{BD} \\ -0.0433 & 0.1436 & 0 \end{vmatrix}$$

$$= [0-(\alpha_{BD})(0.1436)]\hat{i} - [0-(\alpha_{BD})(-0.0433)]\hat{j}$$

$$= (-0.1436\,\alpha_{BD})\hat{i} + (-0.0433\,\alpha_{BD})\hat{j} \ \frac{m}{s^2}$$

PROB. 15-125 CONT.

$$-\omega_{BD}^2 \vec{r}_{D/B} = -(16.41)^2\left[(-0.0433)\hat{i} + (0.1436)\hat{j}\right]$$

$$= (11.66)\hat{i} + (-38.67)\hat{j} \quad \frac{m}{s^2}$$

$$\vec{a}_D = (-384.6)\hat{i} + (-222.1)\hat{j} + (-0.1436\alpha_{BD})\hat{i}$$

$$+ (-0.0433\alpha_{BD})\hat{j} + (11.66)\hat{i} + (-38.67)\hat{j}$$

$$a_{Dx} = 0 = -384.6 - 0.1436\alpha_{BD} + 11.66$$

$$\alpha_{BD} = -2597 \frac{m}{s^2} \circlearrowleft$$

$$a_{Dy} = -222.1 - 0.0433(-2597) - 38.67 = -148.3 \frac{m}{s^2}$$

$$\boxed{\vec{a}_D = (-148.3)\hat{j} \frac{m}{s^2}}$$