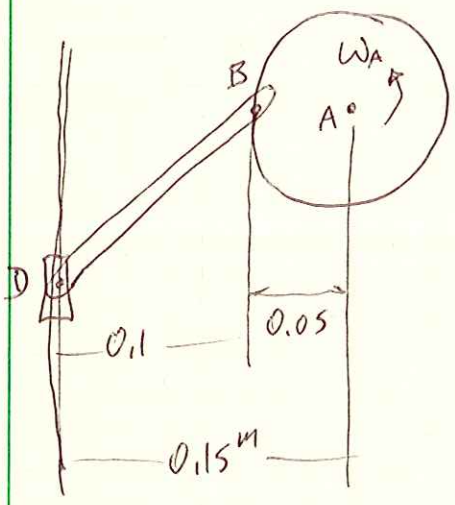
PROB. 16-126

$L = 0.25^m$, $m = 5^{kg}$, $\omega_A = 52.36 \frac{RAD}{s}$

FIND $\vec{D}$ WHEN $\theta = 90°$



KINEMATICS

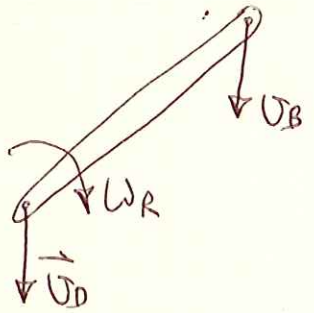
$$\vec{v}_B = \omega_A \hat{k} \times \vec{r}_{AB}$$

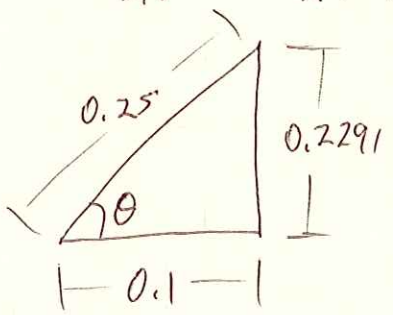
$$\vec{v}_B = -(52.36 \tfrac{RAD}{s})(0.05^m)\hat{i} = (-2.618)\hat{i} \tfrac{m}{s}$$

$$\vec{v}_D = (-v_D)\hat{i}$$

$$\vec{v}_B = \vec{v}_D + \vec{v}_{B/D}$$

$$\vec{v}_{B/D} = \omega_R \hat{k} \times \vec{r}_{DB}$$





$$\theta = \cos^{-1}\left(\frac{0.1}{0.25}\right)$$

$$\theta = 66.42°$$

$$\vec{r}_{DB} = (0.25^m)[(\cos 66.42°)\hat{i} + (\sin 66.42°)\hat{j}]$$

$$\vec{r}_{DB} = (0.1)\hat{i} + (0.2291)\hat{j}^m$$

$$\vec{v}_{B/D} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \omega_R \\ 0.1 & 0.2291 & 0 \end{vmatrix}$$

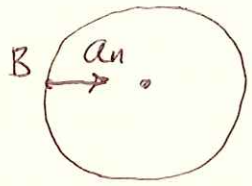
$$= (0 - 0.2291\omega_R)\hat{i} - (0 - 0.1\omega_R)\hat{j}$$

$$= (-0.2291\omega_R)\hat{i} + (0.1\omega_R)\hat{j} \tfrac{m}{s}$$

PROB. 16-126 CONT.

$$(-2.618)\hat{j} = (-v_D)\hat{j} + (-0.2291\omega_R)\hat{i} + (0.1\omega_R)\hat{j}$$

X-DIRECTION: $\boxed{\omega_R = 0}$

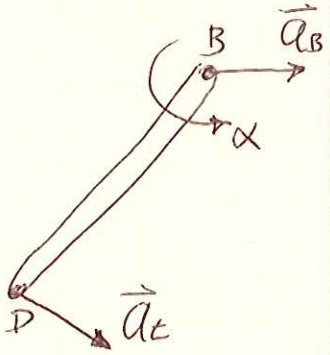


$$\vec{a}_B = \alpha_A \hat{k} \times \vec{r}_{AB} - \omega_A^2 \vec{r}_{AB} = (\omega_A^2 r_{AB})\hat{i}$$

$$\vec{a}_B = [(52.36\ \tfrac{RAD}{s})^2 (0.05\ m)]\hat{i} = (137.1)\hat{i}\ \tfrac{m}{s^2}$$

$$\vec{a}_D = (a_D)\hat{j}$$

$$\vec{a}_D = \vec{a}_B + \vec{a}_{D/B} = \vec{a}_B + \vec{a}_t + \vec{a}_n \quad (\vec{a}_n = 0 \text{ SINCE } \omega_R = 0)$$



$$\vec{a}_t = \alpha \hat{k} \times \vec{r}_{BD}$$

$$\vec{r}_{BD} = -\vec{r}_{DB} = (-0.1)\hat{i} + (-0.2291)\hat{j}\ m$$

$$\vec{a}_t = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \alpha \\ -0.1 & -0.2291 & 0 \end{vmatrix}$$

$$= [0 - (-0.2291)\alpha]\hat{i} - [0 - (-0.1)\alpha]\hat{j}$$

$$\vec{a}_t = (0.2291\alpha)\hat{i} + (-0.1\alpha)\hat{j}\ \tfrac{m}{s^2}$$

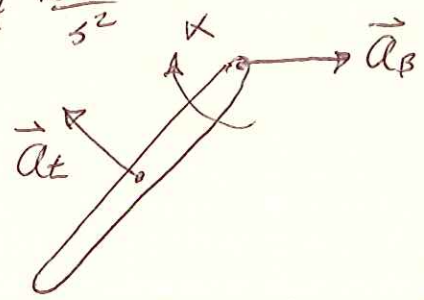
$$(a_D)\hat{j} = (137.1)\hat{i} + (0.2291\alpha)\hat{i} + (-0.1\alpha)\hat{j}$$

X-DIRECTION:

$$0 = 137.1 + 0.2291\alpha \Rightarrow \alpha = -598.4\ \tfrac{RAD}{s^2}$$

ACCELERATION OF POINT G:

$$\vec{a}_G = \vec{a}_B + \vec{a}_{G/B}$$



PROB. 16-126 CONT

$$\vec{a}_{G/B} = \vec{a}_t + \vec{a}_n = \alpha \hat{k} \times \vec{r}_{BG} - \omega_R^2 \vec{r}_{BG}$$

$$\vec{r}_{BG} = \frac{1}{2}\vec{r}_{BD} = (-0.05)\hat{i} + (-0.1145)\hat{j}\ m$$

$$\vec{a}_{G/B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & -598.4 \\ -0.05 & -0.1145 & 0 \end{vmatrix}$$

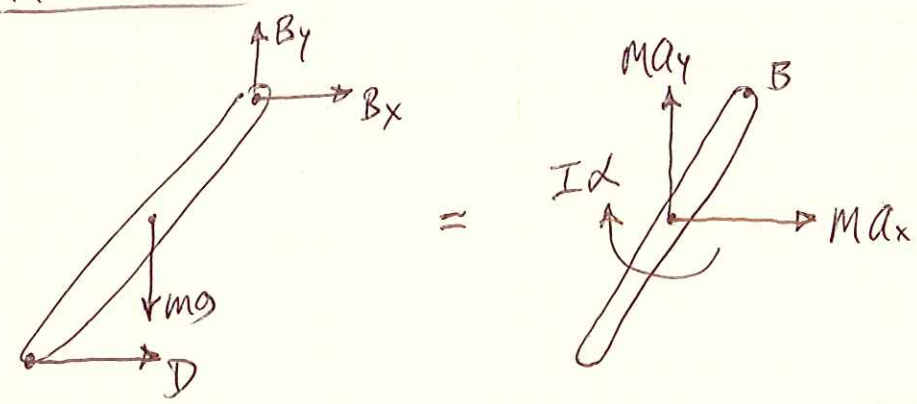
$$\vec{a}_{G/B} = [0 - (-598.4)(-0.1145)]\hat{i} - [0 - (-598.4)(-0.05)]\hat{j}$$

$$\vec{a}_{G/B} = (-68.55)\hat{i} + (29.92)\hat{j}\ \frac{m}{s^2}$$

$$\vec{a}_G = (137.1)\hat{i} + (-68.55)\hat{i} + (29.92)\hat{j}$$

$$\vec{a}_G = (68.55)\hat{i} + (29.92)\hat{j}\ \frac{m}{s^2}$$

KINETICS



$$\Sigma M_B = \Sigma (M_B)_{EFF} \quad +\circlearrowleft: \quad (0.2291^m)D + (0.05^m)(5^{kg})\left(9.81\frac{m}{s^2}\right)$$

$$= (0.1145^m)(5^{kg})\left(68.55\frac{m}{s^2}\right) - (0.05^m)(5^{kg})\left(29.92\frac{m}{s^2}\right)$$

$$-\frac{1}{12}(5^{kg})(0.25^m)^2\left(598.4\frac{RAD}{s^2}\right)$$

$$\boxed{D = 59.92^N}$$