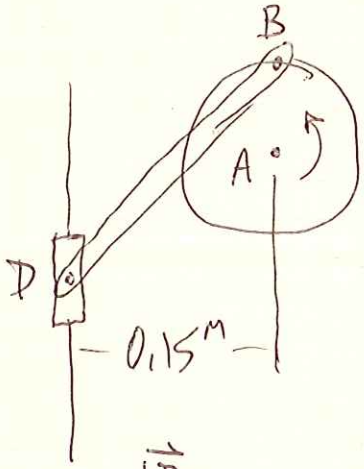
PROB. 16-125

$r_B = 0.05^m$, $L_R = 0.25^m$, $m_V = 5^{kg}$, $\omega_A = 52.36 \frac{RAD}{s}$ ↺

FIND $\vec{v}$ WHEN $\theta = 0$



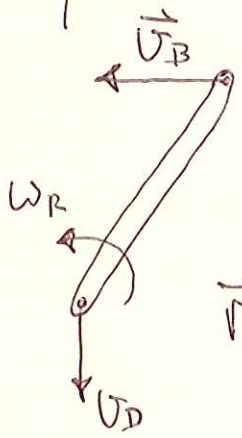

KINEMATICS

$\vec{v}_B = \omega_A \hat{k} \times \vec{r}_{AB} = -\left(52.36 \frac{RAD}{s}\right)(0.05^m)\hat{i}$

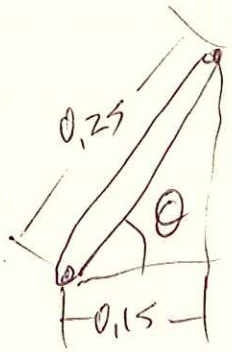
$\vec{v}_B = (-2.618)\hat{i} \frac{m}{s}$

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

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




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




$\theta = \cos^{-1}\left(\frac{0.15}{0.25}\right) = 53.13°$

$\vec{r}_{DB} = (0.25^m)\left[(\cos 53.13°)\hat{i} + (\sin 53.13°)\hat{j}\right]$

$\vec{r}_{DB} = (0.15)\hat{i} + (0.2)\hat{j}^m$

$$\vec{v}_{B/D} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \omega_R \\ 0.15 & 0.2 & 0 \end{vmatrix}$$

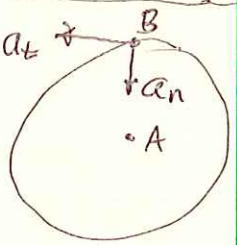
$\vec{v}_{B/D} = (0 - 0.2\omega_R)\hat{i} - (0 - 0.15\omega_R)\hat{j} = (-0.2\omega_R)\hat{i} + (0.15\omega_R)\hat{j} \frac{m}{s}$

$(-2.618)\hat{i} = (-v_D)\hat{j} + (-0.2\omega_R)\hat{i} + (0.15\omega_R)\hat{j}$

PROB. 16-125 CONT.

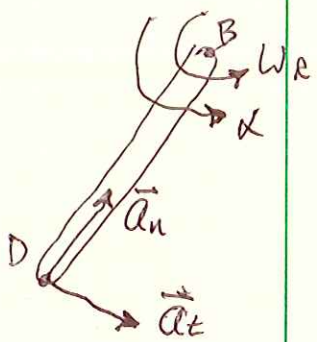
X-DIRECTION: $-2.618 = -0.2\,\omega_R \Rightarrow \boxed{\omega_R = 13.09\ \frac{RAD}{s}}$ ↻

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




$\vec{a}_B = \left[-\left(52.36\ \frac{RAD}{s}\right)^2 (0.05^m)\right]\hat{j} = (-137.1)\hat{j}\ \frac{m}{s^2}$

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




$\vec{a}_D = \vec{a}_B + \vec{a}_{D/B} = \vec{a}_B + \vec{a}_t + \vec{a}_n$

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

$\vec{r}_{BD} = -\vec{r}_{DB} = (-0.15)\hat{i} + (-0.2)\hat{j}^m$

$$\vec{a}_t = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \alpha \\ -0.15 & 0.2 & 0 \end{vmatrix}$$

$\vec{a}_t = [0-(-0.2)\alpha]\hat{i} - [0-(-0.15)\alpha]\hat{j} = (0.2\alpha)\hat{i} + (-0.15\alpha)\hat{j}\ \frac{m}{s^2}$

$\vec{a}_n = -\omega_R^2 \vec{r}_{BD} = -\left(13.09\ \frac{RAD}{s}\right)^2 \left[(-0.15)\hat{i} + (-0.2)\hat{j}\right]^m$

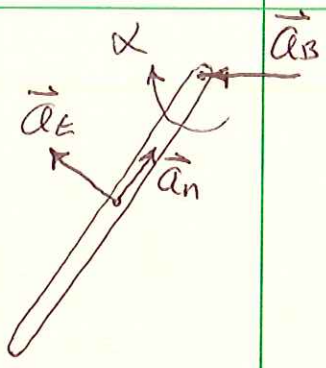
$\vec{a}_n = (25.70)\hat{i} + (34.27)\hat{j}\ \frac{m}{s^2}$

$(a_D)\hat{j} = (-137.1)\hat{j} + (0.2\alpha)\hat{i} + (-0.15\alpha)\hat{j}$

$+ (25.7)\hat{i} + (34.27)\hat{j}$

X-DIRECTION: $0 = 0.2\alpha + 25.7 \Rightarrow \boxed{\alpha = -128.5\ \frac{RAD}{s^2}}$ ↻

PROB. 16-125 CONT.




FIND ACCELERATION OF POINT G:

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

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

$$\vec{r}_{BG} = (0.125^m)\left[(-\cos 53.13^\circ)\hat{i} + (-\sin 53.13^\circ)\hat{j}\right]$$

$$\vec{r}_{BG} = (-0.075)\hat{i} + (-0.1)\hat{j}\ ^m$$

$$\vec{a}_t = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & -128.5 \\ -0.075 & -0.1 & 0 \end{vmatrix}$$

$$\vec{a}_t = [0-(-128.5)(-0.1)]\hat{i} - [0-(-128.5)(-0.075)]\hat{j}$$

$$\vec{a}_t = (-12.85)\hat{i} + (9.637)\hat{j}\ \frac{m}{s^2}$$

$$\vec{a}_n = -\omega_R^2 \vec{r}_{BG} = -\left(13.09\ \frac{RAD}{s}\right)^2\left[(-0.075)\hat{i} + (-0.1)\hat{j}\right]^m$$

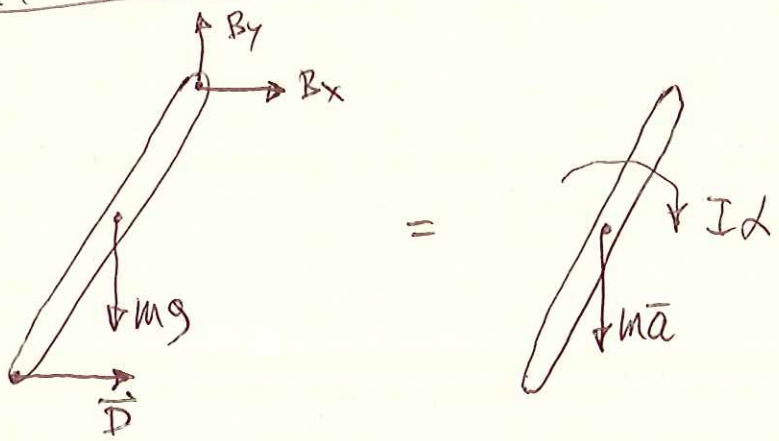
$$\vec{a}_n = (12.85)\hat{i} + (17.13)\hat{j}\ \frac{m}{s^2}$$

$$\vec{a}_G = (-137.1)\hat{j} + (-12.85)\hat{i} + (9.637)\hat{j}$$
$$+ (12.85)\hat{i} + (17.13)\hat{j}$$

$$\boxed{\vec{a}_G = (-110.3)\hat{j}\ \frac{m}{s^2}}$$

PROB. 16-125 CONT.

KINETICS




$\Sigma M_B = \Sigma (M_B)_{EFF}$ $+\circlearrowleft$:

$$(0.075^m)(5^{kg})(9.81\ \tfrac{m}{s^2}) + (0.25^m)(\sin 53.13^\circ)D = -I\alpha + (0.075^m)(5^{kg})(110.3\ \tfrac{m}{s^2})$$

$$3.679 + 0.2D = -\tfrac{1}{12}(5^{kg})(0.25^m)^2(128.5\ \tfrac{RAD}{s^2}) + 41.36$$

$$\boxed{D = 171.7^N \rightarrow}$$