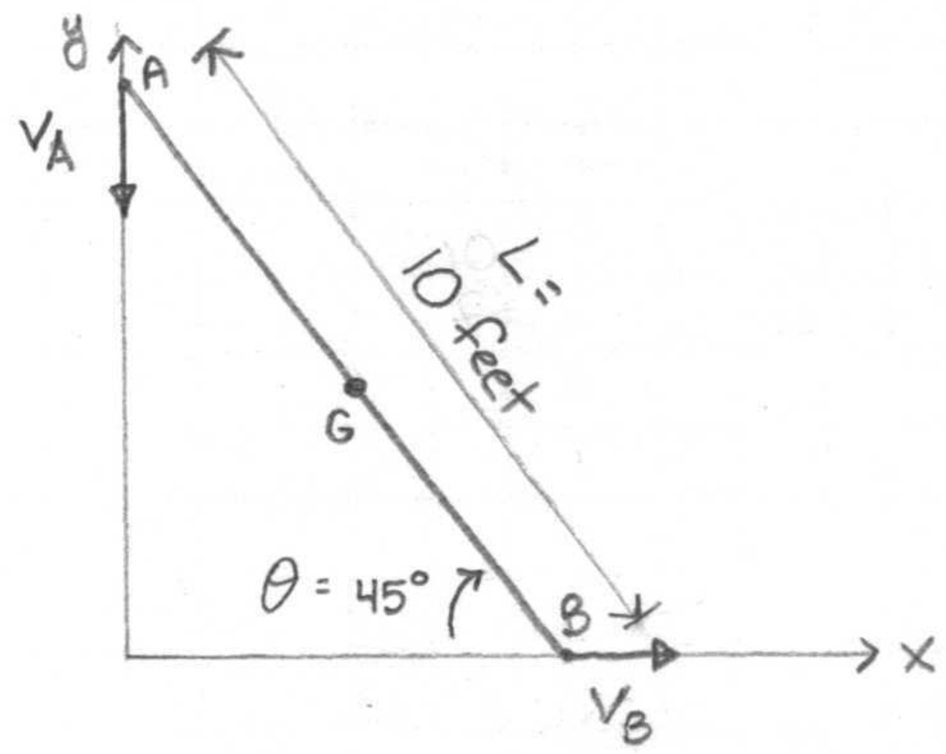
14.2



Given $v_y = 1$ ft/s

We know $\vec{V}_G = \vec{V}_A + \vec{\omega} \times \vec{r}_{G/A}$

$$\vec{V}_A = -1 \text{ ft/s}\, \hat{j}$$
$$\vec{\omega} = \omega \hat{k}$$
$$\vec{r}_{G/A} = \frac{L}{2}\left(\sin\theta\, \hat{i} - \cos\theta\, \hat{j}\right)$$

To find $\vec{\omega}$, we know $\vec{V}_B = \vec{V}_A + \omega\hat{k} \times \vec{r}_{B/A}$,
where $\vec{r}_{B/A} = L(\sin\theta\, \hat{i} - \cos\theta\, \hat{j})$, $\vec{V}_B = V_B\, \hat{i}$

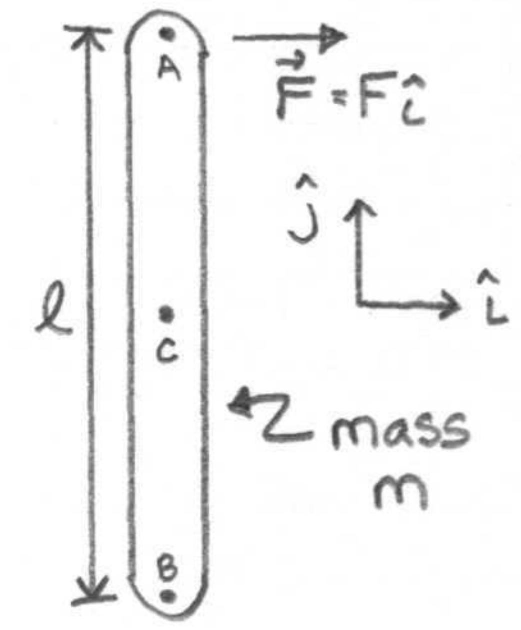
$$\therefore \quad V_B \hat{i} = -1 \text{ ft/s}\, \hat{j} + \omega L\left(\hat{k} \times \sin\theta\, \hat{i} + \hat{k} \times -\cos\theta\, \hat{j}\right)$$
$$V_B \hat{i} = -1 \text{ ft/s}\, \hat{j} + \omega L\left(\sin\theta\, \hat{j} + \cos\theta\, \hat{i}\right)$$
$$\{\} \cdot \hat{j} \longrightarrow 0 = -1 \text{ ft/s} + \omega L \sin\theta \quad \therefore \quad \omega = \frac{1}{L\sin\theta}$$

$$\vec{V}_G = -1 \text{ ft/s}\, \hat{j} + \frac{1}{L\sin\theta}\hat{k} \times \frac{L}{2}\left(\sin\theta\, \hat{i} - \cos\theta\, \hat{j}\right)$$
$$= -1 \text{ ft/s}\, \hat{j} + \frac{1}{2\sin\theta}\left[\sin\theta\, \hat{j} + \cos\theta\, \hat{i}\right]$$
$$= -1 \text{ ft/s}\, \hat{j} + \frac{1}{2}\hat{j} + \frac{1}{2}\cot\theta\, \hat{i} \quad @ \ \theta = 45°$$

$$\therefore \quad \boxed{\vec{V}_G = 0.5 \text{ ft/s}\, \hat{i} - 0.5 \text{ ft/s}\, \hat{j}}$$

$$\therefore \quad \text{Speed} = \|\vec{V}_G\| = \sqrt{0.5^2 + 0.5^2} = \boxed{0.707 \text{ ft/s}}$$

14.11



a) $\Sigma \vec F = m\vec a_c$ OR $F\hat\imath = m\vec a_c = m a_c\hat\imath$

$\{\}\cdot\hat\imath \to F = m a_c$

$\therefore \boxed{a_c = F/m}$

b) $\Sigma \vec M_c = \dot{\vec H}_c = I^c_{zz}\,\dot{\vec\omega}_c = \frac{1}{12}m\ell^2\dot\omega\hat k$

$\Rightarrow \ell/2\,\hat\jmath \times F\hat\imath = \frac{1}{12}m\ell^2\dot\omega\hat k$

$\dot\omega = \alpha$

$-\frac{F\ell}{2}\hat k = \frac{1}{12}m\ell^2\dot\omega\hat k$, $\{\}\cdot\hat k \to \frac{-F}{2} = \frac{1}{12}m\ell\dot\omega$

$\therefore \boxed{\alpha = -6F/m\ell}$

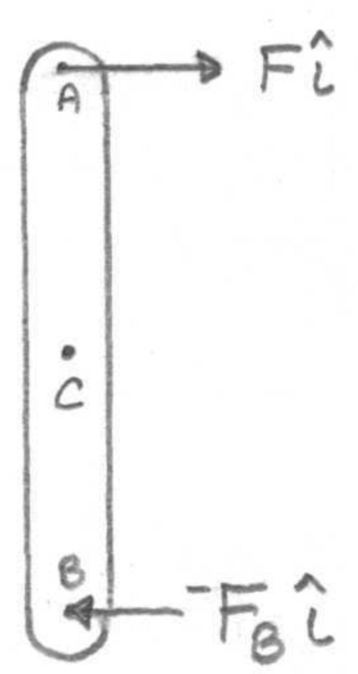
c) $\vec a_A = \vec a_c + \vec a_{A/c} = \vec a_c + \dot{\vec\omega}\times\vec r_{A/c} - \omega^2\vec r_{A/c}$, where $\omega = 0$ initially

$\therefore \vec a_A = \vec a_c + \dot{\vec\omega}\times\vec r_{A/c}$

$= \frac{F}{m}\hat\imath - \frac{6F}{m\ell}\hat k \times \left(\frac{\ell}{2}\hat\jmath\right) = \frac{F}{m}\hat\imath + \frac{3F}{m}\hat\imath$

$\{\}\cdot\hat\imath \longrightarrow \boxed{a_A = 4F/m}$

d)



$\Sigma\vec F = F\hat\imath - F_B\hat\imath = m\vec a_c \quad \therefore \vec a_c = \frac{F-F_B}{m}\hat\imath$

$(\Sigma\vec M_c = \dot{\vec H}_c = \frac{1}{12}m\ell^2\dot\omega\hat k)\cdot\hat k$

$\Rightarrow -\frac{\ell}{2}(F+F_B) = \frac{1}{12}m\ell^2\dot\omega \quad \therefore \dot\omega = \frac{-6}{m\ell}(F+F_B)$

$\vec a_B = \vec a_c + \vec a_{B/c} = \vec a_c + \dot{\vec\omega}\times\vec r_{B/c}$

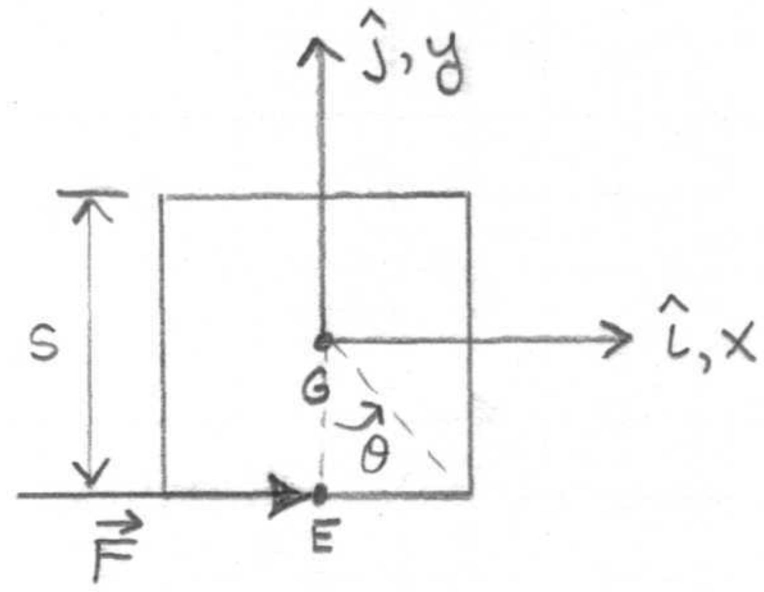
$= \frac{F-F_B}{m}\hat\imath - \frac{6}{m\ell}(F+F_B)\hat k \times \left(-\frac{\ell}{2}\hat\jmath\right)$

$= \frac{F-F_B}{m}\hat\imath - \frac{3}{m}(F+F_B)\hat\imath = 0\hat\imath$

$\{\}\cdot\hat\imath \longrightarrow F - F_B - 3(F+F_B) = 0 = F - 3F - F_B - 3F_B = -2F - 4F_B$

$\therefore \boxed{\vec F_B = \frac{-F}{2}\hat\imath}$

14.15



$\vec{F} = 1\,\text{N}\,\hat{i}$

$m = 1\,\text{kg}$

$s = 1\,\text{m}$

a) $\{\sum \vec{F} = 1\text{N}\,\hat{i} = m a_G \hat{i}\} \cdot \hat{i}$

$\therefore\ a_G = {}^{1\text{N}}/_{1\text{kg}} = 1\,{}^{\text{m}}/_{\text{s}^2}$

$\ddot{x}_G = 1\,{}^{\text{m}}/_{\text{s}^2} \rightarrow \dot{x} = 1\,{}^{\text{m}}/_{\text{s}}t + \dot{x}_0$

$\rightarrow x = 1\text{m}\, t^2/_2 + \dot{x}_0 t + x_0,$

where $\dot{x}_0 = x_0 = 0$

$\therefore\ \boxed{x_G(t) = 0.5\text{m} \times t^2}$

b) $\sum \vec{M}_G = \dot{\vec{H}}_G \rightarrow \vec{r}_{E/G} \times \vec{F} = I^G_{zz}\, \dot{\vec{\omega}}_c$

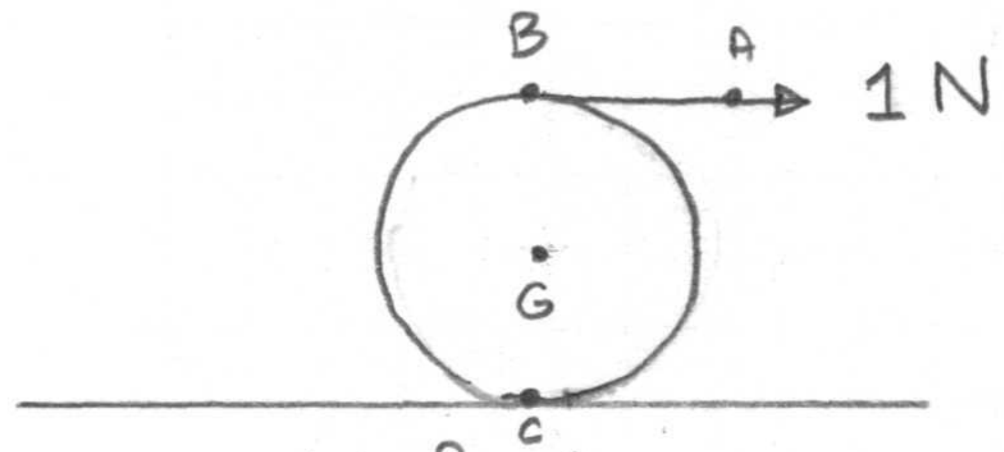
$\therefore\ \frac{s}{2}(\sin\theta\,\hat{i} - \cos\theta\,\hat{j}) \times (1\text{N}\,\hat{i}) = \frac{1}{12}(2s^2 m)\dot{\omega}\,\hat{k}$

OR $\frac{s}{2}(1\text{N})(-\cos\theta)(\hat{j}\times\hat{i}) = \frac{1}{6} m s^2 \dot{\omega}\,\hat{k}$

$0.5\,\text{Nm}\cos\theta\,\hat{k} = \frac{1}{6}(1\text{kg})(1\text{m})^2\,\dot{\omega}\,\hat{k}$

$\{\}\cdot\hat{k} \longrightarrow \boxed{\ddot{\theta} - 3\,[\text{s}^{-2}]\cos\theta = 0}$

14.33



$I = 0.5\ kgm^2,\ M = 1\ kg,\ R = 1\ m$

a) $\sum \vec{M}_C = \dot{\vec{H}}_C$ OR $\vec{r}_{B/C} \times \vec{F} = \vec{r}_{B/C} \times m\vec{a}_G + I^G \dot{\omega}\hat{k}$,

where $\vec{a}_G = -\ddot{\theta} R \hat{\imath}$

$$\therefore\ (2\hat{j}) \times (1N\hat{\imath}) = (2\hat{j}) \times (-m\ddot{\theta}R\hat{\imath}) - I^G\ddot{\theta}\hat{k}$$

$$-2\hat{k}\ [N\text{-}m] = 2m\ddot{\theta}R\hat{k} - I^G\ddot{\theta}\hat{k}$$

$$\{\}\cdot\hat{k} \rightarrow \quad -2\ N\text{-}m = [(2m)mR - I^G]\ddot{\theta}$$

$$\therefore\ \ddot{\theta} = \frac{-2\ Nm}{2m(1kg)(1m) - 0.5\ kgm^2} = \boxed{-4/3\ rad/s^2}$$

b) $\vec{a}_B = \vec{a}_G + \vec{a}_{B/G} = \vec{a}_G + \vec{r} \times \vec{\alpha}$

$= -\ddot{\theta}R\hat{\imath} + (R\hat{j}) \times (-\ddot{\theta}\hat{k})$

$= -\ddot{\theta}R\hat{\imath} - \ddot{\theta}R\hat{\imath} = -2\ddot{\theta}R\hat{\imath}$

$$a_A = a_B = -2\ddot{\theta}R = 2(4/3\ rad/s^2)(1m) = \boxed{8/3\ m/s^2}$$