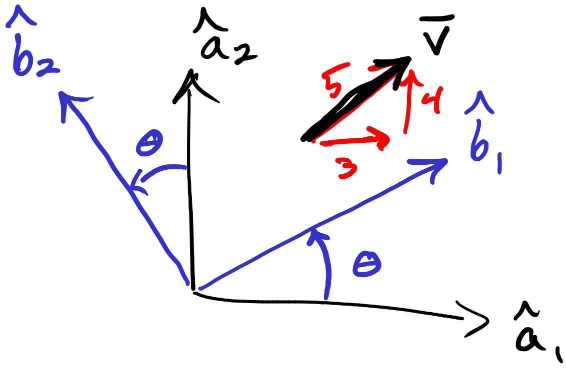
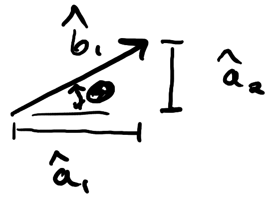
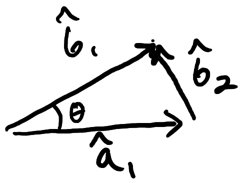




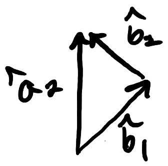
$$\bar{V} = 3\hat{a}_1 + 4\hat{a}_2 = x_b\hat{b}_1 + y_b\hat{b}_2$$

$$3(\underbrace{\cos\theta\,\hat{b}_1 - \sin\theta\,\hat{b}_2}_{\hat{a}_1}) + 4(\underbrace{\sin\theta\,\hat{b}_1 + \cos\theta\,\hat{b}_2}_{\hat{a}_2})$$

$$\bar{V} = (3\cos\theta + 4\sin\theta)\hat{b}_1 + (4\cos\theta - 3\sin\theta)\hat{b}_2$$



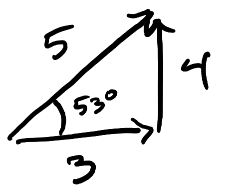
$$\hat{a}_1 = \cos\theta\,\hat{b}_1 - \sin\theta\,\hat{b}_2$$

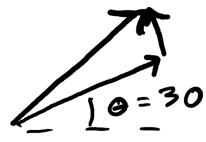


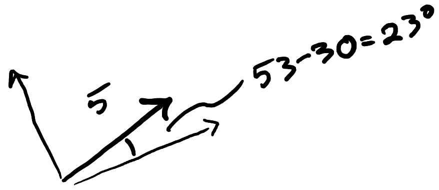
$$\hat{a}_2 = \sin\theta\,\hat{b}_1 + \cos\theta\,\hat{b}_2$$

$$\begin{bmatrix} \hat{b}_1 \\ \hat{b}_2 \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} \hat{a}_1 \\ \hat{a}_2 \end{bmatrix}$$

$$\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} \hat{b}_1 \\ \hat{b}_2 \end{bmatrix} = \begin{bmatrix} \hat{a}_1 \\ \hat{a}_2 \end{bmatrix}$$

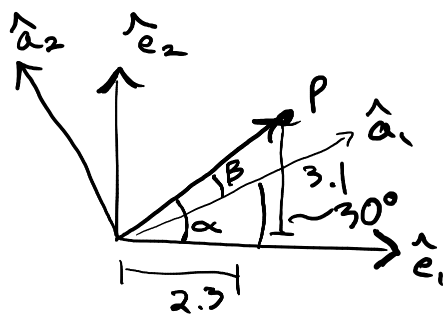






$$\bar{V} = \underbrace{5\cos 23^\circ}_{x_b}\hat{b}_1 + \underbrace{5\sin 23^\circ}_{y_b}\hat{b}_2$$

3.3



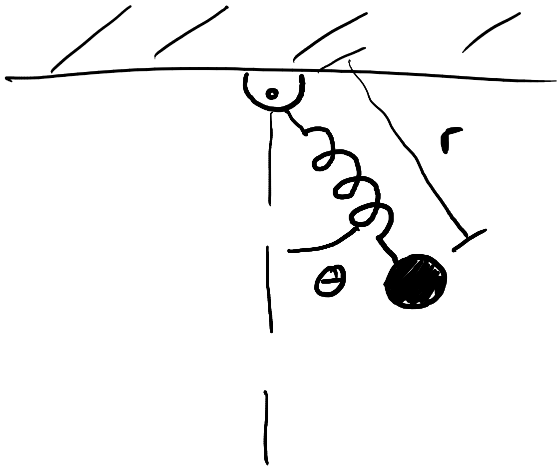
$$r = \sqrt{2.3^2 + 3.1^2}$$

$$\bar{r}_p = r\,\hat{e}_r$$

$$\hat{e}_r = \frac{2.3}{r}\hat{e}_1 + \frac{3.1}{r}\hat{e}_2$$

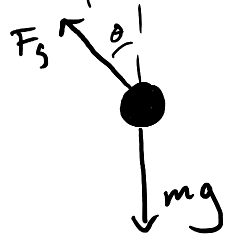
$$\tan\alpha = \frac{3.1}{2.3}$$

$$\beta = \alpha - 30^\circ$$



2DOF's
=
2 eom's

FBD



KD

$$\hat{e}_r \longrightarrow \quad -K(r-l_0) + mg\cos\theta = m(\ddot{r} - r\dot{\theta}^2)$$

$$\hat{e}_\theta \longrightarrow \quad -mg\sin\theta = m(r\ddot{\theta} + 2\dot{r}\dot{\theta})$$

eom

$$\boxed{\begin{aligned} \ddot{r} &= r\dot{\theta}^2 - \frac{k}{m}(r-l_0) + g\cos\theta \\ \ddot{\theta} &= -\frac{2\dot{r}\dot{\theta}}{r} - \frac{g}{r}\sin\theta \end{aligned}}$$

linearize (engr approach)

$\theta \ll 1 \quad \theta \sim \sin\theta \quad 1 \sim \cos\theta \quad \dot{\theta} \lll 1$

$$\ddot{r} = -\frac{k}{m}(r-l_0) + g$$

$$\ddot{\theta} = -\frac{g}{r}\theta$$