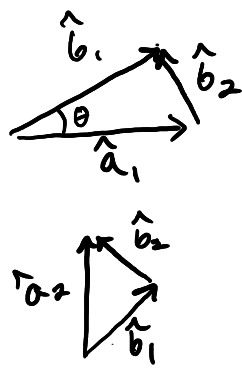


$$\begin{aligned}\bar{V} &= 3\hat{a}_1 + 4\hat{a}_2 = x_b\hat{b}_1 + y_b\hat{b}_2 \\ 3(\underbrace{\cos\theta\hat{b}_1 - \sin\theta\hat{b}_2}_{\hat{a}_1}) &+ 4(\underbrace{\sin\theta\hat{b}_1 + \cos\theta\hat{b}_2}_{\hat{a}_2}) \\ \bar{V} &= (3\cos\theta + 4\sin\theta)\hat{b}_1 + (4\cos\theta - 3\sin\theta)\hat{b}_2\end{aligned}$$

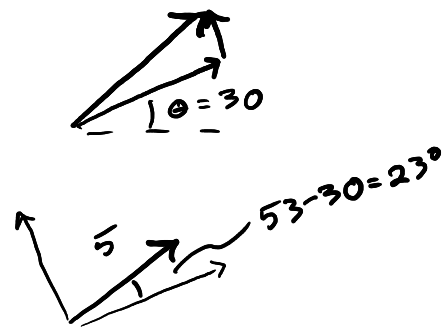
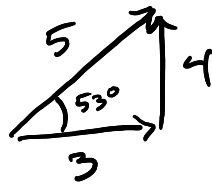


$$\hat{a}_1 = \cos\theta\hat{b}_1 - \sin\theta\hat{b}_2$$

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

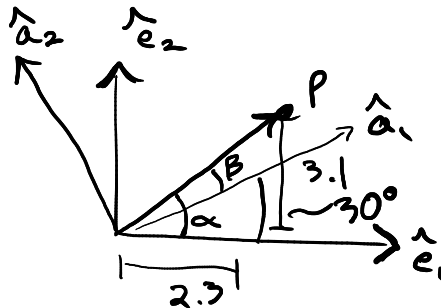
$$\begin{bmatrix} \hat{b}_1 \\ \hat{b}_2 \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} \hat{a}_1 \\ \hat{a}_2 \end{bmatrix}$$

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



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

3.3



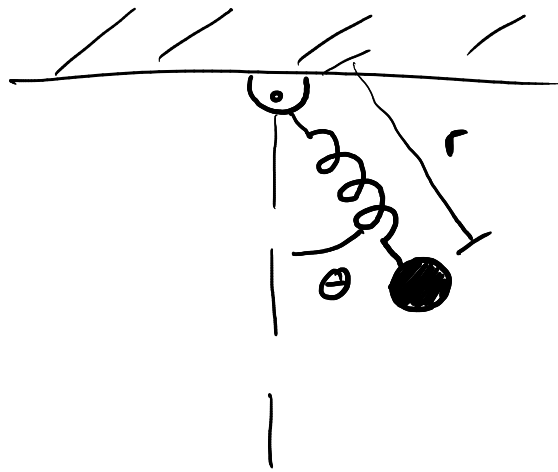
$$r = \sqrt{2.3^2 + 3.1^2}$$

$$\vec{r}_p = r \hat{e}_r$$

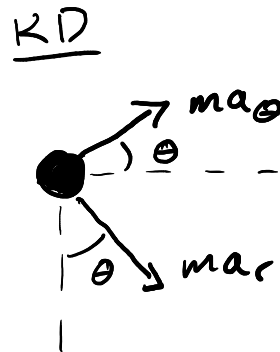
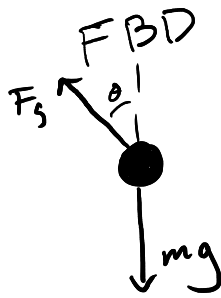
$$\hat{e}_r = \frac{2.3}{r} \hat{e}_1 + \frac{3.1}{r} \hat{e}_2$$

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

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



2 DOFs
=
2 eom's



$$\begin{aligned} \hat{e}_r \rightarrow & -K(r-l_0) + mg \cos \theta = m(\ddot{r} - r\dot{\theta}^2) \\ \hat{e}_\theta \rightarrow & -mg \sin \theta = m(r\ddot{\theta} + 2\dot{r}\dot{\theta}) \end{aligned}$$

eom
✓

$$\begin{cases} \ddot{r} = r\dot{\theta}^2 - \frac{K}{m}(r-l_0) + g \cos \theta \\ \ddot{\theta} = -\frac{2\dot{r}\dot{\theta}}{r} - \frac{g}{r} \sin \theta \end{cases}$$

linearize (engr approach)

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

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

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