The two bars $A$ and $B$ shown make up the main parts of the Quick Return Mechanism. Pin $p$ is fixed to $A$ and bar $B$ has a slot that allows pin $p$ to move freely along the slot. Assume $\dot{\theta} = \omega_A \frac{\text{rad}}{\text{s}}$, a constant. Measure the angle $\theta$ from $\hat{n}_1$. Let the angular speed of bar $B$ be given by $\dot{\beta} = \omega_B$, not constant. Measure the angle $\beta$ from $\hat{n}_1$ as well. The work here is all kinematical and is essentially part of step 5 of the six step process. Use Mathematica and the vector tools. Follow previous quizzes and such posted on the class website.

1. Determine the following quantities as a function of $\theta$:
   
   (a) the magnitude of the absolute velocity of pin $p$,
   
   (b) the magnitude of the absolute acceleration of pin $p$,
   
   (c) the velocity of pin $p$ as seen from bar $B$ expressed in vectors in $B$,
   
   (d) the acceleration of pin $p$ as seen from bar $B$ expressed in vectors in $B$,
   
   (e) the plots all of these quantities,
   
   (f) the point on each bar $A$ and $B$ that experiences the most acceleration during the motion, and
   
   (g) explain via analysis why it is called a “Quick Return” mechanism. Hint: look at $\beta$ and its derivatives.

2. Animate the device allowing the parameters $R$ and $D$ to vary.

3. Find the ratio of $R/D$ that allows the quickest return.