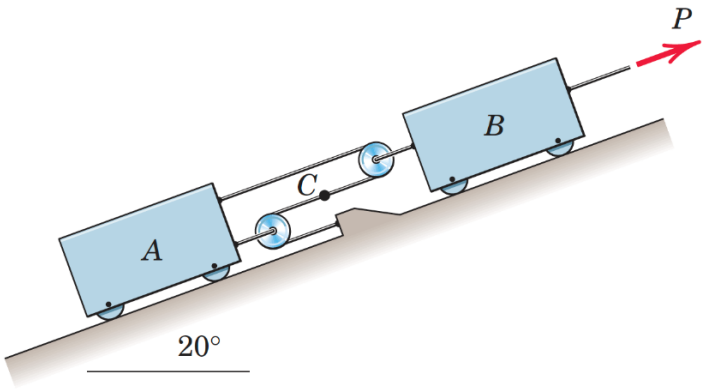
Problem Set 1
ME 104, Fall 2024

Due: Sept 13, 2024, 11:59pm

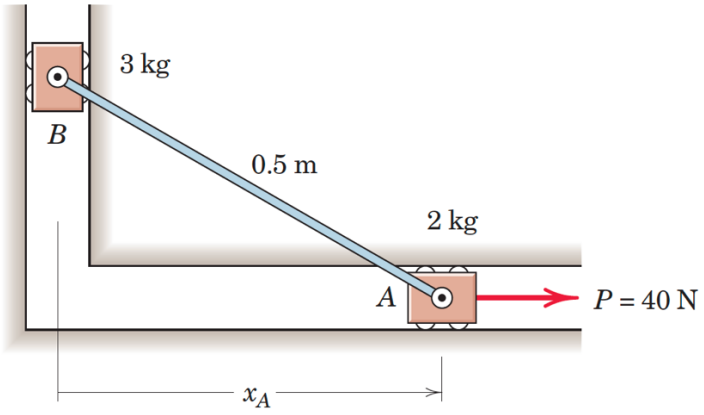
Instructions:

- Submit your homework on gradescope only.
- Please do each problem on a new page.
- Make sure to include the problem number at the top for each problem.
- Show all steps and draw clear FBD's when using Newton's laws.
- Please write legibly!!! If we can't read your solution, there will be lost points.
- Please put a box around your final answer(s).

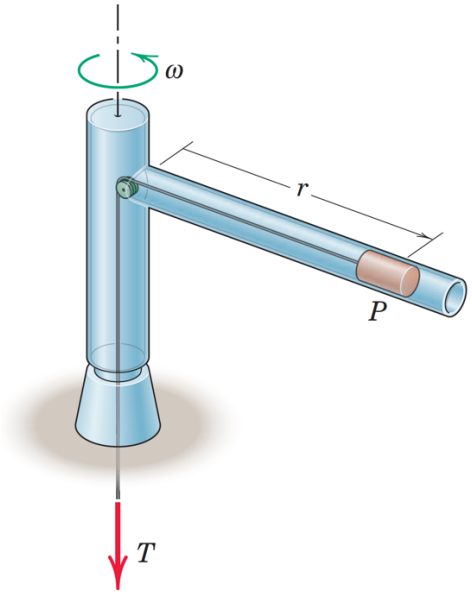
1) Under the action of force *P*, the constant acceleration of block *B* is 3 ft/sec^2 up the incline. For the instant when the velocity of *B* is 2 ft/sec up the incline, determine the velocity of *A*, the acceleration of *A*, and the absolute velocity of point *C* of the cable.



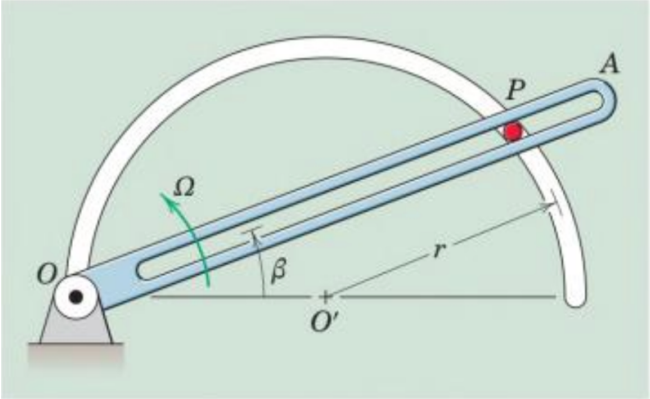
2) The sliders *A* and *B* are connected by a light rigid bar of length $l = 0.5$ m and move with negligible friction in the slots, both of which lie in a horizontal plane. For the position where $x_A = 0.4$ m, the velocity of *A* is $v_A = 2$ m/s to the right. Determine the acceleration of each slider and the force in the bar at this instant.



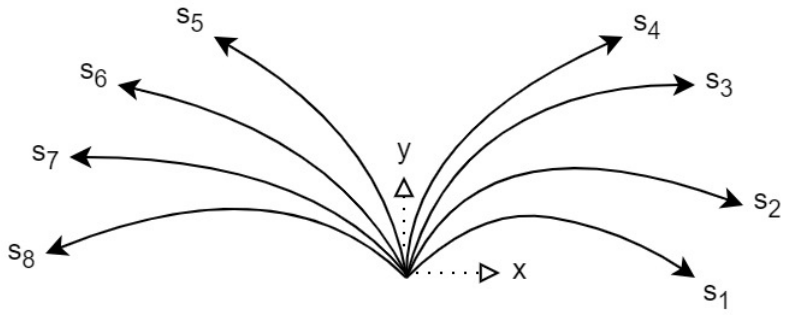
3) The hollow tube assembly rotates about a vertical axis with angular velocity $\omega = \dot{\theta} = 4$ rad/s and $\dot{\omega} = \ddot{\theta} = -2$ rad/s^2. A small 0.2-kg slider *P* moves inside the horizontal tube portion under the control of the string which passes out the bottom of the assembly. If $r = 1$ m, $\dot{r} = -3$ m/s, and $\ddot{r} = 2$ m/s^2, determine the tension *T* in the string and the horizontal force exerted on the slider by the tube.



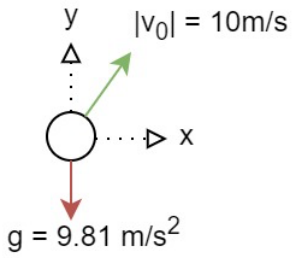
4) A 0.2-kg particle *P* is constrained to move along the vertical-plane circular slot of radius $r = 1.0$ m and is confined to the slot of arm *OA*, which rotates about a horizontal axis through O with a constant angular rate $\Omega = 2$ rad/s. For the instant when $\beta = 22°$, determine the magnitude of the force *N* exerted on the particle by the circular constraint and the magnitude of the force *R* exerted on it by the slotted arm.



5) Computer Problem: Using Python or MATLAB, in this problem you will simulate a firework starting at the moment of the mid-air explosion! You will track the motion of eight firework sparks that are all initially propelled outward with a speed of 10 m/s moving in eight different directions within a single vertical plane. Assume the sparks begin at the same point in the sky. Suppose each spark has a mass of 10 grams, feels 9.81 m/s^2 of gravity, and experiences a linear air drag of the form $\boldsymbol{F}_{Drag} = -c_s\boldsymbol{v}$. In a single plot, show the trajectories of your eight sparks from the initial explosion to 1.5 sec later for two values of drag; $c_s = 0.001$ N s/m and 0.01 N s/m. Explain in words how the visuals of your fireworks display change as the drag coefficient goes up. Please include your code along with your plots.



(a) Sample particle trajectories at t = 1.5s



(b) Particle (m = 10g) initial conditions