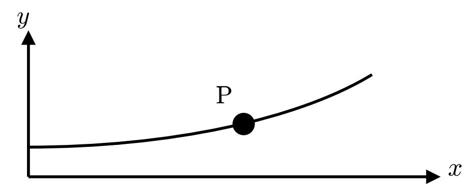
Problem 1 (20 points):

Given: Particle P is able to slide along a rigid guide whose shape is given in terms of its Cartesian components as: $y(x) = \frac{1}{2}x^2 + 8$, where x and y are given in meters. The x-component of the velocity of P is a constant 3 m/s.

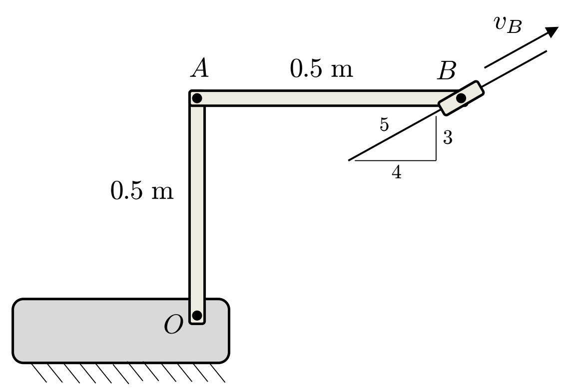
Find: When particle P is at the position of $x = 2$ m:
(a) Determine the Cartesian components for the velocity and acceleration of P.
(b) Determine the rate of change of speed of P.
(c) Determine the the radius of curvature for the path of P.



Problem 2 (20 points):

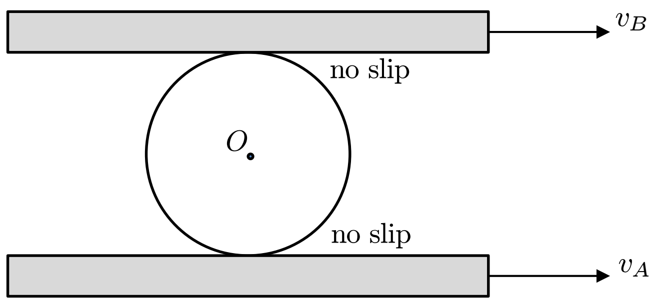
Given: The mechanism shown below is made up of links OA and AB. Point O is pinned to ground and Point B is constrained to move along a straight-line path. At the instant shown, link OA is vertical, link AB is horizontal, and v_B is travelling at a constant speed of 5 m/s in the direction shown.

Find: At this instant:
(a) The angular velocity of links OA and AB.
(b) The angular acceleration of links OA and AB.



Problem 3 (20 points):

Part A (6 points):



A disk is constrained to roll without slip between two moving surfaces. If each *surface* is moving to the right and $v_B > v_A$, determine the following (circle the correct answer):

- Point O moves:

  Left   Right   Not enough information to determine

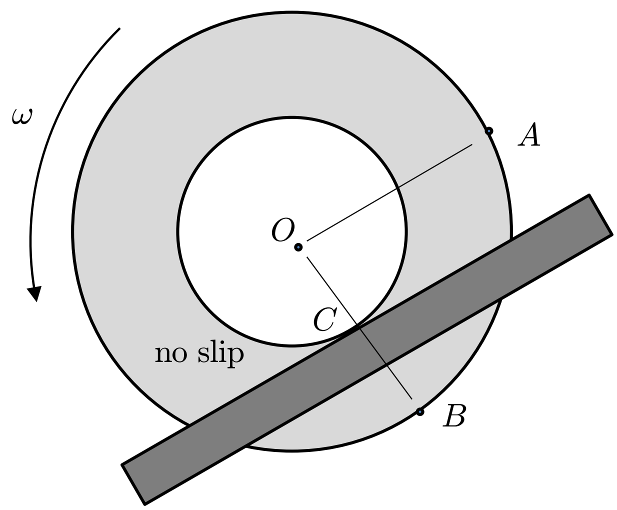
- The angular velocity of the disk is:

  Clockwise   Counter-Clockwise   Not enough information to determine

- The speed of point O is best described by:

  $v_O < v_A$ $v_A < v_O < v_B$ $v_O > v_B$ Not enough information to determine

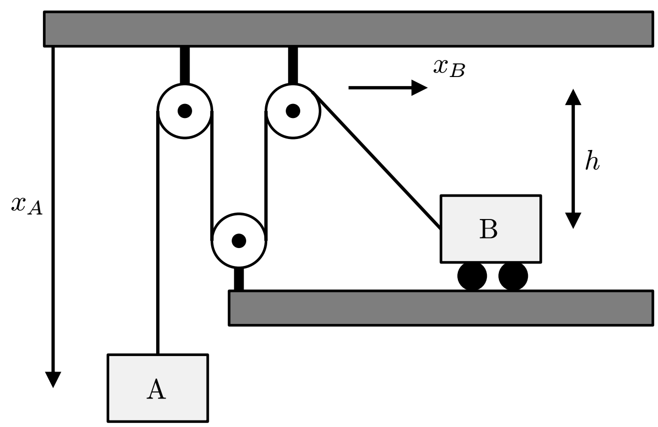
Part B (6 points):



The stepped wheel shown above rolls without slip, in the direction indicated, along an inclined plane. Assuming ω is constant, on the drawing above:

(a) Sketch the velocity and acceleration vectors associated with Point O.
(b) Sketch the velocity and acceleration vectors associated with Point A.
(c) Sketch the velocity and acceleration vectors associated with Point B.

Part C (4 points):



The motion of the two particle system shown above is constrained by an inextensible rope. Circle the correct answer for each of the following questions, assuming $x_B = 1$ m at the instant shown.

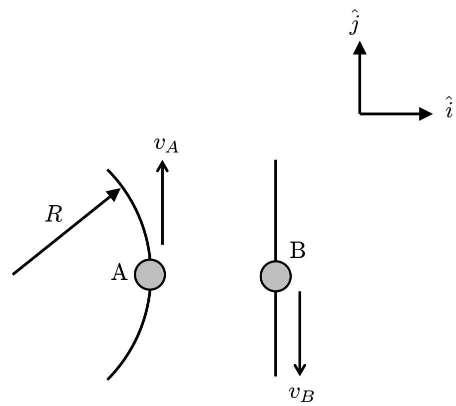
- The rope-length constraint associated with this problem is best described by:

  $3x_A + x_b = L$ $\qquad$ $x_A + x_B = L$ $\qquad$ $x_A + \sqrt{h^2 + x_B^2} = L$ $\qquad$ $3x_A + \sqrt{h^2 + x_B^2} = L$

- The relationship between the speeds of particles A and B is best described by:

  $|v_A| < |v_B|$ $\qquad$ $|v_A| = |v_B|$ $\qquad$ $|v_A| > |v_B|$ $\qquad$ Not enough information to determine

Part D (4 points):



Particle A moves along a circular path (of radius R) with constant speed v_A. Particle B moves along a straight-line path with constant speed v_B. Circle the appropriate answer below relative to the position shown.

- The velocity of Particle A with respect to Particle B is:

$v_A\hat{j}$ $\qquad$ $v_B\hat{j}$ $\qquad$ $(v_B - v_A)\hat{j}$ $\qquad$ $(v_A + v_B)\hat{j}$ $\qquad$ $\vec{0}$

- The acceleration of Particle A with respect to Particle B is:

$\frac{v_A^2}{R}\hat{i}$ $\qquad$ $-\frac{v_A^2}{R}\hat{i}$ $\qquad$ $\vec{0}$ $\qquad$ $\frac{v_B^2 - v_A^2}{R}\hat{i}$ $\qquad$ $\frac{(v_B - v_A)^2}{R}\hat{i}$