Exam No. 1 - sample exam problems
Problem No. 1

Given: Particle P travels within the x-y plane along a path given by $y(x) = \frac{x^2}{2} - 10x$, where x and y are given in feet. The y-component of the position for P is increasing at a *constant* rate of 10 ft/sec.

Find: For the position of P corresponding to x = 9 ft:

a) determine the *velocity vector* of P.
b) determine the *acceleration vector* of P.
c) determine the *rate of change of speed* of P.
d) determine the *radius of curvature* for the path of P.

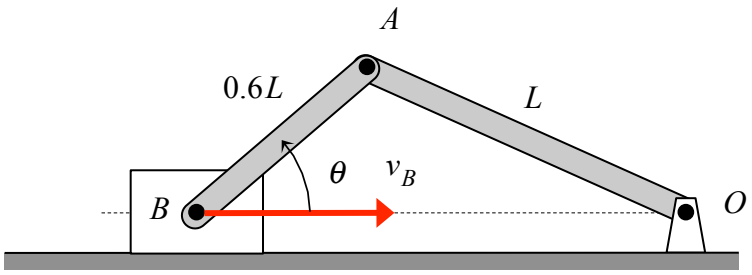
Exam No. 1 - sample exam problems
Problem 2A

Given: The mechanism shown below is made up of links AB and AO, with the lengths of AB and AO given by 0.6L and L, respectively. Block B is attached to end B of link AB, with B being constrained to move along a straight path with a constant speed of v_B.

Find: For the instant when $\theta = 90°$:

a) Determine the angular velocities of links AB and AO. *Write your answers as vectors in terms of L and v_B only.*

b) Determine the angular accelerations of links AB and A). *Write your answers as vectors in terms of L and v_B only.*

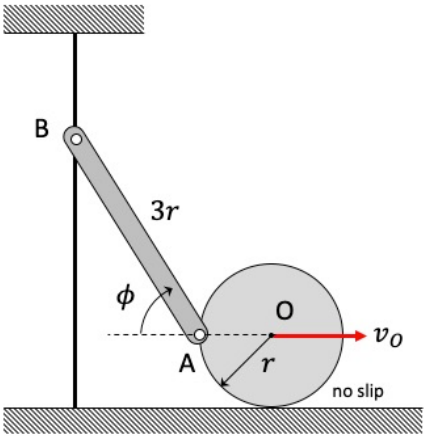


Work appearing above this line will NOT be graded

Exam No. 1 - sample exam problems
Problem 2B

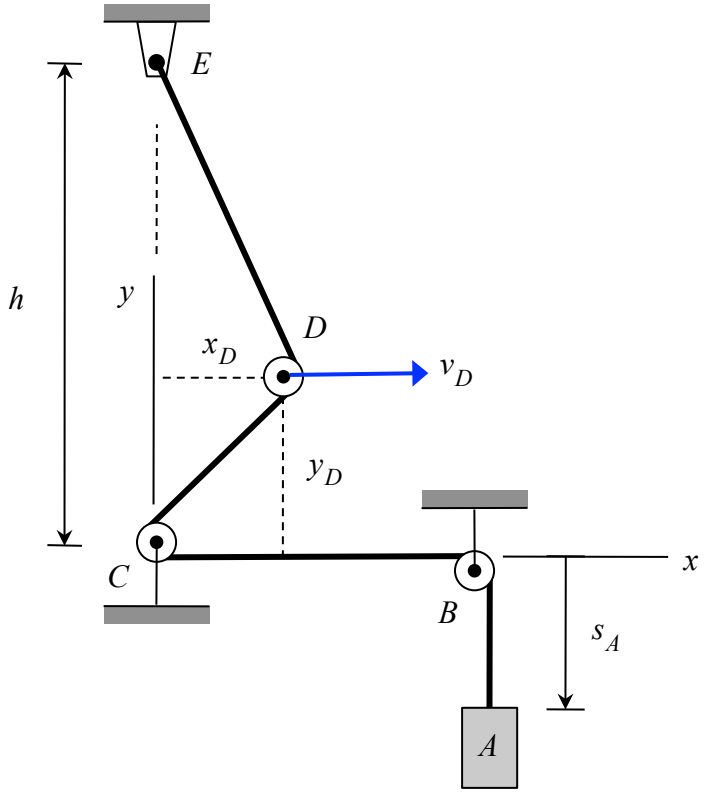
Given: A disk having a radius of r is rolling without slipping on a rough horizontal surface to the right with its center O moving at a *constant* speed of v_O. A rigid bar having a length of $3r$ is attached to point A on the circumference of the disk. End B is constrained to moving on a vertical guide. At the position shown, point A is on the same horizontal line as point O.

Find: At the position shown, determine the velocity and acceleration of end B of the bar.



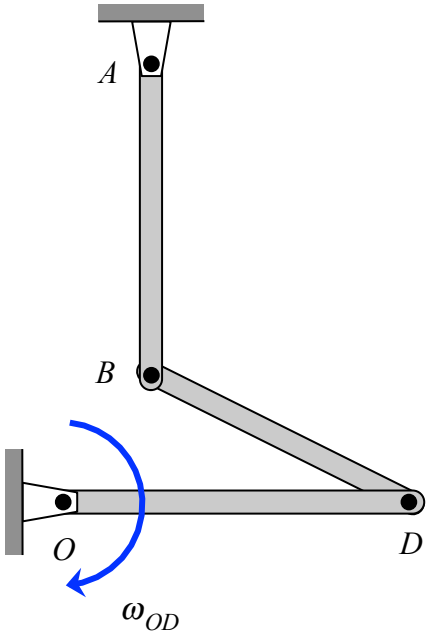
Exam No. 1 - sample exam problems
Problem No. 3A

An inextensible cable connects block A to ground at E, with the cable being wrapped around two fixed pulleys at B and C, and a moveable pulley at D. When pulley D is at the location $(x_D, y_D) = (0.3, 0.4)\, m$, the center of pulley D is known to have a velocity of $\vec{v}_D = (2\hat{i})\, m/s$. Determine the speed of block A at that instant. Use $h = 0.8\, m$. Assume the pulleys to have small radii.



Exam No. 1 - sample exam problems
Problem 3B

Use a STRAIGHT EDGE in any drawings that you make for this problem. You must provide a JUSTIFICATION for your answers below.



The mechanism shown above has been drawn to scale. Let $\vec{\omega}_{AB}$, $\vec{\omega}_{BD}$ and $\vec{\omega}_{OD}$ represent the angular velocity vectors of links AB, BD and OD, respectively.

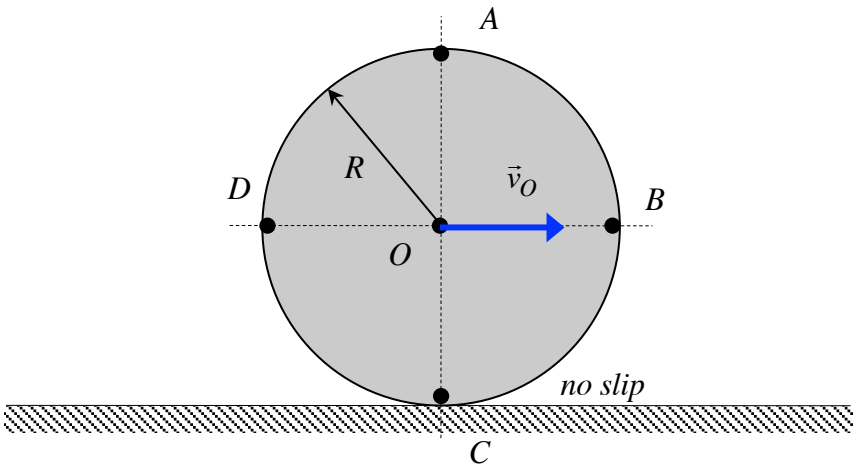
- Circle the correct answer below regarding the relative sizes of $|\vec{\omega}_{BD}|$ and $|\vec{\omega}_{OD}|$:

$|\vec{\omega}_{BD}| > |\vec{\omega}_{OD}|$ $\quad$ $|\vec{\omega}_{BD}| = |\vec{\omega}_{OD}|$ $\quad$ $|\vec{\omega}_{BD}| < |\vec{\omega}_{OD}|$

- Circle the correct answer below regarding the relative sizes of $|\vec{\omega}_{AB}|$ and $|\vec{\omega}_{BD}|$:

$|\vec{\omega}_{AB}| > |\vec{\omega}_{BD}|$ $\quad$ $|\vec{\omega}_{AB}| = |\vec{\omega}_{BD}|$ $\quad$ $|\vec{\omega}_{AB}| < |\vec{\omega}_{BD}|$

Exam No. 1 - sample exam problems
Problem No. 3C



A circular disk with an outer radius of R rolls without slipping on a horizontal surface with its center O moving with a speed of v_O.

- On the figure above, draw the velocity vectors for points A, B and D on the circumference of the disk.
- Let v_O, v_A, v_B and v_C denote the speeds of points O, A, B and C, respectively, on the disk. Rank these speeds in order of increasing magnitude.

- On the figure above, locate a point on the circumference of the disk that has the same speed as point O.

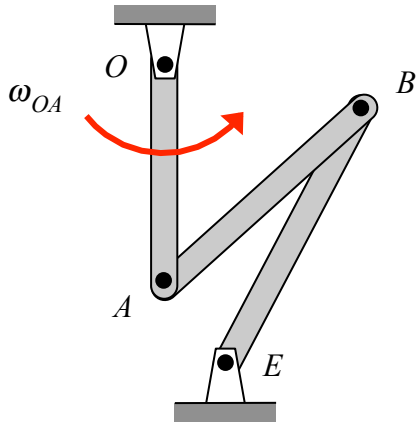
Exam No. 1 - sample exam problems
Problem No. 3D

The mechanism shown below has been drawn to scale. For the position shown:

i) What is the sense of rotation for link AB: *clockwise*, *counterclockwise* or *stationary*?

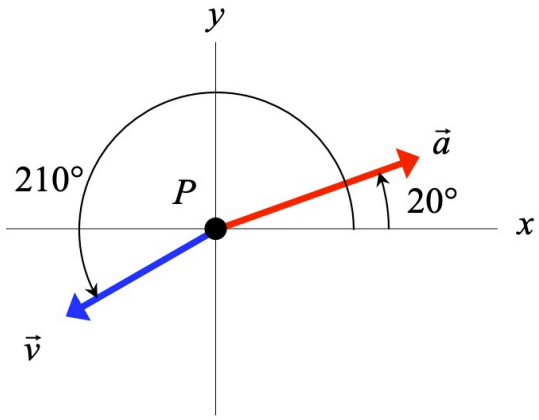
ii) Which is larger: the angular speed of link BE, $\left|\omega_{BE}\right|$, or the angular speed of link AB, $\left|\omega_{AB}\right|$?

HINT: Locate the instant center for link AB.



Exam No. 1 - sample exam problems
Problem No. 3E

NOTE: You are not required to show your work on Problem 3. There is no partial credit awarded for the different parts of the problem.



The velocity and acceleration of point P are shown above with $|\vec{v}| = 25 m/s$ and $|\vec{a}| = 15 m/s^2$

PART A (2 points) – circle the correct response

a) Point P is moving with *increasing* speed.

b) Point P is moving with *constant* speed.

c) Point P is moving with *decreasing* speed.

PART B (2 points)

What is the radius of curvature of the path of P?