ME 274 – Summer 2020 ***Name*** _____

Examination No. 1 (PM)

PROBLEM NO. 1 – 20 points

Given: Block A moves to the left with a speed of v_A and an acceleration of a_A. Block A is connected to particle P with an inextensible cable, with P able to slide within a slotted arm. The arm is rotating CCW with a *constant* rate of $\dot{\theta}$.

Find: For this problem:

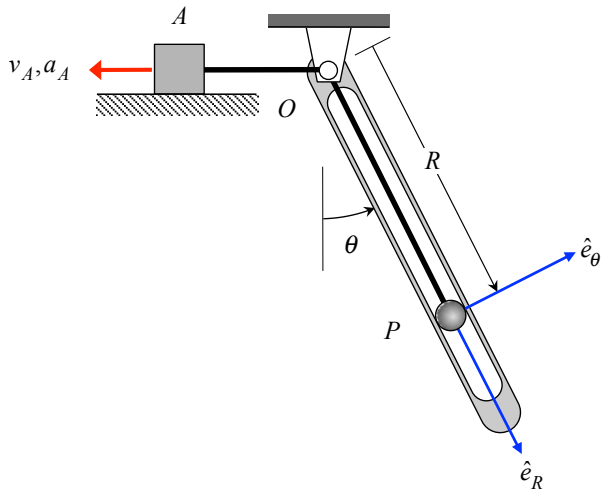
a) Determine the velocity and acceleration vectors for point P. Write your answers using the polar unit vectors shown in the figure below.

b) Make a sketch of the velocity and acceleration vectors for P.

c) Determine the *rate of change of speed* of P.

d) Determine the *radius of curvature* for the path of P.

Use the following parameters in your analysis: $v_A = 10\ ft/s$, $a_A = 5\ ft/s^2$, $\dot{\theta} = 4\ rad/s$, $R = 3\ ft$ and $\theta = 30°$.



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Examination No. 1 (PM)

PROBLEM NO. 2 – 20 points

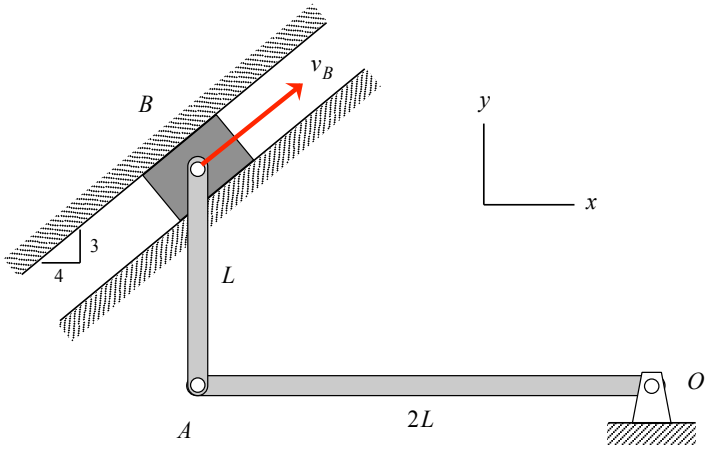
Given: A mechanism is made up of links AB and OA, along with a sliding piston B. B moves along a straight slot with a constant speed of v_B.

Find: At the position shown, AB is vertical, and OA is horizontal. For this position:

a) Determine the angular velocity of bar links AB and OA. Write your answers as vectors.

b) Determine the angular acceleration of bar links AB and OA. Write your answers as vectors.

Leave your answers in terms of, at most, L and v_B.



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Examination No. 1 (PM)

PROBLEM NO. 3 – 20 points TOTAL

PART A – 4 points

You are a passenger in automobile P. Your forward motion, in terms of the Cartesian coordinates shown in the figure, is described by the following velocity and acceleration vectors:

$$\vec{v} = \left(20\hat{i} - 15\hat{j}\right) m/s$$

$$\vec{a} = \left(3\hat{i} + 5\hat{j}\right) m/s^2$$

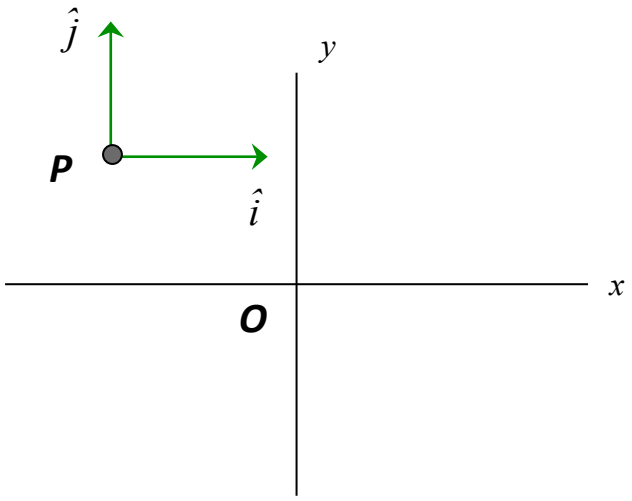
Choose the response below that most accurately describes the motion of you in the automobile:

a) You are slowing down.

b) You are traveling with a constant speed.

c) You are increasing in speed.

d) More information is needed in order to determine the characteristics of the roadway path.



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Examination No. 1 (PM)

PROBLEM NO. 3 (continued)

PART B – 4 points

Blocks A and B are connected by an inextensible cable. B is moving to the right with a speed of v_B. Let v_A represent the speed of block A.

Choose the response below that most accurately describes the motion of A:

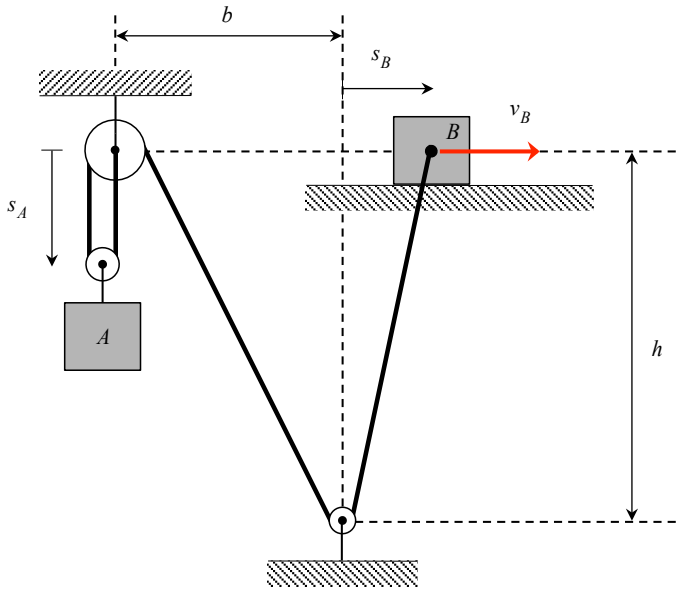
a) $v_A < v_B / 2$

b) $v_A = v_B / 2$

c) $v_B / 2 < v_A < v_B$

d) $v_A = v_B$

e) $v_A > v_B$



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Examination No. 1 (PM)

PROBLEM NO. 3 (continued)

PART C – 4 points

Consider the scaled drawing of a mechanism shown below, with the locations for the instant centers for links AB and DE are shown in the figure. Link OA is rotating CCW with an angular speed of ω_{OA}. Let ω_{AB}, ω_{BH} and ω_{DE} represent the angular speeds of links AB, BH and DE, respectively, and let v_A and v_B represent the speeds of points A and B, respectively. Choose the correct responses in Parts C1, C2, C3 and C4 below.

Part C1

a) $\omega_{AB} = CCW$

b) $\omega_{AB} = 0$

c) $\omega_{AB} = CW$

Part C2

a) $\omega_{BH} = CCW$

b) $\omega_{BH} = 0$

c) $\omega_{BH} = CW$

Part C3

a) $\omega_{DE} = CCW$

b) $\omega_{DE} = 0$

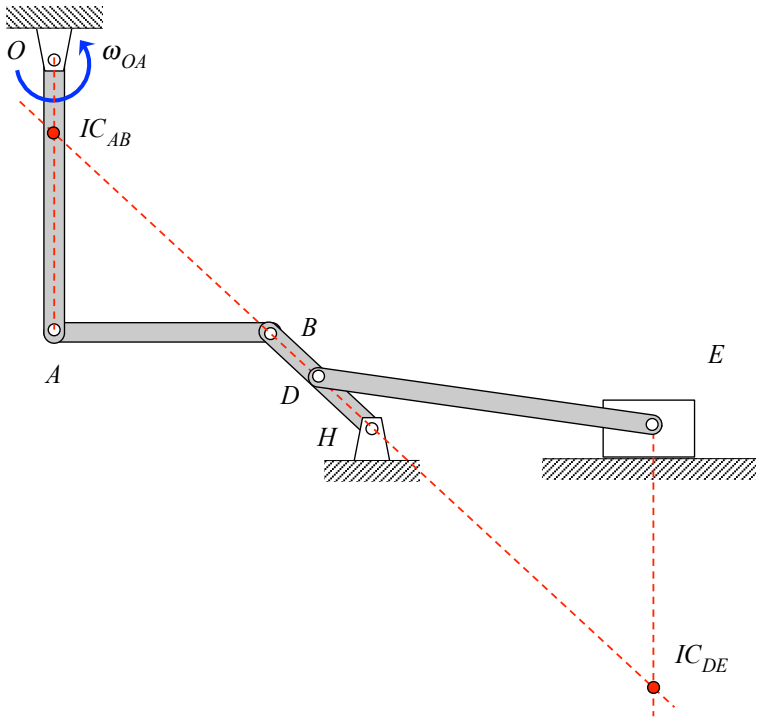
c) $\omega_{DE} = CW$

Part C4

a) $v_A > v_B$

b) $v_A = v_B$

c) $v_A < v_B$



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Examination No. 1 (PM)

PROBLEM NO. 3 (continued)

PART D – 4 points

Consider the linkage made up of links OA and AB, with the angular orientation of these links given by the angles θ_1 and θ_2. (Note that these angles are both measured from fixed, horizontal lines, as shown in the figure.) The constant rotation rates for these two links are given by $\dot{\theta}_1$ and $\dot{\theta}_2$. The following moving reference frame kinematics equation is to be used to describe the acceleration of point B:

$$\vec{a}_B = \vec{a}_A + \left(\vec{a}_{B/A}\right)_{rel} + \vec{\alpha} \times \vec{r}_{B/A} + 2\vec{\omega} \times \left(\vec{v}_{B/A}\right)_{rel} + \vec{\omega} \times \left(\vec{\omega} \times \vec{r}_{B/A}\right)$$

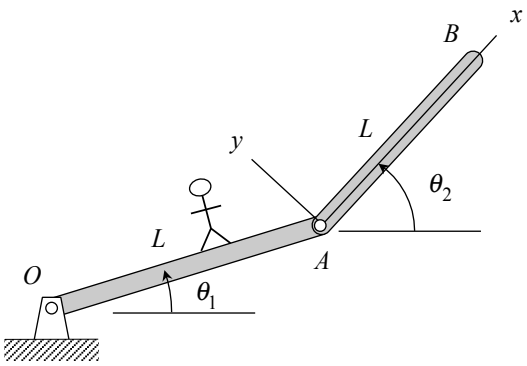
Using an observer attached to link OA, fill in the following terms below for this equation:

$\vec{\omega} =$

$\vec{\alpha} =$

$\left(\vec{v}_{B/A}\right)_{rel} =$

$\left(\vec{a}_{B/A}\right)_{rel} =$



PART E – 4 points

Aircraft A and B travel in the *xy*-plane, with A moving on a straight path and B moving on a circular path having a radius of 4000 ft, have velocity vectors of:

$$\vec{v}_A = \left(-300\,\hat{i} - 400\,\hat{j}\right) ft/s$$

$$\vec{v}_B = \left(-300\,\hat{i} - 600\,\hat{j}\right) ft/s$$

respectively. With what *speed* is B traveling <u>*as seen by an observer on aircraft A*</u>?