***Sample exam problems - ME 274 - Exam #3***

The following is a set of ME 274 Exam #3 problems from past school terms. Please feel free to use these problems in your preparation for your exam this semester. Please do not use these problems to suggest which topics that will or will not be covered on your exam, nor to suggest the level of difficulty that you should expect on your exam.

These problems are provided to you for a set of talking points in your interaction with instructors, TAs and colleagues. We will NOT be providing solutions for these problems. Please do not ask for solutions.

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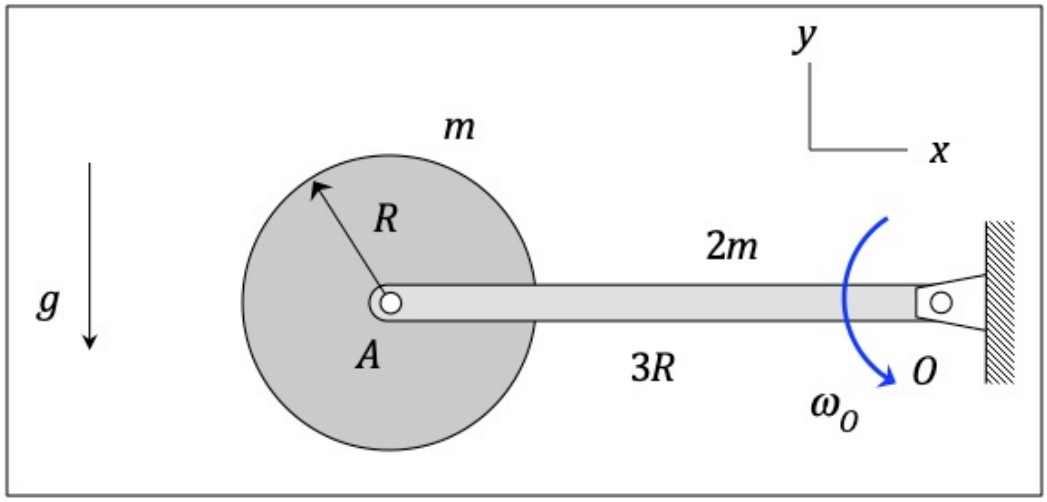
***Examination No. 2 (REGULAR)***

***PROBLEM NO. 1 – 20 points***

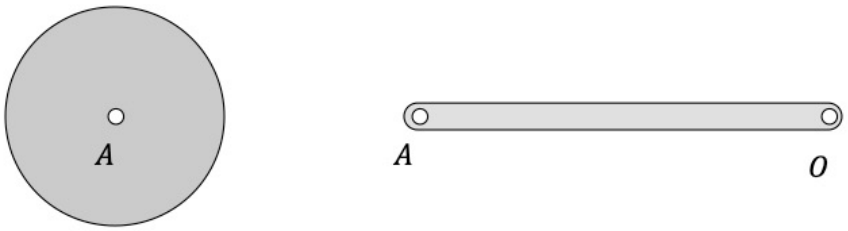



***Given***: Thin homogeneous bar OA (having a mass of $2m$ and length of $3R$) is pinned to ground at end O. A homogeneous, circular disk (of radius $R$ and of mass $m$) is pinned to bar OA at end A. The system is released with bar OA being horizontal and rotating in the counterclockwise sense with an angular speed of $\omega_0$, and with the disk having zero angular speed.

***Find***: It is desired to know the angular acceleration of the disk and the acceleration of point A, on release. Please follow the four steps provided below, and present your work within the appropriate steps.

***Solution:***

*SETP 1*: Draw individual free body diagrams of the disk and bar OA below.



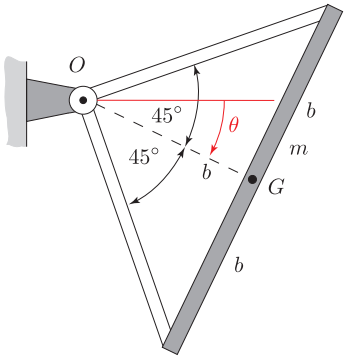

*STEP 2*: Kinetics

*STEP 3*: Kinematics

*STEP 4*: Solve for the angular acceleration of the disk and the acceleration of point A. Write your answers as vectors. Leave your answers in terms of, at most: $m$, $g$, $R$ and $\omega_0$.

*Problem 2, Part 2 (18 points):*

**Given:** A uniform slender bar of mass $m$ and length $2b$ is mounted in a right-angle "L-bracket" of negligible mass. It is released from rest at $\theta = 0$, i.e., when points $G$ and $O$ are on the same horizontal line. Use $g$ as the gravitational constant.




**Find:** Determine the following quantities:

(a) Draw a free-body diagram of the bar in its initial position. Clearly indicate any datum that you use on the free-body diagram.

(b) Use the *principles of work energy* to derive an expression for the angular velocity $\omega$ in terms of $b$, $g$, and $\theta$.

Express your answers as vectors.

**Solution:**

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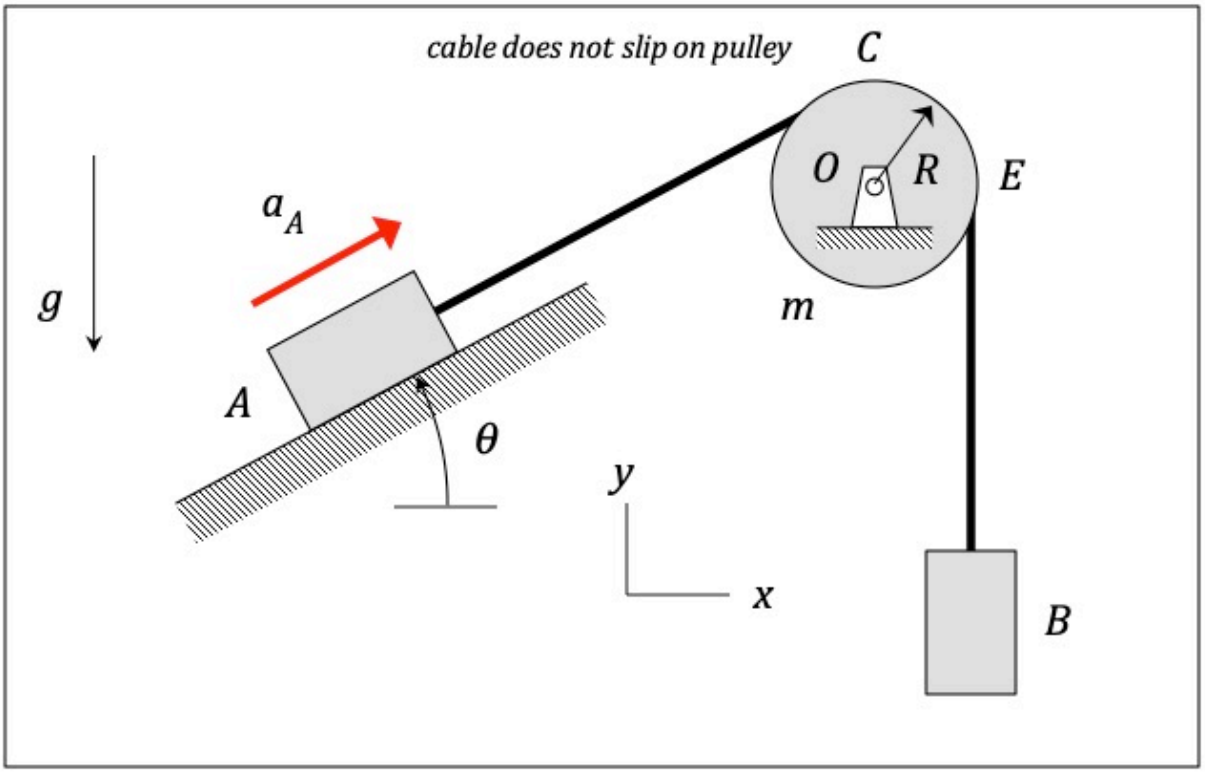
***Examination No. 2 (REGULAR)***

***PROBLEM NO. 3 – 20 points TOTAL***

*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.*




Blocks A and B are connected by an inextensible cable. The cable is supported by a homogeneous pulley of mass *m* and radius *R*, with the cable not slipping on the pulley. It is known that A has an acceleration of $a_A$ up the incline. Let $T_{AC}$ and $T_{BE}$ represent the tensions in sections AC and BE of the cable, respectively.

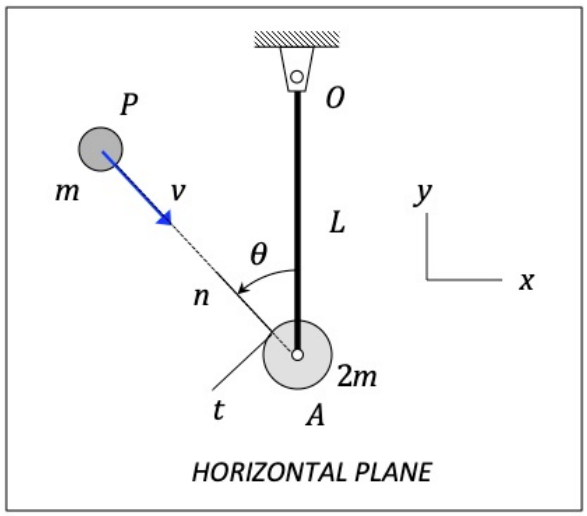
***PART A (2 points) – choose the correct response***

a) $T_{AC} > T_{BE}$

b) $T_{AC} = T_{BE}$

c) $T_{AC} < T_{BE}$

d) More information is needed to answer this question.




Particle A (of mass $2m$) is attached to rod OA (having negligible mass), with OA being pinned to ground at O. With A being stationary, a second particle P (of mass $m$) approaches A with a speed of $v$ in the direction shown above, with $0<\theta<90°$. As a result of the impact, P sticks to A.

***PART B – choose the correct TRUE/FALSE responses below***

***B.1 – 1 point*** The *linear momentum* for particle A is conserved in the $t$-direction: *TRUE* or *FALSE*

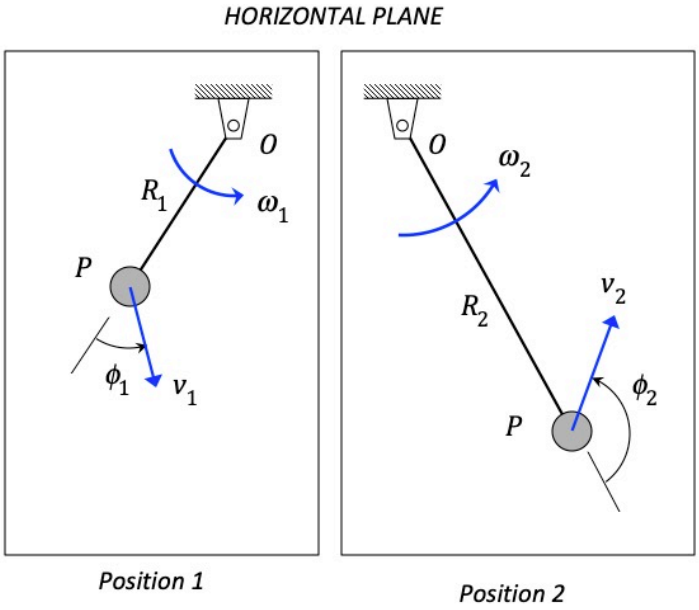
***B.2 – 1 point*** The *angular momentum* for particle A about point O is conserved: *TRUE* or *FALSE*

***B.3 – 1 point*** The *mechanical energy* for particle A is conserved: *TRUE* or *FALSE*

***B.4 – 1 point*** The *linear momentum* for A+P is conserved in the $t$-direction: *TRUE* or *FALSE*

***B.5 – 1 point*** The *angular momentum* for A+P about point O is conserved: *TRUE* or *FALSE*

***B.6 – 1 point*** The *mechanical energy* for A+P is conserved: *TRUE* or *FALSE*




Particle P is attached to ground through an *extensible* band OP (of stiffness *k*) as shown. For Position 1, it is known that $0 < \phi_1 < 90°$, with the band being stretched. At Position 2, it is known that $90° < \phi_2 < 180°$ and $R_2 > R_1$. Let $v_1$ and $v_2$ be the speeds of P at Positions 1 and 2, respectively.

***PART C – choose the correct responses below***

***C.1 – 1 point***

a) $v_2 > R_2\omega_2$

b) $v_2 = R_2\omega_2$

c) $v_2 < R_2\omega_2$

d) More information is needed in order to answer this question.

***C.2 – 1 point***

a) $\omega_2 > \omega_1$

b) $\omega_2 = \omega_1$

c) $\omega_2 < \omega_1$

d) More information is needed in order to answer this question.

***PART C (continued)***

***C.3 – 1 point***: If the stiffness *k* of the band is *increased*, then:

e) $\omega_2$ will *increase*.

f) $\omega_2$ will *remain the same*.

g) $\omega_2$ will *decrease*.

h) More information is needed in order to answer this question.

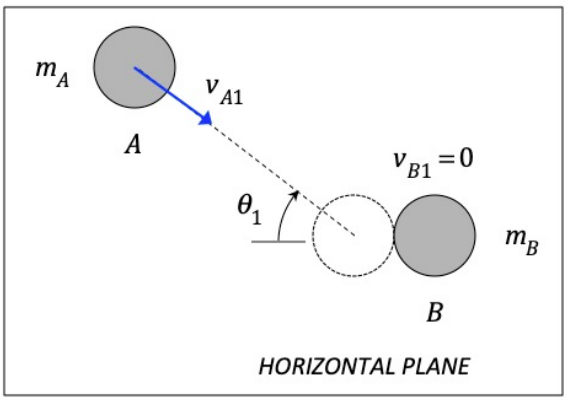
***C.4 – 1 point***

a) $v_2 > v_1$

b) $v_2 = v_1$

c) $v_2 < v_1$

d) More information is needed in order to answer this question.




***PART E***

Particle A (having a mass of $m_A$) impacts a stationary particle B (having a mass of $m_B$). The coefficient of restitution for this impact is *e*. Let $v_{A2}$ and $v_{B2}$ represent the speeds of A and B, respectively, after impact. Assume that the contact surfaces at the contact point are smooth.

***E.1 – 1 point: choose the correct response***

If $\theta_1 = 0$, $e = 0$ and $m_A = m_B$, then:

a) $v_{A2} = 0$

b) $v_{A2} = v_{B2} \neq 0$

c) $v_{A2} > v_{B2} \neq 0$

d) $v_{B2} > v_{A2} \neq 0$

e) None of the above.

***E.2 – 1 point: choose the correct response***

If $\theta_1 = 0$, $e = 1$ and $m_A = m_B$, then:

a) $v_{A2} = 0$

b) $v_{A2} = v_{B2} \neq 0$

c) $v_{A2} > v_{B2} \neq 0$

d) $v_{B2} > v_{A2} \neq 0$

e) None of the above.

***E.3 – 1 point: choose the correct response***

If $\theta_1 = 0$, $e = 1$ and $m_A = 2m_B$, then:

a) $v_{A2} = 0$

b) $v_{A2} = v_{B2} \neq 0$

c) $v_{A2} > v_{B2} \neq 0$

d) $v_{B2} > v_{A2} \neq 0$

e) None of the above.

***E.4 – 1 point: choose the correct response***

If $0 < \theta_1 < 90°$, $e = 0$ and $m_A = m_B$, then:

a) $v_{A2} = 0$

b) $v_{A2} = v_{B2} \neq 0$

c) $v_{A2} > v_{B2} \neq 0$

d) $v_{B2} > v_{A2} \neq 0$

e) None of the above.