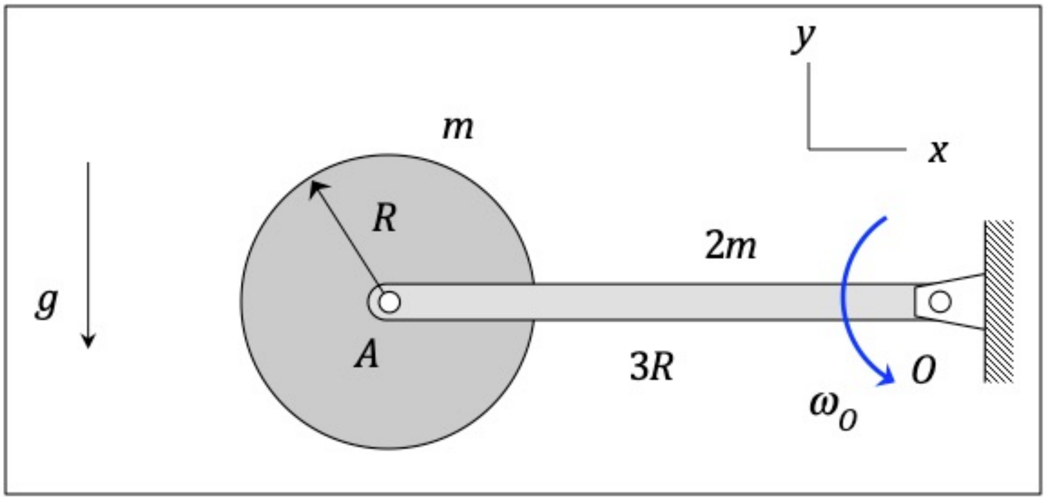
NOTE: These sample exam problems are intended for use as talking points during the exam review session. We will NOT be providing solutions for these problems. WeeklyJoys has many sample exam problems with solutions for your use while studying for your exam.

ME 274 – Summer 2022 ***Name*** ________________________________

Examination No. 2 (REGULAR)

PROBLEM NO. 1 – 20 points

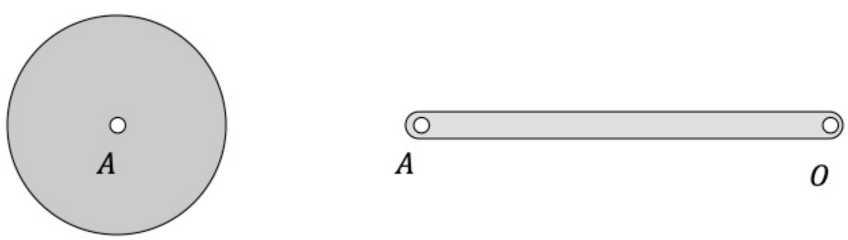


Given: Thin homogeneous bar OA (having a mass of $2m$ and length of $3R$) is pinned to ground at end O. A homogeneous, circular disk (of radius R and of mass m) is pinned to bar OA at end A. The system is released with bar OA being horizontal and rotating in the counterclockwise sense with an angular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

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



<u>*STEP 2*</u>: 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 ω_0.

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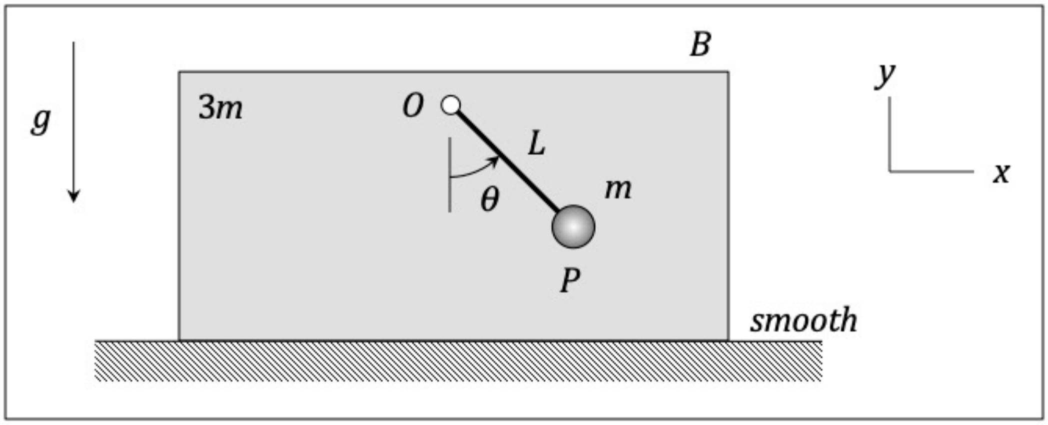
Examination No. 2 (REGULAR)

PROBLEM NO. 2 – 20 points



Given: Particle P (having a mass of m) is attached to block B (having a mass of $3m$) through rigid link OP (having negligible mass and a length of L) by a smooth pin joint at O. Block B is constrained to move along a horizontal smooth surface. With P and B being at rest, the system is released with $\theta = 90°$.

Find: It is desired to know the velocities of P and B when $\theta = 0$. Please follow the four steps provided below, and present your work within the appropriate steps.

Solution:

<u>*SETP 1*</u>: Choose you "system" and draw the appropriate free body diagram(s) for your system.

<u>*STEP 2*</u>: Kinetics (HINT: Consider using the linear impulse/momentum and work/energy equations.)

STEP 3: Kinematics

STEP 4: Solve for the velocities of P and B when $\theta = 0$. Write your answers as vectors. Leave your answers in terms of, at most: m, g and L.

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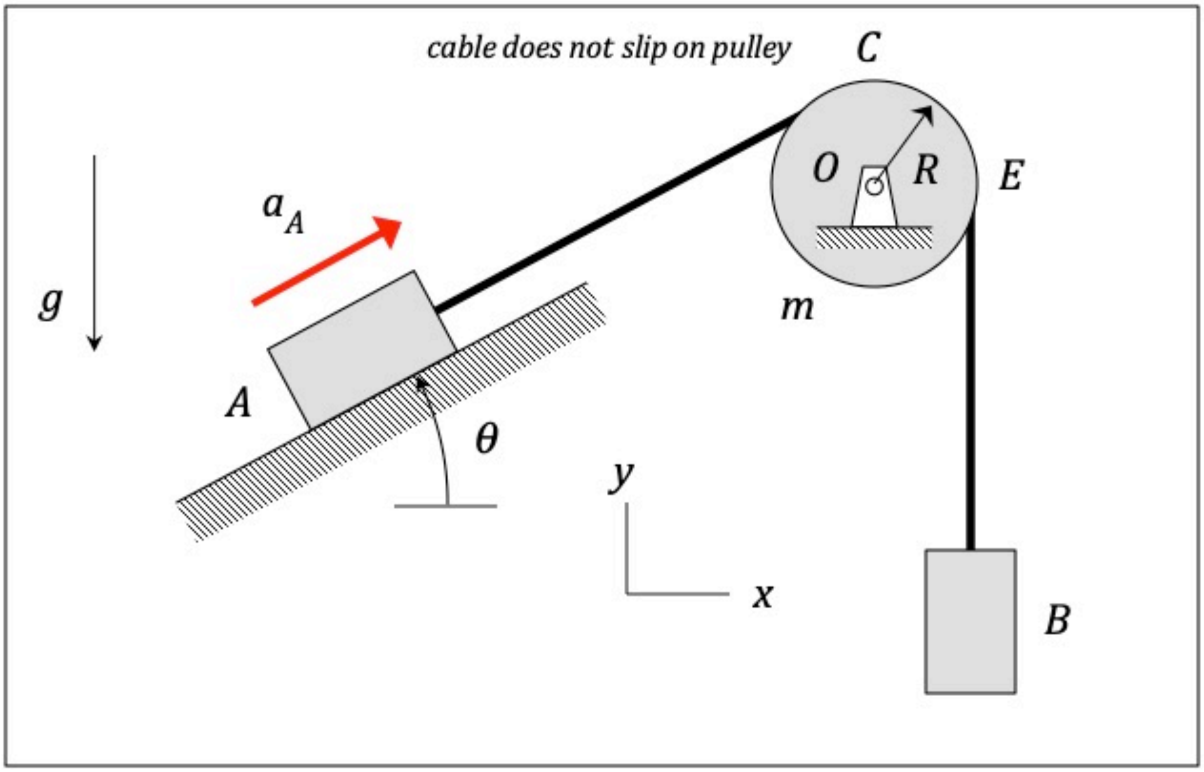
Examination No. 2 (REGULAR)
PROBLEM NO. 3 – 20 points TOTAL

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.

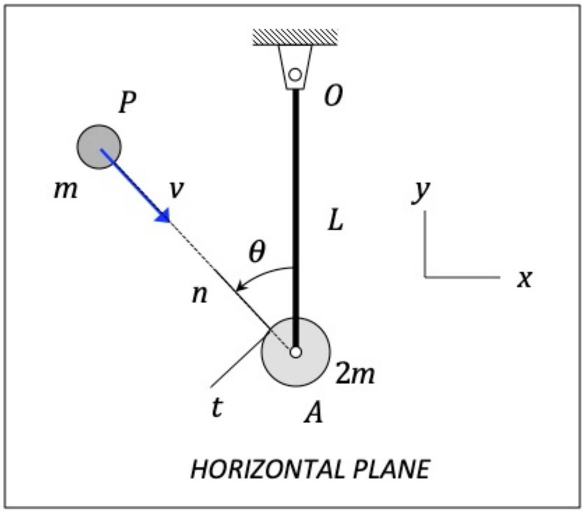
PART A (2 points) – choose the correct response

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 2*m*) 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*

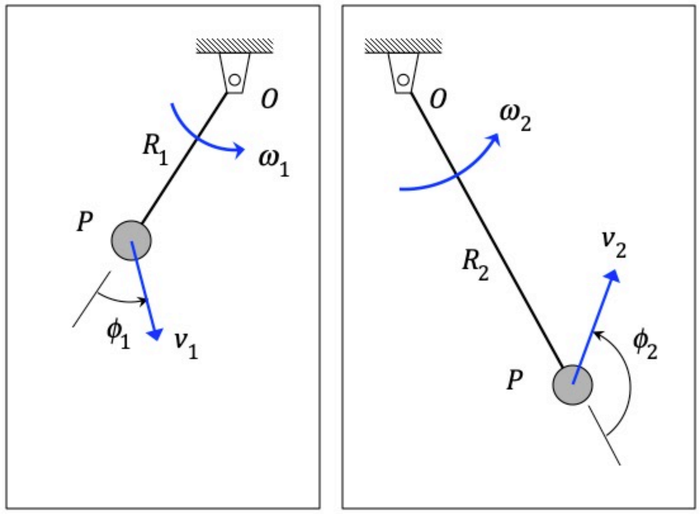
B.3 – 1 point The *mechanical energy* for particle A is conserved: *TRUE* or *FALSE*

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*

HORIZONTAL PLANE



Position 1 Position 2

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) ω_2 will *increase*.

f) ω_2 will *remain the same*.

g) ω_2 will *decrease*.

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

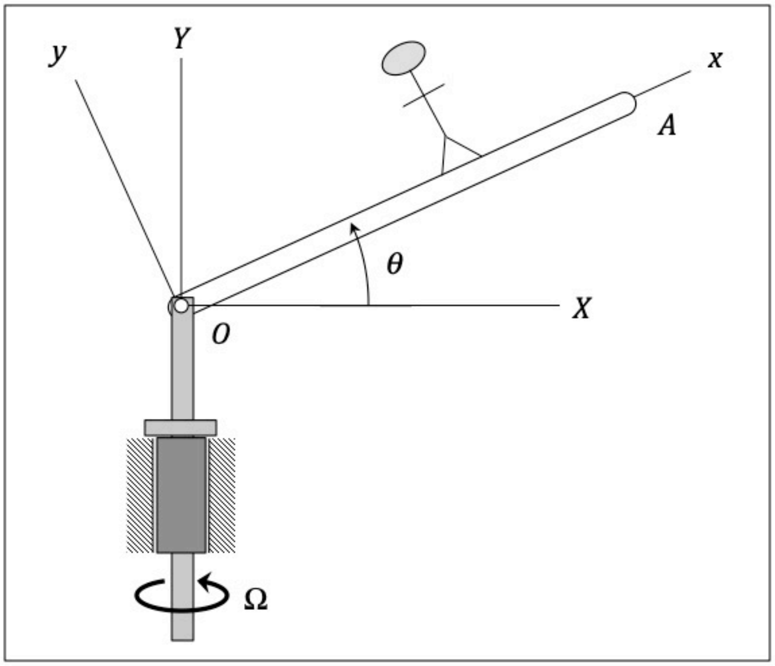
C.4 – 1 point

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 D (4 points)

The vertical shaft above is rotating about a fixed axis with a *constant* rate of Ω. Bar OA is pinned to the vertical shaft, with the elevation angle θ increasing at a *constant* rate of $\dot{\theta}$. The following moving reference frame kinematics equation is to be used to describe the acceleration of point A:

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

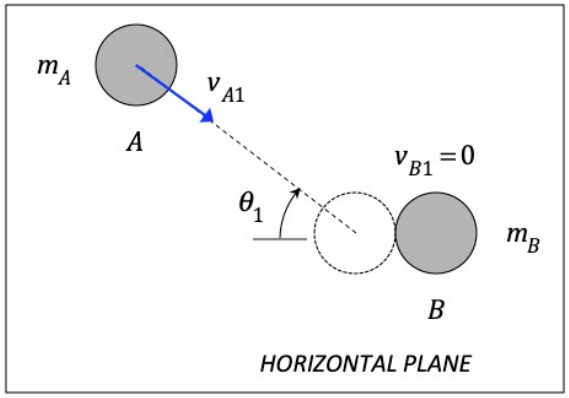
Using an <u>*observer attached to bar OA*</u>, fill in the following terms below for this equation (in terms of their xyz-coordinates):

$\vec{\omega} =$

$\vec{\alpha} =$

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

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



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.