UNIVERSITY OF SASKATCHEWAN
GE 226.3 – MECHANICS III
FINAL EXAM – APRIL 12, 2002

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3 HOURS
CLOSED BOOK, CALCULATORS PERMITTED. SHOW YOUR WORK.
ANSWER ALL 5 QUESTIONS. ALL QUESTIONS HAVE EQUAL VALUE.
GIVE FINAL ANSWERS TO 3 SIGNIFICANT FIGURES.

FORMULAE:

$$\bar{v}_B = \bar{v}_A + \bar{\omega} \times \bar{r}_{B/A}$$

$$\bar{a}_B = \bar{a}_A + \bar{\alpha} \times \bar{r}_{B/A} - \omega^2 \bar{r}_{B/A}$$

Additional formulae are appended to the end of the examination paper.

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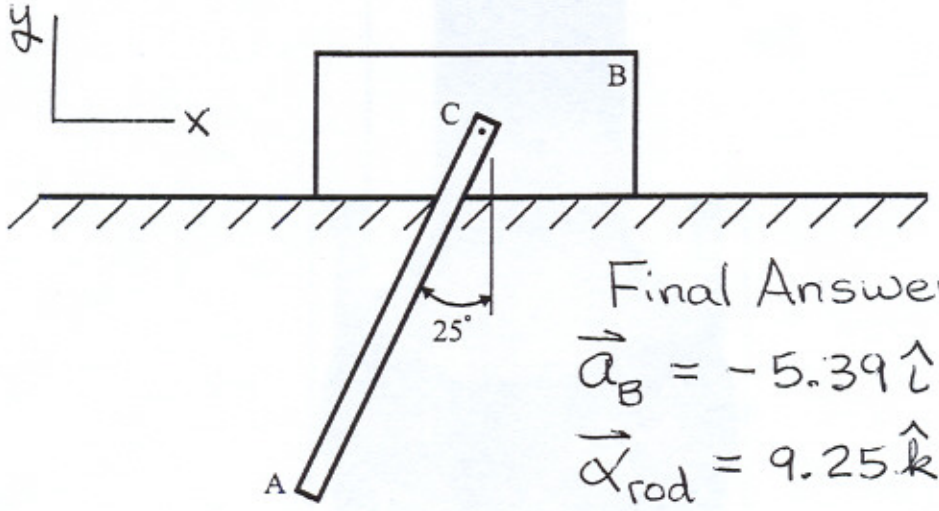
1. A uniform rod AC, of weight 30 lb and length 3 ft, is pin-connected to the 40-lb block B. The system is released from rest in the position shown. There is no friction between the block and the horizontal surface.



Final Answers:

$\vec{a}_B = -5.39\,\hat{i}$ ft/s^2

$\vec{\alpha}_{rod} = 9.25\,\hat{k}$ rad/s^2

For the instant immediately after the system has been released from rest, determine

(a) the acceleration of the block, and

(b) the angular acceleration of the rod.

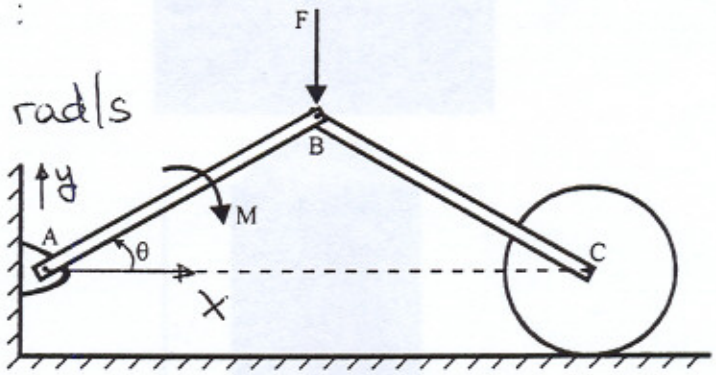
2. The linkage shown is released from rest at $\theta = 30°$. During the motion, a constant vertical force F = 50 N is applied at point B, and a constant clockwise torque M = 20 N·m is applied to link AB, as shown. Each of links AB and BC has a mass of 2 kg and a length of 800 mm. The solid circular disk, which rolls on the horizontal surface without slipping, has a mass of 3 kg and a radius of 250 mm.

Final Answers:

$\vec{\omega}_{AB} = -6.27\hat{k}$ rad/s

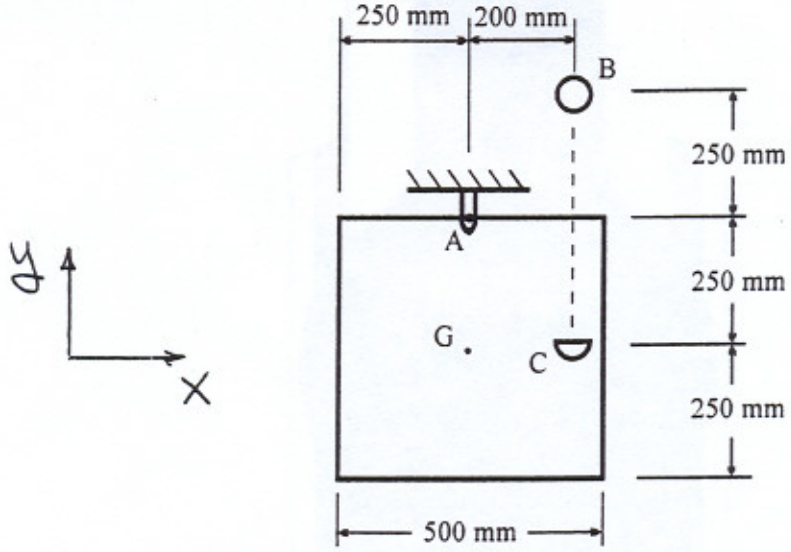
$\vec{\omega}_{BC} = -\vec{\omega}_{AB}$

$= 6.27\hat{k}$ rad/s



Determine the angular velocity of link AB and the angular velocity of link BC when $\theta = 10°$.

3. An 8-kg wooden panel is suspended from a pin support at A and is initially at rest. A 2-kg metal sphere is released from rest at B and falls into a hemispherical cup C attached to the panel at the same level as the mass center G. The hemispherical cup has negligible mass.

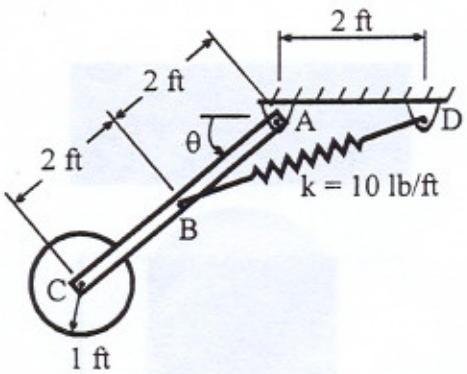


Final Answer:

$\vec{v}_G = -0.302\hat{\imath}$ m/s

Assuming that the impact is perfectly plastic, determine the velocity of the mass center G of the panel immediately after impact.

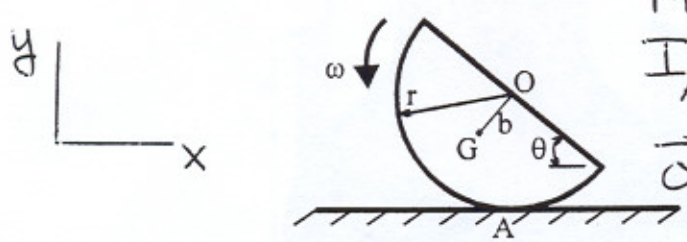
4. The assembly consists of a 5-lb slender rod AC to which is pin-connected a 12-lb disk and spring BD. The spring in its unstretched state has a length of 1 ft. The disk has a radius of 1 ft.



Final Answer:
$\vec{\omega}_{rod} = (3.12 \frac{rad}{s})\hat{k}$

If the rod is brought into the horizontal position $\theta = 0°$, and the disk is given a counterclockwise rotation of 3 rad/s when the rod is released from rest, determine the angular velocity of the rod at the instant $\theta = 30°$.

5. The semicircular disk having a mass of 10 kg is rotating at $\omega = 4$ rad/s at the instant $\theta = 60°$. The disk has a radius $r = 0.4$ m and its center of mass G is located a distance $b = 0.170$ m from geometric center O. The coefficient of static friction at A is $\mu_s = 0.5$ and the kinetic coefficient of friction at A is $\mu_k = 0.4$.



Final Answers:
$I_A = 1.72 \text{ kg}\cdot\text{m}^2$
$\vec{\alpha} = 13.9\hat{k} \text{ rad/s}^2$

For the instant shown, determine the moment of inertia of the disk about point A. Also, find the angular acceleration of the disk at this instant.

- End of Examination -