Université d'Ottawa
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GNG 1105/ 1505
Final Exam

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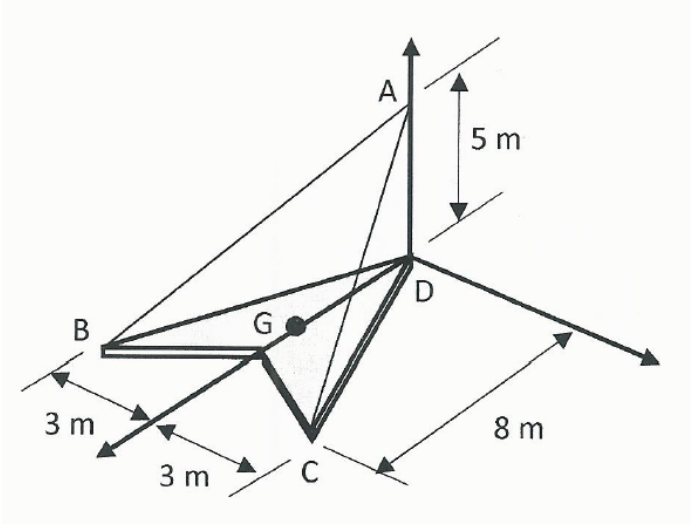
Time: 3 hours

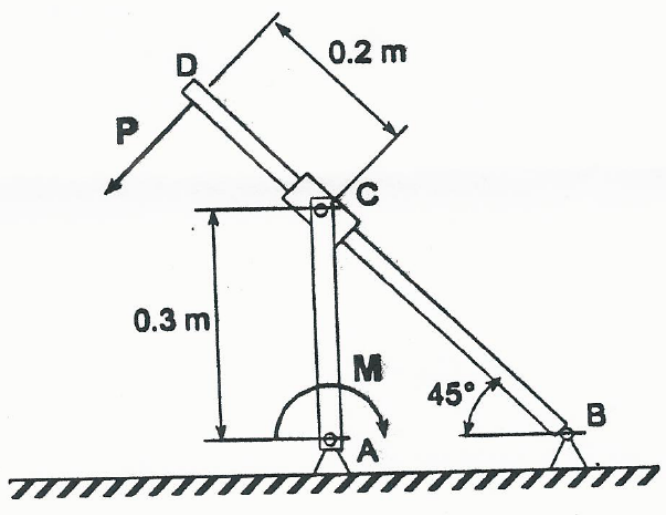
Closed book examination. Only non-programmable calculators are allowed. All other electronic devices are not allowed. All questions are of equal value.

1. A horizontal plate with a mass of 800 kg is held in place by a ball and socket joint at D and two cables (AB and AC) as shown. The distance between the centre of mass of the plate (G) and the joint at D is 4m.

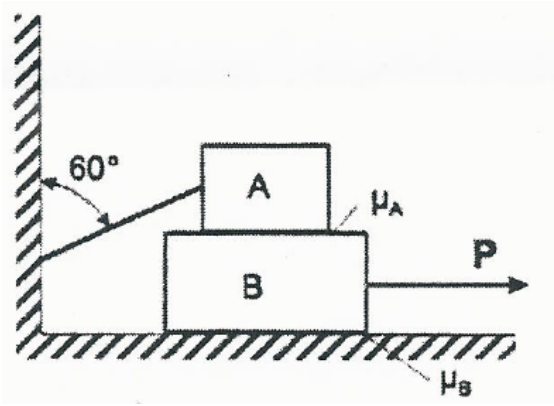


a. Draw the free body diagram for the plate.
b. Write, in vector form, the tension in cables AB, AC and the weight of the plate.
c. Calculate the tension forces in each cable and the components of the reaction at point D.

2. The mechanism shown has pin joints at A and B and is driven by a couple M=100 Nm at A. Joint C is a frictionless slider which is attached to member AC by a frictionless pin. (a) Calculate the force P required to maintain the system in equilibrium. P acts at right angles to BD, and AC is vertical. (b) Determine the reactions at A and B.

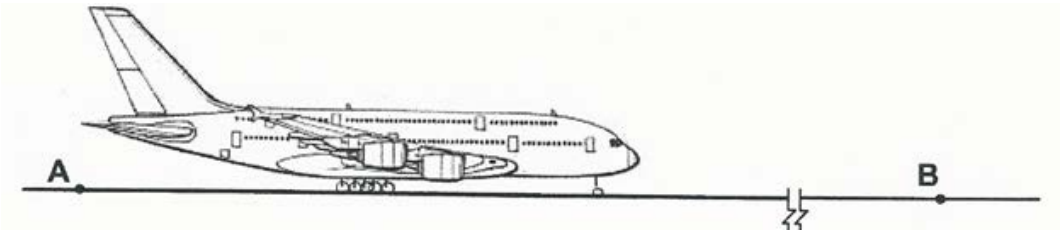


3. Block A in the sketch has a mass of 20 kg and is attached to the wall by means of a cord at an angle of 60° with the vertical, while block B has a mass of 40 kg. The coefficient of static friction between A and B is 0.2, while the coefficient of static friction between B and the floor is 0.3. Determine the minimum force P required to cause Block B to slide (i.e. Motion impending).

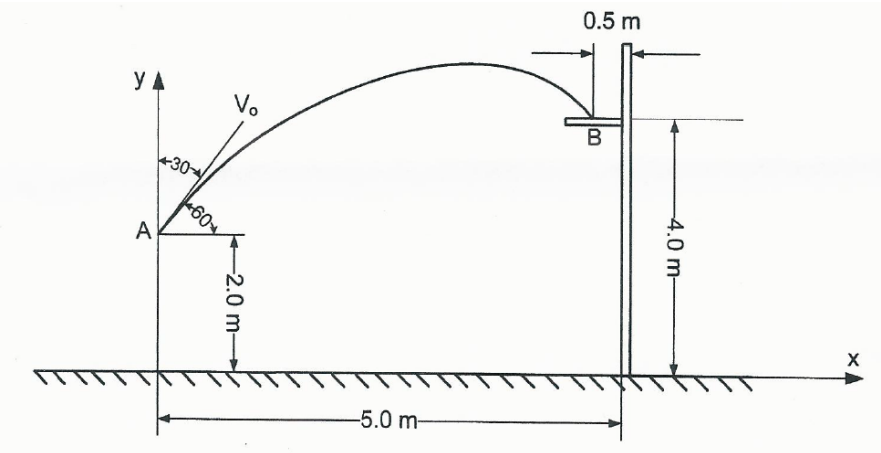


4. Parts (a) and (b) are independent.

(a) An airplane begins to take-off on the runway at point A with zero velocity and a constant acceleration a. Knowing that it will take off 30s later at point B and that the distance AB is 900m, determine (a) the acceleration a, (b) the take-off velocity V_B.



(b) A basketball player threw the ball at point A with an initial velocity, V_o, which makes 60° with the horizontal. It falls through a hoop at B. Determine the initial velocity, V_o, of the ball ($g=9.81 m/s^2$).



Useful Equations:

$$x = x_o + vt \qquad x = x_o + v_o t + \frac{1}{2}at^2 \qquad \sum \vec{F} = m\vec{a}$$

$$v = v_o + at \qquad v^2 = v_o^2 + 2a(x - x_o)$$

$$\sum F_x = ma_x \quad , \quad \sum F_y = ma_y \quad , \quad \sum F_z = ma_z$$