NATIONAL EXAMINATION - MAY 2009

- STATICS AND DYNAMICS -

(04-BS-3)

3 HOURS' DURATION

Notes:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer-paper a clear statement of any assumption made.

2. This is a **"CLOSED BOOK"** examination. However, candidates may bring **ONE 8½"×11" sheet** of self-prepared notes. Candidates may use one of two calculators, the **Casio** or a **Sharp** approved models.

3. Squared paper will be provided, on request of the candidate, as an aid in the conducting of graphical solutions, if that is the method of solution preferred.

4. Candidates are required to complete **2 questions from PART A** and **2 questions from PART B**.

5. If more than four questions are presented for assessment then only the **first four undeleted solutions encountered will be marked**.

6. All questions are of equal value.

PART A - STATICS
(ANSWER ANY 2 0F THE 3 QUESTIONS)

I. Find the forces acting on all of the pins of the frame shown in figure 1. Each of the pulleys has a mass of 75 kg and may be assumed to be frictionless.

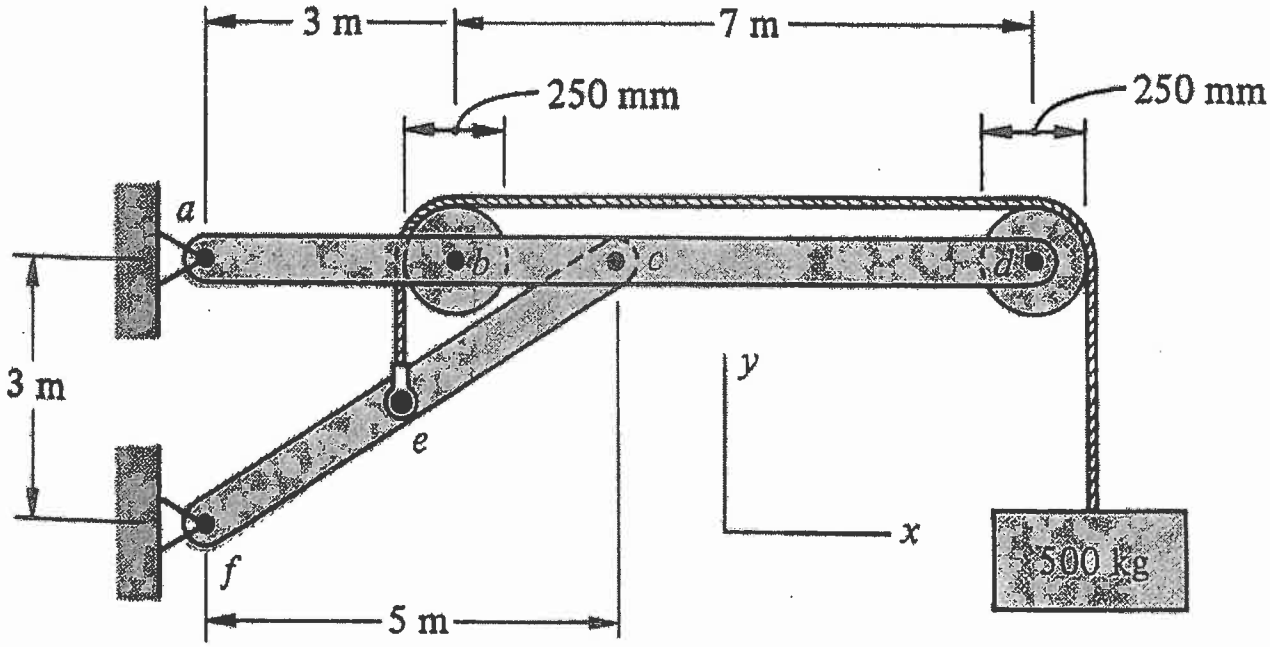

FIGURE 1.

II. A truck tailgate is shown in figure 2. A homogeneous crate of density 120 lb_f / ft^3 rests on the 85 lb_f tailgate. The centre of mass of the tailgate is located 7.5 inches from the z-axis in the positive x direction and 32.5 inches from the x-axes in the positive z direction. Assuming the hinges at ***a*** and ***b*** do not exert any force in the z direction, determine using ***cartesian vector methods***:

a) the tensile force in the chain supporting the tailgate, and

b) the total forces acting on the hinge pins at ***a*** and ***b***.

HINT: Use point ***b*** as a reference point for moments.

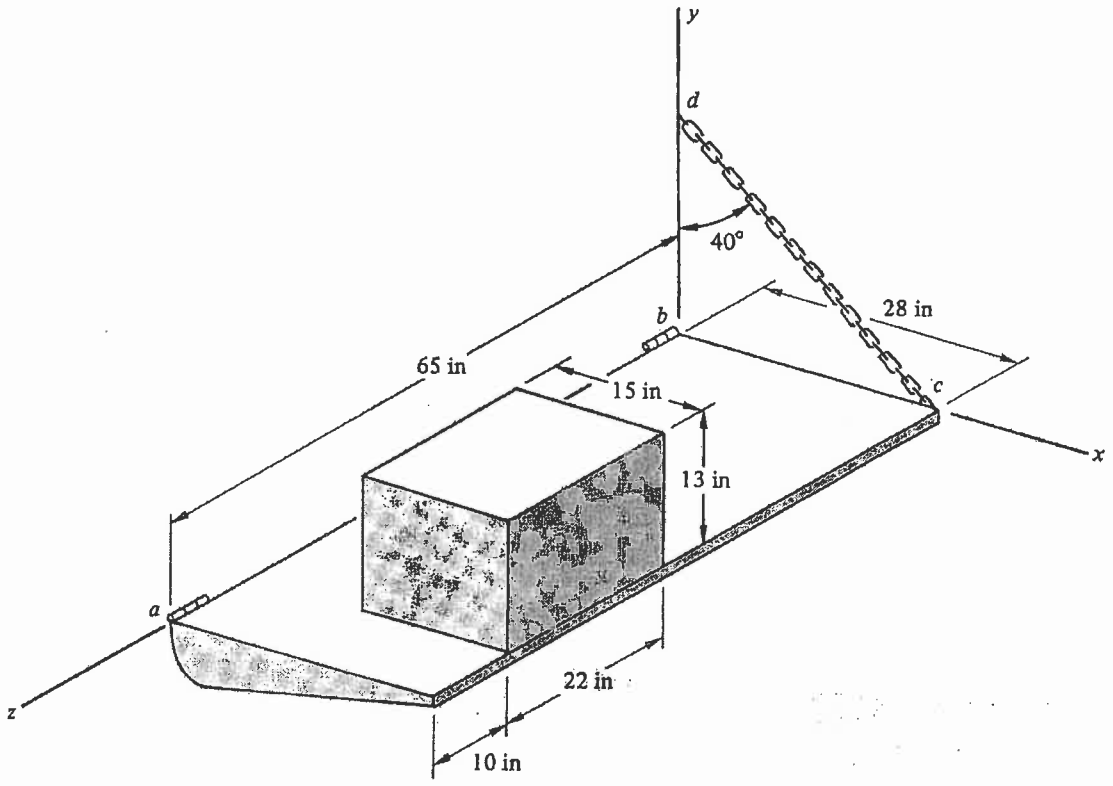

FIGURE 2.

III. In figure 3, block A weighs 5 lb_f and block B weighs 3 lb_f.

a) Determine the minimum value of the spring force required to hold block A in the position shown and the corresponding value of the pin force at a.

b) The spring is replaced by a counterclockwise couple, in the plane of the figure, applied to the link. Determine the magnitude of the couple so that motion of block A will be impending and the corresponding value of the pin force at a.

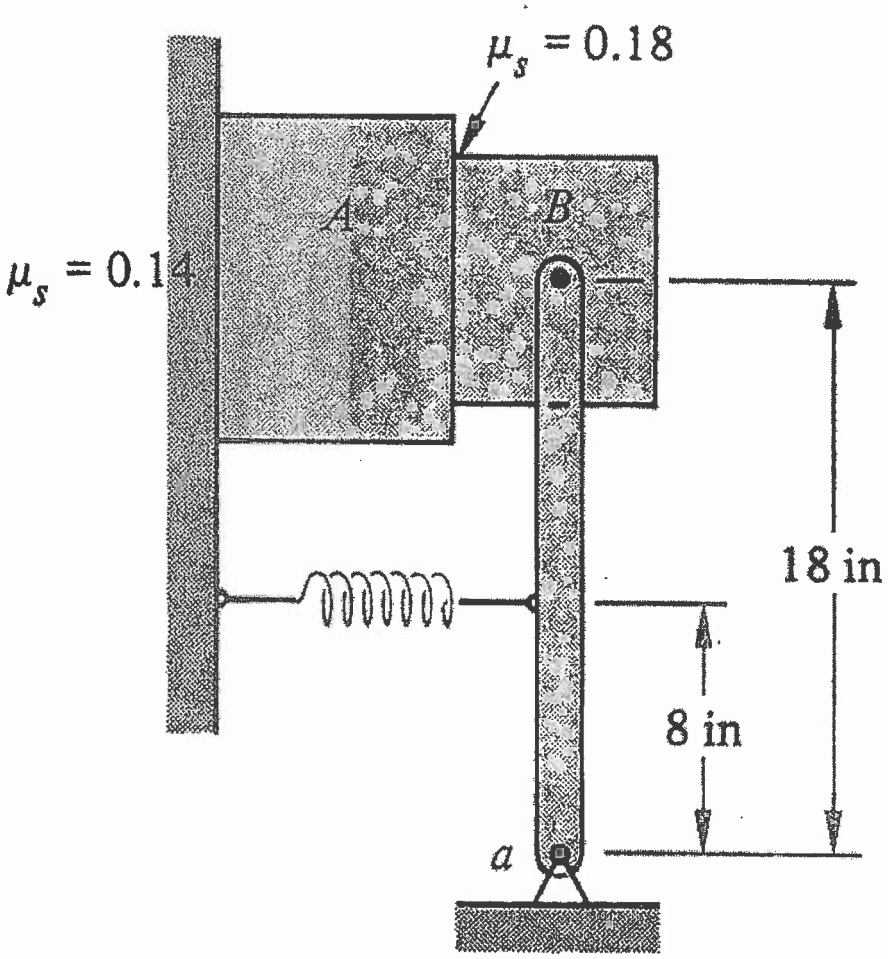

FIGURE 3.

PART B - DYNAMICS
(ANSWER ANY 2 0F THE 3 QUESTIONS)

IV. The system shown in figure 4 is initially at rest. A second block of mass 3.5 kg is attached to block ***B***. Determine the angular velocity of the pulley when block ***A*** has moved through a distance of 1.75 metres. Neglect the mass of the pulley.

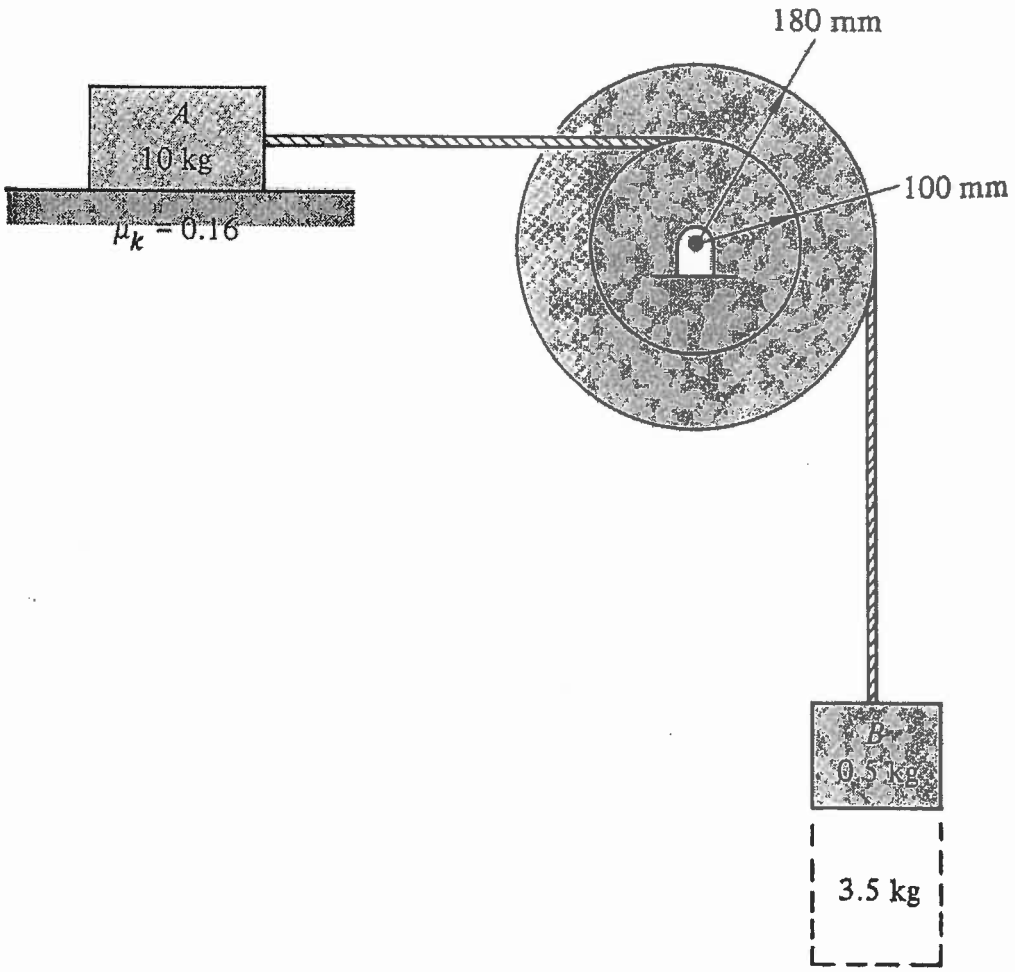

FIGURE 4.

V. Block ***B***, which has a mass of 600 grams rests on the edge of a table, as shown in figure 5. A second block, block ***A***, which has a mass of 400 grams moves to the right with a velocity of v_A and strikes block ***B***, causing the trajectory shown in the figure. The coefficient of restitution of the impact is 0.95. Determine the initial velocity v_A and the final velocity v_A' of block ***A***.

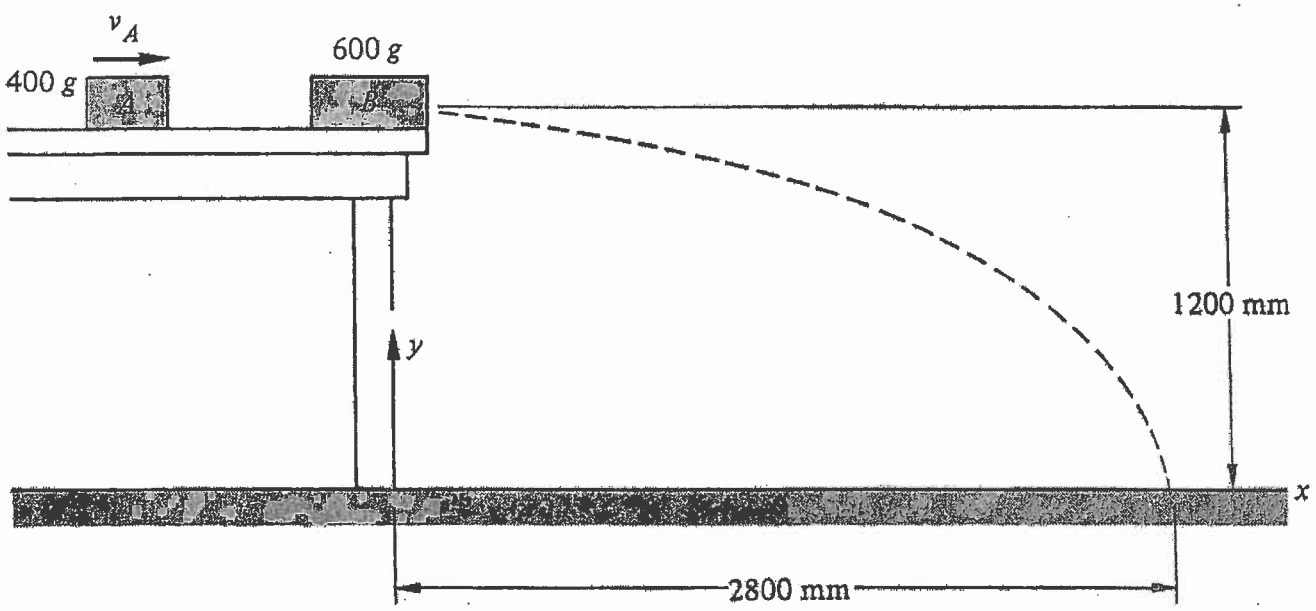

FIGURE 5.

VI. The rotor assembly shown in figure **6A** consists of a solid aluminium disk to which is attached a brass plug. The rotor assembly is mounted in the horizontal plane and a set of *xyz* axes is attached to the disk. An inextensible cable is wrapped around the rim of the disk and is connected to a 600 gram mass.

a) Find the mass, and the location of the centre of mass, of the rotor assembly, and the mass moment of inertia of the assembly about the axis of rotation.
b) Determine the acceleration of the mass and of the rotor assembly, and the cable tensile force.
c) Find the horizontal components of the force on the rotor assembly hinge pin 2 seconds after the mass is released from rest. Assume that the initial angular position of the rotor assembly was such that, at $t = 2$ seconds, the cable force is parallel to the y-axis and acting in the negative sense of this axis, as shown in figure 6B.

The density of brass is 8550 kg/m^3 and the density of aluminium is 2770 kg/m^3.
Neglect any friction between the rotor and the cable.

The mass moment of inertia for a cylinder is $I_{oz} = \frac{1}{8} m d^2$

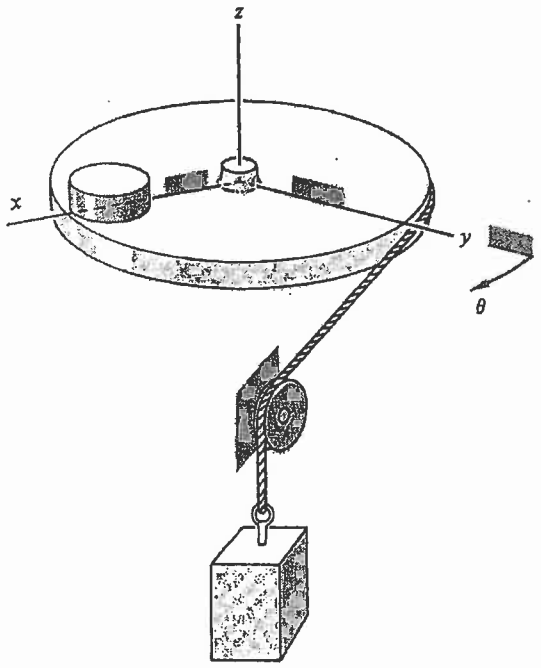

FIGURE 6A.
(See next page for Figure 6B)

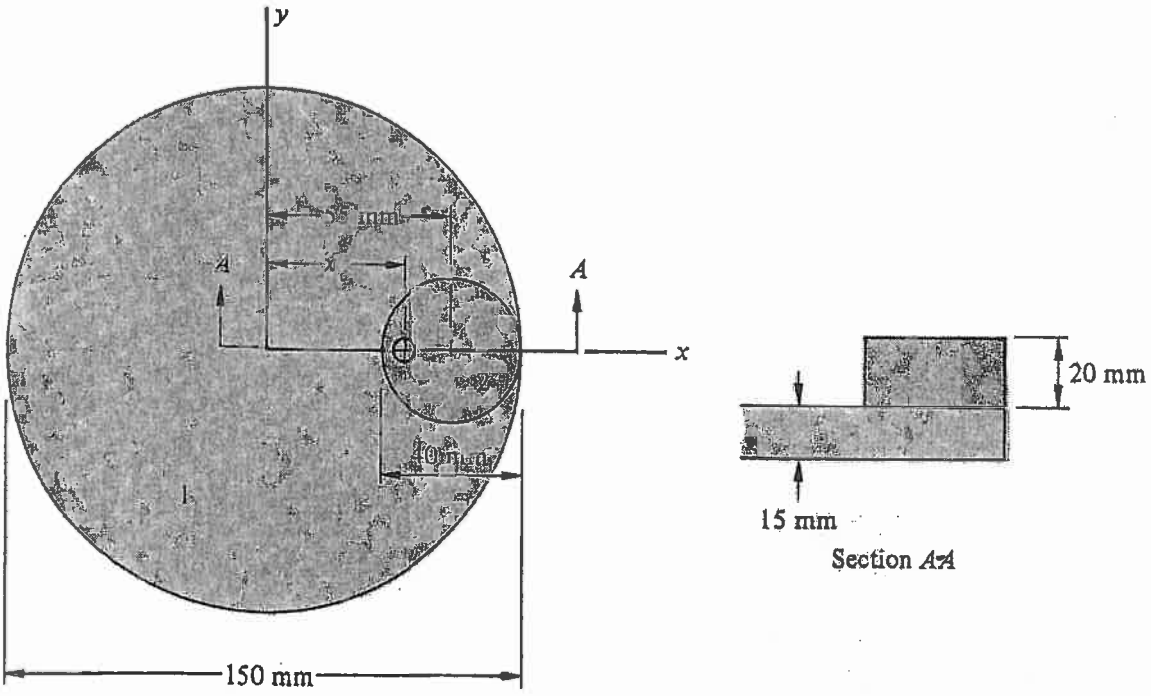

FIGURE 6B.