NATIONAL EXAMINATION - MAY 2017

04-BS-3, STATICS AND DYNAMICS

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. A rigid, weightless boom supports a weight of 800 N as shown in figure 1. The boom is hinged so that its motion is restricted to the x-y plane. Using **cartesian vector** methods determine;

a) the tensile force in the cable ***a-b*** between the boom and the wall,
b) the reaction force and the moment acting at point ***"O"*** on the boom.

NOTE: Express your answers in cartesian vector form.

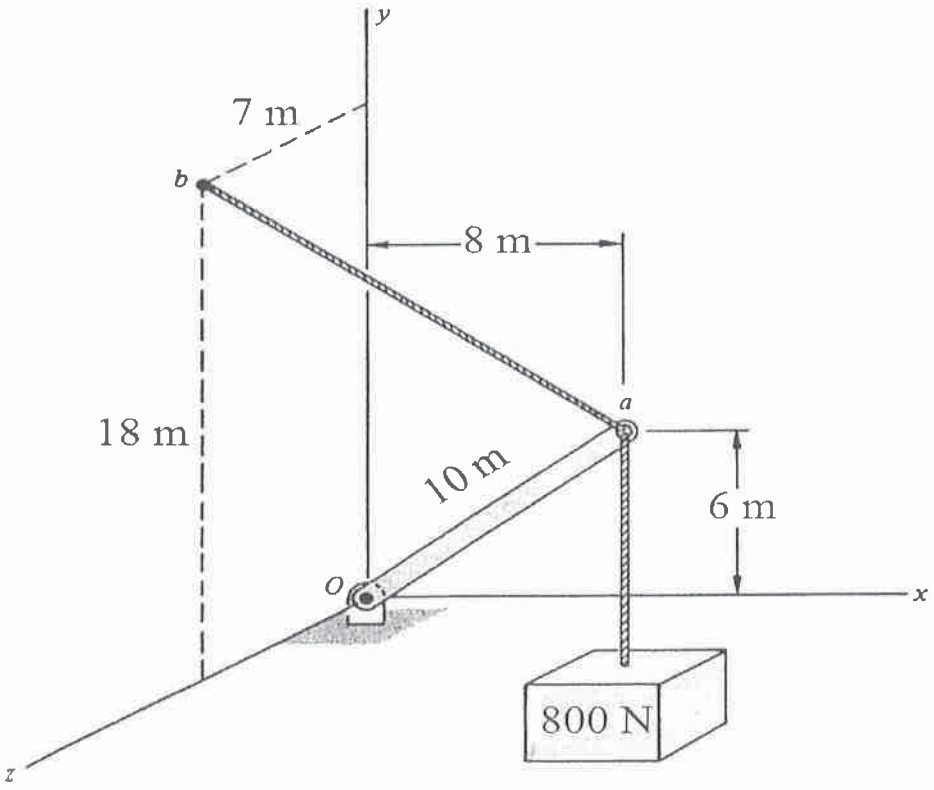

FIGURE 1.

II. Determine the magnitude and sense of the forces in all of the members for the structure shown in figure 2.

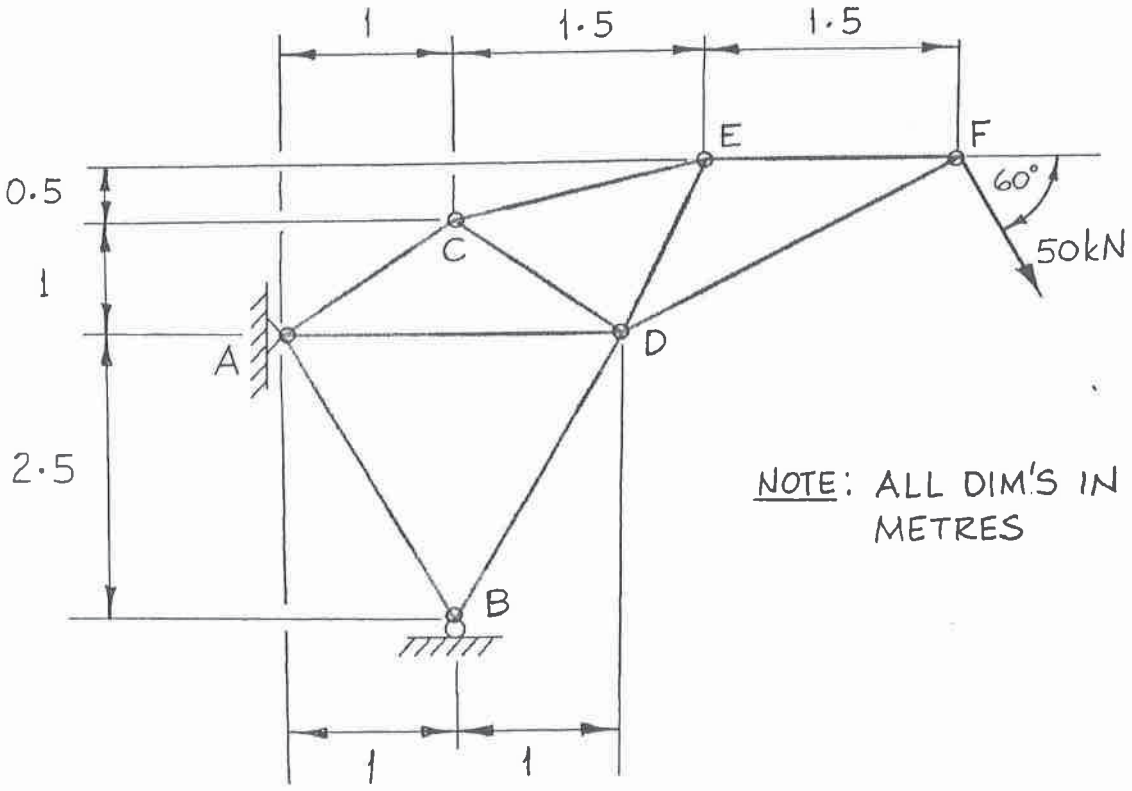

FIGURE 2.

III. Block ***A*** has a weight of 50 Newtons, and block ***B*** weighs 100 Newtons. Sliding motion is impending for the configuration shown in figure 2. Determine the value of the coefficient of static friction between block ***B*** and the inclined surface if the contacting surfaces of block ***A*** and the plane are assumed to be frictionless.

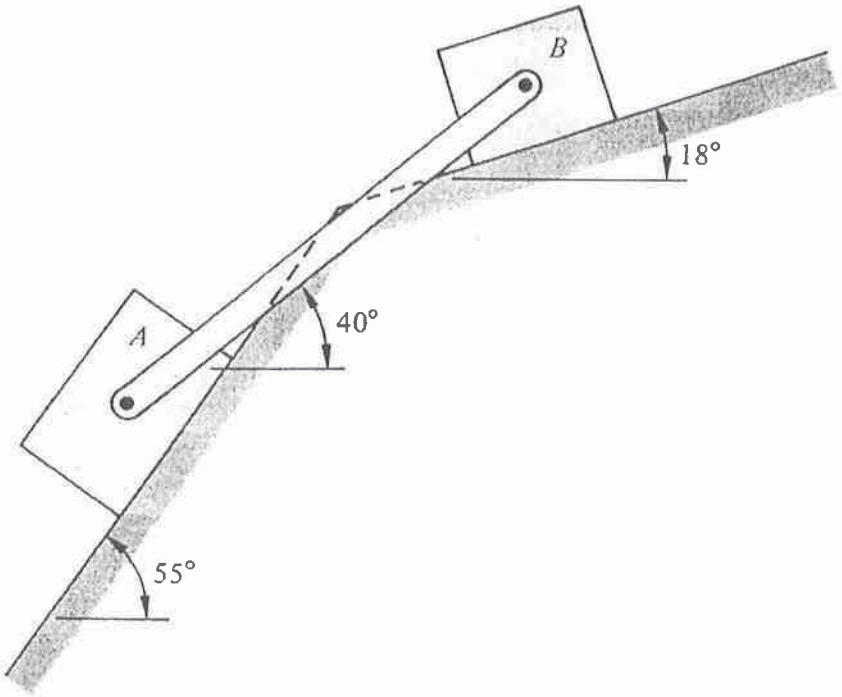

FIGURE 3.

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

IV. At time $t = 0$ vehicle ***B*** just passes beneath the centre of the overpass and vehicle ***A*** is 1000 ft away from the centre of the overpass. At this instant $v_A = 35$ mi/hr and vehicle ***A*** starts to accelerate at 4 ft/sec^2, while vehicle ***B*** continues at a speed of 55 mi/hr. Determine the relative displacement, velocity and acceleration of vehicle ***A*** with respect to vehicle ***B*** at the time that vehicle ***A*** crosses the centre of the overpass.

Note: 1 mile = 5280 ft

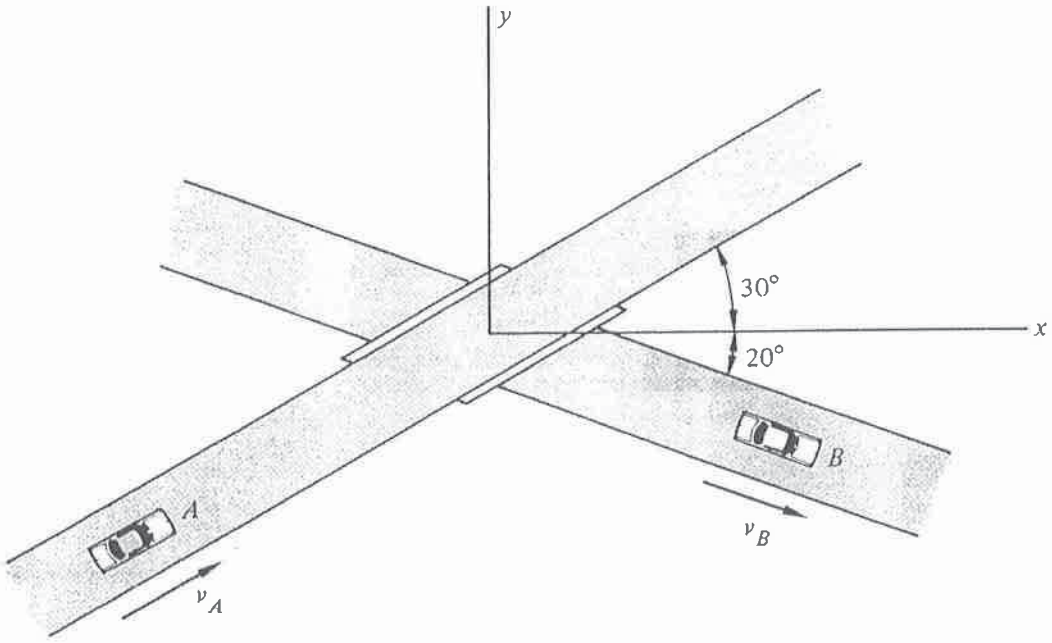

FIGURE 4.

V. The simple pendulum in figure 5 is released from rest at position $\theta = 20$ degrees. Sphere ***A*** impacts sphere ***B***, which is initially at rest in the position shown. Both spheres have a mass of $m = 150$ grams. The length of the string attached to sphere ***A*** is $l = 900$ mm. If the coefficient of restitution is $e = 0.92$ for the impact between the two spheres, determine the values of x (horizontal distance) and y (maximum vertical height) of the trajectory of sphere ***B*** after the impact.

Note: All frictional effects may be neglected, and the mass of the string is negligible.

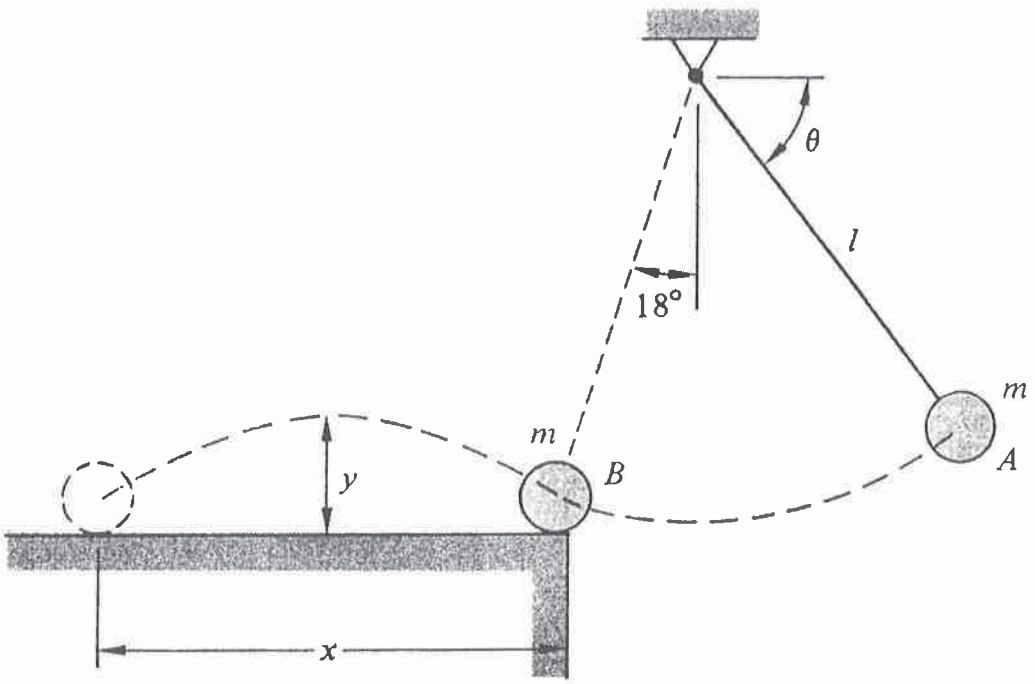

FIGURE 5.

VI. (Note: Parts A and B of this question have equal value.)

Figure 6 shows a model of a cylinder-crank arrangement for an internal combustion engine. When the piston is in the position shown in the figure, it has a downward velocity of 180 in/sec.

A) Determine the corresponding angular velocity of the crank ***bc***.

B) Assuming that the crank ***bc*** has a constant angular velocity and direction as found from part A, determine the angular acceleration of the connecting rod ***ab*** and the acceleration of point ***a*** on the piston.

Note: Assume the mass of the crank, connecting rod and piston to be negligible.

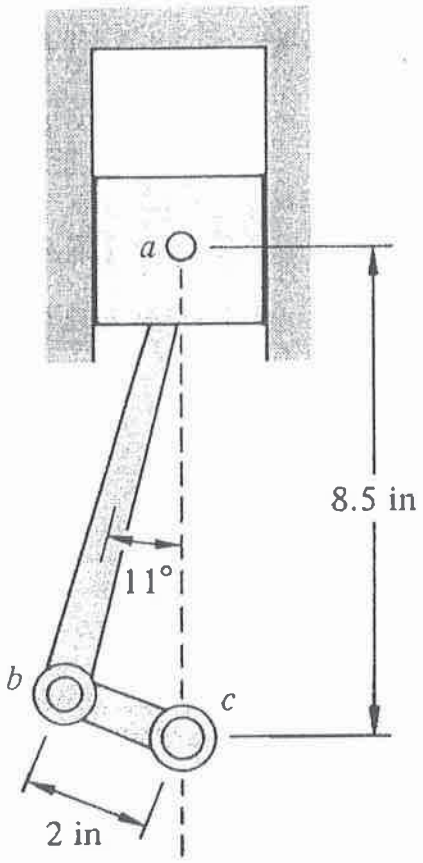

FIGURE 6.