NATIONAL EXAMINATION - DECEMBER 2019

- 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 **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.

7. **The 8½"×11" sheet of self-prepared notes MUST be submitted along with the examination paper and the answer booklet.**

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

I. The rod assembly is used to support the 250 N cylinder at ***F***, as shown in the figure. Using ***cartesian vector methods***, determine the components of reaction at the ball-and-socket joint ***A***, the smooth journal bearing ***E***, and the force developed along rod ***CD***. The connections at ***C*** and ***D*** are ball-and-socket joints.

NOTE: Neglect the weight of the rod members.

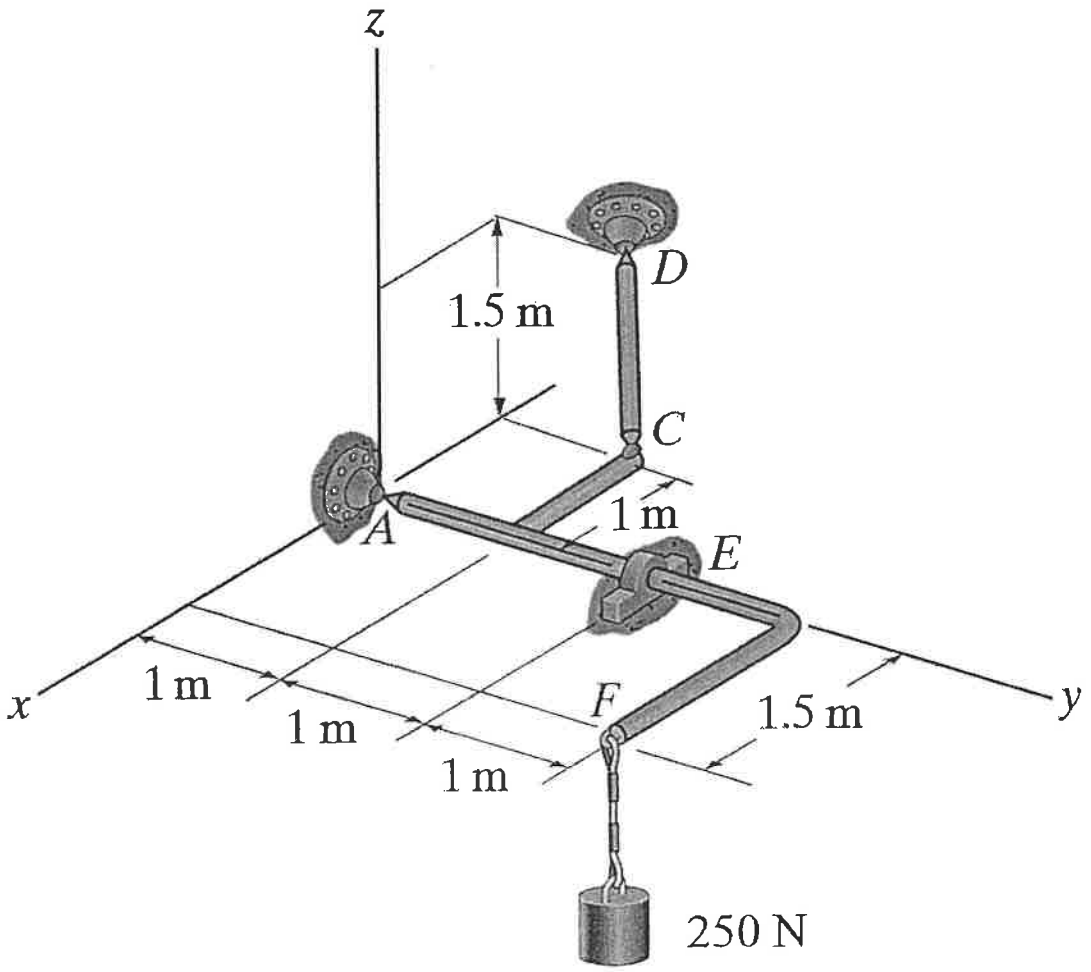

FIGURE 1.

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

NOTE: Each division on the grid shown represents 1 metre.

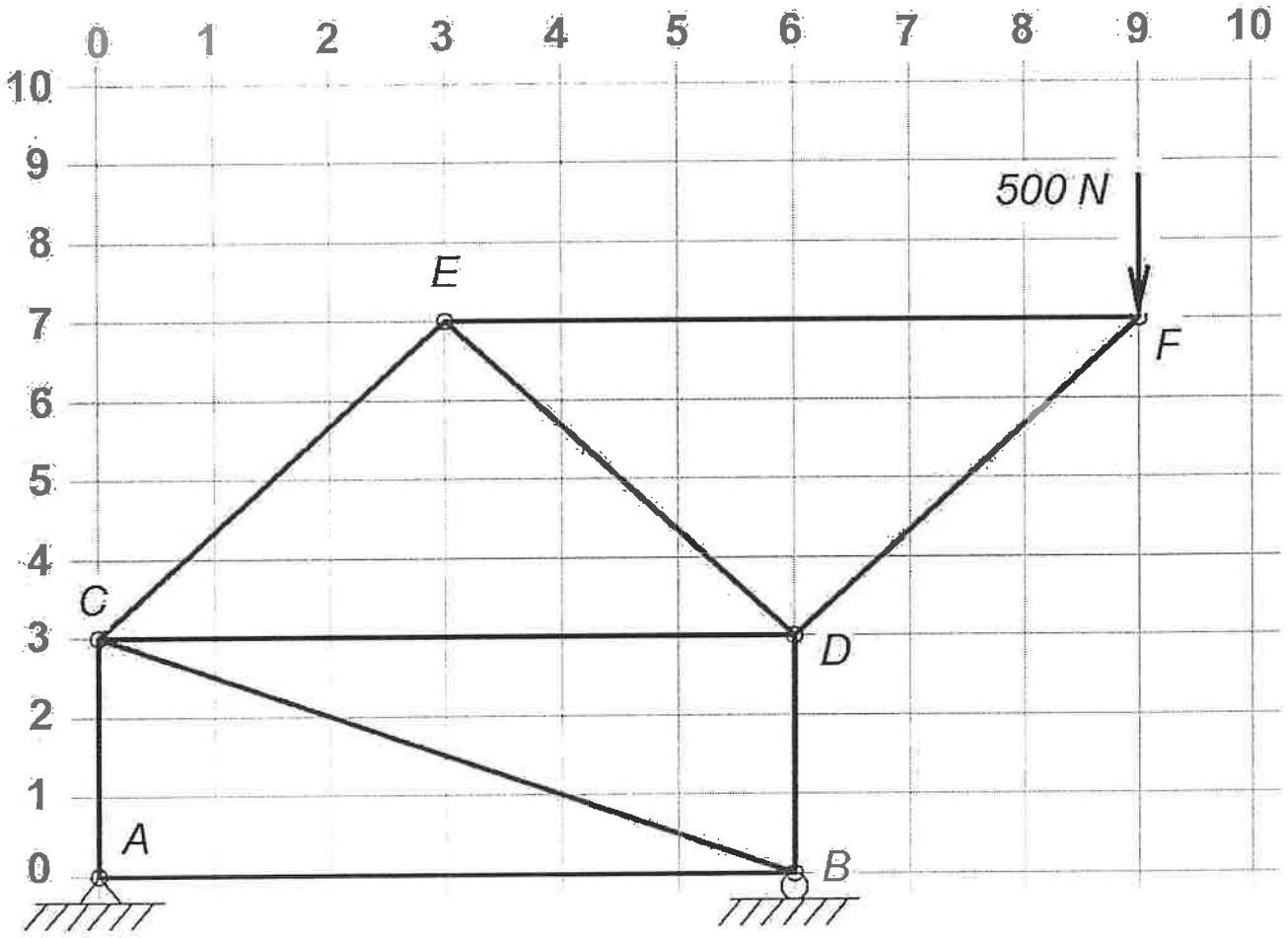

FIGURE 2.

III. Block A weighs 50 N and block B weighs 30 N. Using the coefficients of static friction indicated; determine the greatest weight of block D that will not cause motion. Clearly state all initial assumptions and verify their validity.

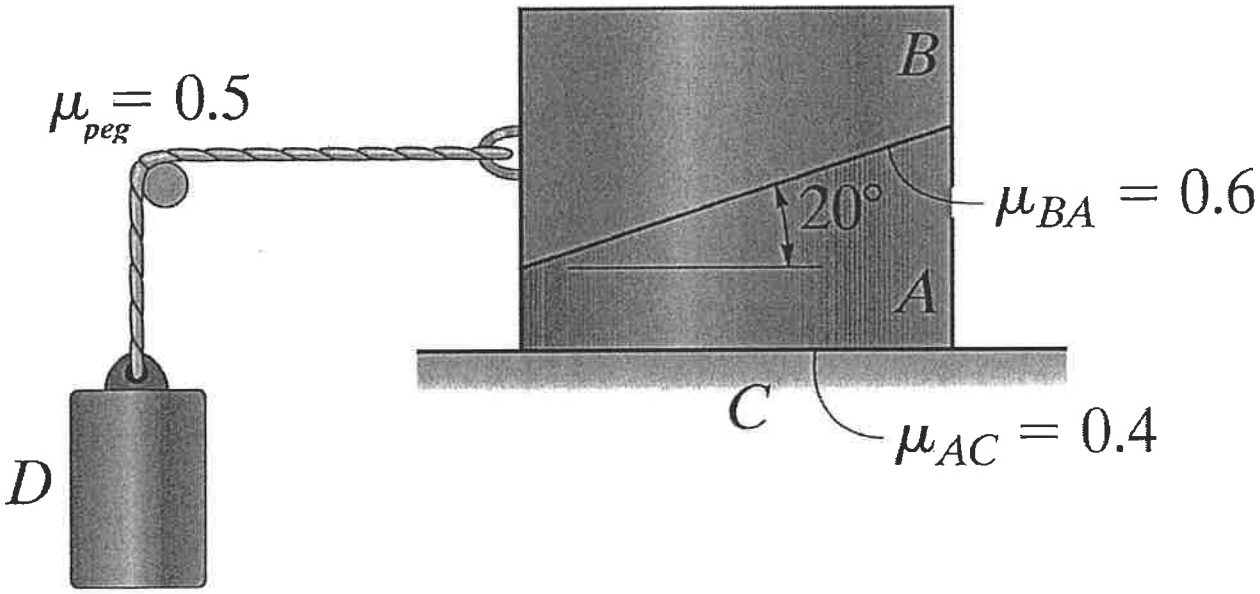

FIGURE 3.

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

IV. The pendulum, shown in figure 4, consists of a 45 N sphere and an 18 N slender rod. The pendulum rotates about a frictionless pin at ***O***. The coefficient of restitution between the sphere and the concrete floor is equal to $e = 0.8$. If the pendulum is released from rest when $\theta = 60°$, determine;

a) The velocity at which the sphere hits the solid concrete floor.

b) The angle θ of rebound after the sphere strikes the floor.

The mass moments of inertia for the slender rod and the sphere about their centres of gravity are,

$$(I_G)rod = \frac{1}{12}\, ml^2 \qquad (I_G)sphere = \frac{2}{5}\, mr^2$$

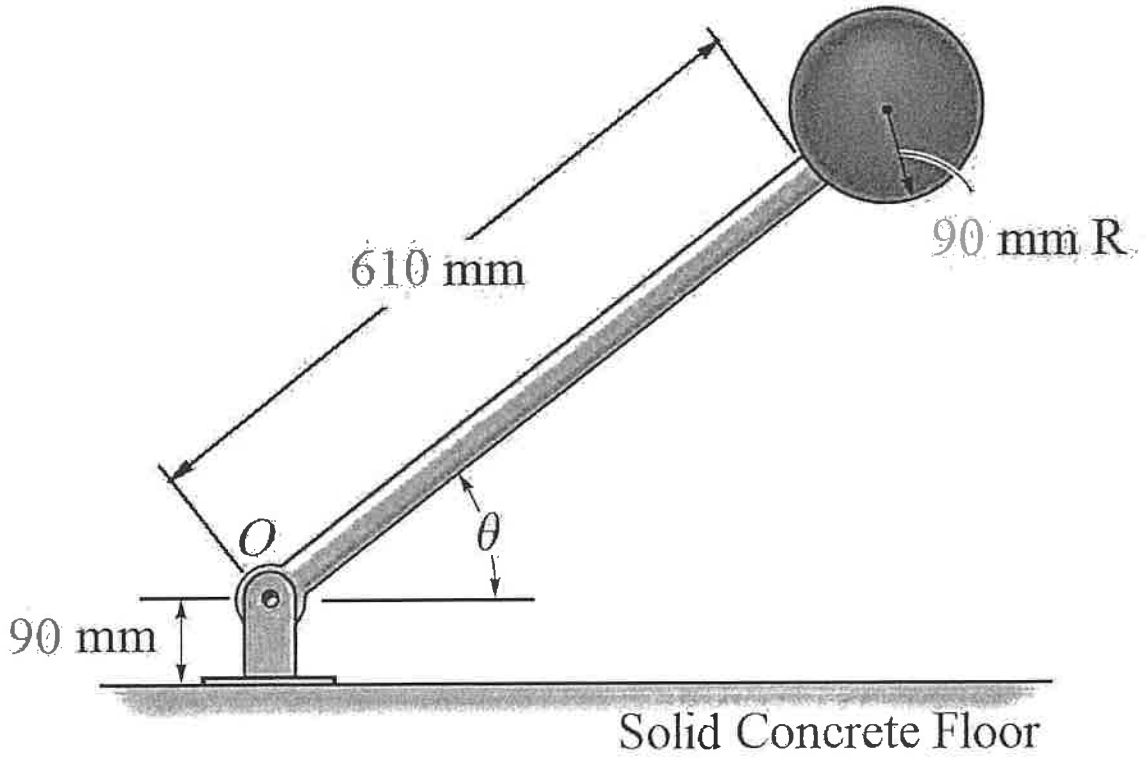

FIGURE 4.

V. A crate weighing10 lb_f exits off the conveyor belt at point A with a velocity $v_A = 2.5$ ft/s and slides down the inclined surface AB. The crate's velocity v_A is parallel to the surface AB. If the coefficient of kinetic friction between the crate and surface AB is $\mu_k = 0.2$, determine the distance x when the box falls onto the cart at point C.

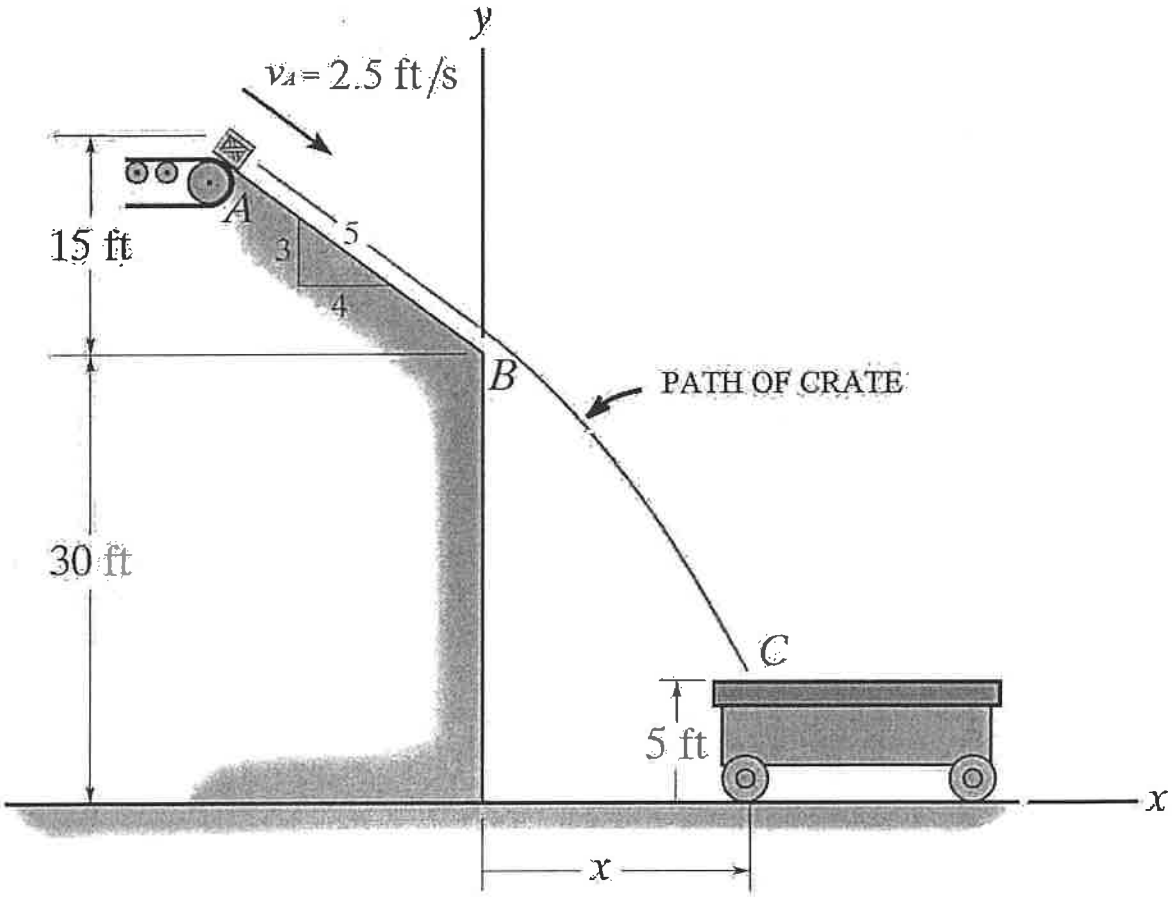

FIGURE 5.

VI. At the instant shown, crank ***CB*** has a constant angular velocity of 2 rad/s counter-clockwise and is horizontal. When ***CB*** is in this position the link ***OA*** is vertical. For this instant, determine,
a) The angular velocities of links ***OA*** and ***AB***
b) The angular accelerations of ***OA*** and ***AB***.

Neglect the mass of the links and any friction at the pins.

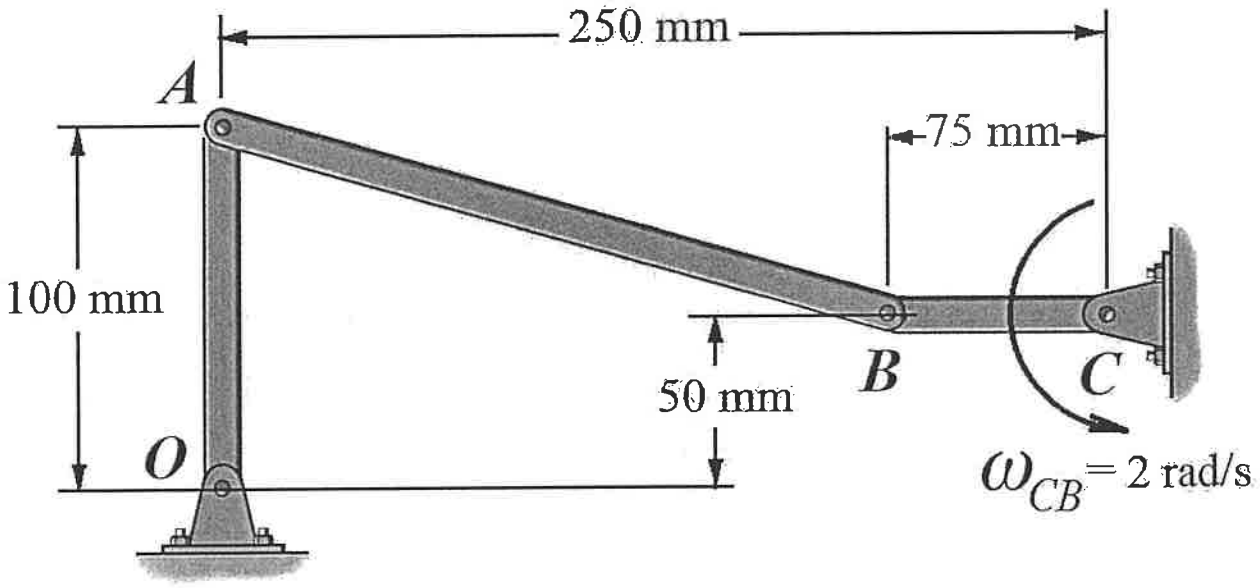

FIGURE 6.