NATIONAL EXAMINATION - DECEMBER 2017

- 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. The pipe assembly supports the vertical loads, as shown in figure 1. Using ***cartesian vector methods***, determine the components of reaction at the ball-and-socket joint A and the tension in the supporting cables BC and BD.

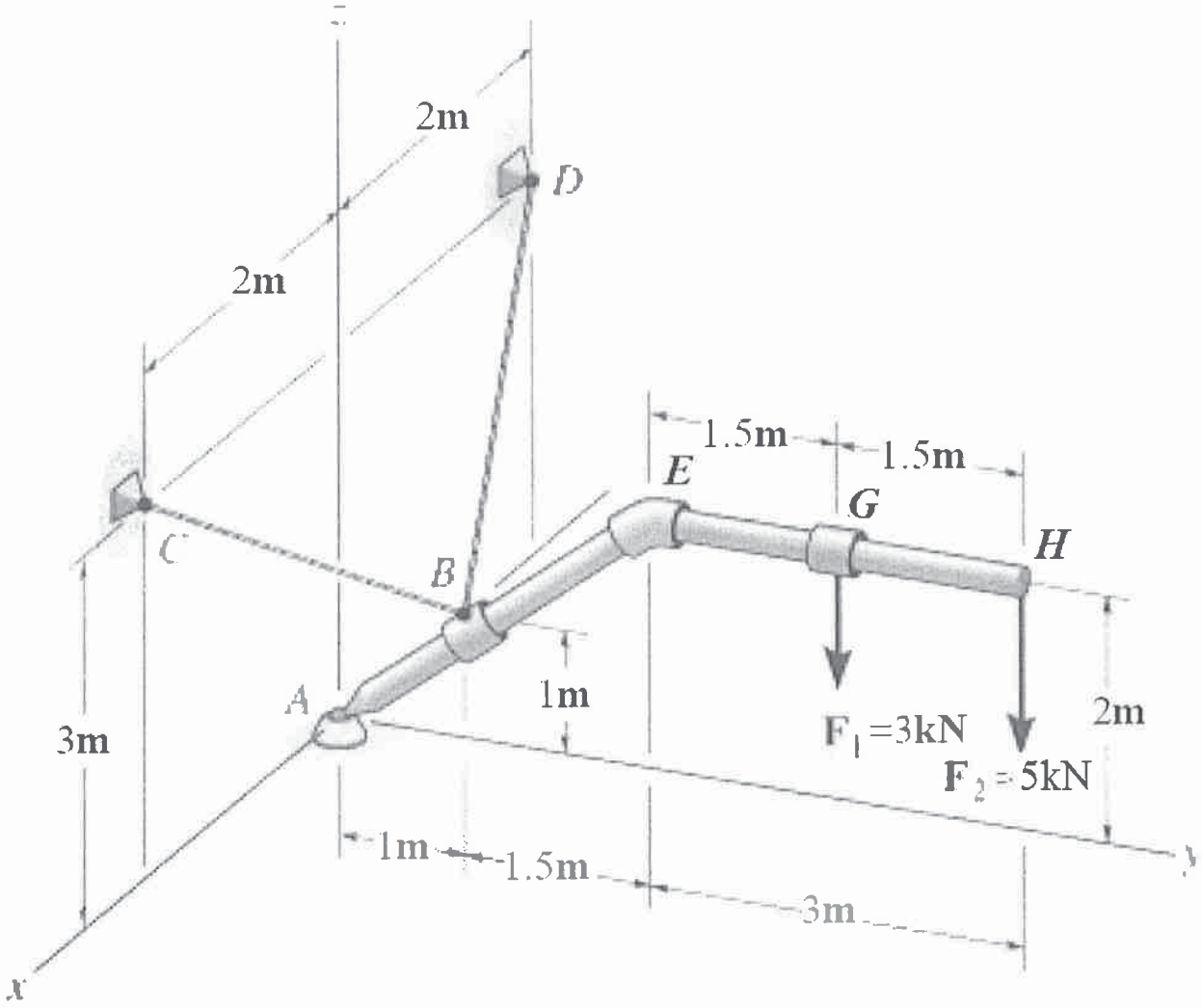

FIGURE 1.

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

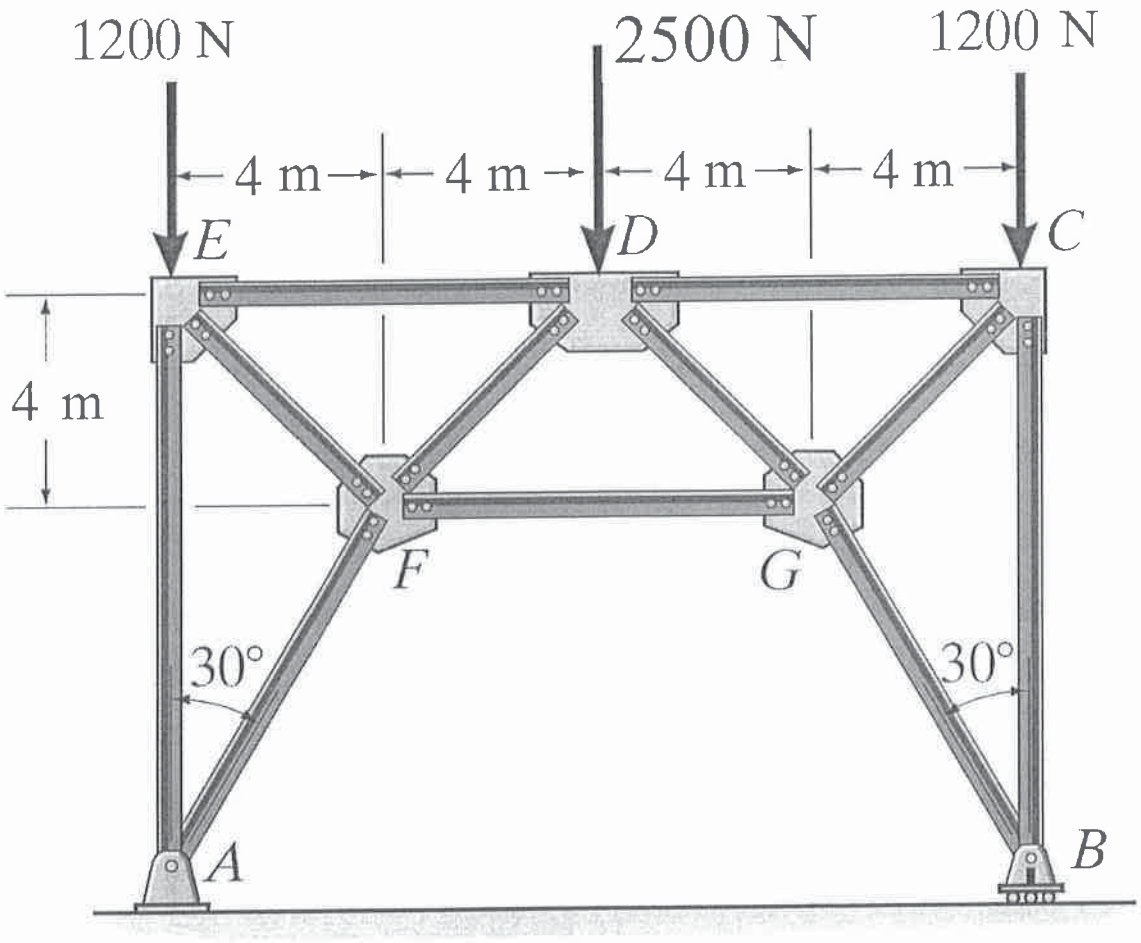

FIGURE 2.

III. The truck in figure 3 has a mass of 1.5 Mg and a center of mass at G. The coefficient of static friction between all four wheels and the ground is $\mu_s = 0.55$, and between the crate and the ground, it is $\mu_s = 0.4$. Determine the heaviest crate the truck can pull along a horizontal surface if;

(a) The truck has rear-wheel drive while the front wheels are free to roll, and

(b) The truck has four-wheel drive.

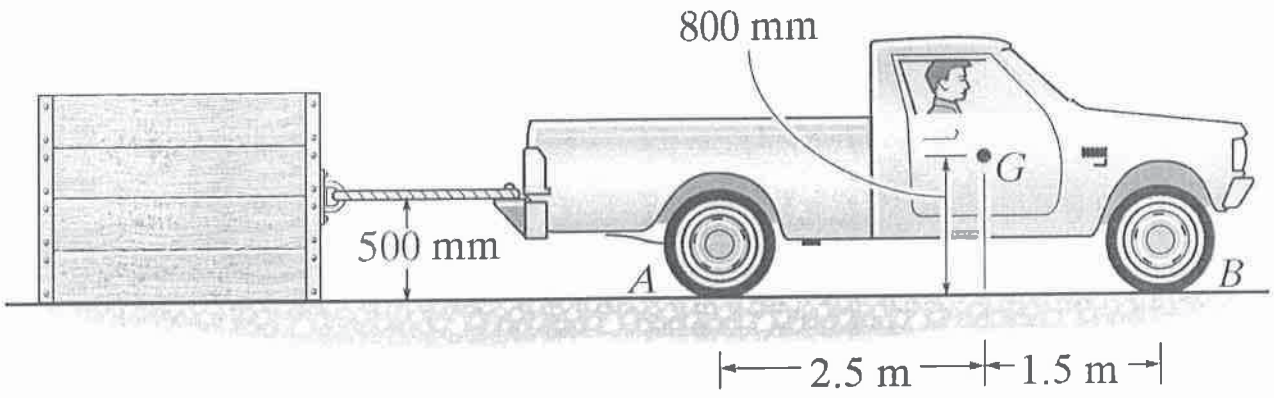

FIGURE 3.

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

IV. A drum of radius 120 mm is mounted on a wheel of radius 180 mm, as shown in figure 4. A rope is wound around the 120 mm drum.

a) If the end **E** of the rope is pulled with a constant velocity $\mathbf{v_E} = 0.6$ m/s, and the wheel rolls without slipping, determine the velocity of point **D** and the velocity of **E** relative to point **A**.

b) If the end **E** of the rope is pulled with an acceleration $\mathbf{a_E} = 1.5$ m/s^2 as well as $\mathbf{v_E} = 0.6$ m/s at the position shown in figure 2, and the wheel rolls without slipping, determine the acceleration of points **A**, **C** and **F**.

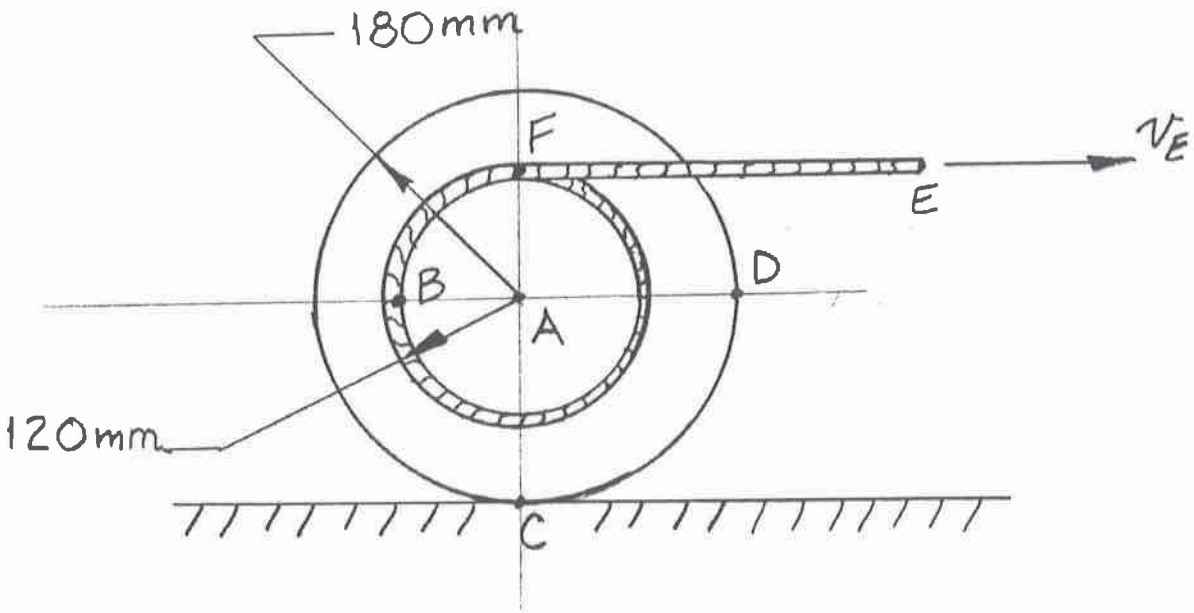

FIGURE 4

V. Block A, which weighs 20 lb_f is released from rest in the position shown in figure 5 and impacts the 40 lb_f sphere B which is at rest. If the coefficient of restitution between A and B is 0.80, determine the velocities of A and B just after the impact.

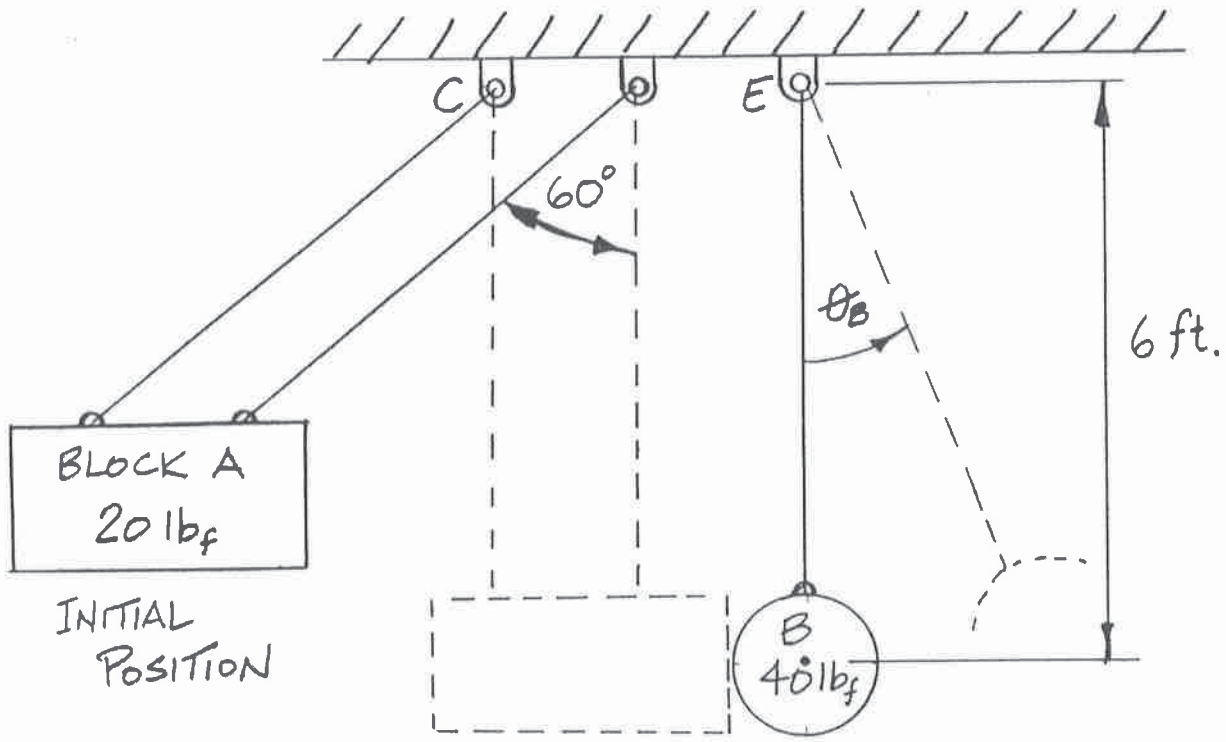

FIGURE 5.

VI. Figure 6 shows a conveyor system used to transport heavy steel plates. The two carriages have shoes which slide along an inclined steel rail, with clamping mechanisms which attach to the plate. The maximum value of the coefficient of kinetic friction between the rail and the shoes is $\mu_K = 0.015$. The plates are released with zero initial velocity from the top of the rail.

a) Derive an expression for the acceleration of the plate.
b) Derive an expression for the normal contact forces between the shoes and the rail.
c) Find the numerical results for parts (a) and (b), if the dimensions shown in the figure are ; a = 6 ft, b = 3 ft, $\beta = 28°$ and the weight of the plate is 750 lb_f .

HINT: Use D'Alembert's principle.

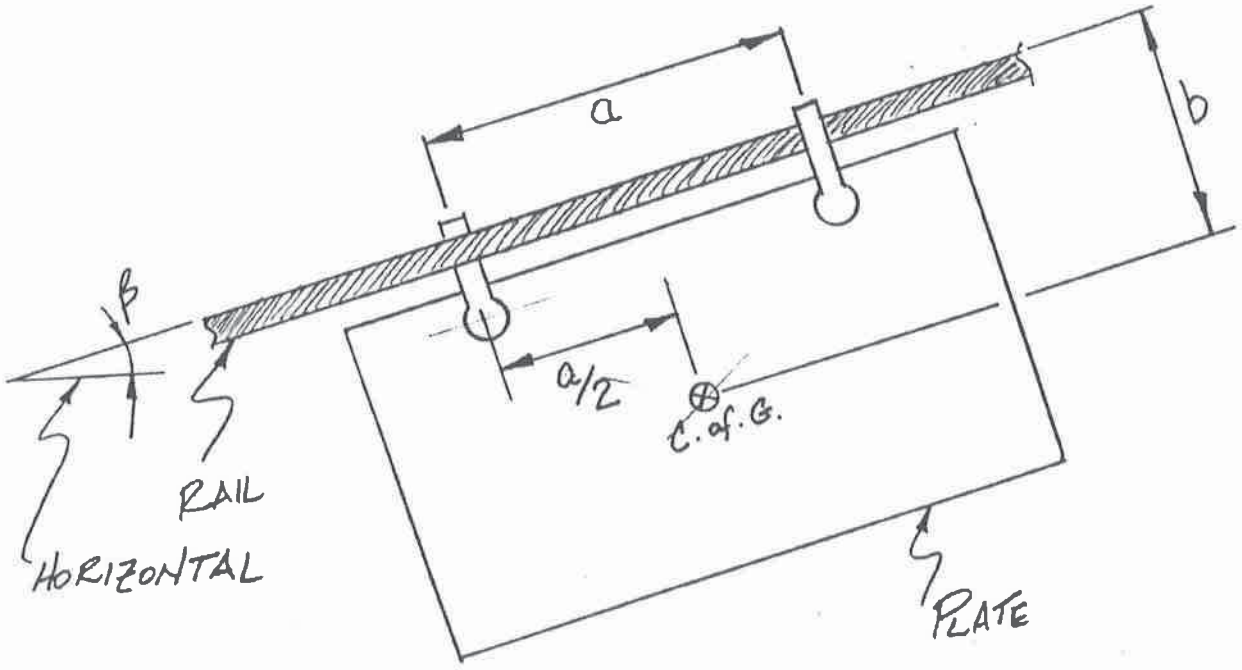

FIGURE 6.