

NATIONAL EXAMINATION - MAY 2016

- 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 formulae only. The formula sheet must be submitted with the solution booklet. Candidates may use one of two calculators, the **Casio** or a **Sharp** approved models.
3. Squared paper will be provided, \_\_\_\_\_ 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 OF THE 3 QUESTIONS)

- I. Figure 1 shows a machine part which is clamped in a vise (at the  $x, y, z$  origin). An inclined hole is to be drilled in the end of the part, as shown. The drill exerts a force of 40 N, and a couple of 3 N.m, on the part. The sense of the couple is clockwise when viewed from the lower right side of the figure. Using *cartesian vector methods*, find the force-moment system exerted by the vise (at the origin) on the part during the drilling operation. Illustrate the force-moment system on a clearly labelled diagram with axes.

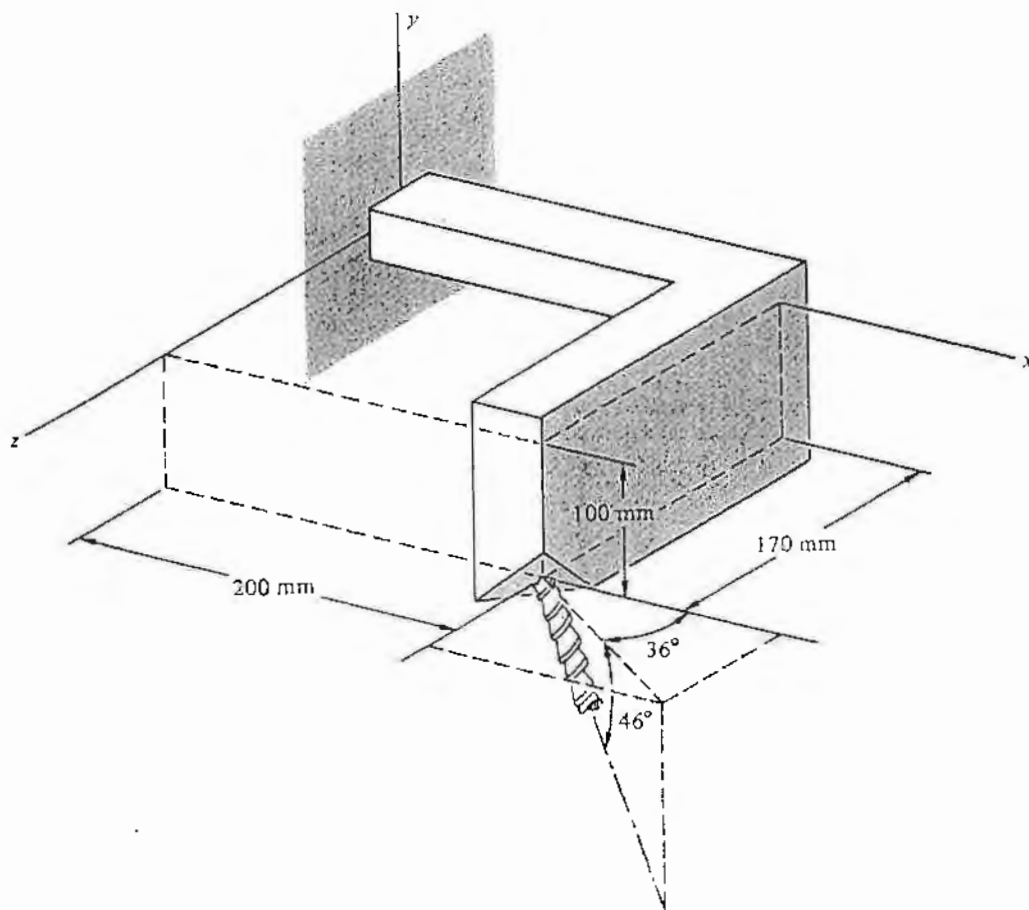
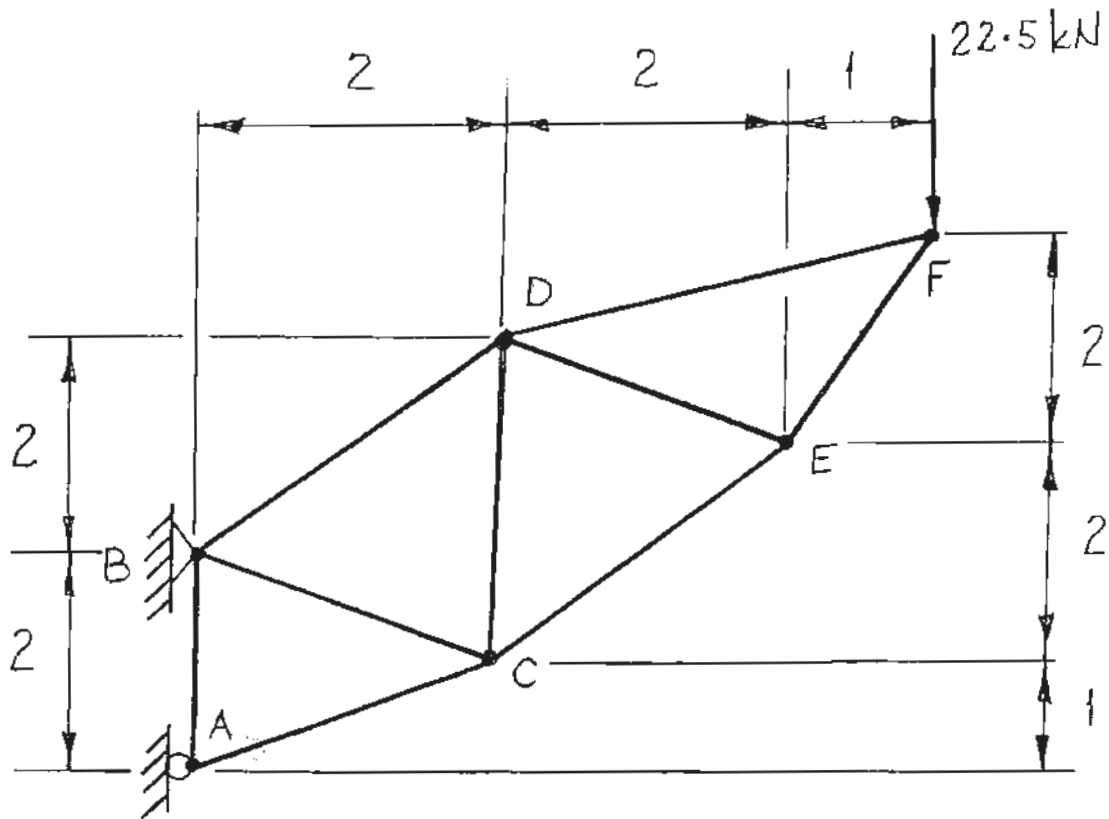


FIGURE 1.

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



NOTE: ALL DIM'S IN METRES

FIGURE 2.

III. The link in figure 3 is weightless. Block *A* weighs 100 N, and block *B* weighs 350 N. The coefficient of static friction between block *A* and *B* is  $\mu_s = 0.15$ , and between block *B* and the inclined surface  $\mu_s = 0.2$ .

A) For what range of values of *P* will the block *B* remain in the equilibrium position shown?

B) Find the corresponding range of values of the force in the link.

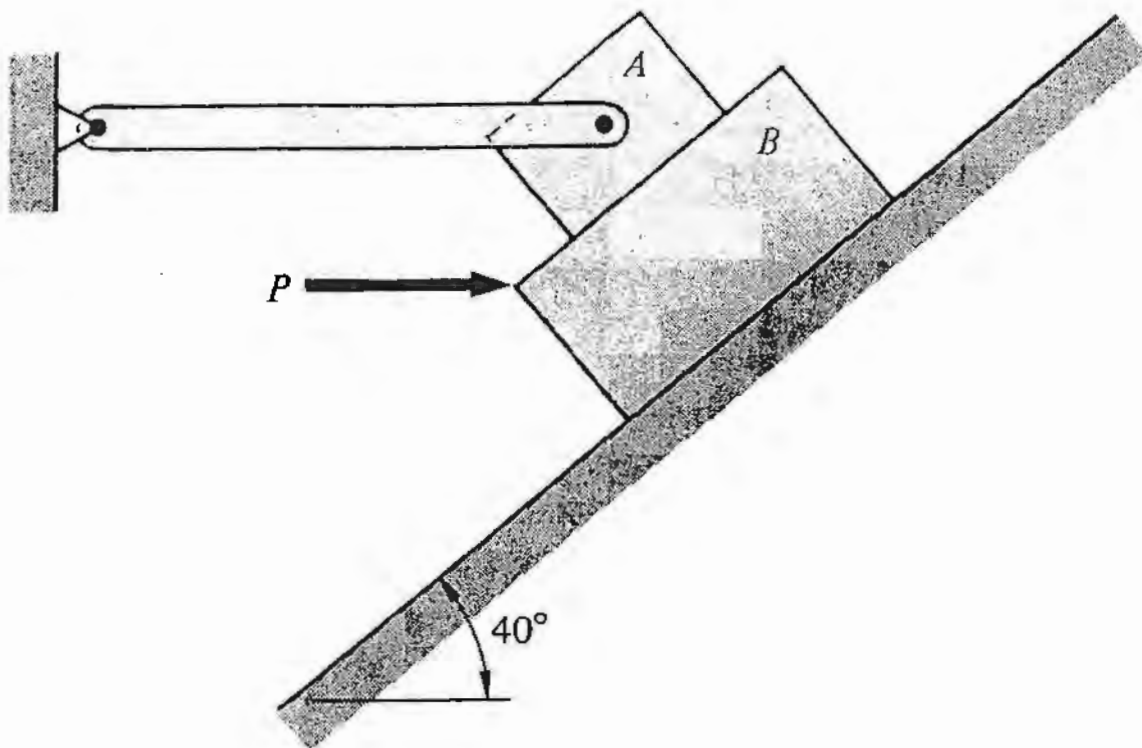
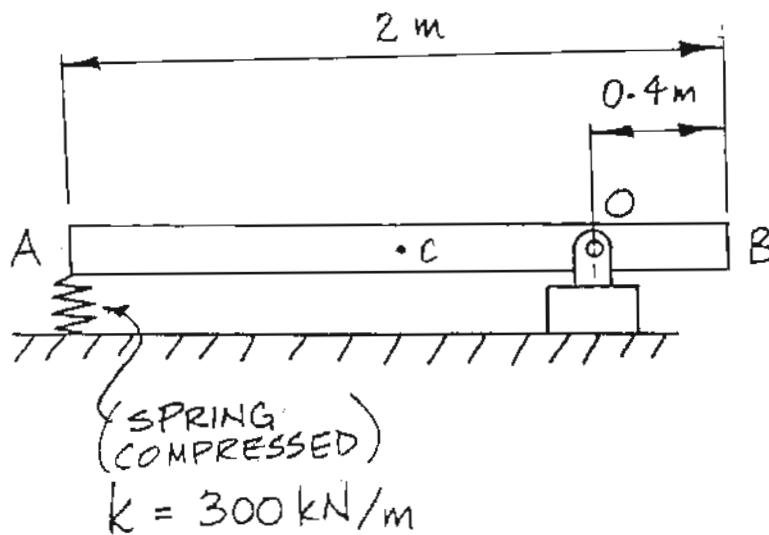


FIGURE 3.

**PART B - DYNAMICS**  
(ANSWER ANY 2 OF THE 3 QUESTIONS)

- IV. A 15 kg slender rod AB is 2 m long and is pivoted about point O which is 0.4 m from end B. End A of the rod is pressed against a spring of constant  $k = 300 \text{ kN/m}$  until the spring is compressed 25 mm. The rod is then in a horizontal position, as shown in figure 4. If the rod is released from this position, determine the rod's angular velocity and the reaction forces at the pivot O as the rod passes through a vertical position.



NOTE: FOR A SLENDER ROD;  $I_c = \frac{1}{12} mL^2$

FIGURE 4.

- V. At the instant shown in figure 5, block **B** is released with zero initial velocity. The velocity of block **A**,  $v_A$ , is constant, and the blocks collide at a position 20 inches from the original position of block **B**. The impact is assumed to be elastic. Block **A** weighs 10 lb<sub>f</sub> and block **B** weighs 12 lb<sub>f</sub>.
- A) Find the velocities of the blocks after impact.  
B) Find the value of the impulse.

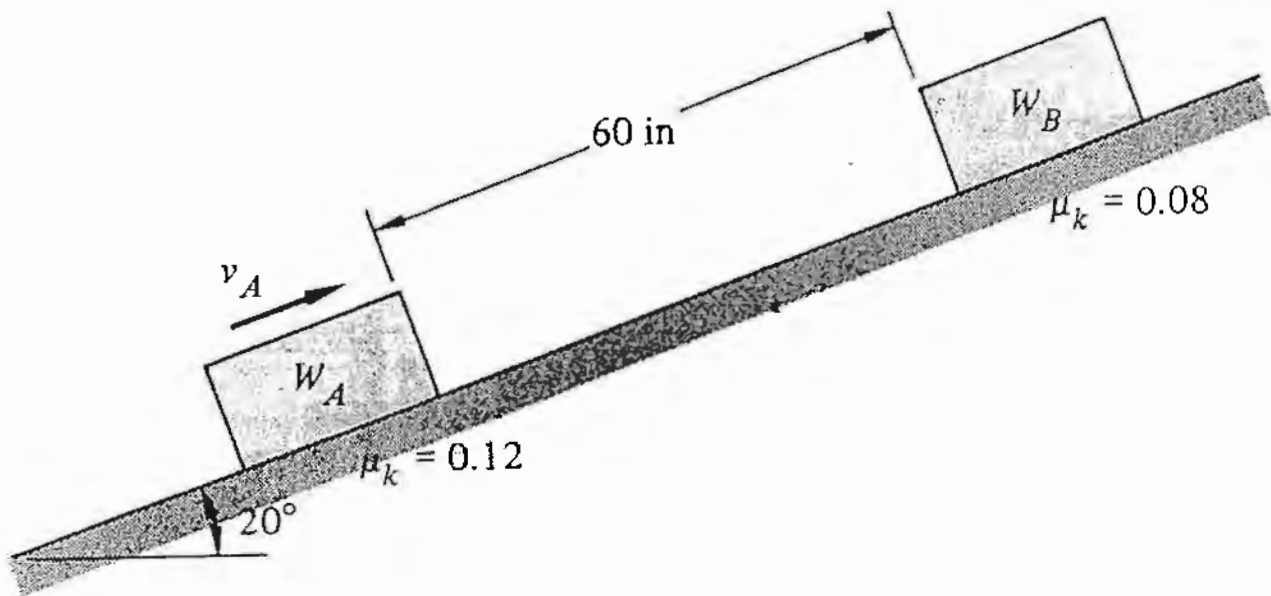


FIGURE 5.

- VI. Figure 6 shows a plane frictionless sliding mechanism. Slider block A moves to the left with a constant velocity of 4 m/sec. Neglecting the masses of the blocks and the link, determine;
- the angular velocity of the link AB.
  - the velocity of the slider block B.
  - the magnitude, direction, and the sense of the velocity of point "a" on the link.
- and
- illustrate the velocities of the blocks and the velocity of point "a" on a clearly labelled diagram.

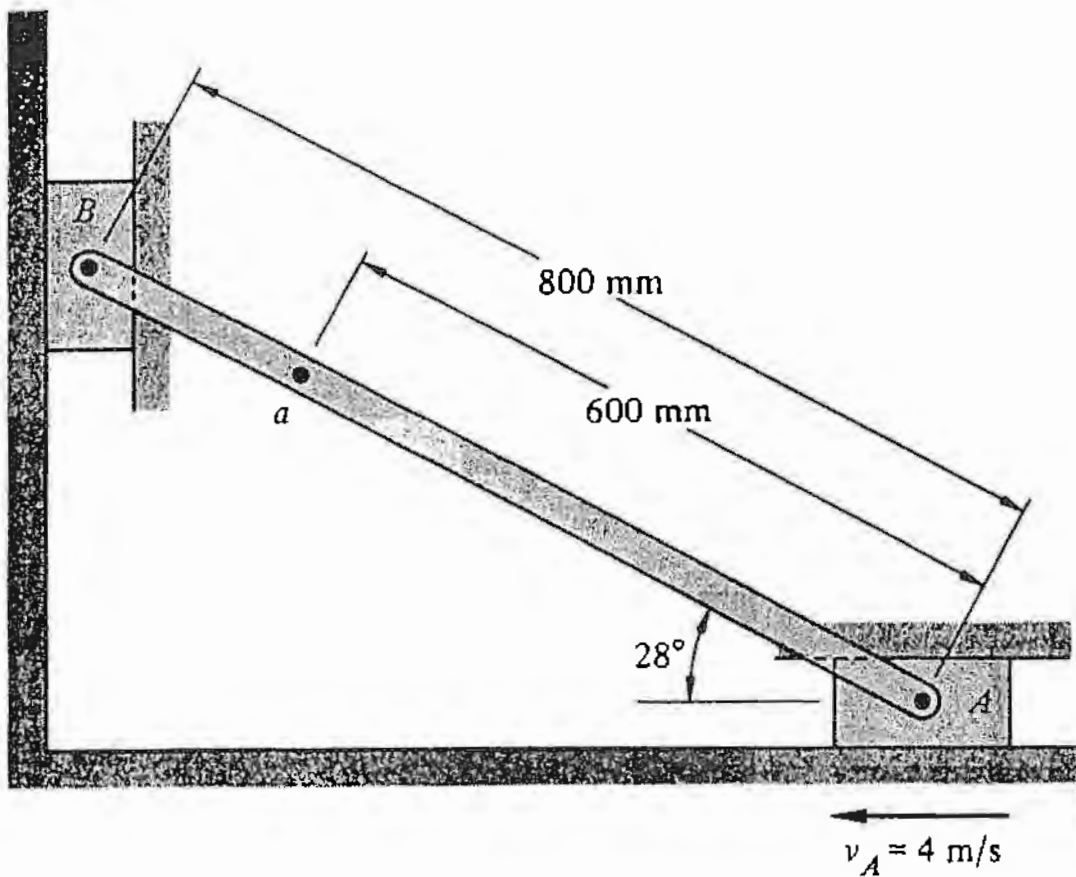


FIGURE 6.

