

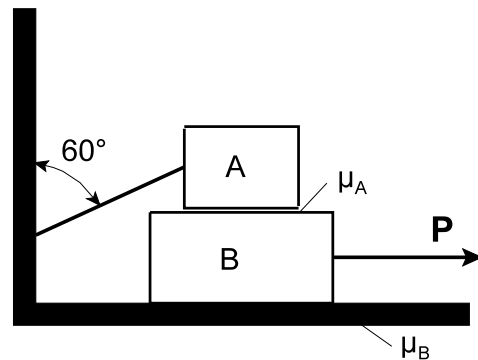
GNG 1100 - ENGINEERING MECHANICS

Final Examination
 18 December 2000
 Profs. Droste, Hallett, Mirfakhraei, and Skaff

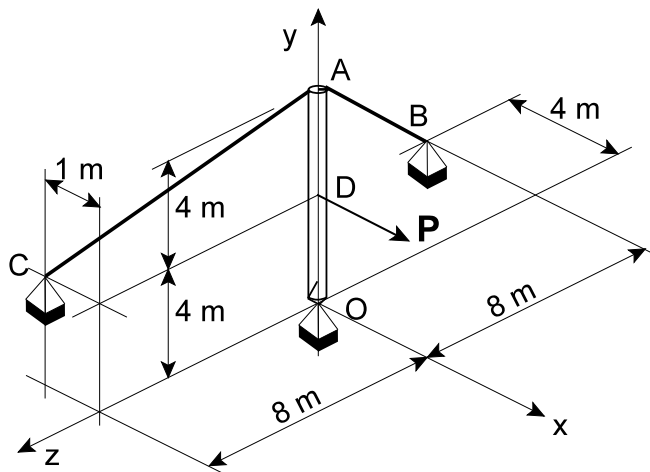
Time: 3 hours
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Closed Book. All calculators allowed. Free-body diagrams must be drawn wherever appropriate.

1. (10 marks) Block A in the sketch has a mass of 20 kg and is attached to the wall by means of a cord at an angle of 60° to the vertical, while Block B has a mass of 40 kg. The static friction coefficient between A and B is $\mu_{SA} = 0.2$, while the static friction coefficient between B and the ground is $\mu_{SB} = 0.3$. Determine the minimum force P required to cause Block B to slide.



2. (10 marks) A mast is supported by a frictionless ball and socket joint at O and by two cables AB and AC. Determine the tensions in the two cables if the applied load $P = 20$ kN. Point B lies in the x-z plane, while point C lies 4 m above the x-z plane.



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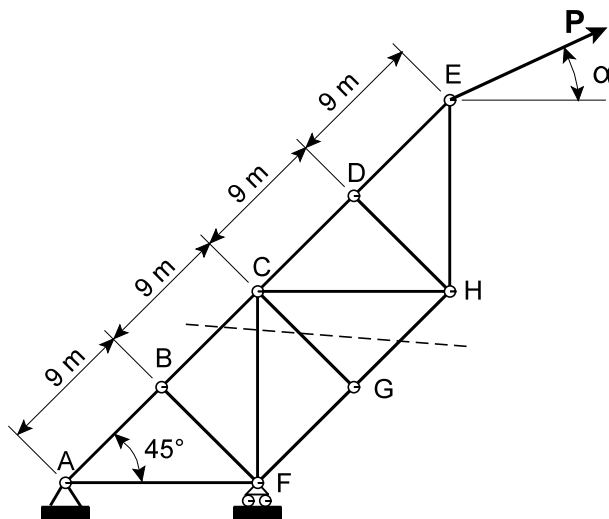
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3. (10 marks) The sketch shows a pin-jointed truss, loaded with a single force **P** as shown.

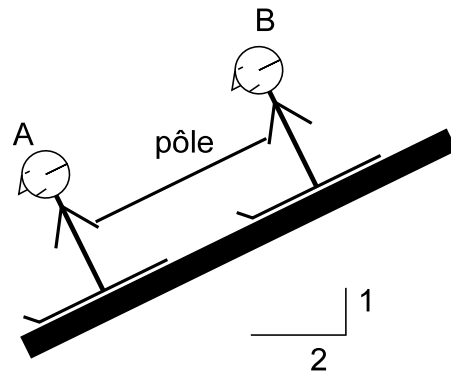
- (a) Identify all zero-force members.
- (b) If the force in member GH is 0.6 kN in compression, and the force in member BC is 4.8 kN in tension, calculate the value of **P** and the angle α . **Hint:** use a section that cuts members BC, CF, CG and GH.

Trigonometric identities:
 $\sin(\theta \pm \phi) = \sin\theta\cos\phi \pm \cos\theta\sin\phi$
 $\cos(\theta \pm \phi) = \cos\theta\cos\phi \pm \sin\theta\sin\phi$



4. (10 marks) Two skiers, A and B, are skiing down a 1:2 slope. Skier A has a mass of 60 kg and B a mass of 80 kg. Owing to differences in ski wax, the friction coefficients are different: skier A has a coefficient $\mu_{KA} = 0.1$, while B has $\mu_{KB} = 0.2$. In order to keep together, the skiers are connected by a ski pole. Neglect the weight of the pole, and assume that the connections of the pole to the skiers' hands are pin joints.

- (a) Calculate the force in the pole (specify tension or compression).
- (b) Determine the acceleration of the skiers.
- (c) If the initial velocity of the skiers is 10 m/s, determine the velocity of the skiers after they have travelled 100 m from their initial position.



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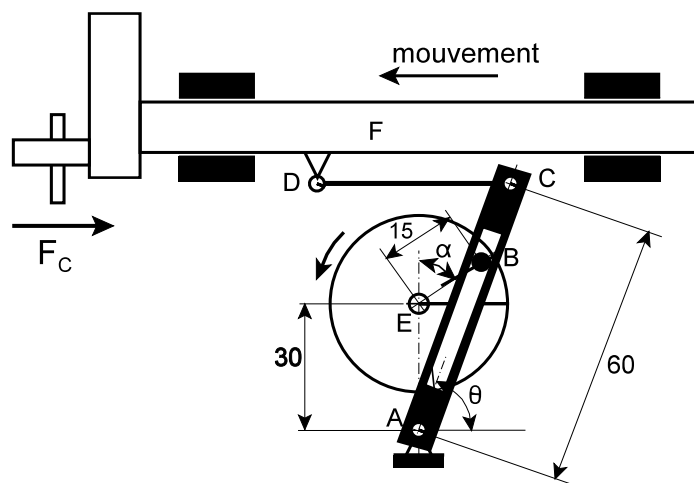
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5. (15 marks) The sketch shows a machine tool called a shaper. The ram F is moved back and forth by the link CD and the slotted lever AC , which is driven by a pin B attached to a wheel. The wheel rotates about E in the direction shown. Joints A , C and D are pinned. The pin B can slide without friction in the slot in lever AC . In the position shown, angle $\alpha = 45^\circ$, and the link DC is horizontal. All dimensions are in cm.



- (a) The cutting force F_c on the tool bit is 400 N, and this produces a force of 400 N in compression in link CD . Determine all forces acting on lever AC .
- (b) The wheel is driven by a motor, which can be represented by a couple moment acting at E . Determine the magnitude of this moment.

Total marks for this paper: 60