ME 270 – Spring 2015 Exam 2 **NAME (Last, First):** ________________________________

Please review the following statement:

I certify that I have not given unauthorized aid nor have I received aid in the completion of this exam.

Signature: ______________________________________

INSTRUCTIONS

Begin each problem in the space provided on the examination sheets. If additional space is required, use the white lined paper provided to you.

Work on one side of each sheet only, with only one problem on a sheet.

Each problem is worth 20 points.

Please remember that for you to obtain maximum credit for a problem, it must be clearly presented, i.e.

- The only authorized exam calculator is the TI-30IIS
- The allowable exam time for Exam 1 is 70 minutes.
- The coordinate system must be clearly identified.
- Where appropriate, free body diagrams must be drawn. These should be drawn separately from the given figures.
- Units must be clearly stated as part of the answer.
- You must carefully delineate vector and scalar quantities.

If the solution does not follow a logical thought process, it will be assumed in error.

When handing in the test, please make sure that all sheets are in the correct sequential order and make sure that your name is at the top of every page that you wish to have graded.

Instructor's Name and Section:

Sections: J Jones 9:30-10:20AM I Bilionis 1:30-2:20PM J Ackerman 3:30-4:20PM
J Jones Distance Learning

Problem 1 __________

Problem 2 __________

Problem 3 __________

Total ______________

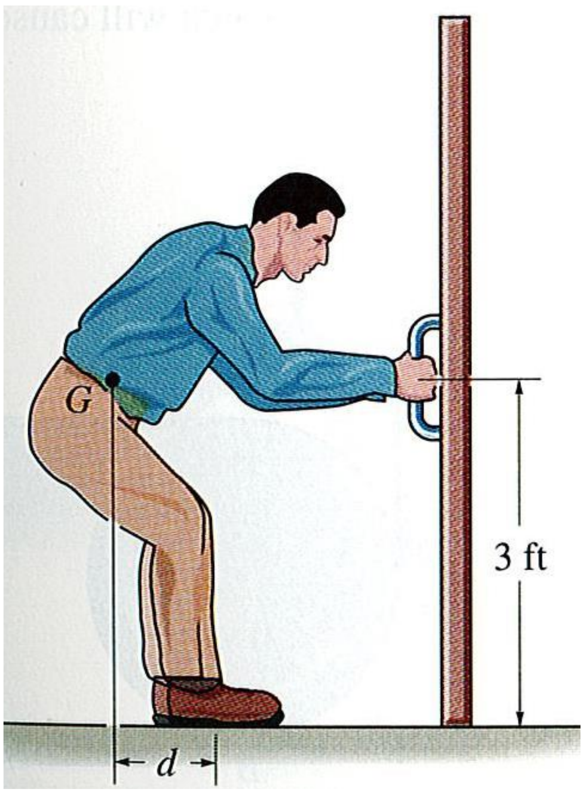
ME 270 – Spring 2015 Exam 2 **NAME (Last, First):** ________________________________

PROBLEM 1 (20 points) – Prob. 1 questions are all or nothing.

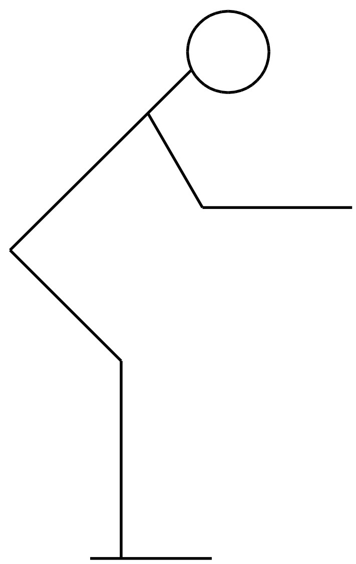
Please show all work.

1A. The man pictured below is trying to open an old door with rusted hinges by pulling horizontally as hard as he can. The man weighs 200 lb and the coeffecient of static friction between his shoes and the ground is $\mu_s = 0.5$.

What is the maximum horizontal force P he can pull with? Determine where he should position his center of gravity G with respect to his feet (find the distance d) in order to exert the maximum horizontal force on the door.



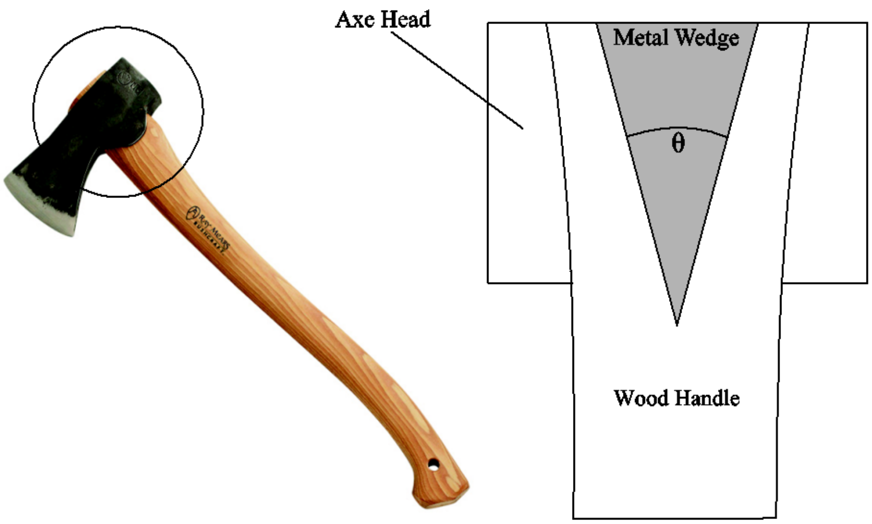
FBD Person

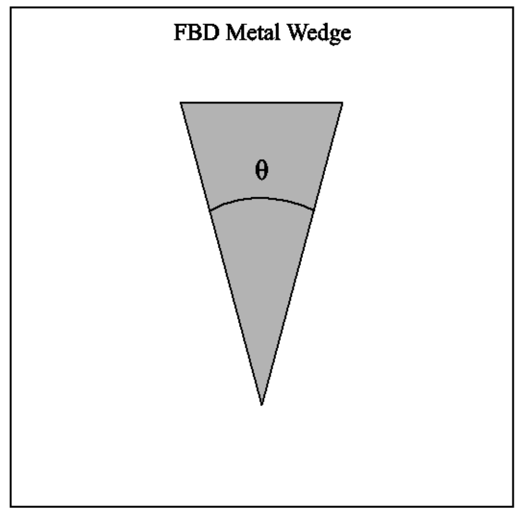


P =	(2 pts)
d =	(3 pts)

1B. Axe heads are commonly attached to a wooden handle by positioning the handle in the axe head and inserting a small metal wedge in the head of the wooden handle so that it expands and increases the normal forces between the handle and axe head. In order for the axe head to stay secure, the metal wedge cannot come out of the handle.

Assuming the coefficient of static friction between the metal wedge and wooden handle is $\mu_s = 0.4$ (i.e., you can assume the normal and friction forces on either side of the wedge are equal), what is the **maximum** wedge angle θ that can be used so the wedge is **self-locking**? *Hint: You only need the equilibrium equation in the y-direction to solve this problem.*

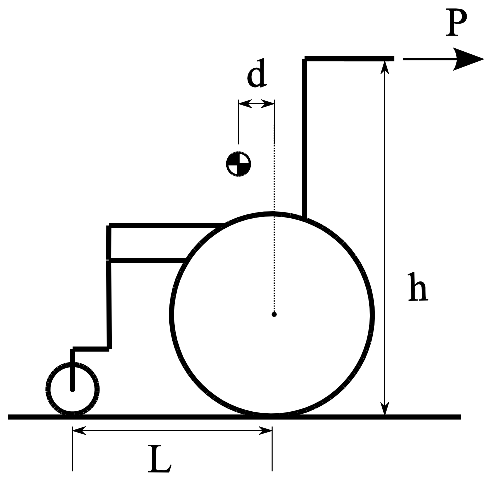


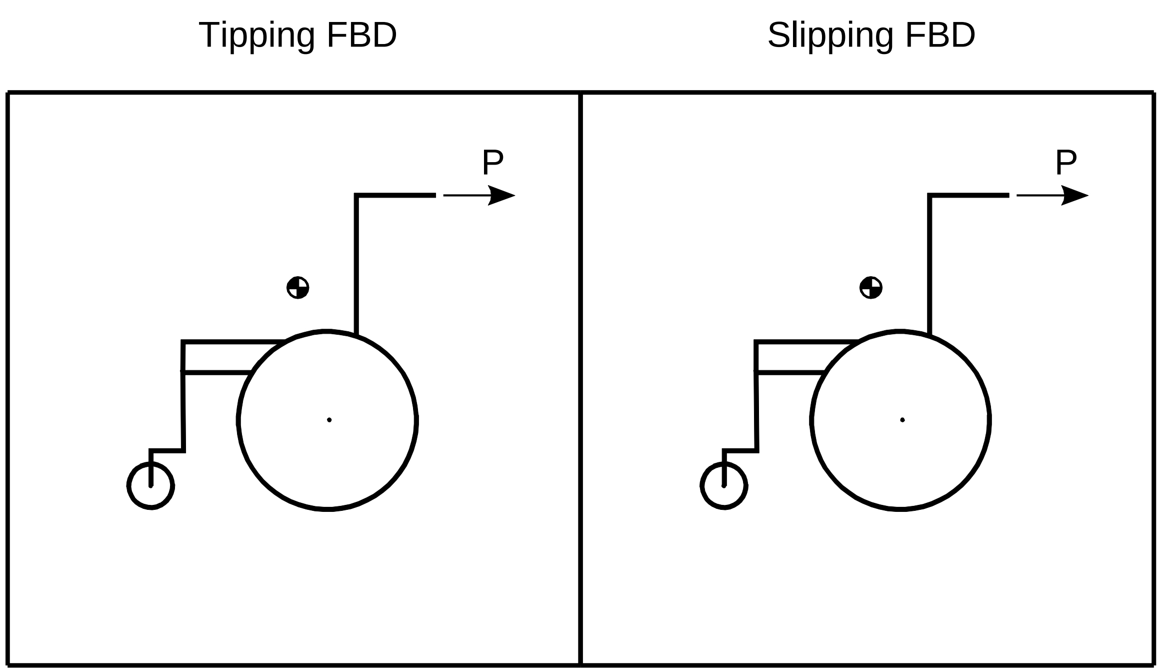


FBD (Use the artwork provided above) (2 pts)

θ = (3 pts)

1C. A wheelchair is about to be pulled backwards by an assistant. The brakes of the wheelchair are accidently left engaged (**the wheels cannot roll**) when the assistant tries to pull with an unknown force P. The wheelchair dimensions are **d = 0.5'**, **h = 3'**, and **L = 2'**. The combined wheelchair and user weighs **200 lb** with the center of gravity shown. It recently rained, so the coefficient of friction between the rubber wheels and the pavement is only $\mu_s = 0.2$. What is the **minimum** load P that will cause the wheelchair to move? Will the wheelchair **tip** or **slip** (make sure to **verify** your assumptions)?

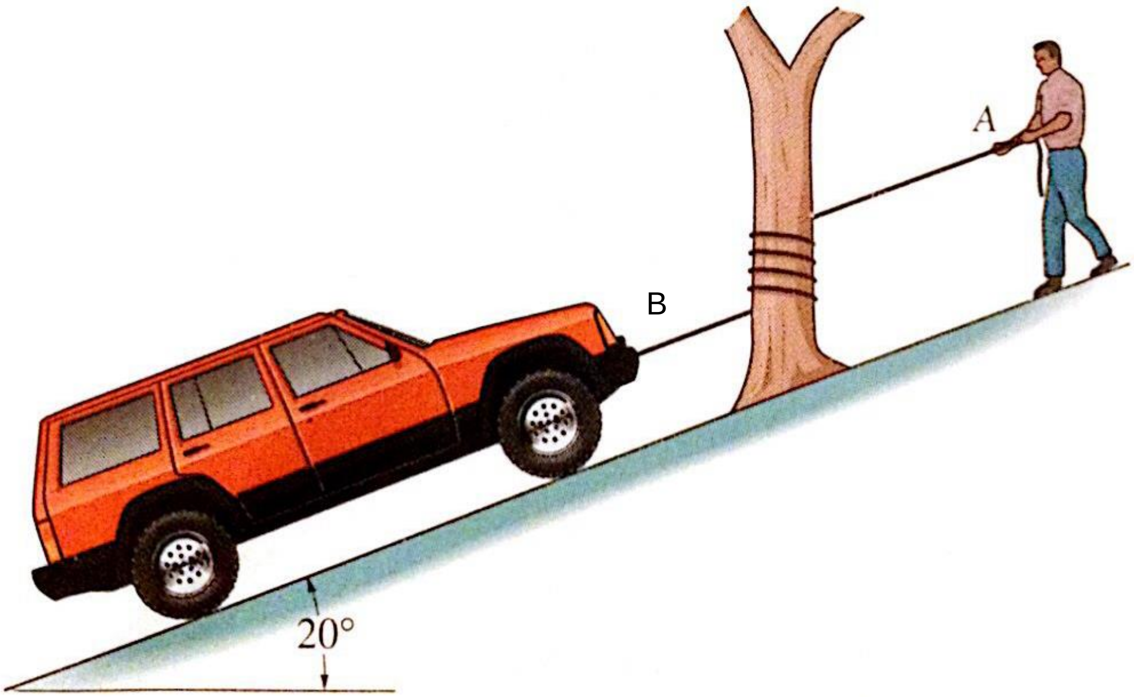




FBD (Use the artwork provided above) (2 pts)

P = , **SLIP** or **TIP** (please circle one) (3 pts)

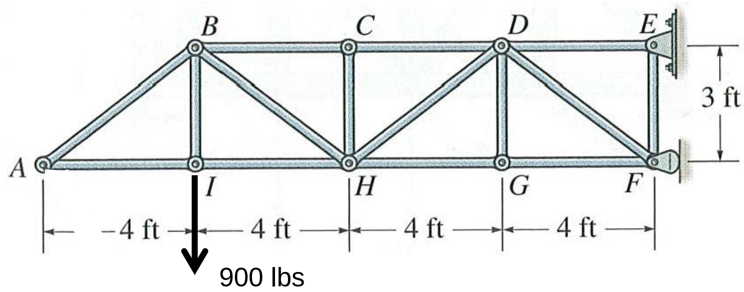
1D. The SUV causes a 2000 lb tension in the rope at B (T_B). The SUV is to be lowered down the slope by a rope that is wrapped around a tree. If the wheels are free to roll (car in neutral) and the man at A can resist a pull of up to 100 lb, determine the **minimum** number of **full turns** (N) of the rope around the tree to prevent the SUV from moving. For this number of full turns, determine the minimum tension (T_A) required to prevent the SUV from moving. Assume the coefficient of friction between the tree and the rope is $\mu_s = 0.3$.



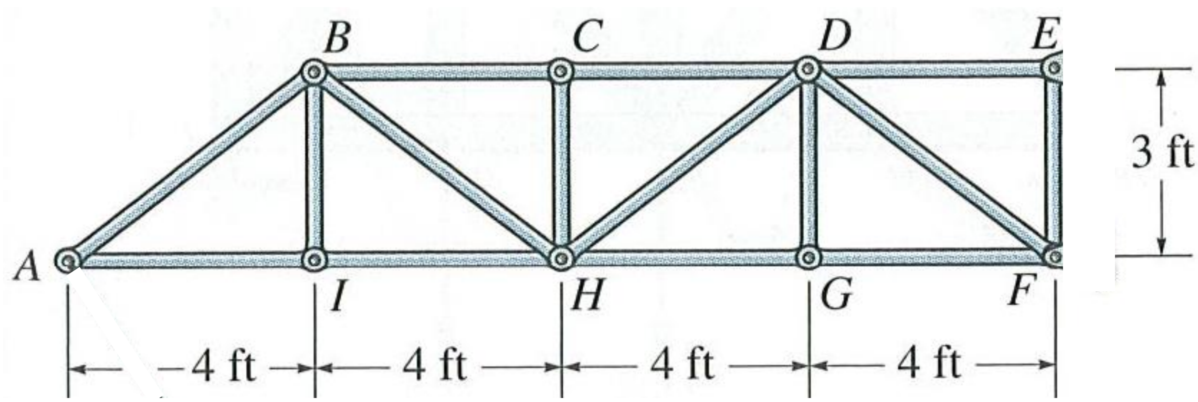
N =	(2 pts)
$(T_A)_{Min}$ =	(3 pts)

PROBLEM 2. (20 points)

GIVEN: Truss A-I is loaded with a 900 lb force as shown and is held in static equilibrium by a pin support at joint E and a rocker support at joint F. You may assume the weights of the individual members of the truss are negligibly small.
(Hint: The diagonal members of the truss can be represented as 3-4-5 triangles.)



FIND: a) On the sketch provided, complete the free-body diagram of the overall truss. (2 pts):



b) Determine the scalar reactions at supports E and F. (3 pts)

E_x =	(1 pt)
E_y =	(1 pt)
F_x =	(1 pt)

c) List all the zero-force members in the truss. There is no need to show any work. (3 pts)

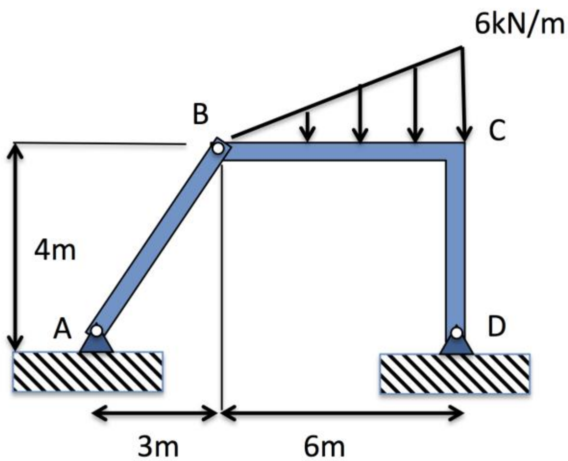
Zero-Force Members = ____	(3 pts)

d) Determine the loads in members GH, DH, and BC. Also, indicate whether each member is in tension, compression, or a zero-force member. Make sure you show all of your work and include any free body diagrams required. (12 pts)

F_{GH} =	(Tension, Compression, Zero) Circle One
F_{DH} =	(Tension, Compression, Zero) Circle One
F_{BC} =	(Tension, Compression, Zero) Circle One

PROBLEM 3. (20 points)

GIVEN: The frame ABCD is made out of the simple weightless members AB and BCD, which are joined with a pin at B. ABCD is held at static equilibrium by two pin supports at joints A and D. A triangle-shaped distributed load acts on the upper face of BC as shown in the figure.

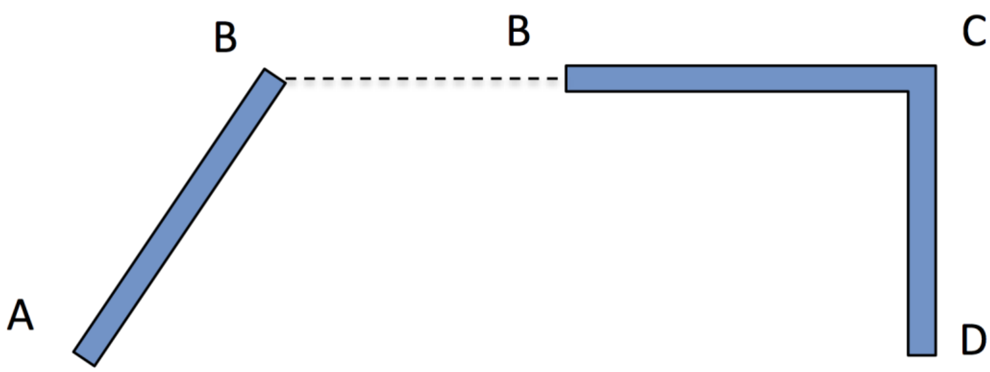


FIND:

a) List all two force members of the frame. There is no need to show any work (2 pts).

Two-Force Members = ____ (2 pts)

b) Draw the free body diagram of each member of the frame (6 pts). On the free-body diagram, please show the distributed load as a single equivalent force and note the magnitude and location of the load.



c) Determine the support reactions at A and D, and the force at joint B acting on member BCD. Express each of the forces in vector form. (12 pts).

$\overline{A}$ =	(6pts)
$\overline{D}$ =	(3pts)
$(\overline{B})_{onBCD}$ =	(3pts)

Exam 2 – Equation Sheet

Buoyancy

$$F_B = \rho g V$$

Fluid Statics

$$P = \rho g h$$

$$F_{eq} = P_{avg}(Lw)$$

Belt Friction

$$\frac{T_L}{T_s} = e^{\mu\beta}$$

ME 270 Exam 2 Solutions – Spring 2015

1a. P = 100 lbs d = 1.5 ft

1b. FBD $\theta = 43.6^{o}$

1c. FBD $P = 33.3$ lbs Tip

1d. $N = 2$ $\left(T_A\right)_{min} = 46.1$ lb

2a. FBD

2b. $E_x = 3600$ lbs $E_y = 900$ lbs $F_x = -3600$ lbs

2c. Zero-Force Members: AB, AI, CH, DG, HI

2d. $F_{GH} = -2400$ lb $= 2400$ lb Compression $F_{DH} = +1500$ lb $= 1500$ lb Tension

$F_{BC} = +1200$ lb $= 1200$ lb Tension

3a. Two-Force Members: AB

3b. FBD

3c. $\bar{A} = 3\bar{i} + 4\bar{j}$ kN $\bar{D} = -3\bar{i} + 14\bar{j}$ kN $\left(\bar{B}\right)_{onBCD} = 3\bar{i} + 4\bar{j}$ kN