Chapter 2: Problems

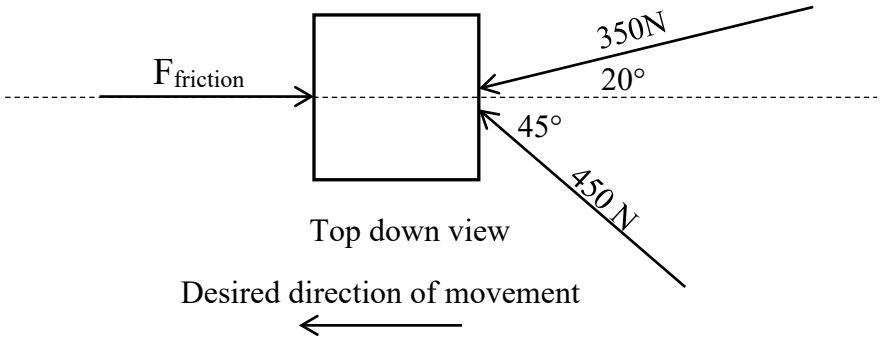
Due: **Tuesday, February 4th (also see Chap 3 Sec 1-3)**

Learning Objectives: Upon completion of the following problems you should be able to:

1. Draw free body diagrams showing the forces acting on objects in the presented scenario.
2. Decompose forces into their horizontal and vertical components.
3. Use Newtons laws of motion and static equilibrium to solve for unknown forces.

Problem 1:

You and your roommate need to move a refrigerator to a new location. You push against the refrigerator with a force of 350 N an angle of 20° above horizontal while your roommate pushes with a force of 450 N at an angle of 45° below horizontal, as shown in the diagram below. If the coefficient of friction for the wood floor is 0.45 and the refrigerator has a mass of 145 kg, will you and your roommate be able to move it?



Problem 2

A 60 kg skier is in a tuck moving straight down a 30° slope. Air resistance pushes backwards on the skier with a force of 10 N (applied opposite the direction of the skiers motion and parallel to the 30° slope). The coefficient of dynamic friction between the skis and the snow is 0.08. What is the resultant force acting on the skier?

A. Draw a free body diagram showing the scenario.
B. Identify all the forces acting on the skier.
C. Identify which forces are known and unknown.
D. Identify the information given in the problem and what you are being asked to solve for.
E. Set up and solve the problem.

Problem 3

It is realtively common for individuals to develop early onset osteoarthritis following ACL repair due to altered loading of the tibiofemoral joint. A biomechanical model can be used to help estimate the compressive and shear forces acting on the joint. This model relies on having estimates of the forces from the gastrocnemius, hamstrings, and quadriceps muscles, since all of these will influence the forces on the knee. You perform a gait analyses and determine the following information about your patient:

- During midstance the knee is flexed 30°.
- The force in the gastroc is 780 N. This force acts at an angle of 3° posterior to the long axis of the tibia.
- The force in the hamstrings muscle is 790 N. This force acts parallel to the femur.
- The force in the quadriceps muscle is 1650 N. This force acts at an angle of 15° anterior to the long axis of the tibia.

A) Draw a free body diagram for this scenario. Be sure to label all the forces and angles involved.

B) Solve for the resultant tibiofemoral compressive and shear forces. The compressive force acts along the long axis of the tibia. The shear force acts perpendicular to the long axis of the tibia. **Hint:** When calculating the final forces, pay close attention to the actions of individual muscles. For example, both hamstrings and gastroc should produce posterior directed shear forces while quadriceps produces and anteriorly directed shear force. All three muscles produce compressive force.