**Force: Introduction to Forces Activity**

*Adapted from “PhyzLab Springboard: Feel the Forces” from Dean Baird's The Book of Phyz*

**Introduction:**
In general, a force is an interaction that causes a change in state of an object. In mechanics, a force is an interaction that causes a change in motion of an object. There are five mechanical forces that we will study in this course. This lab is designed to introduce you to these forces and the associated free-body diagrams. The five forces are as follows:

1. **WEIGHT (GRAVITY)**
   Weight is an interaction between any two objects with mass. The weight of an object on the earth acts toward the center of the earth—straight down. The weight depends on its mass (m) and gravitational acceleration (g): \( F_g = mg \).

2. **NORMAL**
   This force represents any compression of any two surfaces against each other. A book resting on a table is prevented from falling to the ground (due to its weight) because the table exerts an upward normal force on the book. The normal force exerted by a surface is always perpendicular to that surface. The normal force is sometimes—but certainly not always—equal in magnitude and opposite in direction to weight.

3. **TENSION**
   When a force is transmitted through a string (or rope, wire, etc.) to an object, the force is called tension. The tension in a string is constant throughout the string.

4. **FRICTION**
   Friction is the force that resists the relative motion of two materials sliding against each other. If the surfaces aren’t moving relative to one another, the friction force is called static friction. If the objects are moving, the frictional force is called kinetic friction. Friction is nearly independent of velocity.

5. **DRAG**
   Whenever a fluid (gas or liquid) encounters a solid object (or vice versa), the force of drag appears. It could be that the solid object is moving through a fluid or that a fluid is moving past a stationary solid object. Drag tends to slow down the movement of the object and is proportional to the object’s relative velocity through the fluid.

**Procedures:**
During the lab, you will be asked to perform tasks and answer questions. **Please do NOT use the names of the forces** in the response until you are specifically asked to do so!
A. Push down on the table with your hand.
   1. The table feels the downward push of your hand. What do you feel?
   2. If there were no friction between your hand and the table, could you still exert this force?
   3. In what direction does this force act? Draw a diagram of your hand pushing down on the table. Draw ONLY a vector (arrow) representing the force the table exerts on you (not the force you exert on the table).
   4. How would you describe the angle of the force relative to the surface of the table?
   5. Consider the normal force between you and the ground. What would happen to the magnitude of that force if someone were standing on top of you? If you were holding a large bunch of helium balloons? (Now you may use the name of the forces.)

B. Hold one end of the string while your partner holds the other end. GENTLY pull.
   1. Suppose you pull while your partner simply holds. Who feels more of this force?
   2. In what direction does this force act? Draw a diagram of your hand and the string. Then draw ONLY a vector (arrow) showing the force as it acts on your hand (do not show the force your hand exerts on the string).
   3. Think about the distribution of forces on the string:
      a. Consider a chain of rubber bands. If the ends of the chain are pulled, which rubber bands will stretch the most? (Choose the correct answer.)
         i. The one at the pulled end will stretch the most.
         ii. The ones near either end of the chain will stretch the most.
         iii. All the rubber bands in the chain will stretch the same amount.
      b. What does this mean about the whereabouts of the force in the string?
      c. What is the name of this force? (Now you may use the name of a force.)
      d. Under what condition does this force occur?
      e. What is one other example of this force?

C. Rub your hands together.
   1. What factors appear to be important for the force your hands experience? (What makes it bigger or smaller?)
   2. What is one other situation in which this force occurs?
   3. Does this force act at one point or is it spread out somehow? Include a diagram in your explanation.
   4. In what direction does this force seem to act? Draw a diagram of a book sliding across the table, moving to the right. Show the total effect of the force acting on the book by drawing a vector (an arrow which shows the size and direction of the force).
   5. What is the name of this force? (Now you may use the name of a force.)

D. Suppose Wile E. Coyote were to run off a cliff.
   1. What force would lead to his falling? (Now you may name a force.)
   2. What factors appear to be important for this force? (What makes it bigger or smaller?)
   3. In what direction does this force act? Draw a diagram of Wile E. Coyote; draw a vector (arrow) for this force.
   4. Does this force act over long distances through space? (Between the Earth and the Sun, for example?)
E. Hold the coffee filter above the table and drop it.
   1. What two forces are operating here? (Now you may use the name of the forces.)
   2. Which force would not be as apparent if the coffee filter were crumpled up? (Now you may a name of a force.)
   3. In which direction does this force act? Draw a diagram of the falling coffee filter showing the vector (arrow) for the total effect of this force. Show the vector (arrow) for the other force you mentioned in number 1, too.
   4. Would this force affect a rock falling to the bottom of a pond? A feather falling on the moon?
   5. List 2 other situations in which this force occurs or is particularly important.
   6. What factors appear to be important for this force? (What makes it bigger or smaller?)

F. The diagrams you have been drawing are called free-body diagrams (or force diagrams) and are used to analyze the forces acting on an object of interest. Draw and label a free-body diagram showing all the forces (hint: there are 3) acting on the van, which is driving uphill: