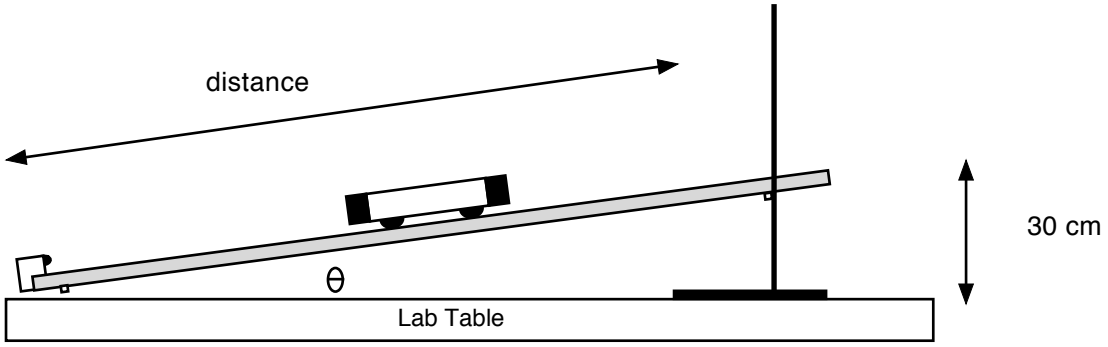
Lab 8-1: **Making the Grade**

Purpose: To investigate the force, the distance, and the work involved in moving an object up an incline as the angle is changed yet the height to which it is lifted remains constant.

Procedure:
l. Place a clamp on a ring stand. Clamp the track in place at an angle of 15º, as shown in the figure below. Pull the cart up the inclined plane at *a constant speed* with a spring scale or force probe kept parallel to the plane, to measure the force. You need not pull it all the way up the ramp. Measure the distance from the bottom of the incline to the ring stand clamp. Record the force and distance in the data table. Also note the height and the weight of the cart.



2. Vary the angle while keeping the height the same by sliding the board up or down inside the clamp to make angles of 30º, 45º, and 60º. For each of the different angles, pull the cart parallel to the board. Record force and distance for each trial in the data table for Part 1.

3. Flip the cart over (so the wheels are up in the air), and repeat step 2 above. Record the data in Part 2.

Data:

Height for all trials 0.3 m Weight of cart _____ N

Part 1: Frictionless

Angle of track	15°	30°	45°	60°
Force (N)				
Distance (m)				
Work done (J)				

Part 2: Friction

Angle of track	15°	30°	45°	60°
Force (N)				
Distance (m)				
Work done (J)				

Calculations:
l. For each trial, calculate the work done in pulling the cart up the hill.

Lab 8-1: **Making the Grade**

Questions:

l. Why should the force probe be kept parallel to the board as the carts are pulled up the hill?

2. Show all the forces acting on the cart as it is moving up the hill at constant speed. Make all force vectors of appropriate length.

3. Is there a net force on the cart? Explain.

4. If you do work on an object, and that object does not change its speed, the work you did was done against some other force or forces. What force(s) did you do work against in this lab? Be specific and use your diagram from question 2 to help you.

5. In this lab, you dragged the cart along the ramp to the same final height. Suppose you lifted the wagon straight up to that same final height, and did not use the ramp.
   a. How much work would you do?

      W = _____J

   b. Would you be doing any work against friction? Explain.

6. What pattern or relationship do you find regarding the work done to get the cart to the top of the ramp at the 4 angles when there was little to no friction?

Part II:

8. This time, was the work done the same each trial?

9. In which trial was the most work done?

10. What forces were you "fighting" in pulling the wooden block up the ramp?

11. If pulling something up a ramp actually requires more work, why would people use a ramp at all? What is the advantage?