Physics Name:

Activity - Simple Machines

Problem: To identify simple machines and to give examples in everyday usage; To determine the efficiency and mechanical advantage of a ramp.

Discussion: When studying work and energy no study is complete without considering "simple machines". A machine is a device that allows one to do work easier or faster. In most cases it allows man to do a difficult task with less force than would be needed without the aid of a machine. One example is the ramp on a moving van. The ramp allows you to raise heavy objects up into the truck with less force than would be needed to lift them.

Be careful not to fall into the misconception that simple machines give you more "energy" or allow you to do less "work". This is NOT true (recall the Law of Conservation of Energy)! The guiding principle behind simple machines is that the work you put in must equal the work you get out (in an ideal, frictionless world). So how does the task get "easier"? Think about a ramp on a moving van. It allows you to apply less force to raise a heavy object. But you must raise it over a longer distance.

$$W_{ramp} = F \cdot \mathbf{d} \qquad W_{lift} = \mathbf{F} \cdot d$$

With the ramp you gain force at the expense of distance but the total work (energy) is conserved. This is all true for an ideal world, of course. In the real world the work you get out will always be less than the work you put in. Some of the work (energy) is lost to friction and other dissipative forces.

Materials:

ramp	spring scale
ruler or meter stick	block with hook

Pre Lab Questions:

1. What is the ideal MA of a ramp? What is the Actual MA of a ramp?

2. What kind of machine is...

_____a.) a car jack (scissors type)
_____b.) a door knob
_____c.) a compound bow
_____d.) a tooth
_____e.) a stairway, a spiral stairway
_____f.) your arm

3. In all of the examples above what *advantage* does the machine give you? What *disadvantages* are related to it?

4. How will you measure how far up the ramp you pulled? How will you measure the height your load was lifted?

Procedure: Make a ramp out of a stack of books and a board. Design an experiment to determine the efficiency and *mechanical advantage* of the ramp. Keep in mind that you will need to use the ramp to do work and you will have to *measure* the amount of work you did (and what you would have had to do without the ramp. You might want to think of pulling a heavy box up a ramp into a moving van, as opposed to lifting it directly into the back of the truck.

Data: Length (m) Height (m) Pull (N) Weight (N)

Analysis:

1. Calculate the ratio of the force you need to lift the block to the force needed to pull it. This is the actual mechanical advantage (AMA) of the ramp.

2. Determine the ideal mechanical advantage (IMA) of the ramp (use your notes or the internet to come up with a formula for this.)

3. Calculate the *work* you would have to do to *lift* the block to the top of your ramp (vertically). This is equivalent to lifting a heavy object into a moving van (the work you get *out*).

4. Calculate the *work* needed to pull the block up the ramp. This is equivalent to using a ramp to get a heavy object into the moving van (the work *in*).

5. Calculate the ratio of the work done in lifting the block to the top of the ramp compared to the work done pulling it up the ramp. This is the efficiency of the ramp.

6. Why is the AMA less than the IMA? Explain.

7. How could you increase the efficiency of your ramp? Explain.