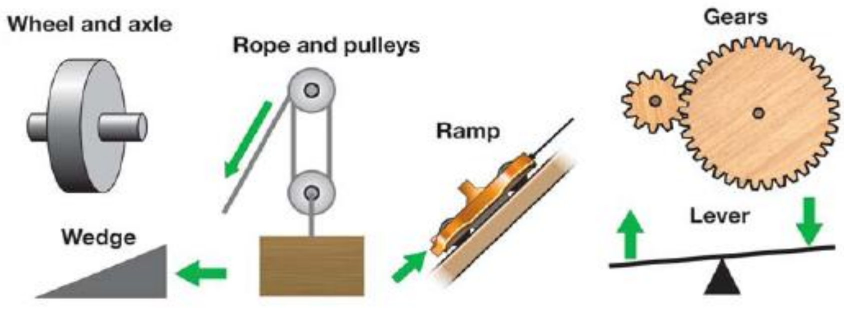
Name: ________________________________

Conceptual Physics - Simple Machines Laboratory

A simple machine is an unpowered, mechanical device such as a lever, that either changes motion from one direction or form to another or provides a mechanical advantage. Below are many examples of the simple machines we will examine in this laboratory:



Machines are designed for the convenience of their users. Oftentimes they are designed with the idea of "multiplying" mechanical force. A well-designed machine provides a mechanical advantage to the user; this is the ratio of the output force (load) to the input force (effort).

MECHANICAL ADVANTAGE OF A SIMPLE MACHINE

$$MA = \frac{F_o}{F_i}$$

Mechanical advantage (MA); Output force (N) (F_o); Input force (N) (F_i)

For this laboratory, you will examine simple (and complex) machines at various stations. Follow the directions at each station and answer the questions.

STATION 1 – Block and Tackle

Note the two block-and-tackle systems, which are also known as rope and pulleys. System "A" has fewer pulleys than System "B."

Calculating Output Force

1. Using the spring scale, hang the basket of marbles from the hook at the end, then write down the mass of the basket as it reads on the spring scale: _______ g   convert to kg: _______ kg

2. Calculate the force of the basket: Force = (mass of the basket [kg])(9.8 m/s^2) = ________ N

Calculating Input Force and Mechanical Advantage of System A:

1. Load the basket in *System A* first; attach the spring scale to the end of the string and slowly pull the basket up, noting the amount of "force" (which the spring scale is indicating as grams).
Write it down here: _______ g   convert to kg: ________ kg

2. Calculate the force applied to lift the basket: Force = (______ kg)(9.8 m/s^2) = ________ N

3. Calculate mechanical advantage System A: MA = ________N_o/ _________ N_i = ________

Calculating Input Force and Mechanical Advantage of System B:

1. Load the same basket in System B, attach the spring scale to the end of the string and slowly pull the basket up, noting the amount of "force" (indicated as *grams* on the scale).
Write it down here: _______ g   convert to kg: ________ kg

2. Calculate the force applied to lift the basket: Force = (______ kg)(9.8 m/s^2) = ________ N

3. Calculate mechanical advantage System B: MA = _______ N_o/ _______ N_i = ________

Analysis of the Block and Tackle systems:
1. Which block and tackle system had the greater mechanical advantage?

2. Is it possible for you to lift your own body weight using a block and tackle system? Why or why not?

STATION 2 – Inclined Planes
At this station you will analyze the amount of input force necessary to lift a load (K'NEX car) up ramps of differing angles. Although Ramp "A" has a different incline than Ramp "B," both planes lift the cars the same height.

Calculating Output Force of the K'NEX Car
1. Using the spring scale, hang the K'NEX car from the hook at the end, then write down the mass of the car as it reads on the spring scale: _______ g convert to kg: _______ kg

2. Calculate the output force of the car: Force = (mass of car [kg])(9.8 m/s^2) = ________ N

Calculating Input Force and Mechanical Advantage of Ramp A (less steep):
1. Place the K'NEX car at the bottom of Ramp A, attach the spring scale to the rubberband on the car and pull it up the ramp slowly, noting the amount of "force" registered on the spring scale (as indicated by grams).
Write it down here: _______ g convert to kg: ________ kg

2. Calculate the force applied to pull the K'NEX car: Force = (_____ kg)(9.8 m/s^2) = _______ N

3. Calculate mechanical advantage Ramp A: MA = ________N_o/ _________ N_i = ________

Calculating Input Force and Mechanical Advantage of Ramp B (steeper incline):
1. Place the K'NEX car at the bottom of Ramp B, attach the spring scale to the rubberband on the car and pull it slowly, noting the amount of "force" registered on the spring scale.
Write it down here: _______ g convert to kg: ________ kg

2. Calculate the force applied to pull the K'NEX car: Force = (_____ kg)(9.8 m/s^2) = _______ N

3. Calculate mechanical advantage Ramp B: MA = ________N_o/ _________ N_i = ________

Analysis of the inclined plane systems:
1. Which inclined plane system had the greater mechanical advantage?

2. Why do you think one inclined plane system had a greater mechanical advantage than the other? What is the trade-off for reducing the input force?

STATION 3 – Everyday Simple Machines

Egg Beaters

1. How many simple machines do you note in the egg beaters? Name all of them.

2. How do egg beaters change motion from one form to another? How is the input motion different from the output motion?

3. Calculate the gear ratio of the egg beater:

    # of output teeth: ____________

    # of input teeth: ____________

4. Explain what would happen if the gears on the egg beaters were switched? Would this be an efficient machine?

Three Hole Paper Punch

1. Identify and name all of the simple machines in the paper punch.

2. What kind of lever is the paper punch? Note where the fulcrum is, the input force, and the output force (where the holes are actually punched in the paper).

3. If you were to design a paper punch for someone to use who is very, very weak, what would you change on it? How could you modify the punch? To examine this notion, try to punch a hole in a piece of paper by pushing down on the area of the punch marked by pink dots, then try to punch a hold by pushing down on the area marked by yellow dots.

Wood Clamps

1. Identify and name all of the simple machines in the wood clamps.

2. Try to clamp tightly the two pieces of wood together by turning the screw on the clamp without using the lever. Next, use the lever. Does the lever provide a mechanical advantage in any way?

3. If you were to design a clamp for someone to use with very weak hands, what would you change?