FLINN SCIENTIFIC

Name________________________________

Inclined Plane Worksheet

Data Table

Distance between starting line and finish line: _______________

Mass of Hall's carriage: _______________

Additional mass added to Hall's carriage: _______________

Inclined Plane Angle	Height of Starting Line	Height of Finish Line	Force Needed to Raise the Hall's Carriage

Results Table

Weight of Hall's carriage plus any additional mass: _______________

Inclined Plane Angle	Ideal Mechanical Advantage	Actual Mechanical Advantage	Energy Required	Ideal Energy Required

Post-Lab Questions

1. Multiply the mass of the Hall's carriage plus additional mass (in kilograms) by the acceleration due to gravity constant (9.81 $\frac{m}{s^2}$) to determine the weight (in Newtons) of the carriage. Record this in the results table.
2. Use Equation 2 to calculate the ideal mechanical advantage for each experimental angle of the inclined plane. Record this information in the Results Table.
3. Use Equation 1 to calculate the actual mechanical advantage for each experimental angle. Record this information in the Results Table.
4. Calculate the amount of energy that was needed to raise the carriage for each inclined plane angle. To do this, multiply the force needed to raise the carriage at a specific angle by how far the carriage traveled along the inclined plane (in meters). The resulting energy will have units called Joules (*J*). Record these calculations, including units, in the Results Table.
5. Calculate the "ideal" energy required to raise the carriage from the starting line height to the finish line height by multiplying the weight of the Hall's carriage by total height the carriage was raised. Record this in the Results Table.

6. What angle of the inclined plane made raising the Hall's carriage the easiest?

7. How does the mechanical advantage compare to the ease of raising the Hall's carriage?

8. What is an advantage of an inclined plane?

9. What is a disadvantage of an inclined plane?

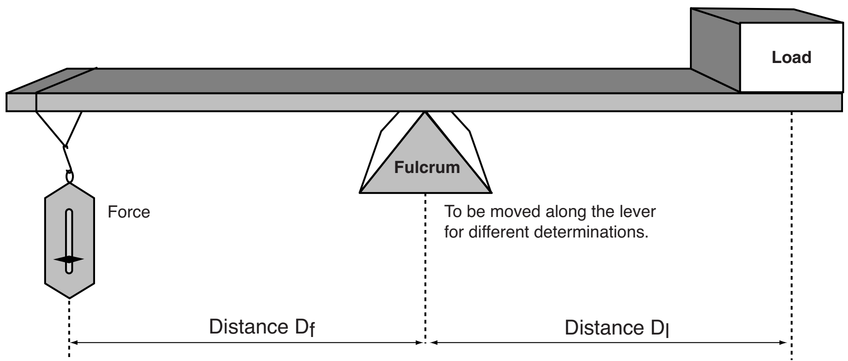
10. Explain why the energy required in each case is similar to the "ideal" energy even though the needed force was less than the weight of the carriage. If any "extra" energy was needed to raise the carriage up the inclined plane, compared to the ideal case, why was it needed?

11. Based on the results of this lab, what would be the best position of a ramp used to raise a 500-lb motorcycle into the back of a truck in the easiest possible way?

Lever Type I Worksheet

Trial	Force to Hold Lever Balanced (Newtons)	Load* (Newtons)	Distance D_f (cm)	Distance D_l (cm)	Mechanical Advantage (MA)
1					
2					
3					
4					

*Load is equal to the total weight of the slotted weights. W = m g, where g = 9.8 m/s^2. 1 N = 1 kg m/sec^2.



Post-Lab Questions

1. In a Type I Lever, where is the fulcrum when the force and load are equal?

2. In a Type I Lever, what happens to the force required to lift a load as the load gets closer to the fulcrum? What happens to the mechanical advantage?

3. When the load is very close to the fulcrum and the force is far from the fulcrum, how does the distance the force moves compare to the distance the load moves?

4. True or False? Defend your answers.

   a. Lever Type I system would be good for moving a heavy object a small distance using less force compared to the weight of the load.

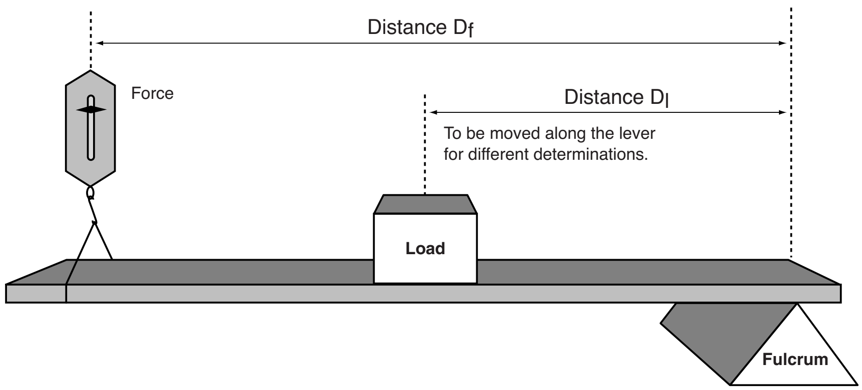
   b. Lever Type I system would be good for moving an object with great speed.

   *c.*A shovel is an example of a Lever Type I.

Lever Type II Worksheet

Trial	Force to Hold Lever Balanced (Newtons)	Load* (Newtons)	Distance D_f (cm)	Distance D_l (cm)	Mechanical Advantage (MA)
1					
2					
3					

*Load is equal to the weight of the slotted masses. W = m g, where g = 9.8 m/s^2. 1 N = 1 kg m/sec^2.



Post-Lab Questions

1. Where would you place a load with this lever system to spend the least force to lift the load?

2. Would Lever Type II be a good system for lifting a heavy load with minimal force? Explain. How might the position of the lever be a problem with a Type II lever?

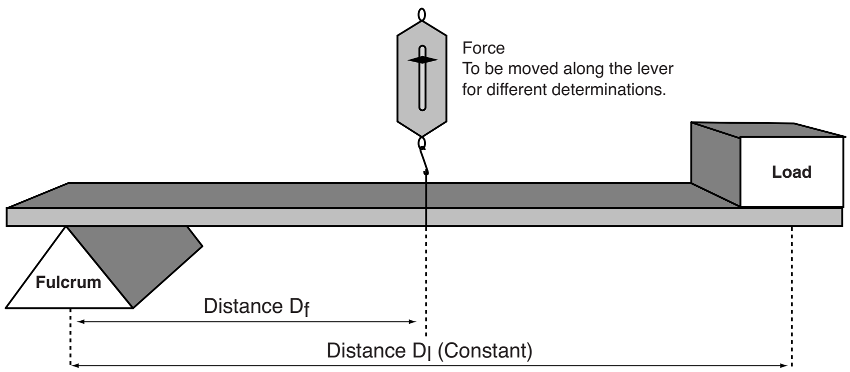
3. Would Lever Type II be a good system for moving a load a long distance? Explain.

4. Think of at least one common item that illustrates a Lever Type II system and explain how it works. What are the advantages and disadvantages of the device for the job?

Lever Type III Worksheet

Trial	Force to Hold Lever Balanced (Newtons)	Load* (Newtons)	Distance D_f (cm)	Distance D_l (cm)	Mechanical Advantage (MA)
1					
2					
3					

*Load is equal to the weight of the slotted masses. $W = m\ g$, where $g = 9.8\ m/s^2$. $1\ N = 1\ kg\ m/sec^2$.



Post-Lab Questions

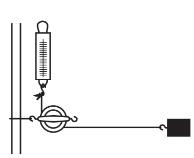
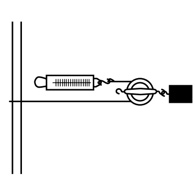
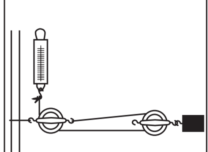
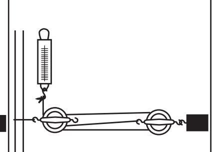
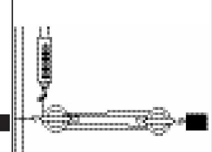
1. What happens to the force required to lift the load as the force gets further from the load and closer to the fulcrum?

2. What happens to the mechanical advantage as the force gets closer to the fulcrum?

3. When the force is close to the fulcrum and a load is lifted, how does the distance the force moves compare to the distance the load moves? When might such an arrangement be advantageous?

4. Why is the fulcrum maintained at the center of the meter stick for all the lever arrangements?

Pulleys Worksheet

Pulley Arrangement	Mass Raised (kg)	Weight (W) (Newtons)	Height (h) raised (Meters)	Work Output (Wh) (Joules)	Input Force (F) (Newtons)	Distance (d) of force (Meters)	Work input (Fd) (Joules)	Number of Supporting Strands	MA	Efficiency $\frac{Wh}{Fd}$ (100%)
										
										
										
										
										

Post-Lab Questions

1. Examine the efficiency calculations for each pulley setup. What are some possible reasons that the efficiency is never 100%?

2. What happens to the force (F) as the mechanical advantage gets larger? What happens to the distance the force moves as the mechanical advantage gets larger?

3. How does increasing the number of pulleys affect the mechanical advantage? How does the number of supporting strings relate to the mechanical advantage? How does the number of supporting strings relate to the *ideal* mechanical advantage of the pulley system?

4. *True or False:* A machine reduces the amount of work you have to do. Explain your answer.

Investigating Gears Worksheet

Part I. Gear Specifications

1. What is the relationship between number of teeth and diameter of the gears?

Part II. Gearing Direction

1. Draw a sketch of a two-gear system with a driver and follower gear. Indicate the direction (CW/CCW) that each gear turns relative to the other gear.

2. Draw a sketch of a three-gear system with a driver, idler, and follower gear. Indicate the direction (CW/CCW) that each gear turns relative to the others.

Part III. Gearing Speed/Distance

1. When the larger driver gear is driving the small follower gear, what happens to the speed of the follower gear compared to the driver gear? (Compare revolutions per unit time.)

2. When the smaller gear is driving the larger gear, what happens to the speed of the follower compared to the driver?

3. Examine the gear specification on Part I of this worksheet. How does the number of teeth on the gears compare to the distance traveled and speed of the gears?

Part IV. Gearing Up/Down

1. Record the amount of force required to lift the 100 g (1 N) weight on the large gear with the small gear.
   ____________ N
2. How does the ratio of the number of teeth on the gears compare to the ratio of the weight lifted and the force required? How does the ratio of the diameters compare?

3. What is the mechanical advantage of this gear setup? Where might such a gear setup be useful?

4. Record the amount of force required to lift the 100 g (1 N) weight on the small gear with the large gear.
   ____________ N
5. What is the mechanical advantage of this gear arrangement? When might such a gear arrangement be used?

