MiSP Simple Machines/Levers Worksheet #1 L3

Name ______________________________ Date _____________

CLEVER LEVER 1 (AIMS *MACHINE SHOP*)

Key Question:
On a lever, how does the size and position of a weight influence the amount of effort needed to move it?

Introduction:

There are three different types of levers. Classification depends on the position of the fulcrum, where the effort is applied, and where the resistance (load) is. This experiment uses a first-class lever where the fulcrum is between where the effort is applied and where the resistance (load) moves. Use of a lever can reduce, increase, or not change the amount of force needed to move an object (this is known as the *resistance*). Mechanical advantage is a number that tells you how a simple machine will change the effort force. If the mechanical advantage is greater than 1, the effort force will be less than the resistance. (For example, if the mechanical advantage is 2, one-half the force will be needed to move the resistance.) If the mechanical advantage is less than 1, the effort force will be more than the effort needed to move the resistance without the simple machine. (A mechanical advantage of 0.5 means that you will need twice the effort force to move the resistance.) A mechanical advantage of 1 means that the effort force will be the same as the force needed to move the resistance without the simple machine.

There are several ways to calculate mechanical advantage in levers. In this experiment we will do it by dividing the resistance force by the effort force:

$$\text{Mechanical advantage} = \frac{\text{Resistance force*}}{\text{Effort force*}}$$

Therefore:
If the effort force is less than the resistance force, the mechanical advantage will be [greater than / less than] 1. (Circle the correct answer.)

If the effort force is greater than the resistance force, the mechanical advantage will be [greater than / less than] 1. (Circle the correct answer.)

If the mechanical advantage is 2, then the effort force is _________ the resistance force.

*In this experiment, force will be measured in pennies.

Procedures:

Follow the steps on page 42 of AIMS *Machine Shop* to set up and make measurements. Your teacher will tell you what experiments (penny amounts and positions) to do. Enter the data for the experiment on the chart on page 43 of AIMS *Machine Shop***.** Enter the four sets of data when the resistance force was 3 pennies on the chart below:

Data:

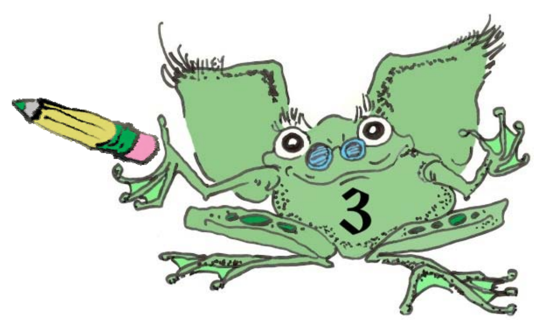
Left Side — Resistance		Right Side — Effort		
Resistance force (pennies) r	Resistance arm length (cm)	Effort arm length (cm)	Effort force (pennies) e	Mechanical advantage r/e
3	12		1	
3	12		2	
3	12		4	
3	12		6	

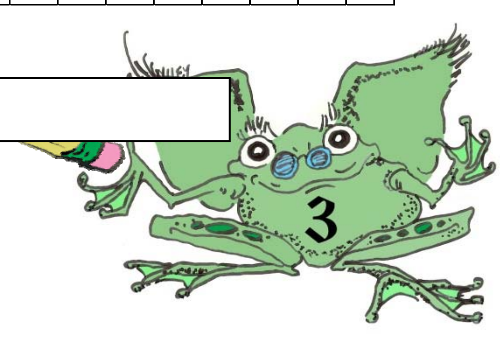
Calculate the mechanical advantage, and fill in the column on the far right.

Graph your data:

Graph the data on the next page to show the relationship between the mechanical advantage (no unit) and the effort arm length (cm).

- Label the *x*-axis.
- Label the *y*-axis.
- Draw a best-fit line between the points.

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Discussion Questions:

Clever Lever 1 Connecting Learning (AIMS *Machine Shop*, p. 44; questions #2 and #4 are not required)

1. With a balanced lever, what pattern can you find between the number of pennies and the distance from the fulcrum on the resistance side, and the number of pennies and the distance on the effort side?

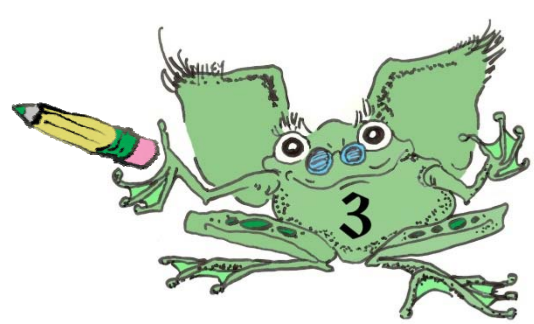
3. How can you determine where two people need to sit on a seesaw in order to balance it?

5. What does the mechanical advantage tell you about the force made by each penny on the effort side compared to the force made by each penny on the resistance side?

6. Use the graph to predict the effort arm length for each effort force below. Remember that mechanical advantage = $\frac{\text{Resistance force}}{\text{Effort force}} = \frac{\text{3 pennies}}{\text{Effort force}}$

   Effort force of 3 pennies (mechanical advantage = _____) __________ cm

   Effort force of 12 pennies (mechanical advantage = _____) __________ cm



7. If you had to design a first-class lever to move a very heavy load, would you make the effort arm long or short?

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8. Use the information from the graph to calculate the unit rate of change (slope) for the Clever Lever 1 graph. If your data points all lie on a line, determine the unit rate of change (slope) of the line. If your data points do not produce a line, determine the slope of the best-fit line that you drew. *(If you use the best-fit line, the ordered pairs to determine slope must be from the best-fit line, not from your data chart.)*

Unit Rate of Change $= \dfrac{\Delta \text{ Effort Arm Length (cm)}}{\Delta \text{ Mechanical Advantage}} = \dfrac{\Delta y}{\Delta x} = \dfrac{(y_2 - y_1)}{(x_2 - x_1)}$

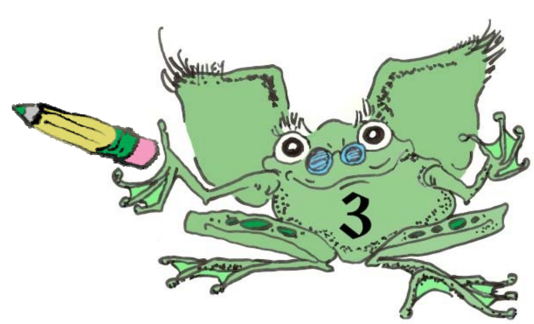
Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Effort Arm Length (cm) Δy	Δ Mechanical Advantage Δx	**Unit Rate of Change (slope)** $\Delta y / \Delta x$

9a. The unit rate of change is a positive number (+). So when the mechanical advantage increases, the distance between the effort force and the fulcrum

(effort arm length) _________________________.

9b. Based on the unit rate of change, if a student changed the effort amount of pennies so that the mechanical advantage increased by 0.5, then she or he would have to change the position of the effort force by moving it

___________________ cm.



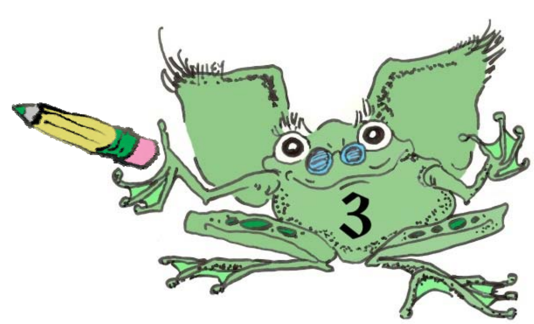
10. Use the equation for a line to calculate the y-intercept. Use the line or best-fit line you used in #8.The equation for a line is

$y = mx + b$
where m is the unit rate of change (slope) and
b is the y-intercept

Y-Intercept
$m =$ Ordered pair (x, y) = (___ , ___) $y = mx + b$ Solve for b:

11. Based on the unit rate of change that you calculated above and the y-intercept, write an equation for the line on the Clever Lever 1 graph.

Equation — Clever Lever 1 line



12a. The Clever Lever 1 experiment used a meterstick as a ruler. We graphed the data when the resistance force was 3 pennies, the resistance arm length was 12 cm, and the fulcrum was at 50 cm. As the effort force (amount of pennies) changed, the position of the effort (effort arm length in cm) had to change. Using the formula above and the limited size of the meterstick, what is the greatest mechanical advantage that a student could have with this setup? Look at the meterstick to help you answer this question.

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12b. How many pennies of effort force would be needed for that mechanical advantage? Remember that mechanical advantage = r/e.

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