MiSP Simple Machines / Inclined Plane Worksheet #2b L3

Name ______________________________ Date _____________

MODIFIED FROM:
MAKING THE GRADE (AIMS *MACHINE SHOP*)

Key Question: How much force does it take to lift 400 grams 20 centimeters in height?

Learning Goal: Students will measure and compare the forces needed to lift an object straight up and on an inclined plane.

Problem:

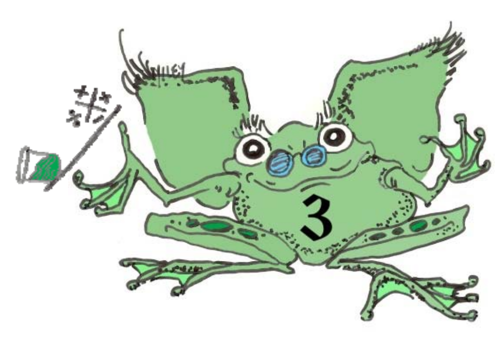
How does the length of an inclined plane affect the force?

Procedures:

1. Follow the instructions given by your teacher for setting up the cup or tub (resistance) and the ramp so it goes to a height of 20 cm. She or he will describe how to read the spring scale and attach it to the tub or cup. The tub or cup will have a mass of approximately 400 g. Your teacher will tell you if it is a different mass. In addition, your teacher will tell you the measurement units that you will be using to measure force.
   Make all force measurements while you are lifting or pulling the tub or cup, after the initial start from rest. Lifting and pulling should be done with a nice, even, continuous, smooth motion—no jerking.

Check off each step as you do the experiment.

- ☐ Lift the filled cup or tub to a height of 20 cm. Measure the force used to move the cup or tub, using the spring scale.
- ☐ Write the force used in __________ units on the data chart.
- ☐ Place the inclined plane ramp on the 20 cm elevation so that the ramp length is 40 cm.
- ☐ Pull the cup or tub up the ramp. Measure the force used to move the cup or tub up the ramp, using the spring scale.
- ☐ Write the force used in __________ units on the data chart.
- ☐ Repeat steps 4, 5, and 6 but make the ramp length 50 cm.
- ☐ Repeat steps 4, 5, and 6 but make the ramp length 60 cm.



☐ Repeat steps 4, 5, and 6 but make the ramp length 70 cm.

☐ Repeat steps 4, 5, and 6 but make the ramp length 80 cm.

☐ Repeat steps 4, 5, and 6 but make the ramp length 90 cm.

☐ Repeat steps 4, 5, and 6 but make the ramp length 100 cm.

Record your data:

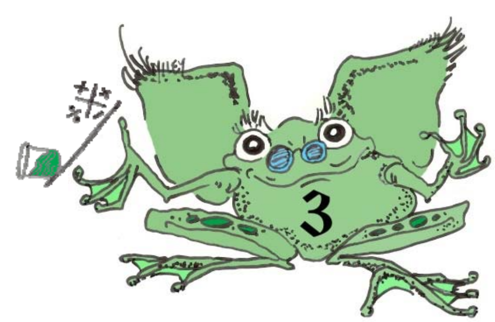
Data Table

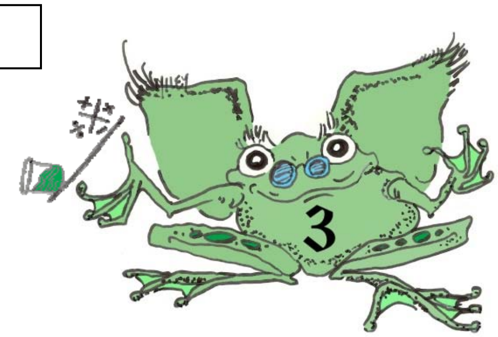
Distance Resistance (cup or tub) Traveled (cm)	Effort Force to move the Resistance (cup or tub) ___________ units
20 straight lift	
40 inclined plane	
50 inclined plane	
60 inclined plane	
70 inclined plane	
80 inclined plane	
90 inclined plane	
100 inclined plane	

Graph your data:

Use the data table to create a graph on the next page. The graph will show the relationship between the distance the resistance (tub or cup) moved and the force needed to move it. This information is in gray in the data table.

- Label the *x*-axis.
- Label the *y*-axis

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Discussion Questions:
Making the Grade Connecting Learning (pp. 195–196, #2–#4, #8)

1. What generalization about the inclined plane can be made from the graphs?

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2. How could you use an inclined plane to help you?

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3. Why did the force go down as the length of the plane got longer? Did you reach the same height?

   ____

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4. Theoretically, comparing the amount of force to the distance to pull for each example should give you the same results. In the activity you will find that these are not exactly the same. What causes the difference?

   ____

   ____

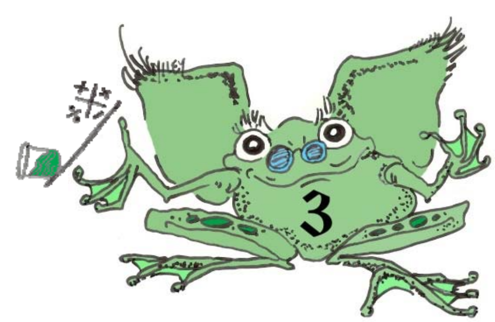
5. Use the graph to predict the force that would be used if the resistance traveled

   55 cm: ________________________

   110 cm: ________________________

6. Look at the line segment on the graph between the 40 cm and 50 cm data points. Complete the sentence, "As the *x*-values on this graph INCREASE,

   the *y*-values ____________________."



7. Use the information from the graph to calculate the unit rate of change (slope) for the line segment between the 40 cm and 50 cm data points. Use the formula below to complete the chart.

Unit Rate of Change = $\frac{\Delta \text{ Effort Force (\_\_\_\_\_\_\_\_\_\_ units)}}{\Delta \text{ Distance Resistance Traveled (cm)}} = \frac{\Delta y}{\Delta x} = \frac{(y_2 - y_1)}{(x_2 - x_1)}$

Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Effort Force (_____ units) Δy	Δ Distance Resistance Traveled (cm) Δx	**Unit Rate of Change (slope)** $\Delta y/\Delta x$

8. Put the calculated unit rate of change (slope) into words to explain how inclined planes make it easier to move objects to higher locations.

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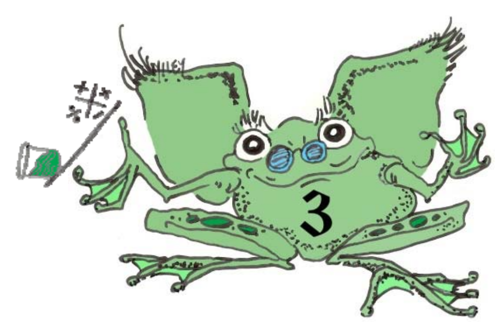

9. Determine the y-intercept for the line segment between the 40 cm and 50 cm data points. Use the equation for a line to calculate the y-intercept. The equation for a line is

$y = mx + b$
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:

10. Based on the unit rate of change (slope) that you calculated above and the y-intercept, write an equation for the line segment between the 40 cm and 50 cm data points. Remember that the equation for a line is $\boldsymbol{y = mx + b}$ and m is the unit rate of change (slope) and b is the y-intercept.

Equation — Line segment from the 40 cm to 50 cm data points

11. The line segment from 40 cm to 50 cm would intersect the x- and y-axes if it was extended. Graphed inclined plane experimental data, as in the experiment you did, would NOT intersect the x- and y-axes. Why not?

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