Name: _____ Date: _____

Student Exploration: Ants on a Slant (Inclined Plane)

Vocabulary: friction, inclined plane, work

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)

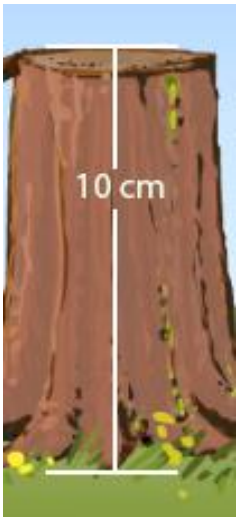
1. Imagine you were lifting *very* heavy jugs to the top of a house. You can either use the stairs on the left or push them up the **inclined plane** on the right. Which option is easier? Why?

_____

2. If a person in a wheelchair wanted to get to the second story of a two-story building, would it be easier to take a short, steep ramp or a long, shallow ramp? Explain.

_____

Gizmo Warm-up



1. In the *Ants on a Slant* Gizmo, ants use a slanted stick to help push food to the top of a tree stump. Drag the stick sideways to change its steepness. Change the number of ants by dragging them to the item. Then click **Play** (▶) to see if the ants can lift the item.

   First, describe a strategy to find out which items are heavier than others.

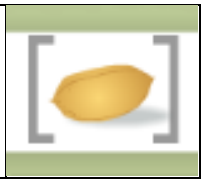
   _____

   _____

   _____

2. List the food items in order, from lightest to heaviest, using your method:

   (lightest) _____, _____, _____, _____ (heaviest)

Activity A: **Inclined planes: pros and cons**	Get the Gizmo ready: • Click **Reset**. • Make sure **No friction** is selected.	

Question: What are advantages and disadvantages of using inclined planes to help lift?

1. Observe: Run a few trials with the Gizmo. Explore both shorter (steeper) and longer (flatter) sticks. Why do you think people (or ants) would choose to use an inclined plane to help lift?

   _____

   _____

2. Predict: Make two predictions below. (Stick lengths in the Gizmo: 10, 15, 20, 25, and 30 cm.)

   A. Which stick length will let you lift a peanut with the *fewest* ants? _____

   B. Which stick length will require the *longest* time to lift a peanut? _____

3. Experiment: Test your predictions. Use all five stick lengths to lift a peanut. List results here.

	10 cm	15 cm	20 cm	25 cm	30 cm
Minimum ants needed to lift peanut					
Time needed to lift the peanut					

4. Draw conclusions: Name an advantage and a disadvantage of using an inclined plane.

   A. Advantage: _____

   _____

   B. Disadvantage: _____

   _____

5. Analyze: The stick doesn't just support the peanut; it actually *pushes up* on it! (Think of what would happen if the stick suddenly disappeared.) This pushing up is what "helps" the ants.

   A. Which kind of inclined plane pushes up *more*? (Circle one.) Steeper Flatter

   B. What do you think causes this? _____

   _____

Activity B: **Work, work, work**	Get the Gizmo ready: • Click **Reset**. • Make sure **No friction** is selected. • Select the **blueberry**. • Select the 10-cm stick (shortest, steepest stick).	

Question: How does length of an inclined plane affect the force needed to lift an object?

1. Form hypothesis: Suppose you already know how many ants it takes to lift an object straight up (using the 10-cm stick). How can you predict the number of ants that will be needed to lift the object with an inclined plane of a certain length?

   Hint: Play with the Gizmo. See how doubling the length changes the number needed.

   _____

   _____

   _____

2. Collect data: How many ants can lift the blueberry straight up (using 10-cm stick)? _____

3. Predict: Use your hypothesis to predict what is the *smallest* number of ants required to lift the blueberry on sticks of other lengths:

   15-cm stick _____ 20-cm stick _____ 30-cm stick _____

4. Experiment: Test your predictions in the Gizmo. How many ants are needed for each?

   15-cm stick _____ 20-cm stick _____ 30-cm stick _____

5. Calculate: The **work** used to lift an item equals the force needed times the distance moved. You can estimate work by multiplying the number of ants times the stick length.

	10 cm	15 cm	20 cm	30 cm
Ants required (minimum number)				
Approximate work (ants x length)				

6. Draw conclusions: How does using an inclined plane affect the work required to lift an item?

   _____

Activity C: **Friction**	Get the Gizmo ready: • Click **Reset**. • Select **Friction**.	

Introduction: When people rub their hands together, **friction** is the force that tries to stop the motion. Friction also can stop a pencil from sliding down a tilted desk.

Question: How does friction affect an object sliding on an inclined plane?

1. Explore: Use the Gizmo to examine the effects of friction. Run several different trials.

   A. Are there times when friction helps the ants? _____

   B. Are there times when friction prevents the ants from lifting the item? _____

2. Investigate: Select the blueberry. Run the test on the 10-cm, 20-cm, and 30-cm sticks. Record the minimum number of ants needed *with* friction, and also *without* friction.

	No friction		Friction	
	Minimum ants needed	Work (ants x length)	Minimum ants needed	Work (ants x length)
10 cm				
20 cm				
30 cm				

3. Analyze: Friction causes work to be "wasted" as heat (which is why your hands get warm).

   A. Does friction waste more work on longer or shorter planes? _____

   B. How can you tell? _____

   C. Why do you think this is? [Hint: Remember the stick presses up on the item. Do your hands get warmer faster if you press them together harder as you rub?]

   _____

   _____

4. Conjecture: Does friction cause more energy to be wasted if the object is heavier? Why?

   _____

   Use the Gizmo to test this. Describe your results in your notebook or on a separate sheet.