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?



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1. 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.

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**Gizmo Warm-up**

1. 649SE5In 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.

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

(lightest) \_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_ (heaviest)

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| --- | --- | --- |
| **Activity A:**  **Inclined planes: pros and cons** | Get the Gizmo ready:   * Click **Reset**. * Make sure **No friction** is selected. | 649SE2 |

**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?

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1. Predict: Make two predictions below. (Stick lengths in the Gizmo: 10, 15, 20, 25, and 30 cm.)
   1. Which stick length will let you lift a peanut with the *fewest* ants? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. Which stick length will require the *longest* time to lift a peanut? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. 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 |  |  |  |  |  |

1. Draw conclusions: Name an advantage and a disadvantage of using an inclined plane.
2. Advantage: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Disadvantage: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. 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.

1. Which kind of inclined plane pushes up *more*? (Circle one.) Steeper Flatter
2. What do you think causes this? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **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). | 649SE3 |

**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.

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

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

15-cm stick \_\_\_\_\_\_\_\_\_\_\_\_\_ 20-cm stick \_\_\_\_\_\_\_\_\_\_\_\_\_ 30-cm stick \_\_\_\_\_\_\_\_\_\_\_\_\_

1. 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) |  |  |  |  |

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

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| **Activity C:**  **Friction** | Get the Gizmo ready:   * Click **Reset**. * Select **Friction**. | 2015-07-16 20_01_39-Ants on a Slant (Inclined Plane) Gizmo _ ExploreLearning |

**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.
2. Are there times when friction helps the ants? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Are there times when friction prevents the ants from lifting the item? \_\_\_\_\_\_\_\_\_\_\_\_\_
4. 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 |  |  |  |  |

1. Analyze: Friction causes work to be “wasted” as heat (which is why your hands get warm).
2. Does friction waste more work on longer or shorter planes? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. How can you tell? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. 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?]

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

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