

Name \_\_\_\_\_

### The Ramp—PhET Simulation

1. Go to the PhET website. Choose “playwithsim.” Next, choose >Physics, >Work, Energy & Power >The Ramp.
2. Play around with the simulation and figure out what everything does. Notice which direction indicates a force in the positive direction.
3. Click the “Reset” button.
  - Why does the small red friction arrow point uphill? \_\_\_\_\_
  - Does the file cabinet slide under these conditions? \_\_\_\_\_
4. Apply a positive force to the cabinet.
  - What happens to the direction of the red friction arrow? \_\_\_\_\_ Why?
5. Click “Reset”. In the “Applied Force” bar to the left of the chart, increase the positive force until the applied force is 200 N. Click “Go!” Although 200 N is greater than the friction force, the cabinet does not move. Why?
6. Click “Pause”. Continue to increase the force using the “Applied Force” bar in the positive direction until a green vector appears on the file cabinet.
  - What does the green vector represent? \_\_\_\_\_
  - Write an equation using applied force  $F_A$ , friction force  $F_F$ , and total force  $F_{NET}$ .  
\_\_\_\_\_
  - This simulation does not show the downhill component of gravity  $F_P$ . Now write an equation using parallel force  $F_P$ , applied force  $F_A$ , friction force  $F_F$ , and total force  $F_{NET}$ .  
\_\_\_\_\_
  - Which way will the cabinet move if you click “Go!”? \_\_\_\_\_ (try it to check your prediction)
7. Click “Reset”. Put the refrigerator on the plank. Vary the angle of the incline. (by clicking and dragging the plank)
  - At what angle is the normal force equal to the weight?
  - What happens to the magnitude of the normal force as the angle of the incline increases? \_\_\_\_\_

- At what angle does the refrigerator begin to slide? \_\_\_\_\_

8. Choose the “More Features” tab. Find the angle at which the cabinet begins to slide. Change the coefficient of friction to the values below and record the angle when the cabinet begins to slide.

Coefficient of Friction ( $\mu$ )	Angle to slide
0.1	_____
0.3	_____
0.6	_____
0.9	_____

What is the relationship between coefficient of friction and the angle at which an object begins to slide?

9. Still under the “More Features” tab, click “Reset”. Devise a plan that allows you to test if the mass of an object affects the angle to slide. Have your instructor initial here \_\_\_\_\_ when you have filled in the variables below and explained your plan.

- Independent variable: \_\_\_\_\_
- Dependent variable: \_\_\_\_\_
- Constant: \_\_\_\_\_

Data Table


- What relationship exists between mass and the angle at which an object begins to slide?

10. Return to the “Introduction” tab and click “Reset”. Slide the starting position to 0m. Set the applied force to +500 N. Open the energy graph and the work graph. Also open the work and energy bar charts using the buttons to the right of the graph. Click “Go”. Replay in slow motion. It may be helpful to freeze the scroll bar in one place to answer these questions.

- What type of energy is equal and opposite to the work done by gravity? \_\_\_\_\_
- What type of energy is equal and opposite to the work done by friction? \_\_\_\_\_
- $W_{\text{applied}} - W_{\text{friction}} - W_{\text{gravity}} =$  \_\_\_\_\_
- $E_{\text{total}} - E_{\text{thermal}} - E_{\text{potential}} =$  \_\_\_\_\_

11. Open the work and energy graphs using the buttons in the lower left. Play with the sim. Write a question regarding work or energy. Challenge a classmate to use the sim to answer your question. Have the classmate initial the paper here: \_\_\_\_\_