Name: _____ **Period:** _____

Ramp: Forces and Motion

Learning Objectives:

1. Describe how the forces on an object change when the object is on an inclined plane
2. Relate energy, force, and motion with objects moving on a ramp
3. Use free body diagrams to explain the net (total) force on an object

Directions:

1. Explore the ***Ramp: Forces and Motion*** simulation with your partner. As you explore, talk about what you find with your partner.

2. Click "Show" on the **Free Body Diagram**. Push the **filing cabinet** back and forth.

   a) What makes the arrows change in length?

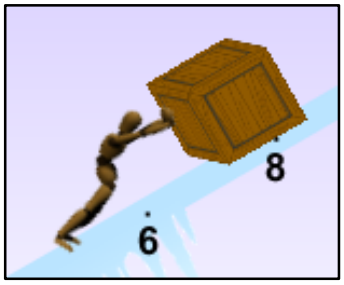
   b) What makes the arrows change in direction?

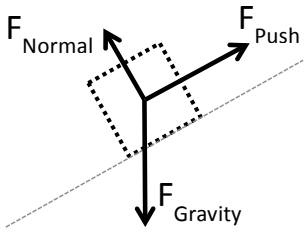
3. What changes when you switch between ice and wood as you push the Filing Cabinet back and forth?

4. On the **wood ramp**, how does each force change as you make the **ramp angle bigger**?

Force	Changes Direction?	Changes Size?
Gravity	☐Yes ☐No	☐Increases ☐Decreases ☐Same
Normal	☐Yes ☐No	☐Increases ☐Decreases ☐Same
Friction	☐Yes ☐No	☐Increases ☐Decreases ☐Same

5. On the right is an example of a **Free Body Diagram** for the crate being pushed up the ice ramp:





Teacher Tip 7/24/12 11:14 AM
Comment [1]: Simulation Tip:
The learning goals in this activity do not utilize all of the tabs or tools in the sim. For this activity, keep students focused on "Introduction" and "Robot Moving Company".

Teacher Tip 7/24/12 11:14 AM
Comment [2]: Demonstration:
Place tennis ball on table.
What forces are acting on the ball?
Create an inclined plane with a textbook, and place the tennis ball on the book.
What forces are acting on the object. How are the two different?

Teacher Tip 7/24/12 11:14 AM
Comment [3]: Class Discussion:
Lead class discussion around how are *force*, *energy*, and *motion* are related.

Teacher Tip 7/24/12 11:14 AM
Comment [4]: Class Discussion:
Generate student excitement around learning to use a science tool that is usually not taught until physics.

Teacher Tip 7/24/12 10:49 AM
Comment [5]: Play Time:
Allow students to explore all tabs on the sim during the play time, even though you will not be using all of them later on.

Teacher Tip 7/24/12 11:14 AM
Comment [6]: Check for Understanding:
Students should answer this question by relating the size of the force vectors and the "speed" of the object.

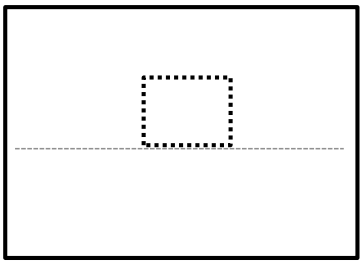
Teacher Tip 7/24/12 11:14 AM
Comment [7]: Class Discussion:
Draw connection to math and geometry skills. (*obtuse angles, acute angles*)

Teacher Tip 7/24/12 11:14 AM
Comment [8]: Class Discussion:
Discuss Free Body diagrams. Drag the diagram on the right over the top of the image on the left.
***there is a clip of this**

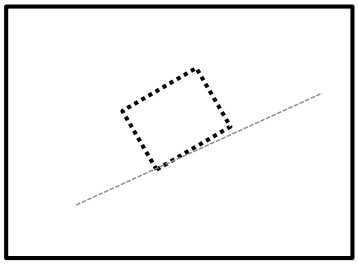
The Free Body Diagram must include:
Object
Arrows representing forces (originating from the center of gravity)
Labels on the force arrows

6. Draw a **Free Body Diagram** for the following situations:

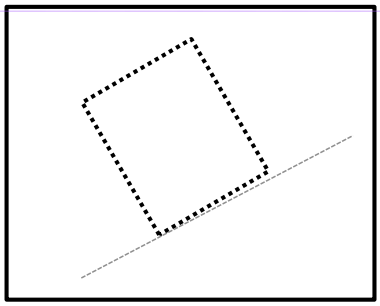
Crate *Not Moving* on Ice



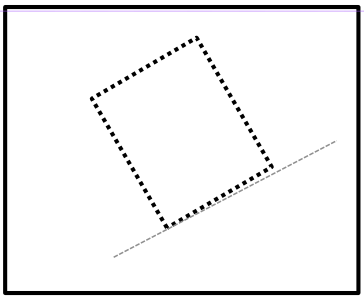
Crate *Not Moving* on Wood



Fridge *Pushed Down* Wood Ramp



Fridge *Pushed Up* Ice Ramp



7. In the game, why does the robot need to use energy to deliver objects safely?

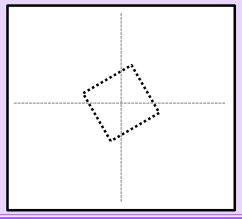
8. Challenge! In the game, deliver all your objects without running out of energy, and gaining the highest score.

Trial 1	Trial 2	Trail 3
Score:	Score:	Score:
Reflection for improvement:	Reflection for improvement:	Reflection for improvement:

Teacher Tip 7/24/12 11:14 AM
Comment [9]: Check for Understanding:
Check that all students have successfully drawn a free body diagram with the following pieces:
-Arrow size represents amount of force
-Arrow points in direction of force
-All arrow originate from the center of gravity of the object
-Gravity points straight down

Teacher Tip 7/24/12 11:14 AM
Comment [10]: Extension Opportunity:
Ask students to draw a coordinate grid on the diagram and label the axis.

Crate *Not Moving* on Wood Ramp



Teacher Tip 7/24/12 11:14 AM
Comment [11]: Possible Sim Difficulty:
Students may have difficulty drawing free body diagrams from sim.
To Address this:
Students can pause the sim when the object is on the ramp to observe the force vectors, however they will need a partner to hit pause while they push the object.

Teacher Tip 7/24/12 11:14 AM
Comment [12]: Check for Understanding:
Ask students do discuss their response with table partner, then ask for share outs. Before moving onto challenge students need to be able to articulate the following:
-The applied force requires energy from the person or object applying the force
-An inclined plane reduces the amount of required force applied to move the object

Teacher Tip 7/24/12 11:14 AM
Comment [13]: Check for Understanding:
The larger the mass of an object, the less force required to move it down an inclined plane.

Teacher Tip 7/24/12 11:14 AM
Comment [14]: Differentiation Opportunity:
What would happen if the ramp was changed to ice? What force is causing this difference? Why? Have student go to the friction tab of the sim, and draw the diagrams from #6 again using friction. Ask student to create a comparison table to share with class.