Computer Simulation: Forces, Friction and Motion

Introduction

Today we will learn about how the force put on an object determines how it will move when there is no friction and when there is friction. Find the appropriate link on my *resources* page, OR:

1. Go to this address: http://phet.colorado.edu/en/simulation/forces-and-motion-basics and choose the sim under PHYSICS, MOTION → "Forces and Motion Basics"
2. Click the button that says "Run Now". It might take a few minutes to load Find the sim in your downloads folder & open it. If it says Java needs updated, click "Later". The screen will look like this:

3. All answers will be recorded on this document.

Explore

1. Place a man on each side of the rope.
2. Hit the "go" button.
3. Hit the "Return" button. Try it again with either the same amount of men on each side or a different amount of men on each side.
4. Hit the "Reset all" button. Click box next to "sum of forces" and "values," continue putting men on each side.
5. Hit the "Return" button.

Questions (Answer each question in the space provided)

1. How can you make the blue side win?

2. How can you make the red side win?

3. How can you get a tie on both sides?

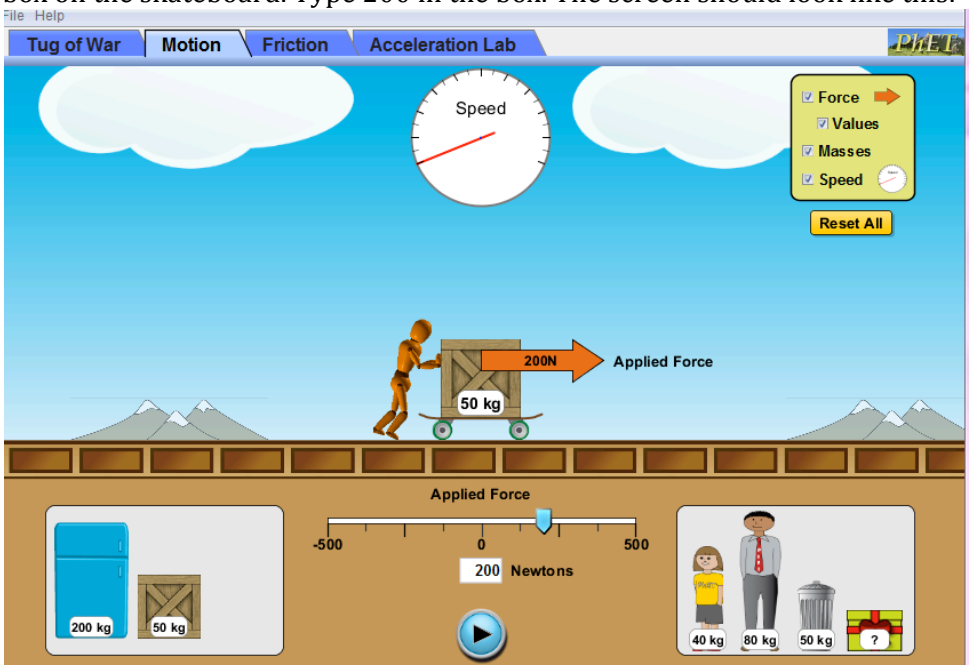
4. If there was only one man pulling the cart what would the sum of forces consist of?

Explain

Title: Forces, Friction, and Motion
Aim: How does applied force and friction affect the speed of an object?
The science concept is: If Sum of forces (or F_{NET}) is not zero, object speeds up or slows down. If F_{NET} is zero then its speed is constant.

Part I- Motion

1. Click the tab "Motion"
2. Check the boxes next to " force, values, masses, and speed"
3. Click the pause button.
4. Place a box on the skateboard. Type 200 in the box. The screen should look like this:



5. Press the play button. Count to ten, what happens? (Look at the speedometer)

6. Repeat steps 4 and 5 with the refrigerator. (look at the speedometer)

7. Click the "Reset All" button.
8. Repeat steps 2-4 using different objects and different applied forces. You can also use the people.
9. What happens to the speed, does it slow down as different objects are added and the applied force is different?

10. Why do you think this happens?

11. If forces are balanced, then the net force is zero. Is there a sum of forces, or net force here?

12. How much time does it take for 1 crate, 2 crates, a refrigerator, the man, the girl, and the mystery object, with same applied force get to maximum speed? Maximum speed is reached when the hand on the speedometer cannot go any further. (Record your answers in table below.) For the next part, you will need a timer. You may use a handheld stopwatch/phone, OR, for an online timer, open a new

browser (Command N), and google “online stopwatch”, or type in this url address: http://www.online-stopwatch.com/full-screen-stopwatch/

13.

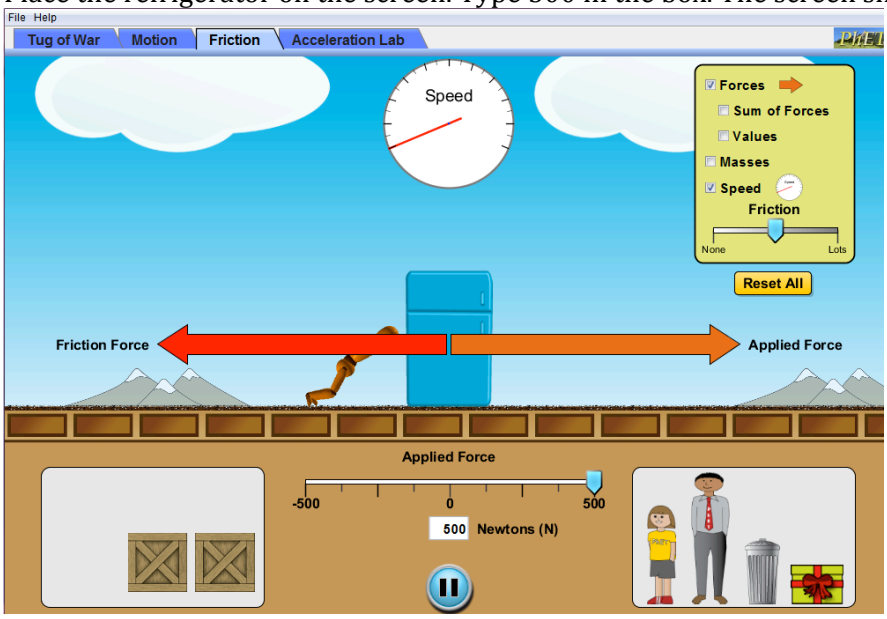
Object	Mass	Applied force (Newtons)	Time (Use stopwatch)
1 crate		300N	
2 crates		300N	
Refrigerator		300N	
Man		300N	
Girl		300N	
Mystery Object		300N	

14. Do you think the object’s mass determines how long it will take for that object to reach maximum speed with an applied force of 300 N? Yes or No, and explain your answer.

15. What approximate mass do you think the mystery box has, based on how long it took to reach maximum speed at 300N?

Part II-Friction

1. Click the tab “Friction”
2. Check the boxes next to “ forces and speed”
3. Place the refrigerator on the screen. Type 500 in the box. The screen should look like this:



4. What happened? Did the refrigerator move?

5. Click the “Reset All” button.
6. Check the boxes next to “values and speed”
7. Place the refrigerator on the screen. Type 500 in the box. Slide the friction tab toward “None”.
8. What happens as you slide the friction tab closer to “None”?
9. Click “Reset All”.

10. Check the boxes next to "values and speed"
11. Place any object on the screen. You can also place the people on the screen.
12. Type 500 in the box. Slide the friction tab toward "None" or "Lots". Stop the friction tab where the friction force arrow is between 100N and 200N.
13. Complete the table. Fill in the missing values.

Object	Applied Force (N)	Friction Force (N)	Sum of Forces (or F_{NET}) (N)
Crate	200	125	
Man	472		272
Refrigerator		51	99
Girl	363	100	
Garbage Can	500		375

*You can use the Friction Tab to help you check your answers.

Come up with a formula we can use to find the sum of the forces (or F_{NET}).
Here are a few suggestions: $F_{NET} = F_{applied} - F_{friction}$ or $F_{NET} = F_{applied} + F_{friction}$ Write your answer below:

14. Calculate the Sum of Forces using the formula you came up with.

15. Click the "Sum of Forces" box. Did you get the same number using the formula you came up with?

16. If you did not, how can you revise your formula to match the Sum of Forces provided on the screen?

Apply

Now we will call all applied forces positive and all friction forces negative.

Use the equation to complete the table. Fill in the missing values.

Object	Applied Force (N)	Friction Force (N)	Sum of Forces, F_{NET} (N)
Box		-210	190
Man	350		274
Refrigerator		-137	363
Girl	200		122
Garbage Can		-50	100
Mystery Object	300		175

1. How does the force placed on an object affect how it moves?

2. What happens if there is too much friction? Will the object move slowly, fast or not at all?

3. What if only a little friction is added, how will the object move?

Part III- Acceleration - *Click the tab "Acceleration"*

1) Use the simulation to answer each of the questions below (Use complete sentences to answer each question:
   a. How do you make the box speed up?
      I make the box speed up by…
      _____
   b. How do you make the box move at a constant speed?
      I make the box move at a constant speed by…
      _____

      Once the box is moving how do you make it stop?
      _____

      Once the box is moving how do you make it change direction?_____
   c. Describe the motion the box undergoes when you make it change direction._____
2) Any change in motion is called acceleration. When does the box accelerate?_____
3) What is the acceleration of each item? *I did the first one. Check my answer. Then find the acceleration of all the others.*

Object	Mass	Acceleration	Force
Young Woman	40 kg	10 m/s^2	400 N
Man in Suit	80 kg		400 N
Bucket	50 kg		500 N

4) Use the table above for the next questions:
   a) How do you find force? (State the equation using words).
   b) How do you find acceleration? (State the equation using words).
      Acceleration =
   c) How do you find mass? (State the equation using words).
      Mass =
5) How much force would the orange man need to use for the 200-kg fridge to accelerate at 5 m/s^2? Always show work.