**FORCE AND NEWTON’S LAWS REVIEW**

To Begin: http:/phetcolorado.edu -> HTML 5 SIMs -> Forces and Motion Basics

**Part I - Newton’s First Law**

Choose the “Motion” window to start the simulation

Make sure the boxes that say “Force”, “Values” and “Speed” are checked!

1. Apply a force of 50 N right to the box. Describe the motion of the box using physics terms (i.e. velocity, acceleration, displacement). Refer to the speedometer in your answer.
2. Reset the scenario (don’t forget to check forces, speed again). Apply a force of 50 N to the right for about 5 seconds then reduce the applied force to zero (the man should stop pushing). Don’t reset the scenario. Describe the motion of the box. Refer to the speedometer in your answer.
3. Apply a force of 50N to the left. Describe the motion of the box.

1. Explain the exact steps needed to make the box come to a stop.

Summary

Newton’s First Law of Motion States “An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force.” Explain how your observations in a - d support this Law.

**Part II - Newton’s Second Law**

1. Reset the sim, don’t forget to check force, values and speed again. Remove the box and place a garbage can on top of the skateboard. Using your timer/phone, measure the amount of time it takes to reach maximum speed using a force of 50 N. Try this again with forces of 100N, and 200N.

|  |  |
| --- | --- |
| **Applied Force (N)** | **Time To Max Speed (s)** |
| 50 |  |
| 100 |  |
| 200 |  |

1. Reset the sim, check force, values, speed and the masses boxes this time. Set the applied force to 200 N Right. Using your timer/phone measure the amount of time it takes to reach maximum speed. Repeat with two crates, one crate and a garbage can, and a refrigerator. Record your findings!

|  |  |
| --- | --- |
| **Object – Mass (kg)** | **Time To Max Speed (s)** |
| 50 |  |
| 100 |  |
| 150 |  |
| 200 |  |

Open up the “Graphical Analysis” Software on the laptop. Create a graph of time vs mass. Sketch this graph in the space below. Recall how acceleration is related to time. Note: In this case the final speed of all the trials is the same. Manipulate your time data to get an appreciation for how the acceleration of the mass changes in each trial. Sketch an acceleration vs mass graph using this data in the space below (use GA software to help you)

Summary

Newton’s Second Law states “The acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object.” Explain how your observations in both a and b support this Law.

**Part III - Friction’s Effects**

The behavior of the skateboard in Part I and part II were not very realistic because friction was not present. At the bottom of the screen is a simulation that includes friction. Select this simulation.

1. Set friction to “none”. Notice how the screen changed. Why do you think the app designers did that?
2. Make sure that only speed box is checked.
   * 1. Apply a force to get the box to about half of it’s maximum speed, then remove the force.
     2. While the box is moving, move the friction slider to 1/2 way.

What happened to the box?

Summary

Is friction a force? What evidence do you have?

**Part IV - Back to Newton’s Second Law**

Reset the Friction app. Make sure Forces and Speed are checked.

1. Apply a force of 50 N. Describe the movement of the box.
2. Apply a force of 100 N. Describe the movement of the box.
3. Apply a force of 150 N. Describe the movement of the box.
4. Check the box that says “Sum of Forces”. Repeat procedures a, b, and c. What was different about c?

Summary

Newton’s Second Law states “The acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object.” Explain how your observations relate to the underlined portion of this Law (hint, you might want to look up the definition of the word “net”).

**Part V: Friction in Detail**

1. Reset the app. Check the force and speed box. Apply 50 N of force to the crate. Slowly click (in 50 N increments) to increase the amount of applied force until the crate starts to move/accelerate. Note the range of force values when the crate first started to move. Record this range below (e.g. starts moving somewhere between 0 and 50 N).
2. Reset the app. Repeat the steps in “a”. Once you have just made the crate move do not adjust the force any higher. Allow the block to move with this constant force for 2.0 seconds. Now reduce the force by 50 N. How does the crate behave immediately after reducing the force by 50 N? Did it keep accelerating? Move at a constant speed or decelerate? Does this behaviour surprise you based on your knowledge of Newton’s 1st and 2nd Law. Why do you think the crate behaves this way?
3. Reset the app. Check the speed, force, sum of forces and values boxes. Adjust the value of the applied force using single Newton increments to determine the exact force required to make the crate move. Mentally note the value of this force so you can record it after in the space below. Now keep increasing the value of the applied force in large 50 N or small single Newton increments. What happens to size of the friction force? What is the value of the friction force now? Why does the friction force behave this way?
4. Repeat step c and after the block has accelerated for 3.0 seconds reduce the applied force to 0 N. What happens to the size of the friction force after the applied force goes to 0 N? How does the crate behave?
5. Reset the app. Check the forces, values and speed boxes. Place another crate on top of the first. Determine the minimum amount of force required to move the crates. Determine the minimum amount of force required to keep the blocks moving at a constant speed. Record these below:
   * 1. How do these values compare to the values found for one crate? What does this tell you about the affect of mass on friction?
6. Reset the app. Check the force and values boxes. Apply 50 N of force to the crate. What is the value of the force of friction now? Record this. Increase the applied force and note how the friction force behaves. Record this behaviour in the space below.

Summary

Make four or more general statements about the force of friction based on your observations in parts a – f.