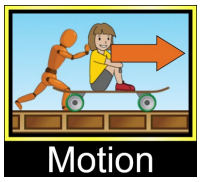
Newton's 1st and 2nd Laws of Motion Activity

Name: _____

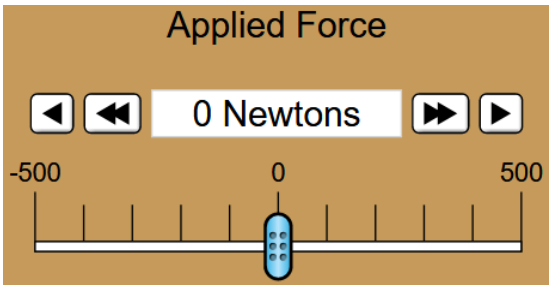
Setup

1. Go to: https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_en.html

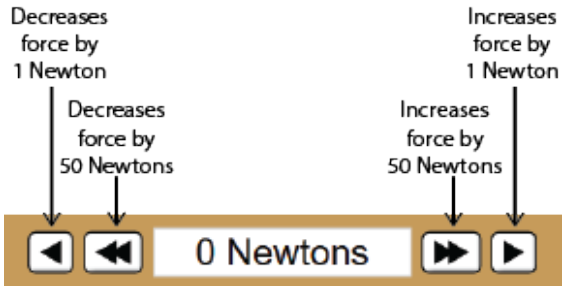
2. Select **Motion**. 

Simulation Information

The applied force can be adjusted by moving the slider or by clicking the buttons. You cannot type a number directly.

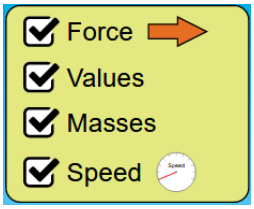


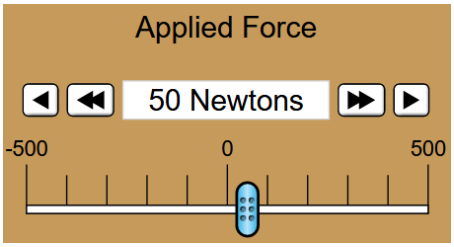
The buttons adjust the force as follows:



Part A – Newton's First Law of Motion

1. Click the reset button. 

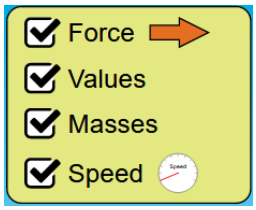
2. Select Force, Values, Masses and Speed. 

3. Set the applied force to apply a 50 N force to the right 

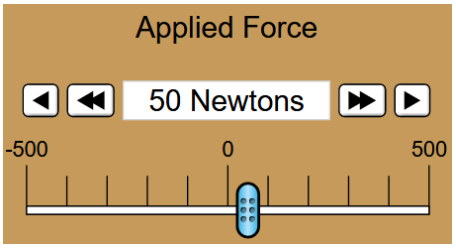
4. Describe the motion of the box using appropriate terms (velocity, acceleration, displacement) and including the direction.

6. Click the reset button. 

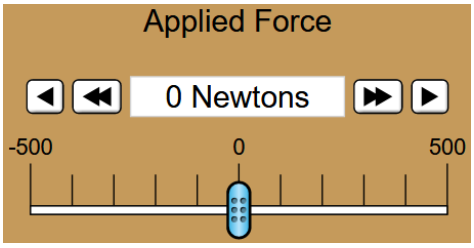
7. Select Force, Values, Masses and Speed.



8. Set the applied force to apply a 50 N force to the right.

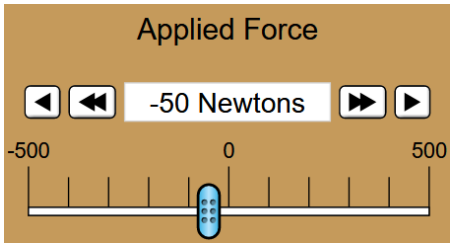


9. When the speedometer shows a speed of approximately 15 m/s reduce the applied force to zero.



10. What happens to the speed when you set the applied force to zero?

11. Set the applied force to apply a 50 N force to the left.



12. What happens to the speed of the box?

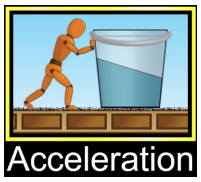
13. Newton's First Law of Motion states:

> *An object at rest remains at rest and an object in motion remains in motion with the same speed and direction unless acted upon by an external unbalanced force.*

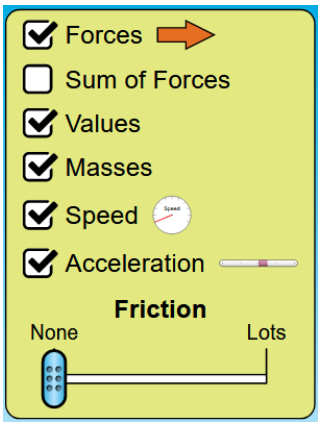
Explain how your observations demonstrate this law.

Part B – Newton's Second Law of Motion

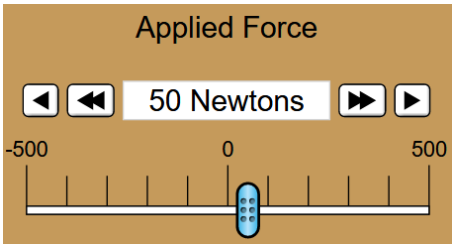
1. Select **Acceleration.**



2. Adjust the settings as shown.



3. Set the applied force to apply a 50 N force to the right.



4. Record the acceleration in the following table.

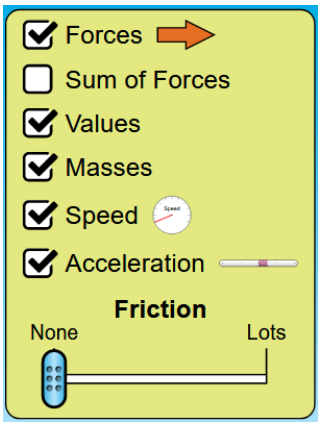
Applied Force (N)	Acceleration (m/s^2)
50	
100	
150	
200	

5. Repeat with the other values in the table. You do not need to reset the simulation between each force.

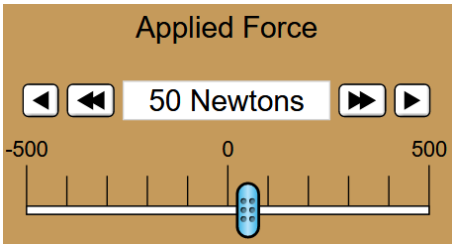
6. Describe the relationship between the applied force and acceleration.

7. Click the reset button. 

8. Adjust the settings as shown.



9. Set the applied force to apply a 50 N force to the right.



10. Record the acceleration in the following table.

Mass (kg)	Acceleration (m/s2)
50	
100	
150	
200	

11. Change the mass to the other values in the table by adding or removing objects and record the acceleration. You do not need to reset the simulation between each different mass.

12. Describe the relationship between mass and acceleration.

13. Newton's Second Law states:

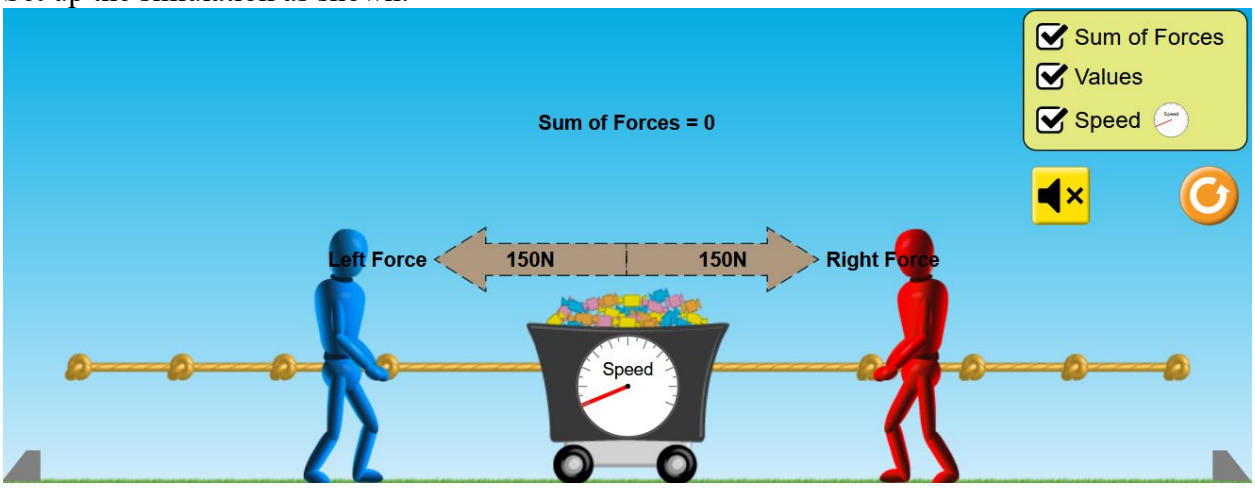
> *The acceleration of an object depends directly upon the net force acting upon the object, and inversely upon the mass of the object.*

Explain how your observations demonstrate this law.

Part C – The Concept of Net Force

1. Select **Net Force.**

2. Set up the simulation as shown:



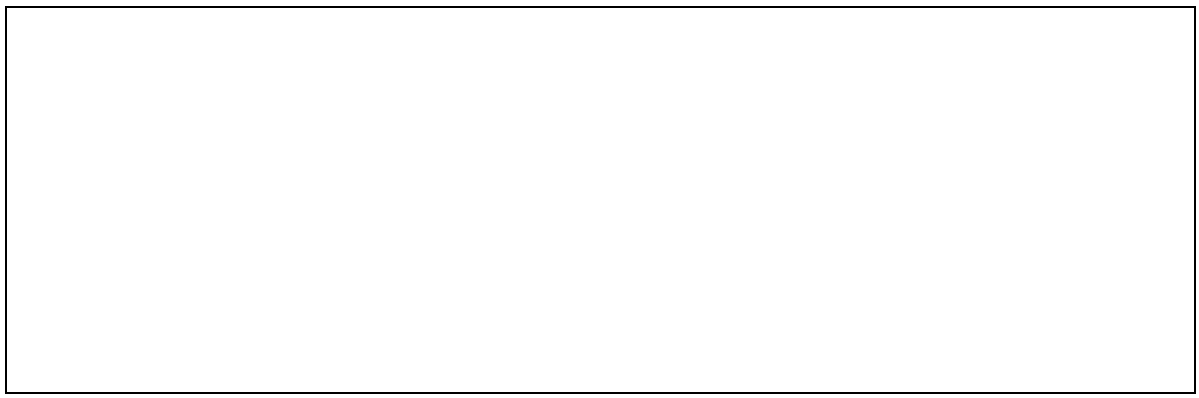
3. Click Go!

4. What happens?

Notice that both the red and blue figure are pulling with the same force but in opposite directions. This means that the net, total, or sum of forces acting on the cart is zero.

5. Add a person to the red (right) side.

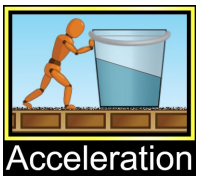
6. What happens?



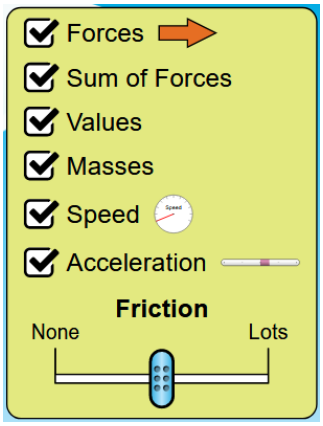
The force on the red (right) side is now greater than the force on the blue side (left). This means that there is a net force towards the right. Since there is a net force to the right, there is now an acceleration to the right.

It is the net force (sum of all the forces) acting on an object that determines the acceleration. When we add these forces together, we must take direction into account (force is a vector). For our purposes forces to the left will be negative and forces to the right will be positive.

7. Select **Acceleration.**



8. Adjust the settings as shown.



9. Adjust the force until the 50 kg box is accelerating at a rate of 1 m/s^2 to the right.

10. Record the values for the friction force and the applied force. Remember to include the direction.

    Friction force = _____

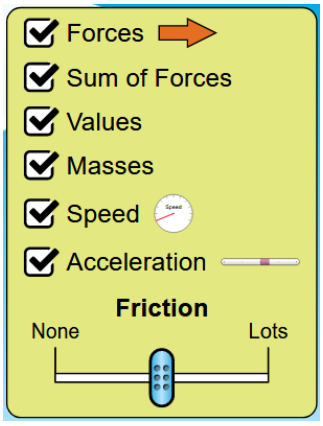
    Applied force = _____

    When we add these values together (remember that forces to the left will be negative), we get a net force of **50 N**. According to Newton's Second law of motion, this should be the result.

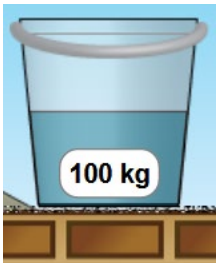
$$F_{net} = ma$$
$$F_{net} = (50\ \text{kg})(1\ \text{m/s}^2)$$

11. Click the reset button.

12. Adjust the settings as shown.



13. Replace the crate with the bucket.



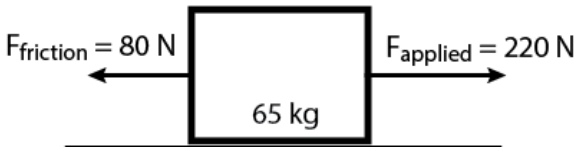
14. The friction force for the bucket is 188 N. Calculate the applied force necessary to accelerate the bucket at a rate of 0.60 m/s^2. Show your work.

15. Use the simulation to check your answer.

Part D – Questions

Answer the following questions.

1. Forces are acting on a block as shown.



   Calculate the acceleration of the block.

2. An applied force of 250 N acts on a 80 kg box causing it to accelerate at a rate of 2.5 m/s^2. What is the friction for acting on the box?

3. An applied force of 200 N acts on a box causing it to accelerate at a rate of 0.5 m/s^2. If the friction force acting on the box is 100 N, what is the mass of the box?

4. An applied force of 300 N is acting on a 250 kg block moving with constant velocity. What is the friction force acting on the block?

5. What applied force is necessary to accelerate a 60 kg block at a rate of 1.5 m/s^2 if the force of friction acting on it is 75 N?