Name: _____ Date: _____

PHYSICS
Activity: PHET Forces and Acceleration Part 1

This simulation is located at the page for PHET Forces and Motion Basics.
The URL is https://phet.colorado.edu/en/simulation/forces-and-motion-basics

Choose the activity: MOTION

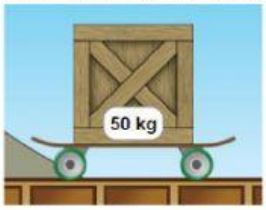
Part 1: Increasing force, hold mass constant

Instructions

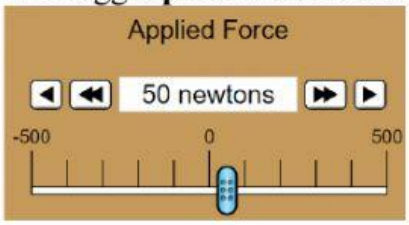
1. For every simulation, check the boxes before you begin. This will show you the values for each of those variables.

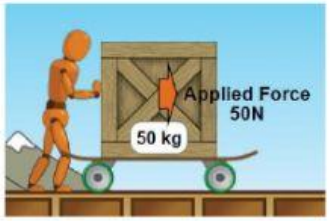
- Force
- Values
- Masses
- Speed

2. Place one 50-kg crate (wood box) on the skateboard. The initial speed of the skateboard and the box will be 0 m/s (it is initially not moving).



3. Press pause to freeze the simulation.  Click the **right double arrow** once—this will toggle **push force to 50 N**.





4. Press play (unpause), then immediately start timing. Observe the speedometer (the dial that displays speed of the moving skateboard and crate).

5. When the skateboard reaches the maximum speed (the figure will fall), stop timing. Record the maximum speed (final speed) and the time in the table.

6. **Reset.** Check the boxes again. Repeat steps 2-5 five more times. Each time, increase the magnitude of the push force by clicking the double arrow multiple times as listed below. Record the maximum speed (final speed) and the time to reach final speed in the table.

- Click right double arrow 2-times: 100 N of push force
- Click right double arrow 4-times: 200 N of push force
- Click right double arrow 6 times: 300 N of push force
- Click right double arrow 8 times: 400 N of push force
- Click right double arrow 10 times: 500 N of push force

Table 1. Calculate acceleration using the acceleration equation based on mass and force. Divide force by the mass to calculate acceleration.

$$a = \frac{F}{m}.$$

Table 2. Calculate acceleration using the acceleration equation based on changing velocity. Use the initial and final speeds and the time. The numerator is final speed minus initial speed. The denominator is time in seconds.

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_0}{t}$$

Table 1

Mass on Skateboard (kg)	Push Force (N)	Acceleration (m/s^2)
50 kg	50 N	
50 kg	100 N	
50 kg	200 N	
50 kg	300 N	
50 kg	400 N	
50 kg	500 N	

Table 2

Initial speed (m/s)	Final speed (m/s)	Time to reach final speed (s)	Acceleration (m/s^2)
0	40		
0	40		
0	40		
0	40		
0	40		
0	40		

Review and Summarize

Your answers must be in complete sentences. Answer the questions concisely. Look at your force, acceleration, and mass numbers.

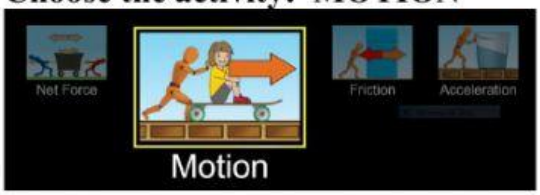
Increasing Force, Constant Mass

1. What happened to the acceleration of the crate on the skateboard as more force was used to push? (look at the values of acceleration)	
2. Generally speaking, what happened to the speed of the crate on the skateboard as more force was used to push it? What did you observe?	
3. Did the inertia of the crate on the skateboard change during this part of the activity? If it did, how did it change?	
4. Write a concise yet complete statement that summarizes what happened in this experiment.	

Activity: PHET Forces and Acceleration Part 2

This simulation is located at the page for PHET Forces and Motion Basics.
The URL is https://phet.colorado.edu/en/simulation/forces-and-motion-basics

Choose the activity: MOTION



Part 2: Increasing mass, hold force constant

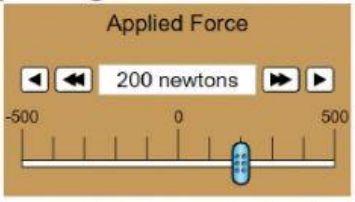
Instructions

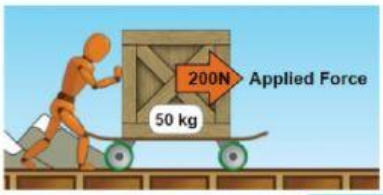
1. For every simulation, check the boxes before you begin. This will show you the values for each of those variables.

- Force
- Values
- Masses
- Speed

2. Place one 50-kg crate (wood box) on the skateboard. The initial speed of the skateboard and the box will be 0 m/s (it is initially not moving).

3. Press pause to freeze the simulation.  Click the **right double arrow** four times—this will toggle **push force to 200 N**. The stick figure will appear and will be pushing on the crate and skateboard with a force of 200 N.





4. Immediately start timing. Observe the  that displays speed of the moving skateboard and Press play (unpause). speedometer (the dial crate).

5. When the skateboard reaches the maximum speed (the figure will fall), stop timing. Record the maximum speed of the moving skateboard and crate (final speed). Report the speed and the time in the table.

6. **Reset.** Check the boxes again. Repeat steps 2-5 five more times. **Use 200 N of push force every time.** Incrementally increase the magnitude of the mass by adding different objects atop the skateboard. Record the total masses. Record the maximum speed (final speed) and the time to reach final speed in the table.

- Two crates (100 kg)
- One crate and metal pail (150 kg)
- Refrigerator (200 kg)
- One crate and refrigerator (250 kg)
- Two crates and refrigerator (300 kg)

.

Table 1. Calculate acceleration using the acceleration equation based on mass and force. Divide force by the mass to calculate acceleration.

$$a = \frac{F}{m}.$$

Table 2. Calculate acceleration using the acceleration equation based on changing velocity. Use the initial and final speeds and the time. The numerator is final speed minus initial speed. The denominator is time in seconds.

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_0}{t}$$

Table 1

Mass on Skateboard (kg)	Push Force (N)	Acceleration (m/s^2)
50 kg	200 N	
100 kg	200 N	
150 kg	200 N	
200 kg	200 N	
250 kg	200 N	
300 kg	200 N	

Table 2

Initial speed (m/s)	Final speed (m/s)	Time to reach final speed (s)	Acceleration (m/s^2)
0	40		
0	40		
0	40		
0	40		
0	40		
0	40		

Review and Summarize

Your answers must be in complete sentences. Answer the questions concisely. Look at your force, acceleration, and mass numbers.

Increasing Mass, Constant Force

1. What happened to the acceleration of the crate on the skateboard as more mass was added to the skateboard? (look at the values of acceleration)	
2. Generally speaking, what happened to the speed of the crate on the skateboard as more mass was added to the skateboard? What did you observe?	
3. Did the inertia of the skateboard change during this part of the activity? If so, how did it change?	
4. Write a concise yet complete statement that summarizes what happened in this experiment.	