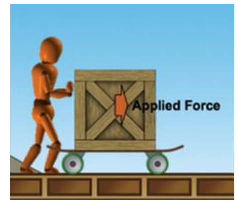
Force and Newton's Laws

Name ______________________________ Date ______ Period ___

To Begin goto phet.colorado.edu > HTML 5 SIMs > Forces and Motion Basics

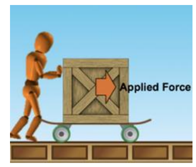


Part I - Newton's First Law

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 terms such as velocity and acceleration. **Refer** to the speedometer in your answer.

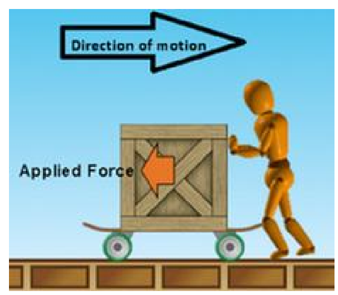
2. What is different if the person pushes with more force?



3. **Reset** the scenario (don't forget to check Force, Values, and 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.

	Speed (m/s)

4. **Explain** step-by-step what is needed to make the box come to a stop.



Conclusion

Newton's First Law of Motion claims: **"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."** How do your observations above support this Law? (IS pgs.180-181)

Evidence:

Reasoning:

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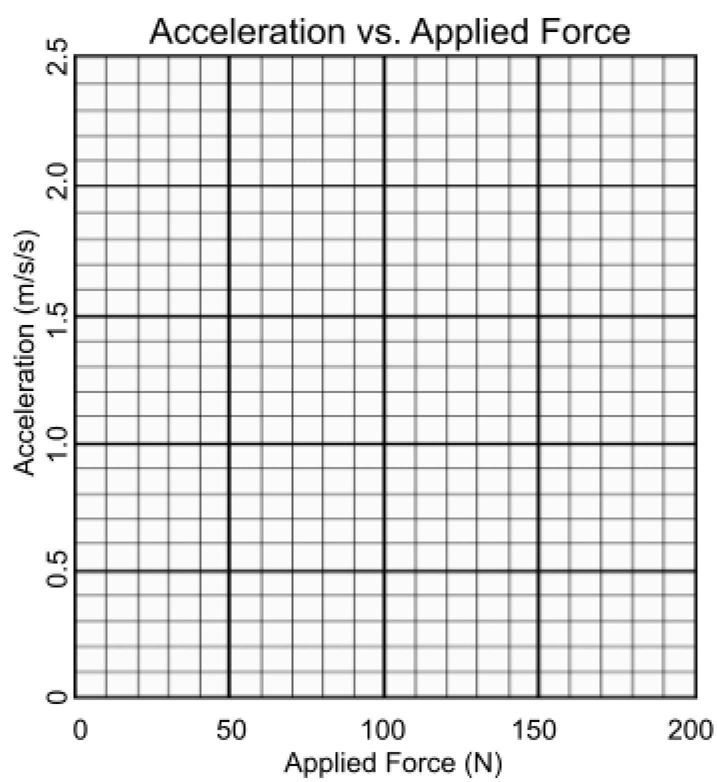
Part II A - Newton's Second Law - *F = m a*

1. ***Reset*** *the Motion simulation. Don't forget to* ***check*** *Force, Values and Speed boxes.*
2. ***Remove*** *the box and* ***place*** *a garbage can (****100 kg****) on top of the skateboard.*
3. *Using a stopwatch,* ***measure*** *the time it takes to reach maximum speed using a force of* ***50 N****.*
4. ***Calculate*** *the acceleration.*
5. ***Repeat*** *with applied forces of* ***100 N****,* ***150 N*** *and* ***200 N****.*

Applied Force (Newtons)	***Max Speed (m/s)***	***Time to Max Speed (seconds)***	***Acceleration = Max Speed/Time to Max Speed (m/s/s)***
50			
100			
150			
200			

- ***Make*** *a line graph of Acceleration versus Applied Force.*



Conclusion

The first part of Newton's Second Law claims:
"The acceleration of an object is directly proportional to the magnitude of the net force and in the same direction as the net force."
How do your observations support this Law? (IS pgs. 182-183)

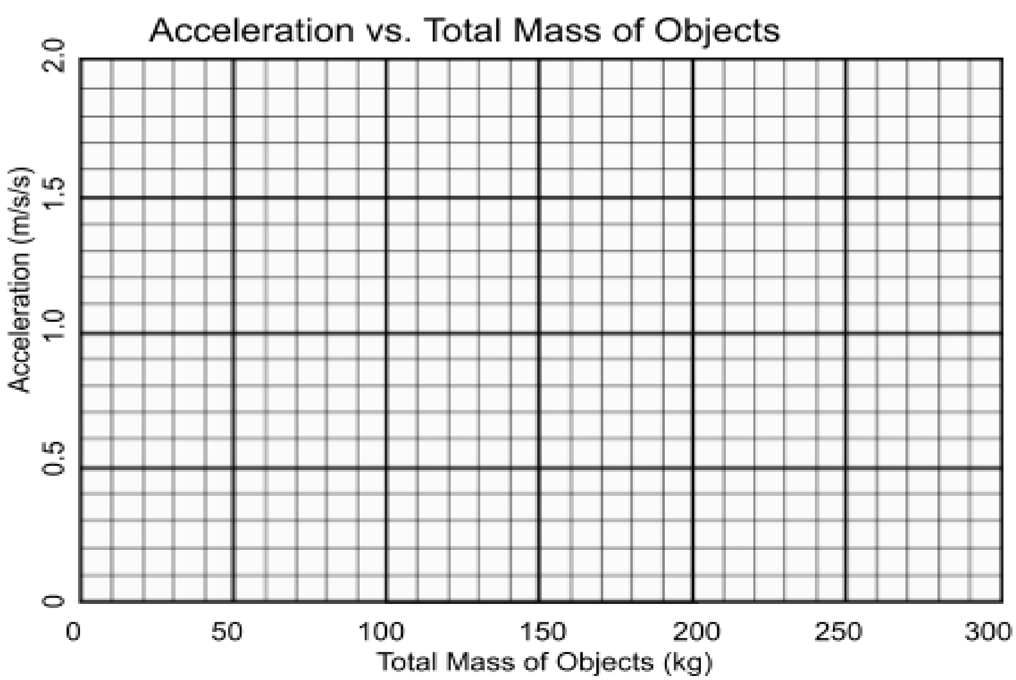
Evidence:

Reasoning:

Part II B - Newton's Second Law - *Mass*

1. ***Reset*** *the Motion simulation.* ***Check*** *Force, Values, Speed and the Masses boxes.*
2. ***Set*** *the Applied Force to* ***100 N*** *Right.*
3. *Using a stopwatch,* ***measure*** *the time it takes a* ***50 kg*** *crate to reach maximum speed.*
4. ***Calculate*** *the acceleration.*
5. ***Repeat*** *with combinations of items for total masses of* ***100 kg****,* ***150 kg****,* ***200 kg****, and* ***250 kg****.*
6. ***Make*** *a line graph of Acceleration versus Total Mass of objects.*

Total Mass of Objects (kg)	***Max Speed (m/s)***	***Time to Max Speed (s)***	***Acceleration = Max Speed/Time to Max Speed (m/s/s)***
50			
100			
150			
200			
250			
300			



Conclusion

The second part of Newton's Second Law claims: **"The acceleration of an object is inversely proportional to the mass of an object"** How do your observations support this Law?

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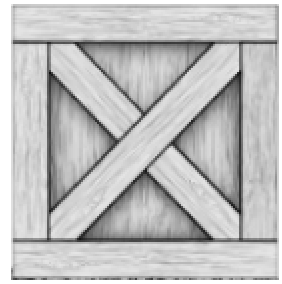
Part III - Friction and Free-Body Diagrams

The behavior of the skateboard in Parts I and II was not very realistic because friction was not present. **Select** the Acceleration simulation.



1. ***Free-Body Diagram:*** On the crate to the right, **draw** an arrow in the center going down and **label** it weight. **Draw** an arrow the same length going up to the bottom of the crate and **label** it Normal. The Normal force is the force of the ground pushing back on the block.

2. The crate has a mass of **50 kg** and is not moving. According to Newton's Laws, what is the Weight and the Normal Force on the crate in Newtons?

Weight?	Normal Force?

3. **Set** Friction to none. What changed on the screen? Why do you think the app designers did that?

4. ***Sliding Friction:*** Make sure that only the speed box is **checked** and Friction is at **None**. **Apply** a force to the right to get the box to about half of its maximum speed, then **remove** the force. While the box is moving, **move** the Friction slider to **halfway**. What happens to the crate? Why?

5. **Repeat** #4 above, but **pause** the simulation with the Friction **halfway** while the crate is still moving. **Check** the Forces and Values boxes. **Draw** an arrow underneath the crate picture above going in the same direction as the friction force and **label** it 'Friction'.

What is the force and direction of sliding friction?	
Calculate the deceleration of the crate from sliding friction using the equation ***a = F/m***.	

6. ***Static Friction:*** **Reset** the Acceleration simulation. Make sure Forces, Sum of Forces, Speed, and Acceleration are **checked** and the Friction slider is set to halfway.

Apply a force of **100 N** to the crate. **Keep** increasing the applied force by **1 N** until the crate accelerates. What is the applied force just before it accelerated?	
Decrease the force to **100 N**. Why is it continuing to accelerate with this lower force?	

Part IV: Friction and Mass

Reset the Acceleration simulation. **Check** all checkboxes. Friction should be set to halfway.

1. **Apply 200 N** of force to the Guy (80 kg).
2. **Slowly** increase the Applied Force by **1 N** until the Guy first starts to move/accelerate.
3. **Record** the Applied Force just before it accelerates in the table as the Max Static Friction.
4. **Record** the Friction Force during acceleration as Sliding Friction in the table.
5. **Repeat** the steps for other Total Masses.

- **Mark** on the legend different colors to represent Max Static Friction and Sliding Friction.
- **Graph** Max Static Friction versus Total Mass.
- **Graph** Sliding Friction versus Total Mass.

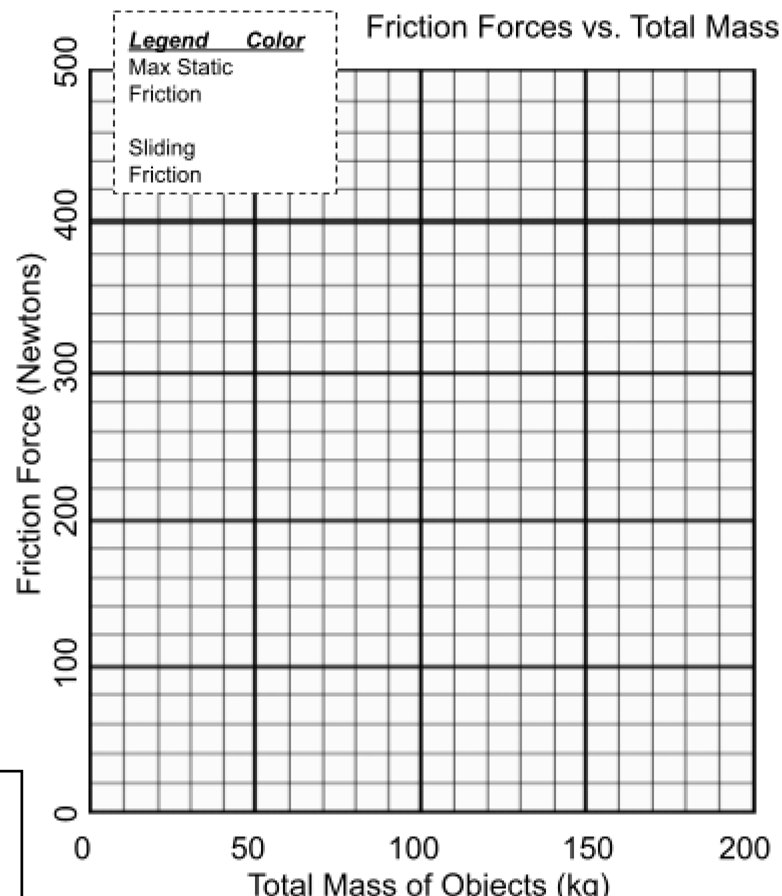
Friction Force Table

Total Mass of Objects	***Max Static Friction (Newtons)***	***Sliding Friction (Newtons)***
Crate = 50 kg	125 N	94 N
Guy = 80 kg		
100 kg		
120 kg		
150 kg		
180 kg		

1. What does doubling the mass do to the Max Static Friction of an object?

2. **Predict** the Max Static Friction for a **200 kg** object.

3. **Predict** the Sliding Friction for an object that is **200 kg.**



Conclusion

According to your data, how is the friction force related to the mass of an object?

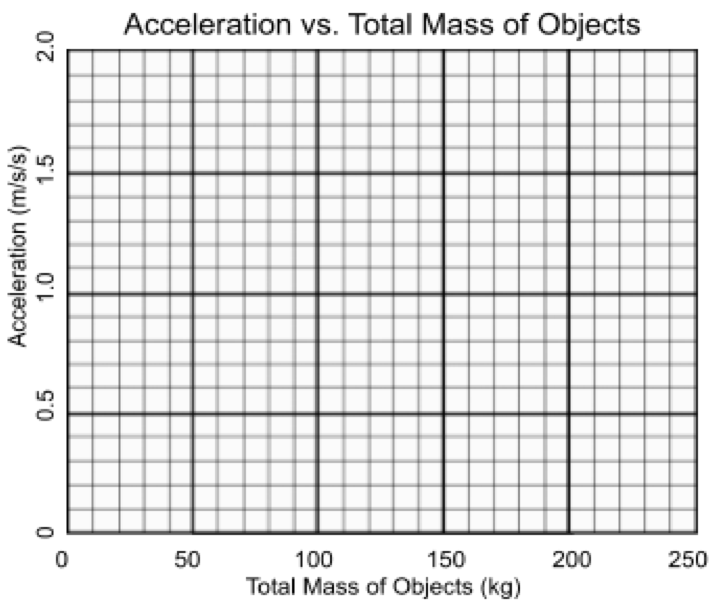
Claim:

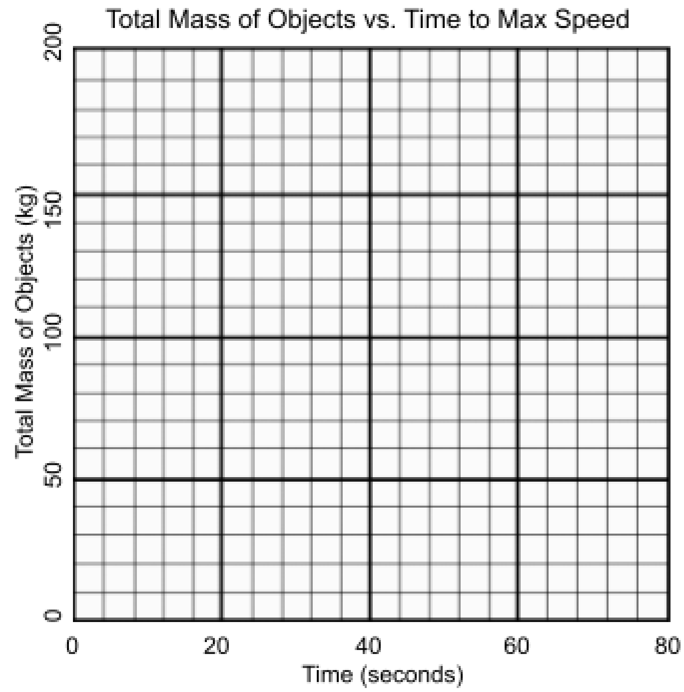
Evidence:

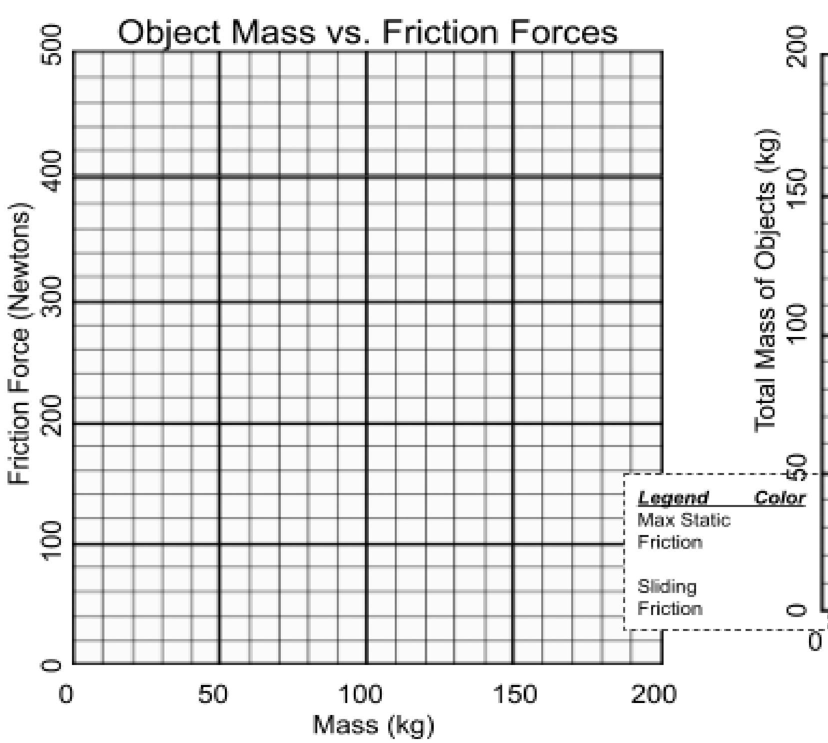
Reasoning:

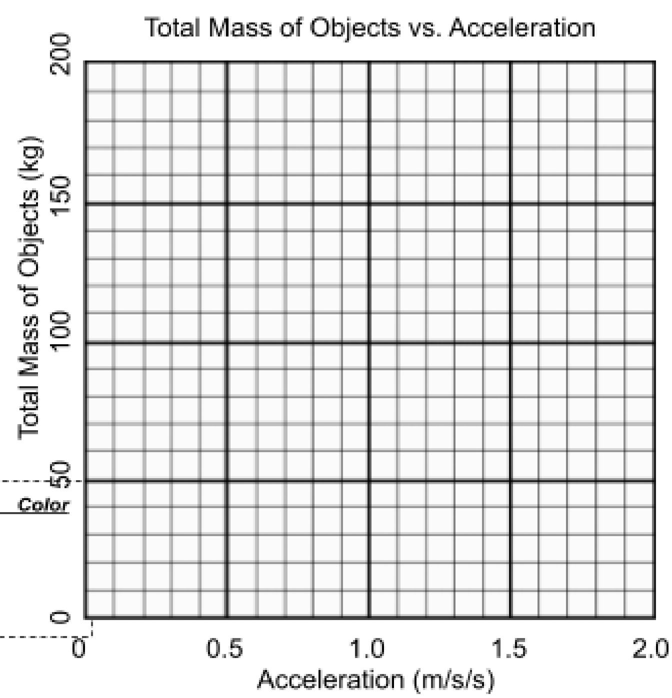
Sandbox

Evidence:









What would be the acceleration

Two objects of the same mass are stacked on each other and sliding at a constant speed. The top object is removed. What effect would that have on the sliding friction and acceleration of the remaining object? Try it to check your answer.