Using Newton's Laws to Solve Problems

Let the thinking begin...mu ha ha.

Learning Goal: By the end of today, I will be able to use the 5 kinematic equations and Newton's laws, together, to solve motion problems.

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Newton was born in 1642, the year that Galileo died. Newton published Principia Mathematica, a set of three books which included much of his own work about physics, as well as a description of Galileo's law of inertia. The law of inertia is now called Newton's first law of motion because it was included with Newton's other laws of motion.

growth of ideas

**First Law of Motion**

If the net external force on an object is zero, the object will remain at rest or continue to move at a constant velocity.

"Objects at rest, want to stay at rest, objects in motion want to stay in motion."

HUGE IDEAS - WOW!

Implications of the First Law of Motion

- A non-zero net force will change the velocity of an object. The velocity can change in magnitude, direction, or both.
- A net force is not required to maintain the velocity of an object.
- External forces are required to change the motion of an object. Internal forces have no effect on the motion of an object.

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**Second Law of Motion**

If the net external force on an object is not zero, the object will accelerate in the direction of this net force. The magnitude of the acceleration is directly proportional to the magnitude of the net force and inversely proportional to the mass of the object.

Yikes, what does that all mean....?

If the mass of the object remains constant, it takes a larger force to create a larger acceleration.

If the force applied to the object is constant, a smaller mass will accelerate faster than a larger mass.

$$F_{Net} = m \cdot a$$

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# Forces - Success Criteria

1. Draw a FBD, choose your positive directions

2. Write an $F_{net}$ equation based on the DIAGRAM

3. Substitute values and F=ma into the $F_{net}$ equation

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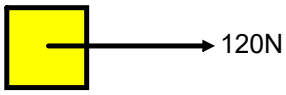
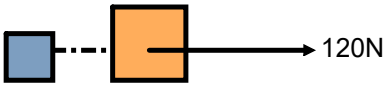
Example

A 40kg mass has an external force of 120N [E] acting on it.

What is the acceleration of the object?




The 40k mass is broken up into two pieces, a 30kg piece and a 10kg piece and they are linked with a length of chain. If the same 120N force is applied, what is the tension force in the chain?

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## Kinematics and Newton's Laws

When using any of the kinematics equations from Unit 1, it is essential that the acceleration remain constant. Now we can extend this restriction by stating that the net force on an object must also remain constant if you use one of the kinematics equations. This is a direct consequence of Newton's second Law, $F_{net} = ma$, which shows that net force is constant when the acceleration is constant.

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## Sample Problem 2

A worker pushes two large boxes across the floor from rest with an applied force of 160.0 N [right] on the larger box (**Figure 9**). The boxes are touching. The mass of the larger box is $m_1 = 32.0$ kg and the mass of the smaller box is $m_2 = 8.0$ kg. The force of friction on the large box is 80.0 N [left] and the force of friction on the smaller box is 20.0 N [left].

(a) Calculate the acceleration of the two boxes. Assume that the boxes start to move.
(b) Determine the force exerted by the larger box on the smaller box.
(c) Determine the velocity of the boxes after 4.0 s.

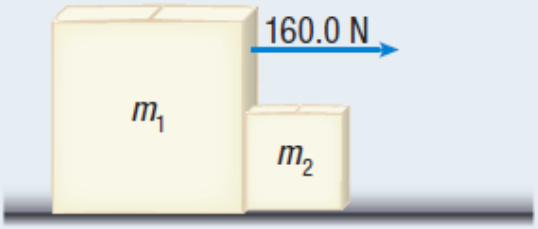


**Figure 9**

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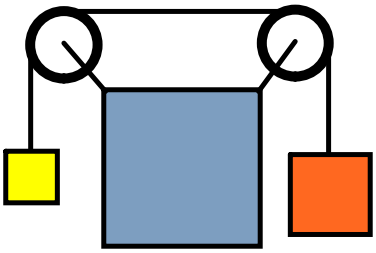
A 2kg mass and a 8kg mass are setup in the following frictionless pulley system.



1. Draw a system motion diagram and FBD for each mass.
2. Write $F_{net}$ statements for each mass.
3. Determine the acceleration of each mass.
4. Determine the tension in the string.

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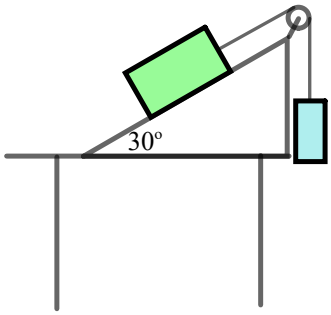
A 3kg mass is hung on the end of a string, over a pulley, and attached to an 8kg mass.
The ramp is considered to be frictionless.
Determine the acceleration of the system and the tension in the string.




Challenge - What angle would be required to create a system that does not move?

Homework

Read pg 88 - 96 (good examples)

page 95 #2, 3, 7, 10

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