Newton's First and Second Laws

Pre-Class Questions

Problem Set (due next time)
Ch 4 - 1, 6, 11, 20

Lecture Outline
1. Newton's First Law - The Law of Inertia
2. Newton's Second Law - $\sum F=ma$
3. Weight - The Force of Gravity

Newton's First Law - The Law of Inertia

"Every object will move with a constant velocity unless a force acts on it."

http://www.youtube.com/watch?v=vfnt8Sdj7cs

Newton's First Law - The Law of Inertia

"Every object will move with a constant velocity unless a force acts on it."

Two key ideas:

The "natural state" of motion is not rest, but any constant velocity.

Force is defined to be the agent that causes velocity to change.

Example 1: For each situation listed describe the motion in terms of Newton's First Law and draw a sketch indicating the forces on the object. (a)A block at rest on a table. (b) The block is being pushed. (c)The block skidding to rest. (d)An air puck sliding across the table. (e)A ball on a string twirling around in a circle.

Newton's Second Law - $\sum F=ma$

"The acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass. The direction of the acceleration is in the direction of the net force."

Two key ideas:

Mass is defined as inertia - the resistance an object offers to changes in motion.

Forces are vector quantities

CONCEPTUAL Physics PRACTICE PAGE

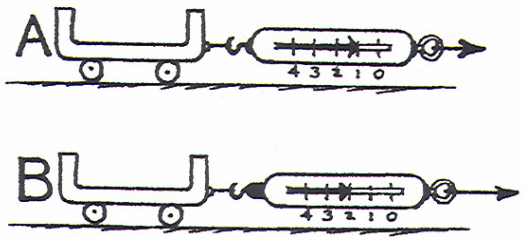
Chapter 4 Newton's Second Law of Motion

Racing Day with a = F/m

In each situation below, Cart A has a mass of **1 kg**. *Circle the correct answers* (A, B, or Same for both).

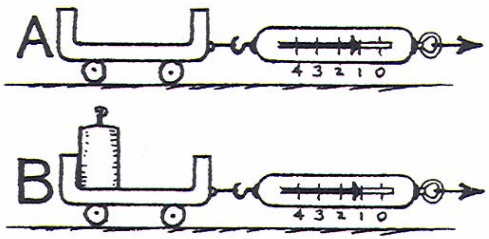
1. Cart A is pulled with a force of **1 N**.
   Cart B also has a mass of **1 kg** and
   is pulled with a force of **2 N**.
   Which undergoes the greater acceleration?

   [A] [B] [Same for both]



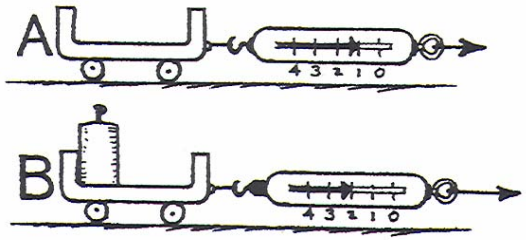
2. Cart A is pulled with a force of **1 N**.
   Cart B has a mass of **2 kg** and is
   also pulled with a force of **1 N**.
   Which undergoes the greater acceleration?

   [A] [B] [Same for both]



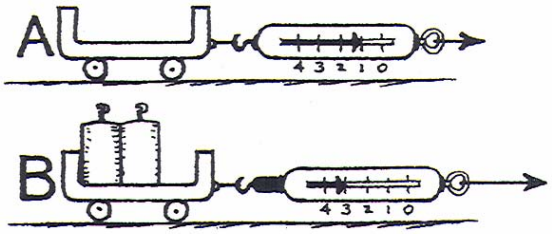
3. Cart A is pulled with a force of **1 N**.
   Cart B has a mass of **2 kg** and is
   pulled with a force of **2 N**.
   Which undergoes the greater acceleration?

   [A] [B] [Same for both]



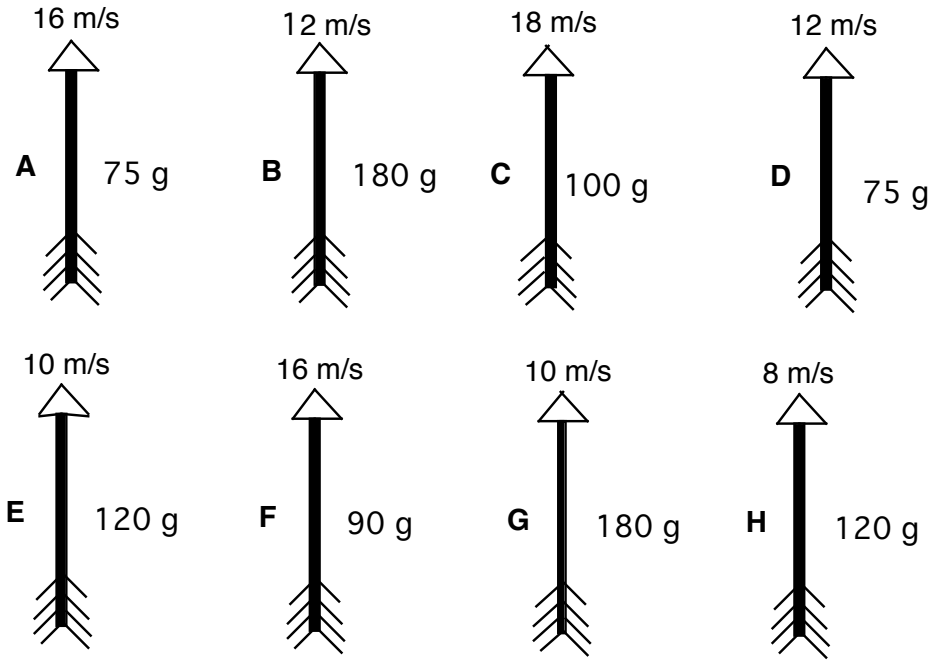
4. Cart A is pulled with a force of **1 N**.
   Cart B has a mass of **3 kg** and is
   pulled with a force of **3 N**.
   Which undergoes the greater acceleration?

   [A] [B] [Same for both]



The eight figures below show arrows that have been shot into the air. All of the arrows were shot straight up and are the same size and shape. The arrows are made of different materials so they have different masses, and they have different speeds as they leave the bows. The values for each arrow are given in the figures. (We assume for this situation that the effect of air resistance can be neglected.) All start from same height.

Rank these arrows, from greatest to least, on the basis of the acceleration of the arrows at the top of their flight.



Greatest 1_____ 2_____ 3_____ 4_____ 5_____ 6_____ 7_____ 8_____ Least

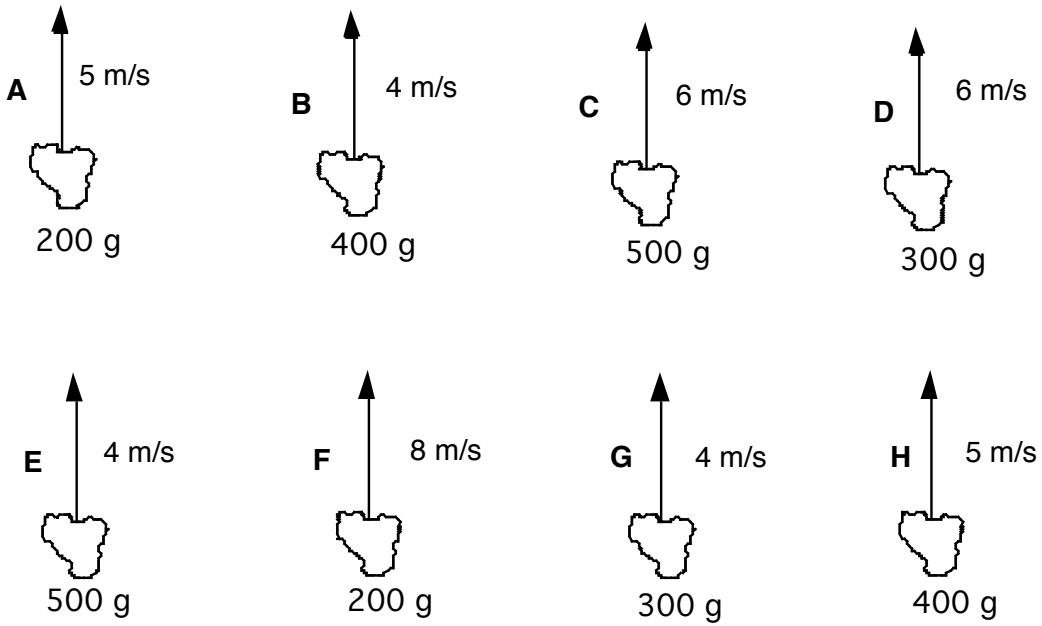
All arrows have the same acceleration but not zero. _____

The acceleration at the top is zero for all these. _____

Please carefully explain your reasoning.

Shown below are eight rocks that have been thrown straight up into the air. The rocks all have the same shape, but they have different masses. The rocks are all thrown straight up, but at different speeds. The masses of the rocks and their speeds when released are given in the figures. (We assume for this situation that the effect of air resistance can be ignored.) All start from the same height.

Rank these rocks from greatest to least on the basis of the net force on the rocks after being thrown.



Greatest 1_____ 2_____ 3_____ 4_____ 5_____ 6_____ 7_____ 8_____ Least

Or, all rocks have the same net force on them but not zero. _____

Or, the net force on all these is zero. _____

Please carefully explain your reasoning.

Example 2: On the average, there are four apples per pound. Find the mass of an average apple.

The acceleration due to gravity on Earth is $10 m/s^2$ while on Jupiter it is $25 m/s^2$.

Use your understanding of the laws of motion and the distinction between mass and weight to fill in the table below.

Object	Earth mass (kg)	Earth weight (N)	Jupiter mass (kg)	Jupiter weight (N)
apple		1.0		
professor	62			
textbook			1.5	
watermelon				50

Lecture 09- Summary

Newton's First Law - The Law of Inertia
"Every object will move with a constant velocity unless a force acts on it."

Two key ideas:

- The "natural state" of motion is not rest, but any constant velocity.
- Force is defined to be the agent that causes velocity to change.

Newton's Second Law - $\sum F=ma$
"The acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass. The direction of the acceleration is in the direction of the net force."

Two key ideas:

- Mass is defined as inertia - the resistance an object offers to changes in motion.
- Forces are vector quantities.

Mass is a property of an object while weight is a force that can act on the objects.
The Mass/weight Rule $F_g = mg$