C of E Teaching Academy:  
Just in Time Teaching  
(Example: Newton's Laws & Buoyancy)

● Assumptions:

➔ You, as “students”, have done the preflights on the web.
  » Most people did (thanks!).
  » Participation = Investment !!

➔ You, as “students”, have read the textbook.
  » I know you haven’t, however for this lesson it won’t matter much.

● How did you feel about the preflights?
  ➔ I choose questions that students have trouble with!  
    (investment)
Newton's Laws

1. An object moving with constant velocity will keep moving with that same velocity (both speed and direction) unless a force acts on it.

2. \( F_{\text{tot}} = ma \)

3. If object 1 exerts a force \( F \) on object 2, then object 2 exerts an equal but opposite force \( (-F) \) on object 1.
Driving your car on I-57 you encounter a bug which (sadly) splatters on your windshield. During the collision between the car and the bug:

1. The force exerted by the car on the bug is BIGGER than the force exerted by the bug on the car.
2. The force exerted by the car on the bug is SMALLER than the force exerted by the bug on the car.
3. The force exerted by the car on the bug is THE SAME AS than the force exerted by the bug on the car. correct

The car has greater mass and velocity than the bug does, so the force is greater.

The car is bigger and heavier than the bug so it has more force.

This is what was told to my daughter in drivers ed. She could not explain it...I suppose the bug is working just as hard as the car.

There is only one force. You can look at it from the bug or the driver’s perspective
Given that I have forgotten the formula for force, I am going to go with the third answer because I don't know how fast the bug or the car are going (or even if they are going in the same direction or if the car just catches up with the bug or vice versa) and think the impact is created by the combined forces, but that the bug gets squashed because it has less mass, not necessarily less force. (Somewhere in the back of my mind I remember a formula (mass x acceleration? So perhaps the logical answer is the first answer, but that seems too easy! The bug in this case obviously feels more impact; is impact the same as force in this case?)

force = mass x acceleration. the car has a larger mass than the bug. unless of course per its size the bug has greater acceleration than the car(?), in which case it might even out or the bug might even have greater force.

newtons third law: if a (bug) exerts a force on a (car), the car exerts an equal and opposite force-- end result is that bug's force acts on the car, the car's force acts on the bug, but the forces aren't equal and since the bug is softer, smaller etc, it gets hurt. the amount of force that each is exerting on the other can be calculated using newton's second law (F=MA.) -- unbalanced net force is acting on the bug and the bug will splatter.
Act 2

Follow-up: During the collision between the car and the bug, which one experiences the greatest acceleration?

1. The car has a greater acceleration.
2. The bug has a greater acceleration. [correct]
3. The accelerations will be the same.

\[ \text{\textbf{VOTE}} \]

\[ F = ma \]

\[ \text{bug} = \text{car} \times \text{bug} \]
In Case 1 shown below, a weight is hung from a rope (over a pulley) and is attached to one side of a spring. The other side of the spring is attached to a wall using a second rope. In Case 2, instead of being attached to a wall, the second rope is attached to a second identical weight.

In which case is the spring stretched the most?

1. Case 1
2. Case 2
3. Same in both cases
In which case is the spring stretched the most?

1. Case 1
2. Case 2
3. Same in both cases  ← correct

VOTE

This answer is based on my experience with installing springs on a garage door. When the spring is attached to something stable it is able to stretch. No amount of pulling by 2 people of equal weight could budge the spring.

The spring should be stretched according to the weight attached to it. Twice as much weight (and additional gravitational pull) should stretch the spring twice as much.

not sure -- just guessing. I think this has something to do with force.
It is being pulled in two directions instead of one.

There are some factors it seems we would need to be sure of our answers - how far is the spring off the floor (i.e., is there enough room for the weights to fall to their full potential given gravity before hitting the floor) and what is the elastic limit of the spring involved? If the weight in case 1 is not enough to fully extend the spring all by itself, then I assume that the second case would in a sense divide the spring into two smaller springs and each would experience the weight of the block and the spring would extend to a greater total length if the weights could fall freely. Question: What is holding the whole contraption in case 2 in the air? If there is no pole or such, then I withdraw my answer since the whole thing would collapse onto the floor. :-)

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Buoyancy

Upward (buoyant) force $F_B$ = weight of displaced liquid.

This is why an object floats if it is less dense than the liquid.
An ice cube floats in a full glass of water as shown below. When the ice melts, the level of the water will:

1. Go up, causing the water to spill out of the glass.  
2. Go down. 
3. Stay the same.  \( \rightarrow \) CORRECT

not sure -- just guessing. It looks like when the ice melts obviously it would turn to water and therefore, increase the amount of water in the glass, causing water to spill out.

water expands when it freezes, so it takes up more space, thus displacing more of the water in the glass. When the ice melts, the liquid will take up less space than the ice, so the water level will go down.

Just seems to make sense--having had MANY glasses of ice water in my life, I can't recall a full one ever overflowing when the ice melted...
Water expands when it is frozen, the water created by the melting of the part of the ice that it already under water will take up less space than the water in its frozen form and that will make room for the water from the top bit of the ice cube when it melts. All of this is dependent on this not taking place in a dry and hot environment otherwise I would choose the second answer, given the speed of evaporation of water from the glass as the ice melts.

Phase change with solid to liquid-- end result is that the water level will go down slightly- water is an unique liquid in that it actually expands when frozen-- molecules are spaced farther away in the solid strucyure. So when the water melts, the liquid water molecules will take up less space than the same molecules in the solid arrangement. Ice is less dense than liquid water

I tried this at home, my ice cube did not float in the same manner as the picture. My water went down. This make sense because water expands when frozen. How do you get an ice cube to float in this way?

frozen water takes up more space than melted water, but given how much of the ice cube sticks out of the glass, I would think that it would be enough to make the water spill out of the glass.
So the idea, in a nutshell, is:

- I get to connect with each student before each lecture.
  - In a class of 500, this is hard to do any other way.

- Students know I look at their answers.
  - They feel a bit “exposed”; They want to know why they are right or wrong.
  - If they are wrong, they see that many others are wrong too, and that they are not alone in their misconceptions.
  - Lecture attendance is good!

- This truly is a fun way to teach.
  - I will never teach any other way again!