Force and Motion – Part I

Mass, Inertia, and Velocity

We need to make sure we are speaking the same language, so first write down your ideas about some definitions:

1. What is the definition of speed? (Check your memory, check with your classmates, write down your ideas.)

2. What is the definition of velocity? What is the difference between speed and velocity?

3. Could two objects have the same speed but different velocities? If not, why not? If so, give an example.

4. Could two objects have the same velocity but different speeds? If not, why not? If so, give an example.

Check your answers with your classmates and with your teacher(s). Make sure we all agree about the definitions of speed and especially velocity.

5. Imagine you are driving a car. There are several things you could do to change the velocity of the car. List some of them here:
   a.
   b.
   c.
   d.
   e.
6. Imagine a ball (not too heavy) is rolling along the table in front of you (you can get a real ball if you like). Now imagine somebody exerts a force on the ball by blowing on it.
   a. Imagine that the person blows in the same direction that the ball is moving (so the force is on the “back” of the ball). Would the velocity of the ball change? If so, how?

   b. Imagine that the person blows in the opposite direction that the ball is moving (so the force is on the “front” of the ball). Would the velocity of the ball change? If so, how?

   c. Imagine that the person blows from the side, in a direction perpendicular to the direction that the ball is moving. Would the velocity of the ball change? If so, how?

7. Now imagine repeating each of the experiments in part 6, above with a heavier ball (imagine that a table tennis ball was replaced with a golf ball, or a tennis ball was replaced with a baseball). How would each of the three cases change?
   a.

   b.

   c.

8. In each case above, what would you say about the “change in velocity” of the ball? When we replace a less massive object with a more massive object, what happens to the change in velocity?
Objects have a tendency not to change their velocity. This “law” of nature is known as “Newton’s first law” after the great Isaac Newton. The more mass an object has, the more of a tendency it has to keep a constant velocity.

9. Newton’s first law could be written: “An object in motion tends to keep the same velocity. The tendency to keep the same velocity is proportional to the mass of the object. That is because massive objects have lots of…”

(Fill in the correct single word. Check with your teacher if you are unsure.)

It turns out that the concept of a “change in velocity” by itself isn’t the most useful for scientists. There is more than one way to get a greater change in velocity.

10. Go back to imagining the less massive ball. Let’s say Jake blows on the “back” of the ball for one second. Now let’s say Karen blows (with the same amount of force) on the back of an identical ball for two seconds. Do you think the two balls would change velocity by the same total amount? Why or why not? Would anything be the same about the motion of the two balls?

11. Let’s say Irena blows on the back of the less massive ball for one second. Now Jamaal blows (with an equal amount of force) on the back of the more massive ball for two seconds. Can you tell which ball will have the greater total change in velocity? Can you tell for sure that anything would be greater for the less massive ball?

12. Scientists often express things not so much in terms of how much velocity changes but how fast it changes. This is such an important concept that we give a special name to the concept of rate of change of velocity. To a scientist, the rate of change of velocity is called acceleration. An you make a hypothesis about the relationship between the mass of an object and its acceleration?

13. To the general public the word “accelerate” means to “speed up”. To a scientist it means to “change velocity.” Your driver’s ed teacher probably taught you that the gas pedal of a car is known as the “accelerator”. From a scientific standpoint, what other controls of the car could be referred to as “accelerators”?