LEPS | Unit 2

LESSON 2: Motion and Force

Purpose and Key Questions

In the first lesson of this unit you thought about the force exerted on an object during a quick push. However, when such a quick push is used to start an object moving, is there still a force pushing the object forward after the initial push is over? This is the question you will consider in this lesson.

For example, **after** you kick a soccer ball, the ball continues to move. Does this continued motion mean that there is still a force pushing the ball forward or is it possible for the ball to keep moving forward without a force pushing it in that direction?

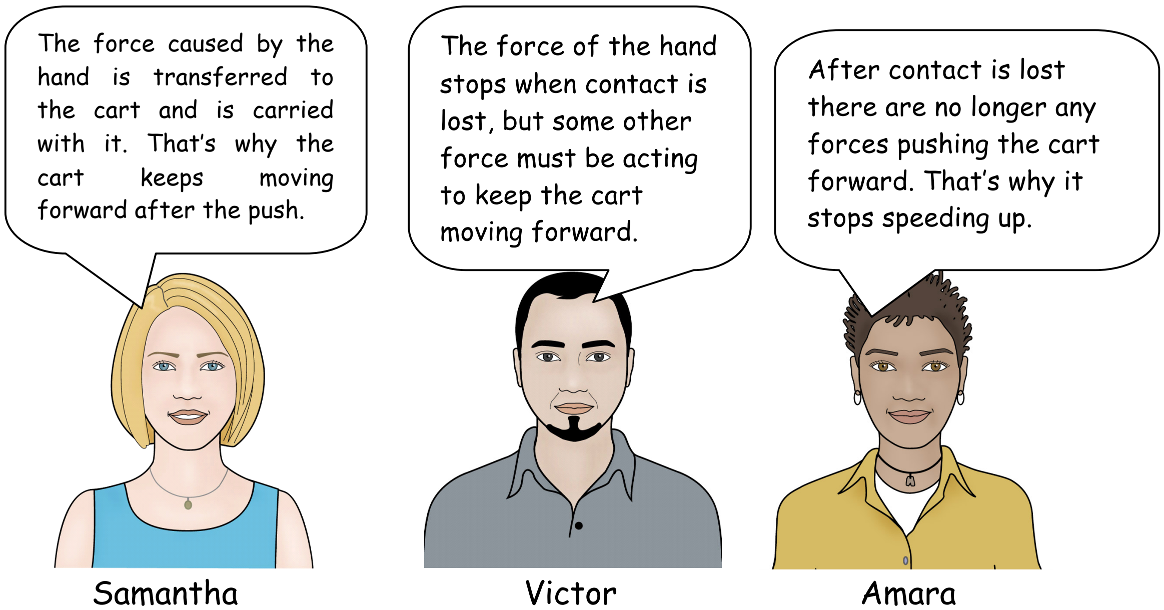
The key question for this lesson is:

> ***When an object is moving, does this mean there must be a force pushing it in the direction of its motion?***

Predictions, Observations and Making Sense

PART 1. Think about giving a low friction cart a quick push on a level track so that it keeps rolling along the track after your push.

Three students are discussing the motion of the cart and the force acting on it. They all agree that while the hand is pushing the cart there is a force acting on it, but have different ideas about whether a force is still pushing the car forward after the hand has lost contact with it.



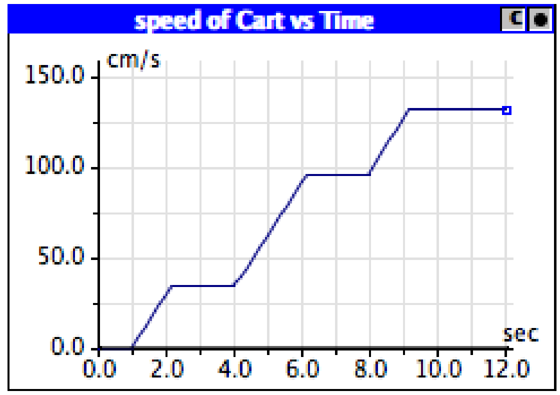
Discuss the students' ideas with you neighbors, decide who you agree with (if any) and note your reasoning below the question. Then participate in the class vote and discussion.

CQ 2-1: In the discussion between three students about the force acting on the cart after the quick push, whom do you agree with?

a. Samantha
b. Victor
c. Amara
d. None of them

<u>PART 2.</u> In this lesson we will use the *I&M Simulator* to compare your thinking to that of scientists.

On the right is a speed-time graph taken from an *I&M Simulator* set-up that models the demonstration from Lesson 1 in which you saw a cart being given two or three successive pushes. (Note: the effects of friction are ignored in this setup.)



Indicate the periods on the speed-time graph when you think the cart in the simulator was actually being pushed forward by someone's hand. How do you know?

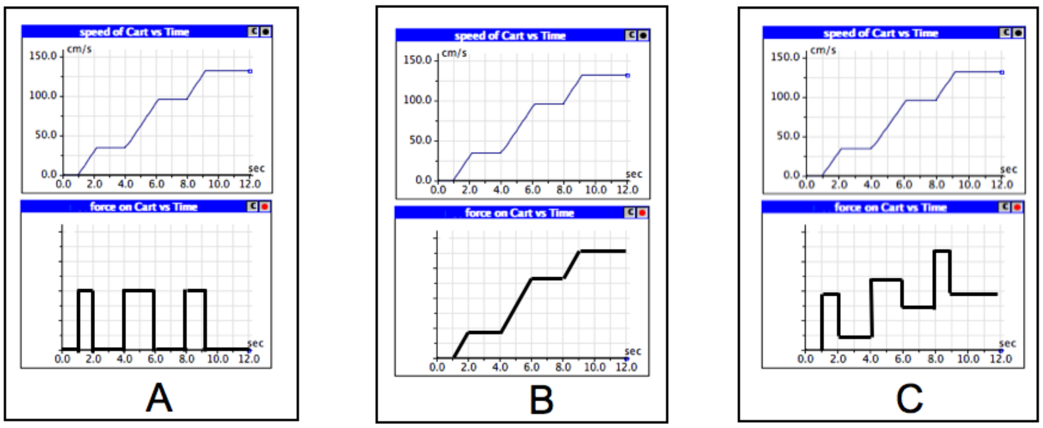
In between your marked sections, do you think there is still a force pushing the cart forward? Why do you think so?

The *I&M Simulator* can also 'measure' **<u>ALL</u>** the forward forces acting on the cart in the simulator model. It does this by displaying a force-time graph that shows the strength of any and all forces pushing the cart forward as it moves. (During any period when there is a force acting on the cart, the graph will show a non-zero value. During any period when there is no force acting, the graph will show a force strength of zero.)

On the next page are three suggestions for what the force-time graph for the cart would look like as the cart moves along the track, producing the speed-time graph shown above.

Discuss these force-time graphs your neighbors, decide which one best represents your thinking, and note your reasoning below the question. Then participate in the class vote and discussion.

CQ 2-2: Which force-time graph best represents your thinking about the force pushing the cart forward as it moves along the track?



Your instructor will now run the *I&M Simulator*, to compare the class' ideas with those scientists' ideas upon which the simulator model is based.

While the simulator is running the cart will be given some shoves (by pressing on the spacebar of the computer keyboard). Each shove will continue (at a constant strength) as long as the spacebar is held down.

Which of the force-time graphs in CQ 2-2 (above) looks most like the simulator result?

PART 3. Now discuss and answer the following questions with your neighbors. Remember to base your reasoning on the evidence you have seen.

During the periods when the simulator cart was being given a shove was there a force pushing it forward? What evidence from the simulator graphs supports your idea?

What action in the real world do these simulator shoves correspond to?

During the periods in between these simulated shoves, was a force pushing the cart forward? Again, what evidence from the graphs supports your idea?

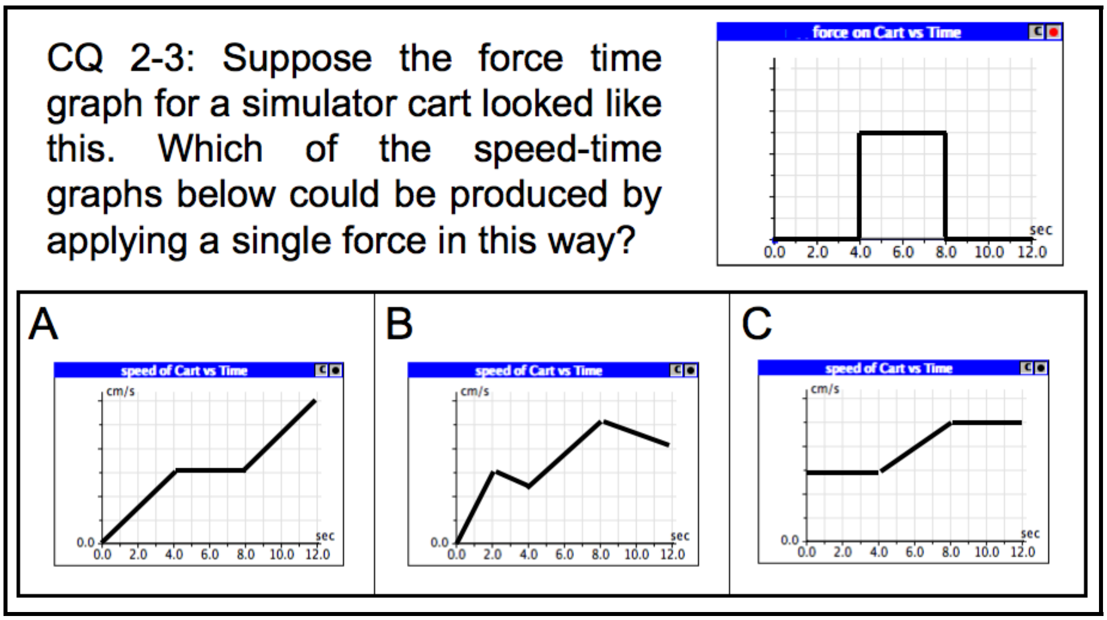
Summarizing Questions

1. While the simulator cart was moving along the track was there a force pushing it forward the whole time or only at certain times? What evidence supports your answer?

2. During a contact push/pull interaction, what do you think is transferred from the source to the receiver: energy, force, both, or neither? Explain your reasoning.

3. During the periods while the simulator cart was being given a shove its speed was increasing. In between these periods its speed remained constant. Why do you think there is this difference

4. Which of the speed-time graphs in the question below would be produced by the given force-time graph?



5. The key question for this lesson is:

When an object is moving, does this mean there must be a force pushing it in the direction of its motion?

Make sure you can answer this question using ideas that are supported by evidence from this activity.