ACTIVITY 8: Explaining Phenomena using Force Ideas

Comparing the Class Consensus Ideas and Scientists' Ideas

During this chapter you have developed ideas about how the forces acting on an object affect its motion.

Your instructor will give you a copy of the handout: *Scientists' Ideas: Newton's Laws*. With your team, review the similarities and differences between the class ideas and the Scientists' Ideas. In the space below each of the scientists' ideas, make a note of any evidence (or examples) you have seen in this chapter that supports the idea.

Scientific Explanations Involving Forces

In this chapter of activities you have been developing ideas about how to describe contact interactions and their effects in terms of the forces that the objects involved exert on each other. You have also been practicing writing and evaluating scientific explanations using these ideas. In this activity you will apply your ideas about forces to explain some more 'everyday' phenomena.

Remember, to construct a scientific explanation using ideas about forces you should first draw a force diagram that shows all the relevant forces acting on the object of interest, and also a speed arrow, if relevant. When writing your narrative, you should keep in mind the criteria of *accuracy*, *completeness*, *logical reasoning* and *clarity* first introduced in Chapter 1.

As was also stated in Chapter 1, it is very important to state explicitly in your narrative whether you are taking the effects of friction to be negligible. This can be the case if you are dealing with situations that involve a vehicle with well-lubricated wheels or an object sliding across a very smooth surface (such as ice), especially if other forces acting on the object are much stronger than any friction forces. If you decide the effects of friction are not negligible, then the force of friction should play a part in the explanation.

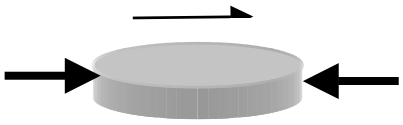
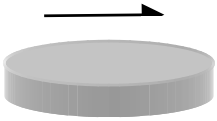
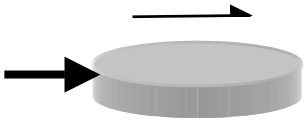
Your first task is to evaluate some explanations written by previous students.

Explaining the motion of an ice-hockey puck

After a hockey player gives a puck a quick 'hit' with his stick, the puck slides across the ice at a speed that is essentially constant. (Note: this could also apply to a well-lubricated cart that is given a quick shove along the track!) Three students in a previous class offered the following force diagrams and explanations in terms of the forces acting on the puck.

Explanation #1: Why does the puck move at a constant speed after it is given an initial hit by a player?

Describe the situation using a diagram:

Student A	Student B	Student C
 Force of stick Force of friction		 Force of stick

Write the narrative:

Student A:	Student B:	Student C:
The force of the stick was transferred to the puck and exactly balances the force of friction opposing the puck's motion. When balanced forces act on an object, its speed will remain constant	After the stick has lost contact with the puck, no forces act on it and so there is nothing to change its speed.	The initial hit is what starts the puck moving. After the hit has stopped it moves at a constant speed.

Evaluate these Explanations:

Decide whether each explanation is *good* or *poor* by reviewing each of the following criteria.

Student A	***Student B***	***Student C***	***Criterion***
YES/NO	*YES/NO*	*YES/NO*	*Complete: All ideas needed are included*
YES/NO	*YES/NO*	*YES/NO*	*Accurate: All included ideas included correspond to established ideas*
YES/NO	*YES/NO*	*YES/NO*	*Logical Reasoning and clarity: Narrative connects ideas to the phenomenon, and is well written.*

Participate in a class discussion about these explanations and make any notes you think necessary.

Taxiing a Plane

When taxiing a plane around an airport (before take-off or after landing) the pilots use the engines to push the plane along the ground. (The engines work in the same way that the fan units push on the carts you have used.) When the aircraft is standing still, with the engines running slowly, the pilot increases the power of the engines to start the plane moving, but when the plane reaches the desired taxiing speed, he reduces the engine power again. Why is this? (If you have never noticed this, next time you are on a plane listen to the engine noise while it is taxiing.)

Your task is to explain why the pilot reduces the engine power once the plane has reached the desired taxiing speed. Answering the following questions should help you think about why this is.

- Do you think a frictional force plays a significant role in this situation or not? Briefly explain your reasoning.

- To start the plane moving and make it speed up, do the forces acting on it need to be balanced or unbalanced?

- Once the plane has sped up to the desired taxiing speed, to maintain that speed do the forces acting on it need to be balanced or unbalanced?

- What do your previous answers imply about the strength of the pushing force needed to start the plane moving and speed it up, versus the force strength needed to maintain a constant speed?

Now write your own explanation to answer the question.

Explanation #2: Why does the pilot reduce the engine power when the plane has reached the desired taxiing speed?

Represent the situation using a diagram:
(Draw two separate force diagrams, one while the plane is speeding up, the other while it is taxiing at a constant speed.)

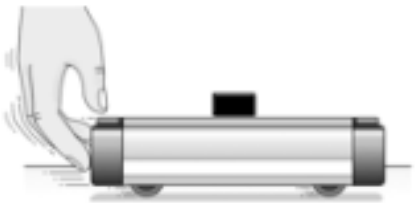
Write the narrative:
(Remember to connect the ideas about forces you use to the actual question being asked.)

Investigating the motion of objects inside a vehicle that suddenly stops.

You have probably noticed that when a vehicle stops suddenly, objects inside it get thrown about. In this part of the activity you will investigate this motion and then use your ideas to judge the validity of a claim made by a bus passenger.
You will need

- Low-friction cart
- Track
- Small block (to represent a case)

Place the block in the middle of the cart and start the cart moving by giving it a push with your hand. (While you are pushing, hold the block in place in the middle of the cart.)



After your push, let the cart move a short distance on its own, then stop it very **suddenly**, again using your hand. Watch the behavior of the block as you stop the cart.

 Describe what happens to the block during the sudden stop.

Why do you think the block behaves in this way? To help you answer this question, **first** think about the following ideas.

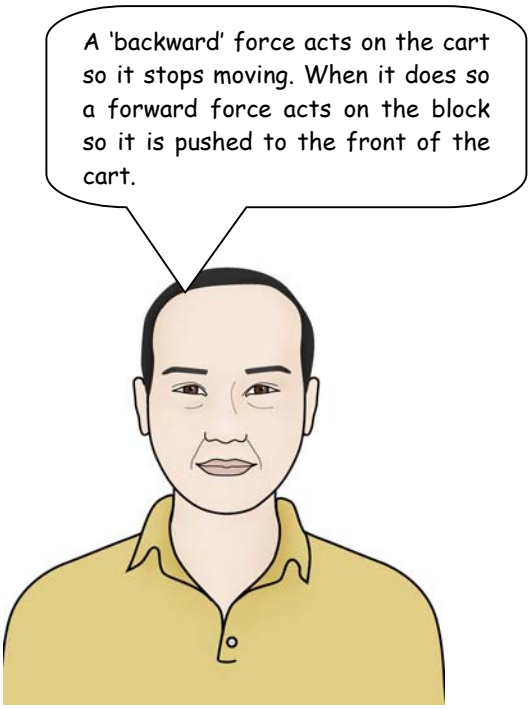
 If an object is already moving, what is needed to make it slow and stop?

 If you had two objects moving together, what would happen if a strong force opposing the motion acted on one of them, but no such force (or a very much weaker force) acted on the other?

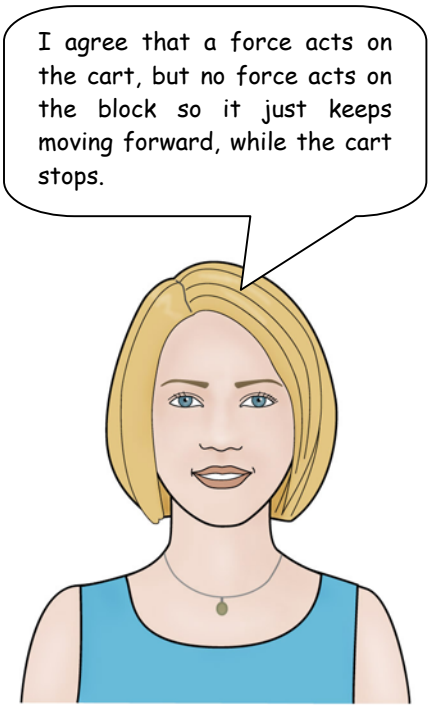
 Does a strong force act on the cart to slow and stop it quickly? If so, what object exerts that force on the cart?

 During the very short period of time while the cart is stopping, does a strong force also act on the block to slow and stop it? If so, what object exerts that force on the block? If not, what will happen to the speed of the block?

Two students were discussing why the block appears to slide forwards on the cart when the cart is stopped suddenly.



Han



Samantha

Do you agree with Han, Samantha, or neither of them? Explain your reasoning.

When the block reaches the front lip of the stopped cart, the block itself then also stops. Why do you think this is?

Using the ideas you thought about above, write an explanation for why the block slides to the front of the cart when the cart is stopped suddenly.

First think about the cart and the block separately, drawing separate force diagrams for each. Then combine your ideas in the written narrative to answer the question.

Explanation #3: Why does the block slide to the front of the cart when the cart is stopped suddenly?

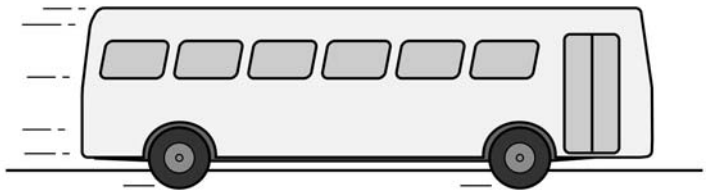
Represent the situation using a diagram:
(Draw separate force diagrams for the cart and block, for the same moment in time while the cart is in the process of stopping.)

Cart: Block:

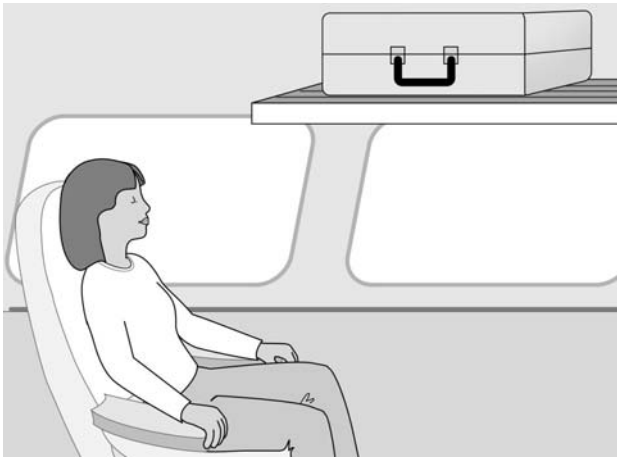
Write the narrative:

You are the expert witness

A passenger is suing a bus company for injuries she claims were sustained when the bus had to brake sharply to avoid hitting an obstruction in the road.



The passenger claims that when the bus braked sharply this caused a case to fly backwards off a luggage rack in front of her and hit her head, while she was seated in the row of seats behind the luggage rack.



As an expert in Newton's Laws you have been called to testify whether this story is credible or not. How would you respond?

Explain your reasoning.

 Participate in a class discussion about these ideas