Force and Acceleration

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This lecture should be given after the lecture on Speed

Materials:
Tape measure
Calculator
Timer (or Watch with seconds hand)
Tennis ball
Whiteboard or other writing surface

Key Words for use by children in discussion:
Force, acceleration, Newtons, net force

1) Refer to the Pegaspeed trading card. Ask the children what speed is. Discuss how speed refers to how fast something is going. Assign children to use the timer and tape measure.
2) Lay the tape measure on the ground for a good distance and have the have select students measure the time it takes another student to walk slowly a set distance, yelling stop when the child reaches the end of the tape measure. Measure the speed in feet per second and calculate the children's speed on the board. Discuss the distance walked in 1 second with the class.
3) Measure the same child's speed again. But this time have another child go behind the one whose speed is being measured and begin pushing about half way down the tape measure, speeding them up for the last part of the distance. Write the new speed on the board, noting that the speed is greater this time. Ask the students, "What happened to the child's speed when the other child pushed them?" Ask them if the child's speed changed. Explain that when the speed of something changes it is called "acceleration." Discuss how their parents push on the accelerator when they want the car to go faster, or in other words, to change the speed of the car.
4) Ask the children how one child got the other child to accelerate. When the children say by pushing, explain that in science you say that the child applied a "force". Switch children and rerun the exercise, always stressing at the end that (1) since there was a change in speed, the child must have accelerated and (2) to get the speed to change you must apply a force.
5) Write on the board that, "Force leads to Acceleration = change in Speed."
6) Have different children hold a ball on a table at rest. Have the children note that the speed is zero feet per second. Have the children push the ball while they explain to the class that they are "applying a force to the ball" in order to "accelerate or change the speed of the ball."
7) Hold the ball up in the air and note that it is at rest. Ask the children what the ball's speed is and note that it is zero. Ask the children what will happen if you let go of the ball. Ask the children whether the ball will change its speed from zero to something else; will the ball accelerate? When they have answered, drop the ball and note that it accelerated. Refer to the board and indicate that if it accelerated, something must have applied a force. Ask the children, "Where did the force that caused the ball accelerate come from?" Conclude that the earth applied a force that scientists call gravity.
8) Put the ball on the ground and ask the children the speed. After noting it is zero ask the children if the Earth is still applying a force, or applying a force. Ask the children why the ball is not accelerating if the earth is pulling on the ball? After discussion, note that the ground is pushing up on the ball with the same force that the earth is pulling down so the ball does not move, it does not change its speed. Ask the students whether a tennis ball always accelerates or changes speed, if you apply a force? Note that if an equal force is applied in the opposite direction the object does not accelerate.
9) Hold a ball up in the air and note that the ball is still feeling a force from gravity pulling it down, but it is not moving. Ask the children why the ball is not accelerating down. Discuss how your hand is applying an opposite force. In other words, the "net force," or sum of all forces, is zero. Ask the class what will happen when you remove the force that your hand is applying to the ball, and why. After discussion, drop the ball and note the force of gravity accelerated the ball towards the ground since the net force on the ball was no longer zero.
10) Write the word "Net" next to "Force leads to Acceleration = change in Speed."

11) Redo the exercise above where one student accelerates another student, but have two children push on either side of the child in the middle so the child does not move. Ask for volunteers to explain why the child being pushed does not accelerate, using the terms from above (Force, acceleration, speed). Note again that each of the children is applying an equal force in opposite directions so the "net force" is zero, and therefore no acceleration occurs.
12) Discuss that forces can be large and small and the units people use to measure force is Newtons, similar to measuring length in feet and time in seconds. Have a student apply a small, then a large force to the ball and discuss how that leads to small, then large acceleration of the ball. "So the bigger the force, the bigger the acceleration". Write this rule on the board. Push one ball slowly from rest and another quickly and ask the children which ball received the greatest amount of Newtons.
13) Apply the same large force applied to the ball above, to a large object in the room such as a file cabinet. Have the students comment on the magnitude of the acceleration observed. Ask the students, "Why did the large object not accelerate as much as the ball, since the same force in Newtons was applied to both?" After discussion, note on the board that the "larger the mass the smaller the acceleration."
14) Ask the students to illustrate the 2 rules of motion written on the board with additional examples in the classroom, and lead them through the discussion.
15) Ask the children to give examples of strong forces they have seen applied, and discuss the source of the force. For example, discuss the space shuttle lift off (accelerating), a car taking off from rest, and a baseball being pitched.

Force and Acceleration lesson highlights checklist

- ☐ Measure student's speed
- ☐ Measure student's speed with pushing
- ☐ Drop ball from height
- ☐ Release ball sitting on ground
- ☐ Hold ball up and discuss net force
- ☐ Students push in opposite direction on another student
- ☐ Small force, small acceleration
- ☐ Large mass, small acceleration
- ☐ Examples of strong forces