Heat

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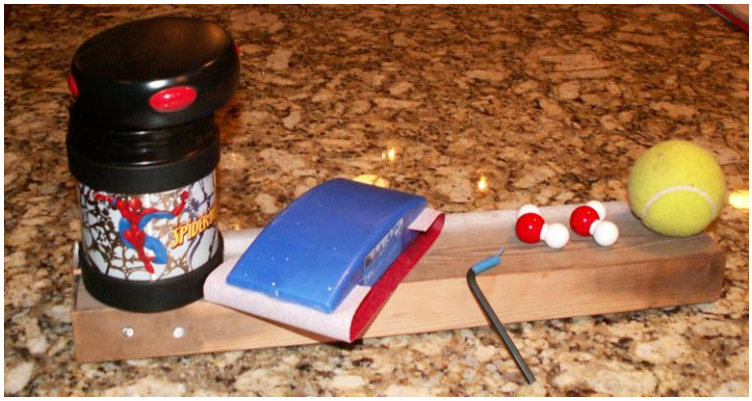
This lecture should be given after the lectures on Table of Elements, and Force and Acceleration

Materials:
Tennis ball
Hot water in a thermos. Use caution when thermos is open
Small metal object that can fit into the thermos of hot water (e.g. an allen key)
Paper towels or napkins
Sandpaper, sandpaper holder, and a piece of wood
4 spheres (2 each of two different colors)
White board or other writing surface



Preparation before the lesson:
Prepare 2 water molecule models and fill a thermos approximately half way with hot water prior to the class. Also attach sandpaper to a holder that allows for easy use to sand wood, even by children (see picture below).

Key Words for use by children in discussion:
Energy, heat, temperature

1) Refer the children to the Pegaspeed trading card. Put a ball on the floor at rest and ask the children what the speed is. After concluding it is zero, push the ball and ask if the speed is still zero. Refer to the Forcen trading card and ask the children about the impact of the push on the speed of the ball, leading them to notice that acceleration had occurred. Note that since there was acceleration, a net force must have been applied.
2) Roll the ball along the floor and ask, "does the ball have energy?". When a child says yes, discuss how they know. Ask the children whether a ball at rest has energy. Focus the discussion on the idea that movement is one indication of energy.
3) Write "Movement Energy" on the board.
4) Roll the ball lightly on the floor and let it stop on its own. While it is rolling note that it has movement energy. When the ball stops ask the class, "where did the energy go?" After the discussion of ideas, suggest that a demonstration might help.
5) Have the children gather around and touch the wood, noting the temperature. Use the sandpaper to sand the wood, reminding the children that the moving sandpaper has energy. While sanding intensely say, "look at all that energy in the sandpaper coming from my arm." Then let the sandpaper sit at rest after using it and discuss the apparent loss of energy. Challenge the thinkers in training with the question, "Is the energy of the moving sandpaper lost?"
6) Have the children touch the warm wood and conclude that the energy of movement changed into heat energy. Ask the children, "how did you know there was heat generated?" Conclude the discussion with the understanding that an increase in heat energy is sensed by us as an increase in temperature.
7) Write "Heat Energy" on the board.
8) Have a number of children illustrate and describe the transfer of energy from the sandpaper to the wood. When a student does not cause enough friction to generate noticeable heat, stress the point that not enough heat energy was generated to noticeably increase the temperature.
9) Have all the young scientists touch their hands to their cheeks and note the temperature. Then have the children rub their hands strongly together and note all the energy their hands have while moving. After much rubbing, have the students stop and put their hands on their cheeks again. Lead the children in a discussion of the transfer of object movement energy to heat energy. Have a few children logically explain the process to the class with guidance when necessary.
10) Conclude with the children that energy of movement can be transferred into heat energy and write an arrow between the two types of energy on the board.

11) Have the children gather around and feel a room temperature metal object. Drop or dip the metal object into a thermos of hot water. Wait a few seconds and then take the metal out and dry it quickly with a paper towel. Have the children touch the metal and ask them if they agree that heat energy was transferred from the hot water to the colder metal object.
12) Ask the children, "inside the metal, what happened to change the temperature so that we recognized heat energy?" Refer the children to the Neutelpro and Pegaspeed trading cards and lead them to conclude that the atoms might be moving with a greater speed when the metal is hotter and that is sensed by us as an increase in temperature.
13) Remind the students that elements or atoms are very small so that in one piece of charcoal there are a trillion trillion atoms. So we cannot see the atoms moving, but our brain can sense the movement of the atoms as temperature using sensory neurons in the skin. Refer to the Brainium trading card and mention that the sensory neurons in the skin will send as signal back to the spinal cord to tell us when something is too hot and we should pull our arm away.
14) Model heat transfer from the atoms in hot water to the atoms in metal. Have one student hold two spheres of one color to represent fast moving water atoms. Have another student hold two spheres of a different color to represent the atoms in the metal. Have the metal atoms dip into the water atoms and speed up when they are hit by the fast moving water molecules. Pull the metal atoms out and ask the students about their temperature. Repeat the demonstration with another pair of students, noting the transfer of heat energy.
15) Take the children back to the beginning of the lesson. Roll the ball on the floor again and ask the children where the movement energy of the ball went, discussing that it generated heat in the floor and ball through friction which occurs when objects rub together. Have the children touch the floor after the ball rolls by and note that the temperature did not change. Ask the children, "so was heat generated from the movement energy?" Lead the discussion to conclude that, unlike in the sanding demonstration, the magnitude of the heat generated by the rolling ball was too low to change the temperature of the floor enough for us to sense the change with the neurons in our finger.

Heat lesson highlights checklist

- ☐ Review speed (Pegaspeed card) using a tennis ball
- ☐ What is energy? = movement (one form)
- ☐ Where did rolling tennis ball's energy go?
- ☐ Sandpaper movement energy ⇨ heat energy
- ☐ Heat energy sensed as temperature change
- ☐ Hand movement energy ⇨ heat energy
- ☐ Movement energy can change to heat energy
- ☐ Heat can be transferred: Hot water ⇨ metal
- ☐ Hands sense temperature increase = increase in speed of atoms (discuss Pegaspeed, Neutelpro, and Brainium trading cards)
- ☐ Have students model heat transfer between atoms in hot water and atoms in metal
- ☐ Discuss conversion of tennis ball's movement energy into a small amount of heat energy