Conservation of Energy

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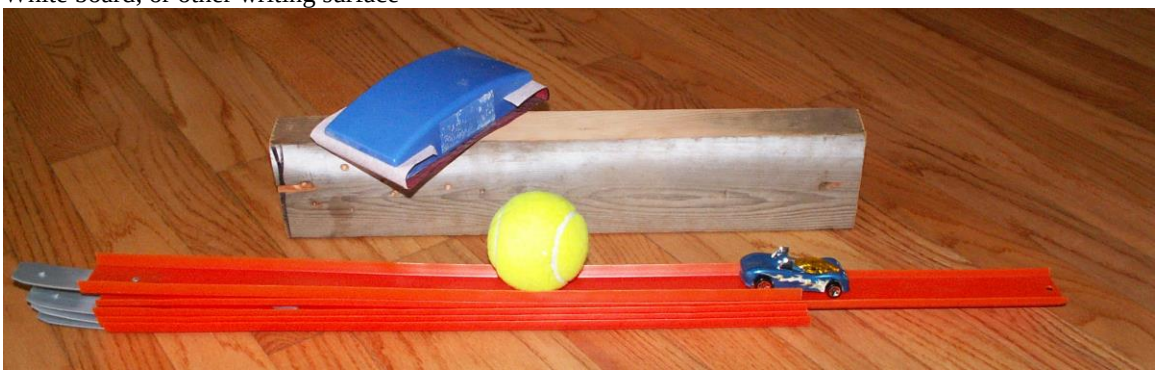
This lecture should be given after the lecture on Heat

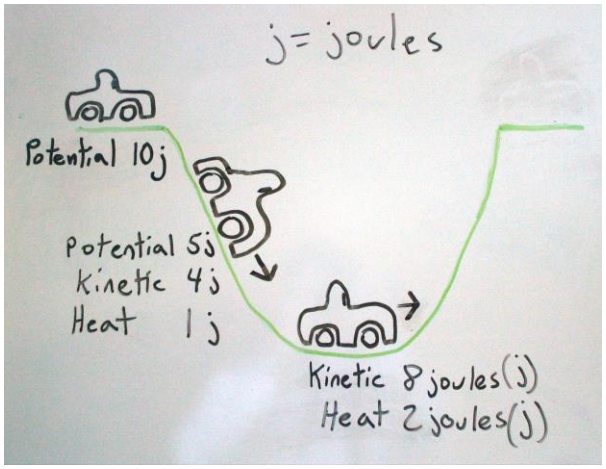
Materials (see picture below):
Tennis balls
Sand paper and block of wood to sand
About 6 foot length of bendable Hot Wheels-like tracks and a car
White board, or other writing surface



Key Words for use by students in discussion:
Energy, temperature, kinetic/movement energy, potential energy, conservation of energy

1) Remind the students that learning in math and science always builds on what you have learned in the past.
2) Mention the Heanug trading card. Roll a tennis ball along the floor and ask the students if the ball has energy. When a student answers, "yes", discuss how they know, focusing on the fact that movement indicates energy. Indicate that scientists call movement energy, kinetic energy. Write "Kinetic Energy" on the board next to the number 1.
3) Roll the ball lightly on the floor, noting the kinetic energy. Discuss with the students whether the ball has kinetic energy, after it stops. When it is concluded that the kinetic energy is gone, ask the students where the energy went. Guide the students to recall from the Heat lesson that it went to heat. Write "Heat Energy" on the board next to the number 2. Ask the students to demonstrate that heat energy has been generated, guiding them to conclude that there was not enough heat energy generated to change the temperature enough for our neurons to detect.
4) Have students circle around for a demonstration and ask them to touch the room temperature wood. Use the sandpaper to vigorously sand the wood. While sanding say, "look at all that kinetic energy." Let the sandpaper sit at rest and ask, "Where is that energy now?" Have a few students touch the wood to prove that the kinetic energy of the sandpaper turned into heat energy, because the temperature sensed by the neurons in our skin was increased.
5) Have students logically demonstrate to the class in words and actions that the kinetic energy of the sandpaper can be transferred into heat energy, sensed as an increase in temperature. As they take turns doing this, ask the students where your arm obtained the energy to give to the sandpaper, discussing how your body gets some of its energy from the food we eat. Write "Food Energy" on the board next to the number 3, and ask the demonstrating child what they ate earlier in the day to give them the food energy to make the sandpaper move.
6) Have different individual students roll the tennis ball and discuss the following transfer of energy:
   - The breakfast they ate today gave their body energy (have them indicate what they ate)
   - Kinetic energy of the arm is transferred to the tennis ball
   - Kinetic energy of ball is transferred to heat energy of the things it touches (floor and air, for example), although the temperature changes are not great enough to sense with out fingers.
7) Note with the students that they now know about three types of energy. Through discussion, reach a consensus that energy can change from one form to another.

8) Lay down the Hot Wheels track flat on the floor and put a car on the track. Mention the Forcen card and ask the students how to accelerate the car. After discussion, select a student to use some of their food energy to apply a small force to the car. Note that the small force resulted in a small amount of kinetic energy in the car, which was then turned into a small amount of heat energy of the wheels of the car and track.
9) Now form a U-shape with the track, asking students to hold it in that shape at the ends, and put the car on the edge of a cliff going into the U-shape. Have the same student from step 8) apply the same small force to the car, just pushing it over the edge. When the car goes zooming down the track, ask the students where all that kinetic energy came from. Discuss student hypotheses. Conclude the discussion by noting that some things have energy that can turn into another type of energy, even though they do not look like they are full of energy. These objects can have something called "potential energy" which cannot be seen like kinetic energy and cannot be felt like heat. Write "Potential Energy" on the board next to the number 4.
10) Discuss the energy transfer as the car example is run again: Although the car on the cliff does not have kinetic energy, it has potential energy because the Earth would really like to apply a force called gravity to the car. When the car goes down the hill, the potential energy it had at the top of the hill gets turned into kinetic energy, which the students see as a faster moving car.
11) On the board, draw a diagram of the track with the car at the beginning of the track before the U-shape. Draw a car mid-way down the track and at the bottom of the U-shape. Discuss the types of energy that the car has at each point. On the figure write Potential Energy for the car at the top of the track, Potential +Kinetic energy for the car mid-way down the track, and Kinetic energy for the car at the bottom.
12) Refer to the Heanug trading card and have the students think of the other energy type that would be generated as the car moved down the track; i.e. heat energy in the track and in its wheels. Note this energy type as well in the figure mid-way down the track and at the bottom of the track (See Figure to the right).
13) Have some students logically describe the transfer of energy illustrated on the board, guiding them when necessary after a period of thinking.



14) Ask the students what will happen after the car goes past the bottom of the track, guiding them to reach the conclusion that some of the kinetic energy will be changed into potential energy.
15) Tell the students that the unit of energy is Joules, and suggest that the energy is 10 joules when the car starts out at the top of the track, and illustrate how this is divided amongst the energy types as the car moves along. Write in numbers to serve as an example, with total energy staying at 10 joules. Go along the track drawn on the board and at each point inquire about the total energy of the car (total of all forms). After discussing the energy at the bottom of the track, stress the observation that the energy is 10 joules at each point.
16) Mention to the students that you just made up the numbers for energy at each point, and ask them if this really occurs in the world. Does the total of all energy always add up to the same amount? Guide the students to the conclusion that while energy can change from one form to another, yes, scientists have found that **the total energy remains constant**. This rule is called the Conservation of Energy. Write this term on the board.
17) Using the car and track, and the board, guide select students through a discussion of the transfer of energy between different forms when the car moves up the other end of the track after zooming by the bottom of the U-shape. Note especially the point on the track at which the car stops, before it moves back down the track again. Ask the students whether the car has energy at that point, and of which types, guiding them if necessary to conclude the car will have potential energy and heat.

Conservation of Energy lesson highlights checklist

- ☐ Review movement energy (Kinetic Energy) -Tennis ball
- ☐ Review heat energy-Tennis ball
- ☐ Review heat energy-Sandpaper and block of wood
- ☐ Student Demo: Food energy ⇨ arm kinetic energy ⇨ sandpaper kinetic energy ⇨ heat energy
- ☐ Student Demo: Food energy ⇨ arm kinetic energy ⇨ ball kinetic energy ⇨ heat energy
- ☐ Have student scientists agree to conclusion that energy can transfer between different forms
- ☐ Demo hot wheels flat track: Food energy ⇨ arm kinetic energy ⇨ car kinetic energy
- ☐ Demo hot wheels U-shaped track, with large kinetic energy following small energy transfer from arm
- ☐ Introduce Potential Energy
- ☐ Discussion on board of energy transfer between energy types with U-shaped hot wheels track
- ☐ Introduce the unit of energy, Joules
- ☐ Enter values for energy types on board, keeping total constant
- ☐ Introduction of Conservation of Energy
- ☐ Discussion of energy transfer between energy types when car goes back up the U-shaped track