Learning Goals:
LG2: All of what goes on in the universe involves some form of energy being transformed into another.
LG3: Energy cannot be created or destroyed but changed from one form to another

Learning Performances:
1. LG3/Predict: Students predict what will happen to a car or ball released from certain height.
2. LG3/Conduct: Ss conduct an investigation that will prompt them to think about the apparent disappearance of energy in a phenomenon.
3. LG3/Reflect: Ss reflect on the seeming disappearance of energy in a system.
4. LG3/Present: Groups of students present their Methods, Data, or Interpretations.
5. LG3/Ask Questions: Students ask each other questions regarding the apparent appearance or disappearance of energy in various phenomena.

Misconceptions:
1. Things ‘use up’ energy. (GN4)
2. Energy is associated only with animate objects (GN7)
3. Energy transformations only involve one type of energy at a time. (TC5)

Materials:
Teacher
Super or tennis or ping-pong ball
Meter stick
matchbox road sections in U-shape
Matchbox car
Paper taped to wall
3-4 different colored markers
Large piece of newsprint

Student

Daily Primer: (5 minutes)
1. Explain in your own words, the two uses of the word ‘conservation’.
2. What might a graph of height vs. peak# look like for a pendulum after five swings. Choose from these options:
3. What might a graph of height vs. peak # look like for a pendulum after swinging for 30 swings? Choose from these options:
Section 9.1: Matchbox car experiment – half of the class (20 minutes)

9.1.1. In groups of 3-4 at each matchbox station students read directions in the student guide and answer the Prediction question that matches their experiment. Give them a chance to write their answers and also ask any questions they have regarding the directions.

9.1.2. Release car at top of ramp and observe as it goes back and forth through U shape until it comes to a rest. In student guide, describe the main transformations that are going on. [e.g. GE → KE → GE → KE]

9.1.3. Place car at the top of the ramp again and measure the height of its top-most bumper. Release car and watch it go down track, up the other side – back and forth until it comes to a rest. Answer question in book: Does car ever come back up to its original height on either side of the track?

9.1.4. Run experiment again, but this time marking with a marker on the piece of paper attached to the wall the peak heights reached by the top-most bumper on each side. Repeat as needed to get a ‘clean’ set of data….don’t use a trial where the car goes off the track or has some other problem. Measure the heights (always from the floor) in cm from the best trial and record in data table.

9.1.5. Create a bar graph on the graph paper provided in student guide. Graph peak # on x-axis, height on y-axis.

9.1.6. Answer question in guide book: How does the height that the car reaches change as the experiment progresses?

9.1.7. What might have happened to the original amount of GE it started with that is not showing up at the end? (car has no motion at the end and it is at the lowest point, so both KE and GE are zero.) Are there any other possible types of energy involved here besides GE and KE?

9.1.8. As a group, prepare a short presentation to explain what happened and your thoughts about it to give to the other half of the class. Make sure you can present something about your Methods, Data (copy your group’s graph onto a large piece of newsprint), and your Interpretations.

Section 9.2: Bouncing experiment—half of the class (20 minutes)

9.2.1. In groups of 3-4 at each bouncing station, students read directions in the student guide and answer the Prediction question that matches their experiment. Give them a chance to write their answers and also ask any questions they have regarding the directions:

9.2.2. One student holds (or tapes) the meter stick vertically against the paper taped to the wall. Bottom of stick is on the floor.

9.2.3. One student holds bottom of ball even with the top of the meter stick and then lets it go. Answer question in book: Does ball ever come back up to its original height? In student guide, describe the main transformations that are going on. [e.g. GE → KE → GE → KE]

9.2.4. Run experiment again, but this time marking with a marker on the piece of paper attached to the wall the peak heights reached by the ball on each bounce. Repeat as needed to get a ‘clean’ set of data….don’t use a trial where the ball hits the wall or has some other problem. Measure the heights from the floor in cm for each peak or bounce from the best trial and record in data table.

9.2.5. Record the original height and the successive peak heights in data table in student guide.
9.2.6. Answer question in guide book: How does the height that the ball reaches change as the experiment progresses?

9.2.7. Graph these heights in chronological order (peak # on x-axis, height on y-axis).

9.2.8. From the graph, what is the general trend of the heights that the ball is reaching each time it bounces?

9.2.9. What might have happened to some of the original GE it started with that is not showing up as KE or GE at the end (ball has no motion and is one the floor).

9.2.10. Are there any other possible types of energy involved here that we didn’t think of at first?

9.2.11. As a group, prepare a short presentation to explain what happened and your thoughts about it to give to the other half of the class. Make sure you can present something about your Methods, Data (copy your group’s graph onto a large piece of newsprint), and your Interpretations.

Section 9.3 Presentations: (12 minutes)

9.3.1. Pick one group from the Matchbox experiment to present their Methods.

9.3.2. Pick a different group from the Matchbox experiment to present their Data (the graph).

9.3.3. Pick a different group from the Matchbox experiment to present their Interpretations.

9.3.4. Pick one group from the Bouncing experiment to present their Methods.

9.3.5. Pick a different group from the Bouncing experiment to present their Data (the graph).

9.3.6. Pick a different group from the Bouncing experiment to present their Interpretations.

9.3.7. Open the class up to questions/clarifications for each other. Encourage everyone to focus most of their attention on the graphs for now.

Section 9.4 Focus on Data and Interpretations (10 minutes)

9.4.1. Spend some time looking at all of the graphs on the board. Ask the students to identify how these graphs differ when taken together as a group from the graphs created the previous day. [these will have a downward trend, whereas the day before the graphs showed a horizontal line]

9.4.2. Have students write about the following question in their guidebooks: “Would you say that the Law of Conservation of Energy was followed in your experiment?” What is your evidence?

9.4.3. Have a few students volunteer their answer to this question. Make sure they are justifying their answer with evidence. After a few students speak, try to generalize with the whole class as to how the graphs show that energy appears to not be conserved.

Activity 8.5 Wrap-Up (5 minutes)

8.5.1. Revisit and discuss #2 and #3 of the daily primer questions.