Energy Conservation

Subject Area	Physics.
Age or Grade	Elementary high school physics.
Estimated Length	One 45-minute lesson (with possible follow-up later, depending on how quickly the groups progress). Part g on the worksheet (see below) can be used as an opener into a lesson about heat as a form of energy.
Prerequisite knowledge and skills	Kinematics, basic knowledge of potential and kinetic energy.
Lesson Goals and New Content	The students will have their first encounter with the idea of energy conservation and total mechanical energy. The goal is for them to experience how energy doesn't disappear or appear, but rather is converted from one form to the other.
Materials Needed	Meter stick. Bouncy ball (basketball or volleyball works well). Worksheet w. instructions.
Procedure	**Opener** (~10 min.) One way to introduce the exercise to the students is to first do a little exercise having them identify the types of energy of a ball at different stages. Throw the ball into the air, and draw a diagram on the board. Then ask the students to identify the types of energy of the ball as it leaves your hand, as it reaches the peak of its motion, and somewhere in between. (Leave your diagram on the board.)

Leave the question open and unanswered for now; it is the driving question behind the lesson. Once you have formulated the question with them, transition to the worksheet.

Development (~25 min.)
Release the students into groups of 3-5 and let them work through the exercise. They will start by dropping a ball and measuring the height to which it bounces, which should only take a few minutes. After that, let them work through the questions in the groups, while you walk around and help them out. In my experience, most groups should be able to make it through questions a-f in the allotted time, but you can extend it as needed and let the closure carry over to the next day. Part g on the sheet will frustrate some of them, but is a lead into a different lesson, so don't give away the answer at this point. (If it frustrates them too much, make that question optional and return to it later.)

Closure (~10 min.)
Briefly go over the worksheet with the class. You should highlight that the initial potential energy of the ball has turned into kinetic energy as it hits the ground. Use the calculated potential and kinetic energies from one group and fill them in on the diagram from your opener. Then, make up a number in between the two and write that as the potential energy at your middle point. Have the class guess what the kinetic energy would be. Most

	of them will probably see the pattern and get the right answer, perhaps with a little guidance. Only now will you introduce the term energy conservation and total mechanical energy. It is my experience that textbooks have many elaborate equations stating energy conservation, explicitly writing out all potential and kinetic energy terms. Students seem to think of these equations as separate and having nothing to do with each other, which confuses them and makes energy conservation a very abstract concept. I find it best instead to emphasize that $ME=PE+KE$, and that $ME_{initial}=ME_{final}$. This contains the central idea you want to embed in their minds, and they relate better to this, having just seen it themselves in the activity.
Evaluation	In addition to the continuous evaluation during the lesson, I would suggest following up with a set of practice problems covering the basic idea of energy conservation, for example as homework for the following day. The concept of energy will also come up many times later in a physics curriculum, presenting many opportunities to continuously evaluate the students' understanding.
Extensions	Part g on the worksheet is more advanced, and depending on how quickly your class progresses through the different parts, you might want to use it as an opener for a different discussion. It can be used as an opener to a discussion on heat as a form of energy.

	Part g contains a discrepant event: the ball started with some amount of energy, and we just concluded that energy is conserved; yet it ends up on the ground not moving (no potential or kinetic energy). To lead on the discussion, ask what happens when you run down the stairs running your hand against the railing. The students should realize that friction generates heat. Now ask why a car engine has to keep working, even when the car drives at a constant speed. The students should realize it is because of friction, which means the engine's work generates heat. When I did this lesson, we had already gone over work with the class. A lesson linking work and energy together follows naturally after this one, focusing on the central concept that you can add energy to an object by doing work on it. I like doing this by having them calculate the energy added to a book being lifted a height *h* at constant speed, and then comparing that to the equation for potential energy. It builds well off this lesson, as the students need to understand energy conservation to appreciate the relationship between work and energy.