612-1315 (15-059) Energy Transformation

Warranty and Parts:

We replace all missing or defective parts free of charge. All products guaranteed free from defect for 90 days. This guarantee does not include accident, misuse, or normal wear and tear.

Introduction:

Two precision machined balls, if substantial enough in size, will, when smashed together, create enough heat at the point of contact to burn a hole in a sheet of paper.

This is a fast and astonishing demonstration of converting **mechanical energy to heat energy!**

The set consists of two heavy balls constructed of highly polished, hardened, chrome-plated steel. This material was selected to provide the smallest possible point of contact to maximize the effect of the demonstration.

Purpose:

To introduce students to energy through the idea of energy transformations and conversion.

To develop ideas of what energy is and how it can be measured.

Other materials needed:

- Safety glasses
- Piece of paper

Background:

Before the 19th century the concept of heat was very different from what it is today. It was believed that if an object felt hot to the touch, it contained a great deal of heat. Heat was considered to be a weightless fluid (or **caloric**) flowing from a hotter to a colder object.

When did the study of thermodynamics, as we understand it, begin? It may have started with Fahrenheit (1724) whose discovery that liquids boil at constant temperatures startled and puzzled the scientific world. In 1798, while boring out a cannon, **Benjamin Thompson** concluded that heat is not a substance but is produced by the motion of particles. But what has become known as the **First Law of Thermodynamics** (which states that *energy can neither be created or destroyed - that the total energy of the universe is constant*) evolved from the **Carnot Principle** (now known as the **Second Law of Thermodynamics**).

Sadi Carnot, a French engineer, demonstrated in 1824 that the work produced by a steam engine is proportional to the heat transferred from the boiler to the condenser, and *work could only be gained from heat by a transfer from a warmer to a colder body*. While his principle was never applied during his brief life, it evolved into Kelvin's absolute temperature scale.

J.P. Joule is widely considered to be the founder of experimental thermodynamics, although he relied on others to develop the necessary mathematical derivations. For this reason, he shares the discovery of the law of the conservation of energy with **Hermann von Helmholtz.** In 1847 Joule established that mechanical, electrical and heat energy are basically the same and can be changed from one form into another; in his honor, the unit of work or energy is called the **joule**.

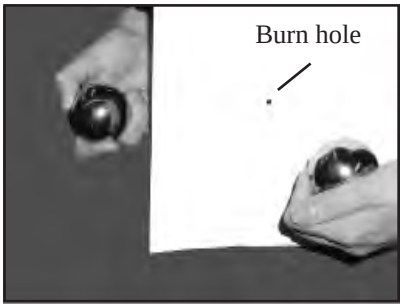
In Helmholtz' classic work, "On the Conservation of Energy", he stated that the various forms of energy can be transformed one into another. His use of the word "force" corresponds to what later became known as energy.

How to use:

1. Put on safety glasses.
2. Take a sheet of 8-1/2 x 11" paper and fold it in half.
3. Set on flat surface (lab bench works best) so that the sheet looks like the letter "L".
4. Make sure no one is standing or sitting at either end of the table.
5. Roll the balls quickly toward each other, making certain that each ball will hit opposite sides of the sheet of paper. The balls should collide with enough force to burn a hole in the paper.
6. If no burn hole appears, either the balls were not travelling fast enough or they did not hit head-on. Adjust your aim and roll again.

Alternate method:

1. Put on safety glasses.
2. Have a helper hold a piece of paper in the air.
3. Hold a ball in each hand.
4. From opposite directions, strike the paper with both balls.
5. The balls should collide head-on.



24-15059

612-1315 (15-059) Energy Transformation

Teacher Page

Benchmarks and Standards

This investigation provides support for the *Benchmarks for Science Literacy* and *National Science Education Standards* shown in the table below.

Benchmarks for Science Literacy			*National Science Education Standard*		
The Physical Setting: Energy Transformation	**4E.1**	Energy cannot be created or destroyed, but only changed from one form into another.	**Physical Science**	Properties and changes of properties in matter (5-12)	
				Motions and forces (5-12)	
	4E.2	Energy in the form of heat is almost always one of the products of an energy transformation.		Transfer of energy (5-8)	
				Conservation or energy and increase in disorder (9 - 12)	
	8E.1	Energy cannot be created or destroyed, but only changed from one form into another	**History and Nature of Science**	**Historical Perspectives**	Science has been practiced by different individuals in different cultures.
	4F.3	Heat can be transferred through materials by the collisions of atoms or across space by radiation			