

## 18.1 Rubber Band Thermodynamics

**Subjects:** Thermodynamics, Entropy, heat

**Description:** The thermal properties of rubber will be explored in this demonstration. Will a rubber band contract or expand when heated?

**Materials:**

Heavy rubber band

2 Ring stands

Springs

Heat gun\*

Paper clips

Ruler or meter stick to measure contraction

\*Shared items: Located in right hand drawer (second from top) across from the chemical storage cabinets.

**Procedure:**

1. Suspend the rubber band between the two springs and attach the springs to the two rings stands.
2. Place the ring stands so that the rubber band is stretched and taught.
2. Heat the rubber band with a heat gun. Does the stretched rubber band become longer or shorter when it is heated?

**Note:** When testing this demo, the rubber band contracted about 1 cm, which wasn't very noticeable to the naked eye. I was able to measure the contraction with a ruler.

**Discussion:**

When rubber is heated it behaves differently than most familiar materials. Most materials expand when they are heated. Consider the liquid in a thermometer. The thermometer works because the liquid expands when its temperature increases. Similarly, a wire made of metal, such as copper, becomes longer as it gets hotter. The expansion of metals with increasing temperature is the principle behind the functioning of home thermostats and of jumping discs.

Whether a material expands or contracts when it is heated can be ascribed to a property of the material called its entropy. The entropy of a material is a measure of the orderliness of the molecules that make up the material. When the molecules are arranged in an ordered fashion, the entropy of the material is low. When the molecules are in a disordered arrangement, the entropy is high.

When a material is heated, its entropy increases because the orderliness of its molecules decreases. This occurs because as a material is heated, its molecules move about more energetically. In materials made up of small, compact molecules, e.g., the

liquid in a thermometer, as the molecules move about more, they push their neighboring molecules away. Rubber, on the other hand, contains very large, threadlike molecules. When rubber is heated, the sections of the molecules move about more vigorously. In order for one part of the molecule to move more vigorously as it is heated, it must pull its neighboring parts closer. To visualize this, think of a molecule of the stretched rubber band as a piece of string laid out straight on a table. Heating the stretched rubber band causes segments of the molecules to move more vigorously, which can be represented by wiggling the middle of the string back and forth. As the middle of the string moves, the ends of the string get closer together. In a similar fashion, the molecules of rubber become shorter as the rubber is heated, causing the stretched rubber band to contract

**Safety:** None

**Disposal:** None

**References:**

1. B.Z. Shakhashiri. Home Experiments website:  
<http://scifun.chem.wisc.edu/HomeExpts/rubberband.html>