Mechanical Properties of Chocolate- How Strong is your Chocolate?

Lesson

Mechanical properties of chocolate

Suggested Grade Level

6-8

Approximate Run Time

50-70 minutes (approximately 2 class periods)

PDE Standards

- 3.2.7 A: Explain and apply technological knowledge.
- 3.2.7 B: Apply process knowledge to make and interpret observations.
- 3.2.7 C: Identify and use elements of scientific inquiry to solve problems.
- 3.2.7 D: Know and use technological design process to solve problems.
- 3.4.7 A: Describe concepts about the structure and properties of matter.
- 3.4.7 C: Identify and explain the principles of force and motion.
- 3.6.7 C: Explain physical technologies of structural design, analysis and engineering, financial affairs, structural production, marketing, research and design.
- 3.7.7. A: Describe the safe and appropriate use of tools, materials, and techniques to answer questions and solve problems.
- 3.7.7. B: Use appropriate instruments and apparatus to study materials.
- 3.8.7 A: Explain how sciences and technologies are limited in their effects and influences on society.

National Standards

- NS 5-8.1: Science as inquiry
  - Abilities necessary to do scientific inquiry.
  - Understandings about scientific inquiry.
- NS 5-8.2: Physical science
  - Properties and changes of properties in matter.
  - Motions and forces.
  - Transfer of energy.
- NS 5-8.5: Science and technology.
  - Abilities of technological design.
  - Understandings about science and technology.

Content Objectives

1. Students will be able to identify the strength of various chocolate bars.
2. Students will know what happens to materials when load is applied to the center.

3. Students will describe the concept of strain by determining the load mass, width, length and thickness of candy bars.

Process Objectives

1. Students will be able to determine the relative strength of various substances using quantitative data.
2. Students will make observations of the strength of chocolate while adding load mass.
3. Students will be able to determine the amount of force needed to break a chocolate bar and the amount of load that it is capable of holding.
4. Students will compare and contrast the strength of various chocolate bars.
5. Students will determine how each variable in the experiment (i.e.: thickness, grooves, load, etc) affects the amount of stress that a candy bar can withstand.
6. Students will identify the terms “strength” and “strain.”

Assessment Strategies

1. Completion of the lab questions.
2. Informal evaluation of participation in group discussion.

Materials

- Mechanical Properties of Chocolate Lab and Questions and Data Sheet
- Chocolate bars

Procedure

Part 1: Relative Strength of Materials

1. Introduce this lesson showing students different materials and ask the students to determine which of these materials is the strongest: wood, Styrofoam, plastic (such as a milk jug), paper, metal and cloth. Allow them to touch each of the materials and make a list of materials from “strongest” to “weakest.”
2. Ask the students to share ideas about why some materials are stronger than others. How could they test each material?
3. Introduce the lab “How Strong is Your Chocolate.” Watch video clip "Bend Twist & Break, Fracture Surfaces" and allow the students a few minutes to make their hypothesis.
4. Complete lab.
5. Discuss the lab with the students. View video clip "Bend Twist & Break, Beyond the Laboratory" before students begin discussion questions.
6. Complete discussion questions.

Part 2: Strength and Strain

1. Review the concepts of strength and strain with the students.
2. Strength is the force per unit area (stress) that a material can support without breaking. Strength of a material can be found by determining how much “load” or “weight” a material can withstand. For example, if you were going to build a bookshelf to hold encyclopedias you probably would not choose paper as your

building material, you would choose a heavy wood or strong, durable plastic. Because books are heavy, they need a strong material to hold them in place.
3. Strength of materials is an area of study in material science where scientists determine the strength of a material by determining how much "stress" a material can withstand. The stress in which a material breaks is a measure of its strength.
4. Ask the students to identify strength of a material is a physical or chemical property. When a material breaks, it is still the same material as before, just in smaller pieces, thus strength of a material is a physical property.

Part 3: Material strength and strain

Use video clips "Bend Twist & Break, Fracture Surfaces" and "Bend Twist & Break, Beyond the Laboratory".

Part 4: Other Examples

1. Teacher-led discussion about how the materials differ and some can withhold more stress than others.
2. What are the advantages and disadvantages of strong materials? What are the advantages and disadvantages of weak materials?

Extension

1. Students can try this experiment again with different materials (such as plastics) to determine which would be an optimal building material. From their data, students can write a proposal to build a structure from the strongest material.
2. Students can research how chemical bonds affect the strength of materials. For example, inorganic materials, such as metals, ceramics and polymers, as well as organic materials, such as silk and bone, exhibit fundamentally different strengths. These differences originate in the variations in the type of bonds between the atoms and molecules that comprise the structure of these substances. For example, although metallic bonds are quite strong and resistant to deformation, they are relatively easy to individually break. This ability leads directly to the ductile characteristics of most metals. In contrast, the very strong and stiff ionic or covalent bonds that make up most ceramics, semiconductors and glasses are very resistant to any type of bond stretching or rupture, which in turns leads to their very brittle nature. Hardness is one measure of the strength of the structure of the mineral relative to the strength of its chemical bonds. Minerals with small atoms, packed tightly together with strong covalent bonds throughout tend to be the hardest minerals. The softest minerals have metallic bonds or even weaker van der Waals bonds as important components of their structure. Hardness can be tested through scratching. A scratch on a mineral is actually a groove produced by microfractures on the surface of the mineral. It requires either the breaking of bonds or the displacement of atoms (as in the metallic bonded minerals). A mineral can only be scratched by a harder substance. A hard mineral can scratch a softer mineral, but a soft mineral can not scratch a harder mineral (no matter how hard you try). The Mohs Hardness Scale starting with talc at 1 and ending with diamond at 10, is universally used around the world as a way of distinguishing minerals.