GRADE LEVEL: 5-8 | TIME REQUIREMENT: 3 HOURS

CHEMISTRY: PROPERTIES OF MATERIALS

1 READING | 2 ACTIVITIES

INTRODUCTION

World War II came at a time when most manufacturing used natural materials. Clothes were mostly cotton and wool, with some linen and silk. Tires were made of rubber from the sap of a tropical plant, and shoes were made of leather, wood, and that very same kind of rubber. The makeup of the furniture in a house or classroom from World War II and even the clothes that students would have worn is radically different from those today.

One of the key things for students to learn in elementary and middle school science is that materials can be identified by their physical and chemical properties. Engineers, manufacturers, and inventors design materials to have specific properties. Leading up to World War II, this design was done by creating different metallic alloys and by choosing plant and animal products to make fibers. Shortages caused by the outbreak of the war and the diminished access to materials were the impetus for scientists to create new materials. The world of today, dominated by materials made from petroleum products, is a result of the revolution in materials science that started in World War II.

OBJECTIVE

Starting with a reading that asks students to consider the makeup of the built world they live in and to compare it to the past, these resources introduce students to the field of Materials Science. One activity is an experience with an unusual material, that also gives students experience with electricity and circuits. You could supplement this, if you want, with students making and/or testing the properties of other unusual materials, like slime, or oobleck, or bubble solutions. The second activity has students exploring how WWII-era advertisements promoted new technologies and manufacturing, and comparing them to the way science and technology are communicated today.

STANDARDS

NGSS DCI PS1.A
Structure and Properties of Matter

NGSS DCI PS3.A
Definitions of Energy

NGSS DCI ETS2.A
Interdependence of Science, Engineering, and Technology

NGSS DCI ETS2.B
Influence of Engineering, Technology, and Science on Society and the Natural World

NGSS SEP
Developing and Using Models

NGSS SEP
Obtaining, Evaluating, and Communicating Information

NGSS CCC
Patterns

NGSS CCC
Energy and Matter

PERFORMANCE EXPECTATIONS

3-5-ETS1-3
Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

5-PS1-1
Develop a model to describe that matter is made of particles too small to be seen.

5-PS1-3
Make observations and measurements to identify materials based on their properties.

MS-PS1-3
Gather and make sense of information to describe that synthetic materials that come from natural resources and impact society.

READING (1)

1. THE MOTHER OF INVENTION

Description
This short reading introduces the idea of material properties and gets students to think of how things are made and modified to match the needs of a community, population, or country. The reading will set up the activities in this unit. You can try grouping students in pairs or fours to read together or in turns, and to answer the questions.

ACTIVITIES (2)

1. SOFT CIRCUITS

Description
This is an activity that explores the properties of materials, conductivity, and complex circuits. Working in groups, students will be able to answer questions about these concepts through experiments making complex circuits. The worksheet that is included with this activity asks students to draw one of their circuits to demonstrate how electricity flows. Additional activities can consist of having students create parallel and series circuits, and then drawing both circuits on their worksheet.

Supplies (per group)
A tennis-ball sized lump of dough (see recipe below)
2 9V batteries with snap wires
A handful of small LED lights of 3-5V

To make the dough:
Recipe is enough for one class — dough will stay fresh for at least one month when wrapped in plastic.

Ingredients:
- 4 Cups water
- 6 Cups white flour
- 1 Cup table salt
- 3/4 Cup cream of tartar
- 4 Tbsp vegetable oil
- Food coloring

Combine five cups of flour and all other ingredients in a pot. Place the pot on the stove over medium heat and stir continuously. The mixture will begin to boil and start thickening. With the heat still on, keep stirring until the mixture forms a single ball. Remove the mixture from the heat, and place the ball of dough on a lightly floured surface and allow it to cool. Once cool, knead the remaining flour into the dough until it reaches a nice consistency.

The high concentration of salt is what makes the dough conductive. The cream of tartar makes the dough smooth and not so sticky.

Instructions
Demonstrate where everyone can see, under a document camera or at the front of the room, how to construct a simple circuit with the dough. Make two small balls of dough that are close together but not touching. Insert one battery wire in each ball, and then connect one of the lights across the balls. Explain that students might have to rotate the wires across the balls (LED bulbs are polar) before the LED lights up. Students are likely to be very surprised when they see the light go on. Next, show them what happens when the two lumps touch—that the light short circuits and goes out. Go around the room, making sure everyone understands, and ask questions to encourage further exploration. Exploration can include setting up multiple batteries and lights in different types of circuits.

2. ANTIQUE ADS

Description
An activity that uses a modified version of Claim Evidence Reasoning to discuss the relationship between technology, engineering, and society. This activity is a thinking scaffold that has students make a claim, provide evidence to support their claim, and then connect the two with reasoning. Students will work in small groups to analyze WWII advertisements and share and compare their findings with those of the rest of the class.

Supplies
Copies of the handout and reproductions (available from Real World Science site) for each student.

Instructions
Lead students in discussions by having students compare WWII advertisements from *Time* or *Newsweek* to modern technology and other ads they have seen. Use the modified Claim Evidence Reasoning framework to structure their thinking.

ACTIVITY
SOFT CIRCUITS

INTRODUCTION

With the onset of World War II, the United States needed to produce much-needed supplies and equipment fast. However, this rush to become an arsenal of democracy also created shortages in materials. This situation was made worse by interrupted supply chains from other countries. For the first time it became necessary to make polymers synthetically instead of just modifying natural products. During the war, manufacturers rushed to design polymers for specific purposes, but polymers didn't truly become a big industry until the end of the war. Once the process began, however, synthetic polymers dominated industrial manufacturing, and they still do today.

You are going to investigate a material with unusual properties. Follow your teacher's instructions, and use the materials you are given to conduct your investigation.

Rolls of copper signal wire (for telephones) are stacked at a signal camp in Naples, Italy, 1944.
(Image: The National WWII Museum, 2002.337.455.)

NAME: **DATE:**

1. What do you think is unusual about the material you are investigating?

2.What do you think gives it this unusual property?

3. Draw a diagram of one of the circuits you made, and show how electrical energy flows through it:

4. What is a substance on which you would like to experiment? Describe its properties and what need it would fulfill.