

ASPHALT COOKIES

STANDARDS

See summary of National Science Education Standards.

Original: <http://books.nap.edu/readingroom/books/nses/>

Standard concept	General standard	Specific Standard	General standard	Specific Standard
Grade level		K-4		5-8
Science as Inquiry (A)	Abilities to do science...	A.1.4.1	Abilities to do science...	A.1.8.4
		A.1.4.5		
Physical Science (B)	Properties of objects and materials	B.1.4.1	... properties of matter	B.1.8.1
		B.1.4.2		
		B.1.4.3		
Earth and Space Science (D)	Properties of Earth Materials	D.1.4.1		
Science and Technology (E)	Understanding about science and technology	E.2.4.2		
	Natural and human-made objects	E.3.4.1		
		E.3.4.2		
Science in ... social perspective (F)	Types of resources	F.3.4.1		
		F.3.4.2		
	Changes in Environment	F.4.4.1		



		F.4.4.2		
	... technology in local challenges	F.5.4.1	... technology in society	F.5.8.3
		F.5.4.2		



ASPHALT COOKIES

INTRODUCTION

Everyone loves **COOKIES!** When you make these delicious chocolate no-bake cookies you also will learn how asphalt is made and used in paving roads.

When asphalt is heated it changes from a solid to a sticky liquid. Small rocks are mixed into the asphalt. As the mixture cools the asphalt hardens. This asphalt and rock mixture is much stronger than the original solid asphalt and can be used for paving roads.

Like the asphalt, the chocolate you use in this recipe becomes a liquid when heated. As you mix other tasty ingredients into your "chocolate asphalt" you'll observe the cookies harden and become stronger as they cool.

OBJECTIVES

- Students are introduced to basic engineering principles, road construction and material science through this engaging activity.
- Students model asphalt pavement production, a specialty in civil engineering, by making no-bake cookies using cocoa, oats, walnuts, and coconut.
- Students learn how material properties and strength can be affected by temperature and mixing materials.

MATERIALS REQUIRED

- **Cookie Ingredients for 8 Students**
 - 1/3 Cup Cocoa Powder or Carob
 - 1/2 Cup Milk
 - 1/4 Pound Butter (1 Stick = 1/4 Pound)
 - 2 Cups Sugar
 - 8 Tablespoons Chopped Walnuts In A Plastic Bag
 - 8 Tablespoons Flaked Or Shredded Coconut In A Plastic Bag
 - 1 Cup Old Fashion Oats in A Plastic Bag
 - 1 Cup Quick Cooking Oats in A Plastic Bag
- **Supplies for the class:**
 - Medium (2 Quart) Pot
 - Crock Pot or Other Heat Source
 - Extension Cord
 - Large Wooden Spoon
 - Ladle
 - 1/4 Measuring Cup
 - 1/8 Measuring Cup
 - Tablespoon Measure
 - Water and Paper Towels for Clean Up



- **Supplies for Each Student:**
 - Steep Sided Bowls or Large Paper Cup
 - Sturdy Spoons
 - Wax Paper cut into 12" squares
 - 16 oz. Sealed Can or Rolling Pin

SAFETY

- This activity requires a heat source - Adult supervision is suggested;
- Cookie recipe uses nuts and cocoa - For students with allergies to these foods consider substituting raisins and carob powder.

ACTIVITY

PROCEDURE

1. Advance Preparation:
 - Review the [background section](#) of this activity at the end of the activity. Check out the [photo gallery](#) for this lesson by following the link. There are pictures of an asphalt plant, drum mixer, construction materials, asphalt samples and laboratory mixing and testing equipment. Click on any [picture in the gallery](#) for a larger version. Consider printing and using these pictures for a class display to have easy reference to pictures of the process of making real asphalt.
 - Prepare the "chocolate asphalt" in advance. In a medium size pot combine the cocoa powder, milk, butter and sugar. Heat, stirring frequently until the mixture boils for 2 minutes. Pour the mixture into the crock pot set at highest temperature. Yields 2 cups (8 1/4 cup portions). Double or triple as needed. Use this "asphalt" to make the model by adding the "aggregate," as listed below.
2. Directions for students
 1. Use the measuring cup and tablespoon to measure the ingredients below into their mixing bowls or paper cups. These materials model the aggregate of actual asphalt.
 - 1/8 cup old fashion oats
 - 1/8 cup quick oats
 - 1 tablespoon walnuts
 - 1 tablespoon coconut
 2. Compare the edible construction materials to the [pictures of the actual asphalt construction materials](#). (http://www.swe.org/iac/LP/asphalt_gallery.html) List the similarities and differences between the edible and real construction materials. Consider weight, roughness, thickness, overall size, porosity.
 3. As you get your "binder," look at the liquid form of the chocolate asphalt binder in the crock pot. When asphalt binder is heated to 300° F, it is also a liquid. Using the ladle, spoon and measure 1/4 cup chocolate asphalt into the materials mixture.



4. Look at the picture of the drum mixer from the asphalt plant. It tumbles all of the construction materials until they are well coated with the asphalt binder. The tumbler works like a clothes dryer. Mixing the ingredients in the model asphalt in your bowl is a similar process. Stir your model asphalt until all of the materials are well coated. Notice - the mixture cools while you stir it, becomes stiffer and starts to stick together. Asphalt behaves in the same manner.
5. When the materials are thoroughly mixed, pour the mixture into a mound on a square of wax paper. Cover the mound with a second piece of wax paper.
6. In the field, the pavement is spread with a paver and then rolled into a thin mat with a roller. The roller is very heavy and pushes all of the air out of the pavement. This helps make the asphalt very strong. Use a can or rolling pin to roll your cookie mixture 1/4"-1/3" thick. Can you still identify the different materials in the cookies?
7. Place your hand over the top of the cookie. Do you feel the heat? When asphalt pavement is first rolled out it is still very hot. Just like the asphalt, the cookies will harden as they cool. (Do you think that the cookies would be as strong if you use less edible materials? More edible materials?) When the cookies have cooled and hardened (20-30 minutes), you can peel off the wax paper and eat the cookie.

EVALUATION

Suggestions for evaluating activity

- For students 6-8, students define the vocabulary words in terms of the cookies and the related asphalt.
- For students 3-6, students identify the parts of the asphalt that the cookies represent: the cookie mixture, the oatmeal, the walnuts, etc.



TEACHER TIPS

WORDS

These words are used in the information and in the process of making asphalt. Work with the students to develop definitions for the words from the information given here or from other resources.

- aggregate
- asphalt
- binder
- civil engineering
- conveyor
- drum mixer
- liquefy
- manufacturer
- pavement
- plant
- porous
- stockpiles
- transport



BACKGROUND INFORMATION:

A variety of materials, machinery and processes are used in the preparation of road paving materials. While you make the chocolate asphalt cookies you will compare the processes and properties of the edible cookie construction materials with actual construction materials and processes.



Paving materials, like asphalt, are manufactured in a plant. An asphalt plant has many parts. There are areas to store and weigh the construction materials, machinery to make the asphalt and a laboratory to test samples for strength and durability.



Asphalt is a combination of "aggregate" and "binder". Aggregates are textured rocks and sand-like materials. Aggregates come in different sizes and textures: coarse, fine or very fine. Most aggregates come from nature: crushed rock or gravel for coarse aggregates; natural sand or finely crushed rocks for fine aggregates. Very fine aggregates are called "fillers". Common fillers are limestone dust or cement.



Aggregates - Notice the different size and textures of rocks



The rocks and other aggregates are stored in stockpiles (large piles) at the asphalt plant. The stockpiles are located near conveyors. The conveyors look like little roller coasters or monorail systems. There are small bins in the conveyor and the rocks or aggregate are scooped into the bins. The conveyor transports the bins around the asphalt plant where the materials are needed.



Stockpile and Conveyor System

The binder is the material that holds (binds) the mixture together. In the past tar was used. Today a substance called bitumen is used as the binder. When the binder is heated to 300°F, it turns into a liquid. When it cools it turns into a hard solid mass. Rocks or aggregate are added to the binder to make the asphalt stronger.

Engineers select and calculate the correct quantities of each rock size needed to produce a strong asphalt pavement. Calculated percentages of the different sizes of rocks are combined to determine the appropriate blend of rock materials. The mixture of rocks and asphalt binder are then compacted and put through a series of tests which smash, stretch, and freeze the pavement to determine the best blend of rocks to use in a certain climate.



Different measuring techniques are used in the field than in the laboratory. In the field engineers use huge quantities of each rock size and weigh them on scales as large as a garage. In the laboratory, much smaller quantities of each material are needed and ordinary measuring utensils are used.



The drum mixer at the asphalt plant tumbles all of the ingredients until they are well coated with the asphalt binder. The tumbler works like a clothes dryer. Mixing the ingredients in the bowls is a similar process. As the cookie mixture cools while it is being stirred, it becomes stiffer and starts to stick together. Asphalt behaves in the same manner.



In the field, the pavement is spread with the paver and then rolled into a thin mat with a roller. The roller is very heavy and smashes all of the air out of the pavement which helps to make the asphalt very strong. You can still see the different materials in the asphalt. Immediately after pavement is rolled out it is still very hot.

