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Messing With Mixtures

Topic
Separating Mixtures

Key Question
How can the ingredients of a mixture be separated?

Learning Goals
Students will:
1. identify what a mixture is; and
2. explore how filtration, settling, and evaporation can be used to separate a mixture.

Guiding Documents
Project 2061 Benchmarks
- *No matter how parts of an object are assembled, the weight of the whole object made is always the same as the sum of the parts; and when a thing is broken into parts, the parts have the same total weight as the original thing.*
- *Heating and cooling cause changes in the properties of materials. Many kinds of changes occur faster under hotter conditions.*
- *Materials may be composed of parts that are too small to be seen without magnification.*
- *When a new material is made by combining two or more materials, it has properties that are different from the original materials. For that reason, a lot of different materials can be made from a small number of basic kinds of materials.*
- *When liquid water disappears, it turns into a gas (vapor) in the air and can reappear as a liquid when cooled, or as a solid if cooled below the freezing point of water.*

NRC Standard
- *A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample. A mixture of substances often can be separated into the original substances using one or more of the characteristic properties.*

*NCTM Standards 2000**
- *Solve problems that arise in mathematics and in other contexts*
- *Understand such attributes as length, area, weight, volume, and size of angle and select the appropriate type of unit for measuring each attribute*

Math
Measurement
mass

Science
Physical science
chemistry
mixtures

Integrated Processes
Observing
Predicting
Collecting and recording data
Comparing and contrasting
Applying

Materials
For each group of students:
2 plastic cups, 8 oz.
small strainer (fine mesh)
balance
masses

For the class:
1 cup plaster of paris
1 cup sugar
1 cup wood shavings or sawdust
4 cups water
medium-sized bucket
large stirring spoon
newspapers
saucepan with lid, optional
hot plate, optional

Background Information
Most of the substances we know are made of different combinations of elements. If they are formed with a definite, set proportion of substances that are strongly linked chemically, they are called *compounds*. Water is an example of a compound; so is table salt. If the ingredients are mixed (often with variable proportions) and not bonded chemically, the combination is called a *mixture*. Powdered drink mix, salad dressing mix, and playground dirt are familiar examples of mixtures.

Pure substances can consist of combinations of both elements and compounds. In this activity students will use plaster of paris, a substance that comes from a rock called gypsum. Gypsum is composed of

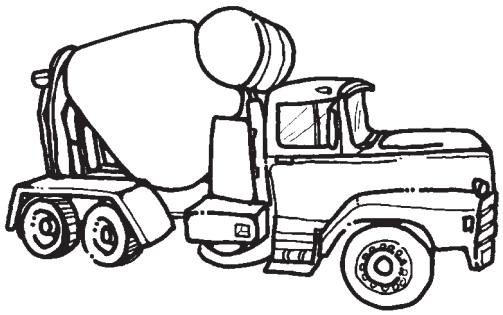
calcium sulfate, a compound of calcium, sulfur and oxygen, and water. Two of the other substances used in this activity, water and sugar, are also compounds. The fourth ingredient, sawdust (or wood shavings), is a mixture.

Mixtures usually can be separated into their original ingredients. For example, unclean water is a mixture of water and other things such as mud and pollutants. Certain tools and technology enable us to make unclean water usable again. Among the common methods used are:

- *filtration* (straining the material through some kind of screen to remove the larger particles),
- *settling* (allowing the more dense materials to sink to the bottom so the less dense material can be separated from it),
- *evaporation* (changing the liquid to a vapor which then escapes into the atmosphere), and
- *distillation* (the heating of a liquid to a vapor, but this time the vapor is caught and condensed to liquid form again).
- In this activity, the students will experience some of these methods used to separate mixtures.

Management

1. This activity will take two class periods (one long, one short) plus observation over a week or more.
2. The proportions listed will make 10-12 portions of mixture. If you need more, double the recipe.
3. Caution the students not to taste the mixture or pour it down the sink. Appropriate disposal of these materials is to contain them and place them in the dumpster.
4. After mixing the ingredients in the bucket, keep stirring right up to the moment you pour them into individual cups; otherwise much of the plaster will sink to the bottom of the bucket and not be included in the student portions.
5. Do not show or give the students tools such as the strainers until such time as they determine they are needed.
6. Designate a place where the cups of mixture can be left without being in danger of getting knocked over. A warm place such as a sunny windowsill will help speed up the process of evaporation.



7. If you have an insect problem in your classroom, you will need to protect the cups of sugar water. Placing the cups in a pan with a few inches of water will help discourage ants and other crawling insects. Net or screen over the top of the cups will help keep out flies.

Procedure

(The following is offered for those students who are ready for more independent work.)

> *Open-ended:*
> Give students with experience in working with mixtures a sample of this mixture and ask them to come up with their own solution to the problem of separating it into its original ingredients. Direct them to carry out their plan, recording and analyzing their processes and results as they go.

Guided Instruction

Day One

1. Tell the class that you are going to create a very interesting and messy mixture. With the class watching and participating, spread out newspapers and put out a large container or bucket. Dump in the plaster of paris and slowly add water so as not to create a cloud of plaster dust that may get in your eyes. Stir well until both ingredients are mixed. Add the sawdust and stir again. Finally, add the sugar and keep stirring. Caution the students not to try to taste the mixture because the plaster and sawdust are indigestible.
2. Distribute a cup of the mixture (and a folded section of newspaper to put under it) to each group of students. Keep stirring between servings to be sure that none of the mixture settles.
3. Have each group of students find the mass of both the cup of mixture and the empty cup and record.
4. Ask the students to think of ways to separate the ingredients of their mixture to get back the four original substances. Have them brainstorm the ideas and make a list. If necessary, guide the discussion to the observation that one of the ingredients (sawdust) is floating and thus may be easier to remove. Ask the students for suggestions as to how to remove the sawdust and list different ideas.
5. Explain to the students that one way used in industry to separate mixtures is called *filtration*. Some may connect this idea to filters they have seen used in coffeepots or vacuum cleaners. Give each group a strainer and a second cup and have them filter out the sawdust by pouring the contents through the strainer into the empty cup. They may need to pour the contents of the cup back and

forth several times to remove as much sawdust as possible. Have the students drain the soggy sawdust into the cup of mixture. Tell them to put the sawdust into the other cup, find its mass, and record. Have them set the sawdust aside on the newspaper and save.

6. Ask the students to identify the ingredients that are left in the cup and discuss how they could be further separated. Record all the suggestions. Encourage them to keep thinking about this problem until the next day. Tell each group to leave the cup and sawdust pile on the newspaper in a designated place where they will not be disturbed. Direct them to tidy their areas and to rinse the extra cup for later use. Be very careful not to let anyone pour any of the mixture in the sink.

Day Two

1. Before the students bring their cups and newspaper to their desks, ask if they have had any more ideas about how to separate the remaining ingredients. List any new ideas.
2. Have the students bring the mixture cups back to their desks **very carefully**. Tell them not to stir it and to try not to disturb the contents any more than necessary. The students should notice that the plaster of paris has settled to the bottom. This will make it possible for them to pour off the sugar/water into the second cup and leave the plaster in the bottom of the first cup. This process is called *settling* and is also used in industry to get rid of some of the denser, undesirable materials.
3. When the students have poured off the sugar water, have them find the mass of the cup with the plaster in it, record, and set it aside. Direct them to observe the sugar water. Again, ask for ideas as to how these remaining ingredients could be separated from each other. Make a list of the suggestions and discuss how they might be carried out.
4. The last stage of separation involves either *evaporation* or *distillation*. Both of these processes involve turning the water to vapor and leaving the sugar behind.

   Evaporation: Have the students put their cups in a safe place, preferably warm, and check on them every day until the evaporation process is complete (the water vapor has escaped to the atmosphere) and only a sugar residue is left. This can take anywhere from a few days to a few weeks depending on how much liquid is in the cup and how warm the surrounding temperature is.

   Distillation: Heat the sugar water mixture in a saucepan over a hot plate. Trap some of the escaping water vapor in the lid of the saucepan, let it cool and condense, and pour it off the lid into a cup to show the water to the children. If you do not use a lid, you are merely speeding up the process of evaporation. In either case, you will end up with sugar residue in the pan. Be careful not to burn it!
5. When the water has evaporated, have the students examine the residue in the cup. Have them find the mass of the cup of sugar, record, and put it with the plaster and sawdust.
6. Have the students look at the pile of sawdust, the cup of plaster, and the cup of sugar residue and review the various separation processes they used. Ask them if the mass of the mixture's components totals the mass they found at the beginning of the activity. Discuss the differences. Challenge them to determine how much water in the original mixture has now evaporated.

Connecting Learning

Day One

1. What do you observe about this mixture? How do you know that it is a mixture and not a compound?
2. What different ways can you think of to separate this mixture back into its original ingredients? Which idea do you think will work the best? Why do you think so?
3. What tools can you think of that might help you and your team separate out the original ingredients?
4. If you were to remove the sawdust again, what would you do to make it easier?
5. How have you seen filtration used in real life? Explain.

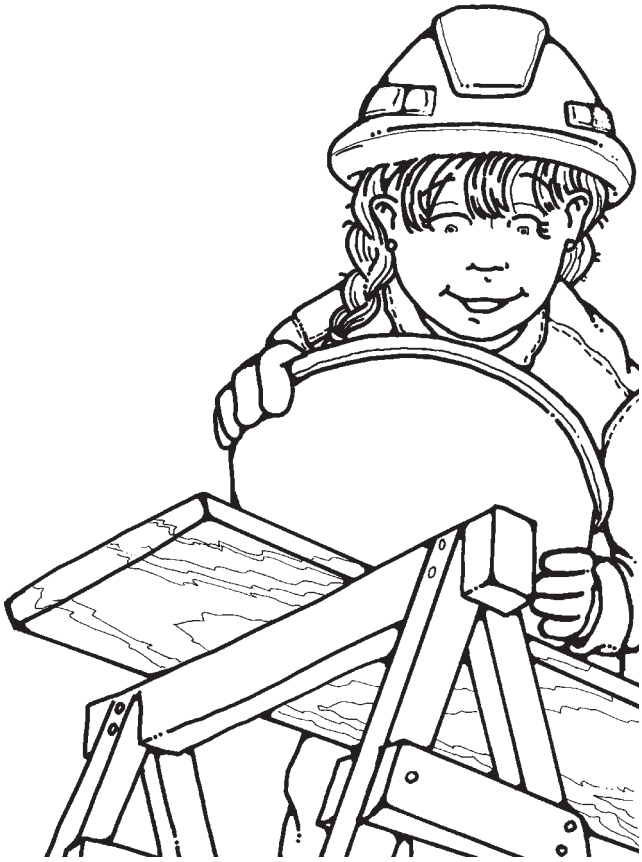
Day Two

1. What do you notice about the plaster after the mixture sat for awhile? Why do you think this has happened? How did it make it easier to separate out the plaster? What is this process called?
2. What other situations have you ever noticed where settling has occurred?
3. Think of different ways that could be used to separate the sugar from the water. Which way seems to be the best one to you? Why?
4. What do you think could be done to speed up the evaporation process?
5. How did you determine how much water had evaporated? Explain your thinking process.
6. What was the most difficult part of separating the whole mixture? What could be done to make it easier?
7. Looking back at what you have experienced, how would you separate this mixture in a different way another time? Think about and explain ways that might make it work faster, or easier, or separate out the ingredients more completely.
8. What are some real-world situations in which mixtures of substances need to be separated? How

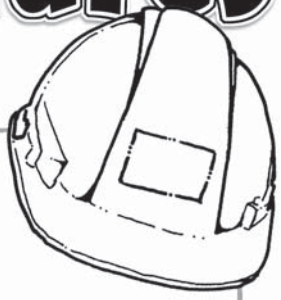
are filtration, settling, evaporation, or distillation used in these situations? (Think about home, school, the cafeteria, business, factories, the environment….) What modern technology do you know about that is used to make separation of mixtures more efficient?

Evidence of Learning

Ask the students to explain how they would separate a mixture of salt, sand, water, and beans. Have them respond in their science logs using pictures and words.



Messing with Mixtures



Key Question

How can the ingredients of a mixture be separated?

LEARNING GOALS

STUDENTS WILL:

1. identify what a mixture is; and
2. explore how filtration, settling, and evaporation can be used to separate a mixture.

Messing with Mixtures

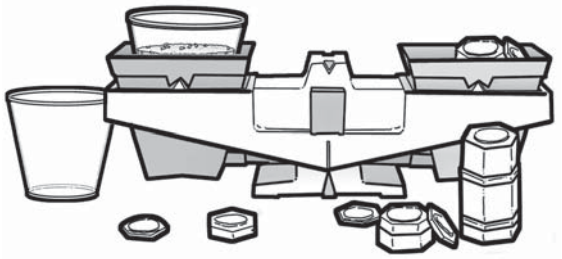
Day 1

Find the mass of: mixture and cup _____

− empty cup _____

_____

mixture _____

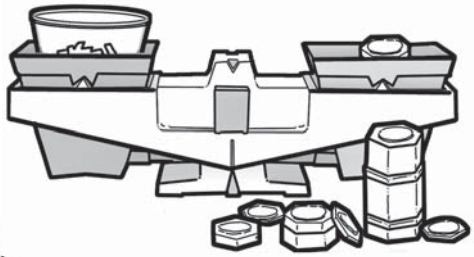


Find the mass of: sawdust and cup _____

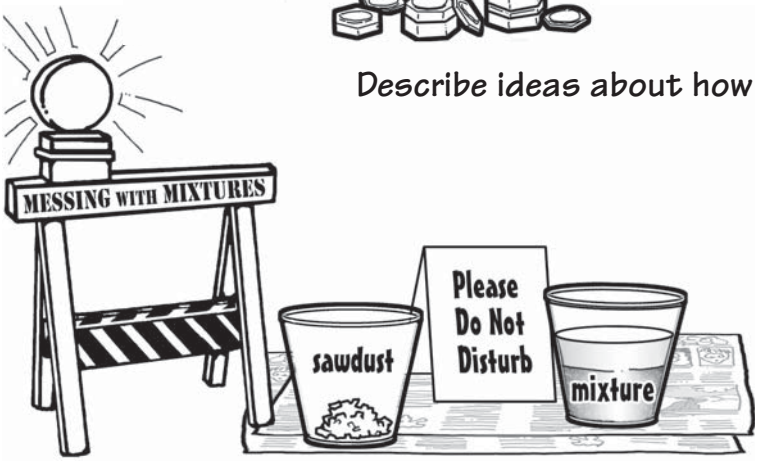
− empty cup _____

_____

sawdust _____

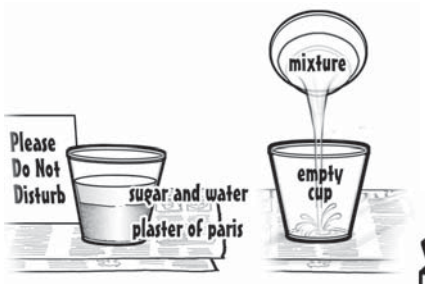


Describe ideas about how to separate the remaining ingredients.



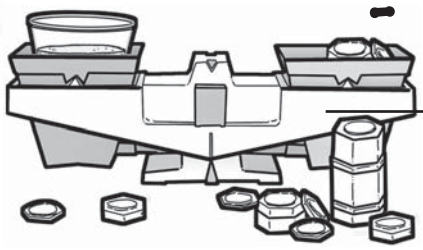
Messing with Mixtures

Day 2



Find the mass of:

plaster of paris and cup _____



− empty cup _____

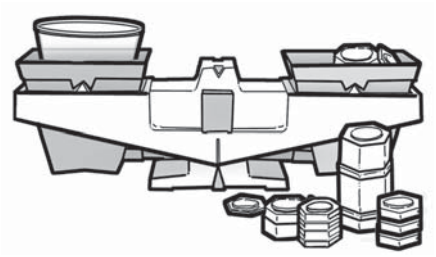
plaster of paris _____

Describe ideas about how to separate the remaining ingredients.

How long do you think it is going to take for the water to evaporate?

What do you think is going to be left in the cup after the water is gone?

Find the mass of:



sugar and cup _____

− empty cup _____

sugar _____

plaster of paris _____

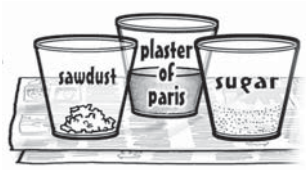
sawdust _____

water _____

\+ sugar _____

total _____

Does the total mass of the component mixtures equal the mass you had at the beginning of the activity? Explain.



Connecting Learning

Day One

1. What do you observe about this mixture? How do you know that it is a mixture and not a compound?
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3. What tools can you think of that might help you and your team separate out the original ingredients?
4. If you were to remove the sawdust again, what would you do to make it easier?
5. How have you seen filtration used in real life? Explain.

Day Two

1. What do you notice about the plaster after the mixture sat for awhile? Why do you think this has happened? How did it make it easier to separate out the plaster? What is this process called?
2. What other situations have you noticed where settling has occurred?
3. Think of different ways that could be used to separate the sugar from the water. Which way seems to be the best one to you? Why?

Connecting Learning

4. What could be done to speed up the evaporation process?

5. How did you determine how much water had evaporated? Explain.

6. What was the most difficult part of separating the whole mixture? What could be done to make it easier?

7. Looking back at what you have experienced, how would you separate this mixture in a different way another time? Think about and explain ways that might make it work faster, or easier, or separate out the ingredients more completely.

8. What are some real-world situations in which mixtures of substances need to be separated? How is filtration, settling, evaporation, or distillation used in these situations? (Think about home, school, the cafeteria, business, factories, the environment….) What modern technology do you know about that is used to make separation of mixtures more efficient?

9. What are you wondering now?

