Putting the World in a Box

OBJECTIVES

- The student will construct models of the particulate level in chemistry and describe the models' limitations.
- The student will use particulate level models to explain the behavior of solids, liquids and gases.
- The student will use particulate level models to describe elements, compounds, and mixtures.
- The student will use definitions of "Solid, Liquid, or Gas" and "Element, Compound, or Mixture" to classify matter based on particulate level information.
- The student will use a particulate model to explain the relationships that exist between "Solid, Liquid, or Gas" and "Element, Compound, or Mixture"

PROBLEM / QUESTION

How can we organize the vast & diverse matter all around us? How can we understand the world from a particle viewpoint?

PRIOR KNOWLEDGE

You will need to use your understanding of "Solids, Liquids, and Gases" and "Elements, Compounds, and Mixtures." You will also use your current understanding of matter at the particulate level.

MATERIALS

Bins of miscellaneous objects (provided by instructor during the activity)

BACKGROUND INFORMATION

Scientists find classification (making groups based on observations) helpful in describing & understanding the world around us. For a classification method to work well at least two criteria are helpful, groups should be: (1) understandable by others, (2) useful for a large numbers of objects. For example, explain how a person might group the animals at the zoo. Explain how that grouping fits the two criteria.

BACKGROUND INFORMATION: DISCUSSION

As you listen to other teams record their classification & comments as to how well these classifications work.

SOLID, LIQUID, GAS PROCEDURE

Scientists have found the categories of "Solid, Liquid, & Gas" to be useful for all matter. Why do these categories work well at categorizing all matter?

As a team, define the categories of Solid, Liquid & Gas. Can all matter be put into these categories? What might be some objects that are challenging to classify? Why are those objects difficult to classify as a solid, liquid, or gas?

Chemists think of matter in terms of what they can observe with their senses, just like you have been doing. They also think about matter on the particulate level. Atoms are too small to see with your eyes or even a microscope, but chemists have evidence that the motion and arrangement of atoms are a big part of why you observe what you do.

Imagine you are "zooming in" closer and closer to an object until you could see the individual particles. As a team of 2 or 3, use the objects in the bin your instructor gives you to create an idea of how the particles of a solid, liquid and gas might be different from each other. As you work, think and write below any observable characteristics of solids, liquids, and gases would your arrangement help explain. Be prepared to explain your arrangement to another team.

SOLID, LIQUID, GAS DISCUSSION

What are some observable characteristics of a solid? liquid? gas? What is a good definition of Solid, Liquid, & Gas? Is it based on macroscopic or particle level descriptions? Use it to classify some challenging substances.

Which arrangements might best explain the characteristics? Why? How could these arrangements be drawn rather than using objects?

The arrangements that were made are "models." What do you think of when you think about models?

Explain why a globe or map would be considered a model.

How would you define "model?"

How does the representation of the particles of a solid, liquid, & gas fit the definition of a model?

All models have limitations (something about them that isn't really like what they are modeling.) What are the limitations of your model of solid, liquid, & gas particles?

ELEMENT, COMPOUND, MIXTURE PROCEDURE

Now that you have some experience categorizing objects and representing their particles, let's go a step farther…

Chemists further classify matter using the 3 categories of "Element, Compound, and Mixture." Without using any resources except your team members, describe the difference between these three and what might be some common examples of each.

Use the research resources provided by your instructor to get additional ideas and examples. Revise your previous work as necessary.

Share your ideas & examples with another team. Change and add to your answers based on your discussion. Prepare some sentences and several examples that can be shared with the class to explain what is meant by Element, Compound, and Mixture. Write them below: NOTE: These should not be definitions that you are quoting from your research.

Share with the class your group's thoughts and listen to the other groups. Record any new ideas or questions by your team's response above.

In teams of 3 or 4, use the bin of objects your instructor provides to prepare particle models of representing these 3 categories: Element, Compound, Mixture.

When your instructor indicates, look at the other team's models and read their descriptions. Record observations below – similarities or differences to your own model, a clever idea, perhaps an idea that you think might be incorrect, or just questions that come to mind.

ELEMENT, COMPOUND, MIXTURE DISCUSSION

The other models are probably different than yours, yet that doesn't mean they are "wrong."

What does your team think are the critical aspects for a model of the particles of an:
Element?

Compound?

Mixture?

How could these be drawn rather than using objects?

Look at the models your instructor shows. How do they show the critical aspects of Element, Compound, & Mixture? What are their limitations?

Can all matter fit into these 3 categories? Explain.

ELEMENT, COMPOUND, MIXTURE RELATIONSHIPS PROCEDURE

While Elements, Compounds, and Mixtures have separate meanings, they are related to each other. Make a model of Elements, Compounds, and Mixtures using the same types of items from the bin. For example, if you used nuts and bolts, there would be nuts and bolts in your representations of Elements, Compounds, and Mixtures.

Share your model with another team.

Draw a diagram below of how you think the terms might relate. Be prepared to share with the class.

ELEMENT, COMPOUND, MIXTURE RELATIONSHIPS DISCUSSION

Your instructor will use your class responses to help you understand the relationships. Adjust your diagram, if necessary.

CONNECTING SOLIDS, LIQUIDS, AND GASES TO ELEMENTS, COMPOUNDS PROCEDURE

We know that matter can change from one of the three phases to another. What are the names for each of these changes?

Draw particle pictures of an element going from solid to liquid to gas.

SOLID LIQUID GAS

Draw particle pictures of a compound going from solid to liquid to gas.

SOLID LIQUID GAS

CONNECTING SOLIDS, LIQUIDS, AND GASES TO ELEMENTS, COMPOUNDS DISCUSSION

Compare your answers in the previous section to someone else. How are they similar? How are they different?

How are your ideas different than those that your instructor presents?

USING YOUR KNOWLEDGE

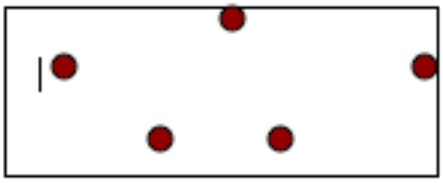
Your instructor has set up several models. For each, determine if you think it represents a Solid, Liquid or Gas. Also determine if each model represents an Element, Compound, or Mixture. Explain your reasoning for your responses.

GOING FURTHER

1. Label each of the following pictures as Solid, Liquid, or Gas. Explain your choice.

2. Label each of the following pictures as Element, Compound, or Mixture of Elements, Mixture of Compounds, or Mixture of Elements & Compounds. Explain your choice.

A



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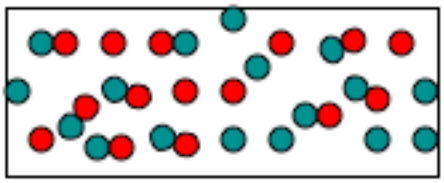

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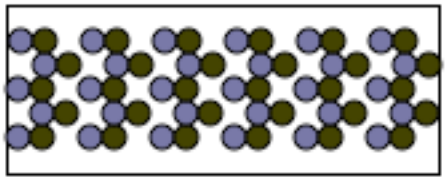

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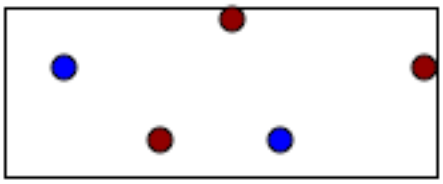

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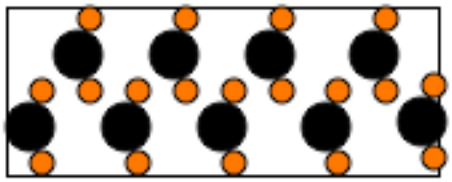

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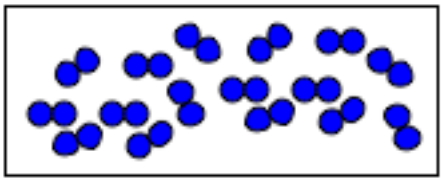

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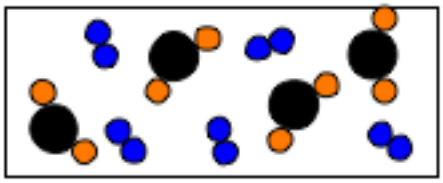
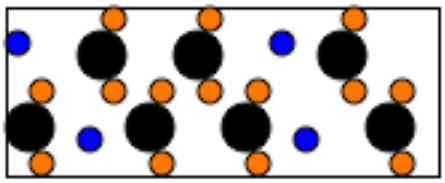


I



3. Choose 4 substances from the list below.
    - Classify each as "Solid, Liquid, or Gas" at room temperature (22^0C)
    - Classify each as "Element, Compound, or Mixture."
    - Draw a particle picture of each. Explain your drawing.

   You should be prepared to do some research, if needed.

   Copper pipe
   Air
   Methane
   Water
   Aluminum foil
   Bronze medallion
   Carbon dioxide
   Helium (like what is sometimes in a balloon)
   Table salt