

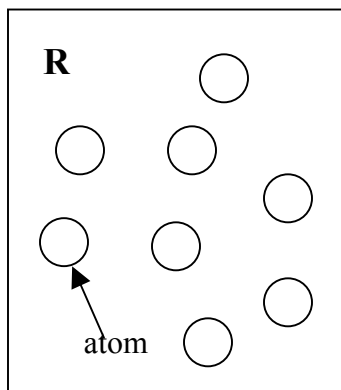
Classification of Matter

How do atoms combine to make different types of matter?

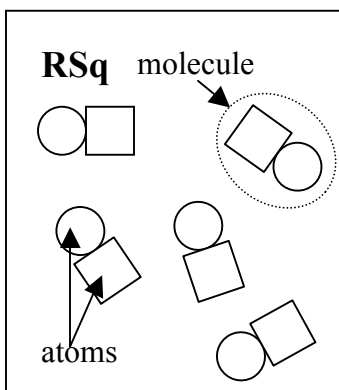
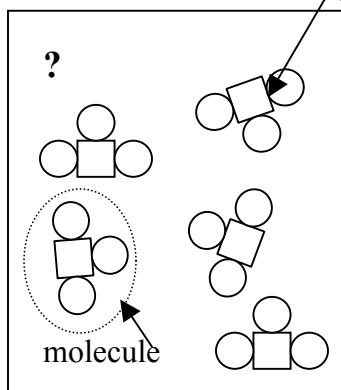
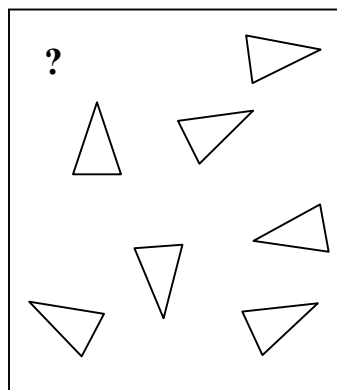
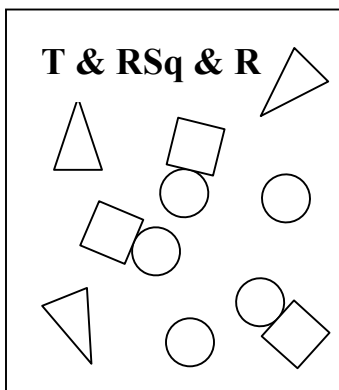
Why?

Look at the things in this room. They are all matter. That matter may be pure or it may be a mixture. Can you tell by looking at it? What if you looked at it under a microscope? Then could you tell? Something that looks pure may not really be pure. It depends on what type of particles that thing is made of. In this activity we will explore how the smallest chemical units of matter determine whether something is classified as an element, a compound, or a mixture.

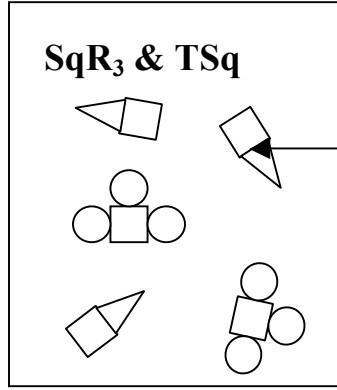
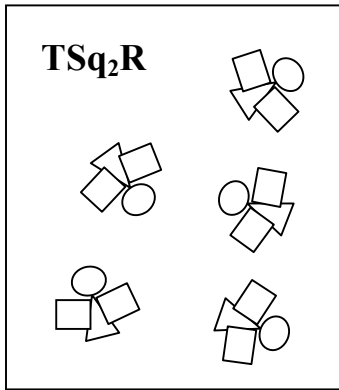
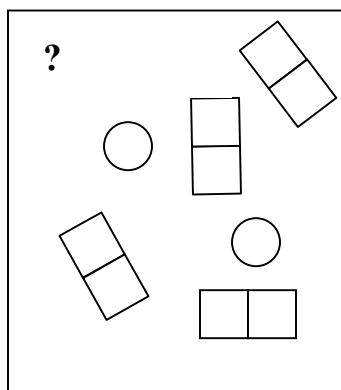
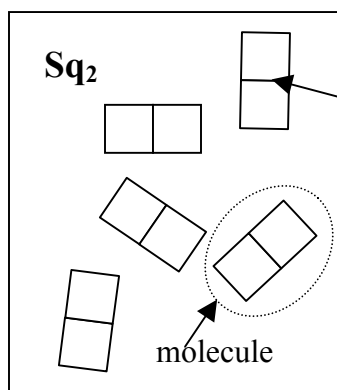
Model 1



8 particles



5 particles



5 particles

1. Circle a molecule of RSq in Model 1. How many atoms are in a molecule of RSq?


2. Circle a molecule of TSq₂R in Model 1.
 - a) How many different types of atoms are found in a molecule of TSq₂R?

 - b) How many Sq atoms are in a molecule of TSq₂R?

3. a) How many different types of atoms are found in a sample of SqR₃ & TSq?
 - b) How many different types of molecules are found in a sample of SqR₃ & TSq?

4. When two atoms are touching in the drawings of Model 1, what is holding the atoms together?

5. a) Can a *particle* be a single atom?
 - b) Can a *particle* be a molecule?
 - c) How many particles are in the drawing representing T & RSq & R in Model 1?
 - d) As a group, agree on a definition of the word “particle”, as it is used in chemistry.

-  6. Compare the codes listed at the top of each drawing in Model 1 with the shapes in that box.
 - a) What do the letters R, Sq and T in the codes represent?

 - b) What do the small numbers (subscripts) in the codes represent?

 - c) When atoms are touching, how is that communicated in the code?

 - d) When atoms or molecules are not touching, how is that communicated in the code?

 - e) In Model 1 there are three drawings that are labeled “?”. Write codes to properly label these drawings.



7. The manager should appoint one group member to cut apart Model 1 to separate the nine drawings. As a team, sort the pictures into those where all the particles in the drawing are identical, and those that have more than one type of particle in the drawing.

Read This!

Matter is classified as a **pure substance** when all of the particles are the identical. Matter is classified as a **mixture** if there are different types of particles present.



8. Identify which set of drawings from #7 are pure substances and which set are mixtures. List the codes for each set here.

Pure Substances		Mixtures
_____	_____	_____
_____	_____	_____
_____	_____	_____

9. How are the codes (chemical formulas) for pure substances different from those for mixtures?

10. As a team, take the set of pure substances drawings from #8 and sort them into those containing only one type of atom and those with two or more types of atoms.

Read This!

Elements are defined as pure substances made from only one type of atom. **Compounds** are defined as pure substances made from two or more types of atoms.



11. Identify which set of drawings from #10 are elements and which set are compounds. List the codes for each set here.

Elements	Compounds
_____	_____
_____	_____
_____	_____

12. How are the codes (chemical formulas) for elements different from those for compounds?

13. Use what you have just learned about chemical formulas to identify the following as element, compound or mixture.

- | | | |
|--------------------|-----------------------|---|
| a. Br ₂ | b. NaHCO ₃ | c. C ₆ H ₁₂ O ₆ & H ₂ O |
| d. Cu & Zn | e. CO ₂ | f. Al |



Extension Questions

14. Often times it is useful to separate matter. (Examples: straining cooked pasta to get the liquid out, using a fuel cell to separate water into hydrogen and oxygen)

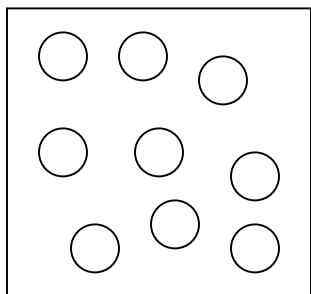
a) Physical methods of separation (filtering, distillation) do not require a chemical change. In other words, no chemical bonds are broken or formed during the separation. Which type(s) of matter (mixtures/compounds/elements) could be separated by physical methods?

b) Chemical methods of separation (decomposition, electrolysis) require a chemical change. In other words, chemical bonds are broken and/or formed during the separation. Which type(s) of matter (mixtures/compounds/elements) would need to be separated by chemical methods?

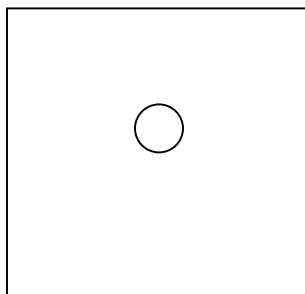
15. Students in a chemistry course were asked the following question on a unit exam:

“Draw a diagram representing an element using circles as atoms.”

a) The following diagrams represent the two types of answers given by students. Which drawing is the best representation of an element? Explain.



Drawing A



Drawing B

b) Imagine that the atom in Drawing B had been removed by physical separation from one of the substances in Model 1. What substances could have been the source of the atom in Drawing B? Is Drawing B a good representation of any of those substances?

Teacher Resources

Learning Objectives:

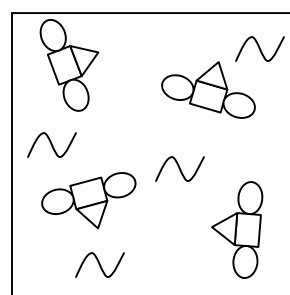
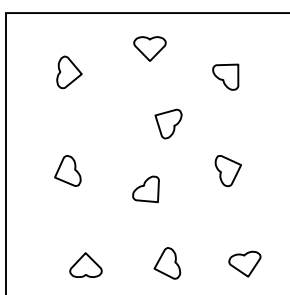
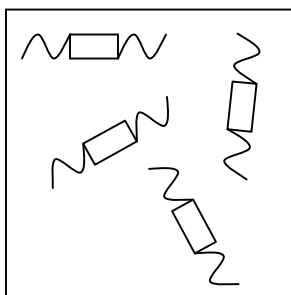
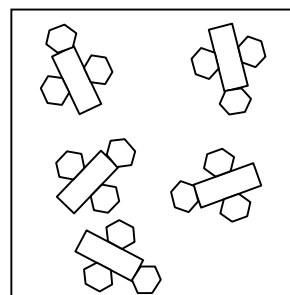
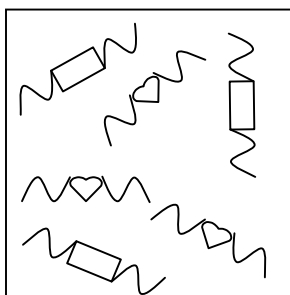
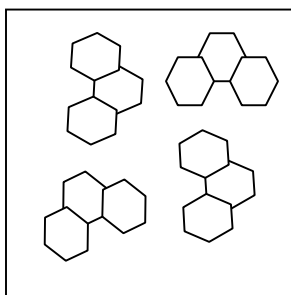
1. Students will be able to read chemical formulas for elements and compounds, determining the numbers of atoms in a molecule.
2. Students will be able to classify matter as a pure substance or a mixture based on molecular representations, or chemical formulas.
3. Students will be able to classify pure substances as elements or compounds based on molecular representations, or chemical formulas.

Prerequisites:

1. Students must know that atoms are held together by bonds which do not easily break.
2. Students must know that matter has mass and takes up space.

Assessment Questions:

1. Identify each of the drawings below as an element, a compound or a mixture.



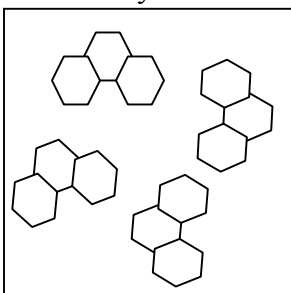
2. Identify each of the common items below as an element, a compound or a mixture. Their chemical formulas have been given to help you out.

- | | |
|---|--|
| a) Sugar ($C_6H_{12}O_6$) | g) Gold (Au) |
| b) Phosphorous (P_4) | h) Granite (SiO_2 & $KAlSi_3O_8$ & $K_3Si_3O_{10}$...) |
| c) Battery Acid (H_2SO_4) | i) Drain Cleaner (Al & NaOH & ...) |
| d) Air (N_2 & O_2 & Ar & CO_2 ...) | j) Sodium (Na) |
| e) Oxygen (O_2) | k) Water (H_2O) |
| f) Milk ($C_6H_{12}O_6$ & H_2O & $C_{50}H_{102}O_3$...) | l) Salt Water (NaCl & H_2O) |

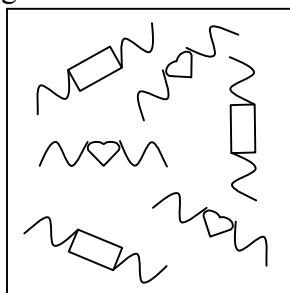
3. Which of the following is **NOT** a true statement?
- Two or more atoms held together with bonds make up a molecule.
 - Pure substances are made of only one type of atom.
 - At least two types of atoms are required to make a compound.
 - Mixtures can be made of two elements, two compounds or an element & a compound.

Assessment Questions (Target Responses):

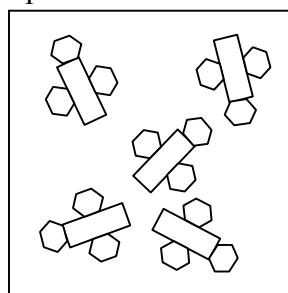
1. Identify each of the drawings below as an element, a compound or a mixture.



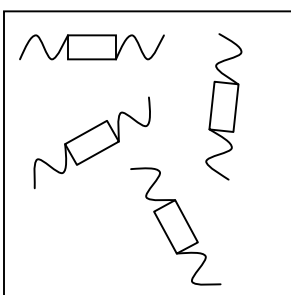
Element



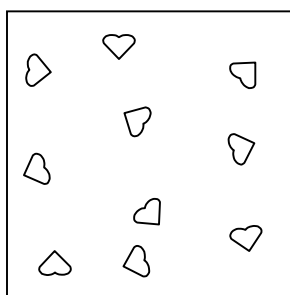
Mixture



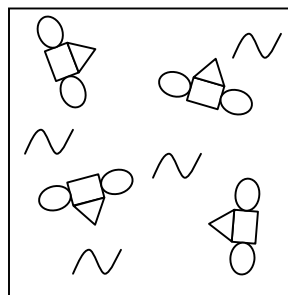
Compound



Compound



Element



Mixture

2. Identify each of the common items below as an element, a compound or a mixture. Their chemical formulas have been given to help you out.

- | | | | |
|---|-----------------|--|-----------------|
| a) Sugar ($C_6H_{12}O_6$) | <i>Compound</i> | g) Gold (Au) | <i>Element</i> |
| b) Phosphorous (P_4) | <i>Element</i> | h) Granite (SiO_2 & $KAlSi_3O_8$...) | <i>Mixture</i> |
| c) Battery Acid (H_2SO_4) | <i>Compound</i> | i) Drain Cleaner (Al & NaOH & ...) | <i>Mixture</i> |
| d) Air (N_2 & O_2 & Ar & CO_2 ...) | <i>Mixture</i> | j) Sodium (Na) | <i>Element</i> |
| e) Oxygen (O_2) | <i>Element</i> | k) Water (H_2O) | <i>Compound</i> |
| f) Milk ($C_6H_{12}O_6$ & H_2O ...) | <i>Mixture</i> | l) Salt Water (NaCl & H_2O) | <i>Mixture</i> |

3. Which of the following statements is **FALSE**?
- Two or more atoms held together with bonds make up a molecule.
 - Pure substances are made of only one type of atom.***
 - At least two types of atoms are required to make a compound.
 - Mixtures can be made of two elements, two compounds or an element & a compound.

Teacher Tips

- In this activity the students will be asked to cut apart the first page so that the pictures can be sorted. It is helpful to have an extra copy of this page for each group that can be cut apart. This allows students to keep their activity intact, with the diagrams. At the very least, the first page should be copied one-sided only.
- Three-dimensional models work great with this activity as well. Petri dishes with “atoms and molecules” made from beads, buttons or other objects are easy for students to sort, and can be stored for use next year.
- Question #15 in the activity addresses the difference between bulk matter and particulate matter. The terms element, compound and mixture refer to bulk samples, while the terms atom and molecule refer to the particulate level. Many students have the misconception that atom = element and molecule = compound.

Materials:

- Each group of students will need a pair of scissors and an extra copy of the first page to cut apart.

Target Responses:

1. Circle a molecule of RSq in Model 1. How many atoms are in a molecule of RSq? *two*
2. Circle a molecule of TSq₂R in Model 1.
 - a) How many different types of atoms are found in a molecule of TSq₂R? *three*
 - b) How many Sq atoms are in a molecule of TSq₂R? *two*
3. a) How many different types of atoms are found in a sample of SqR₃ & TSq? *three*
 - b) How many different types of molecules are found in a sample of SqR₃ & TSq? *two*
4. When two atoms are touching in the drawings of Model 1, what is holding the atoms together?
bonds
5. a) Can a *particle* be a single atom? *yes*
 - b) Can a *particle* be a molecule? *yes*
 - c) How many particles are in the drawing representing T & RSq & R in Model 1? *eight*
 - d) As a group, agree on a definition of the word “particle”, as it is used in chemistry.
A particle is a single atom or group of atoms that are bonded together which function as one unit. (Answers may vary)
6. Compare the codes listed at the top of each drawing in Model 1 with the shapes in that box.
 - a) What do the letters R, Sq and T in the codes represent?
R = round Sq = square T = triangle

b) What do the small numbers (subscripts) in the codes represent?

The number of atoms of that type in a molecule.

c) When atoms are touching, how is that communicated in the code?

They are all listed in one code together.

d) When atoms or molecules are not touching, how is that communicated in the code?

An “&” symbol separates the codes.

e) In Model 1 there are three drawings that are labeled “?”. Write codes to properly label these drawings.

T SqR_3 $Sq_2 \& R$

7./8. Identify which set of drawings from #7 are pure substances and which set are mixtures. List the codes for each set here.

Pure Substances

R T
 SqR_3 RSq
 Sq_2 TSq_2R

Mixtures

$T \& RSq \& R$
 $Sq_2 \& R$
 $SqR_3 \& TSq$

9. How are the codes (chemical formulas) for pure substances different from those for mixtures?

All mixture codes include an “&” symbol.

10./11. Identify which set of drawings from #10 are elements and which set are compounds. List the codes for each set here.

Elements

R
 T
 Sq_2

Compounds

SqR_3
 RSq
 TSq_2R

12. How are the codes (chemical formulas) for elements different from those for compounds?

Elements only have one capital letter while compounds have at least two capital letters in their codes.

13. Use what you have just learned about chemical formulas to identify the following as element, compound or mixture.

a. Br_2 *element*

b. $NaHCO_3$ *compound*

c. $C_6H_{12}O_6$ & H_2O *mixture*

d. Cu & Zn *mixture*

e. CO_2 *compound*

f. Al *element*

14. Often times it is useful to separate matter. For example, you strain cooked pasta to get the liquid out. In a fuel cell, water is separated into hydrogen and oxygen.

a) Physical methods of separation (filtering, distillation) do not require a chemical change. In other words, no chemical bonds are broken or formed during the separation. Which type(s) of matter (mixtures/compounds/elements) could be separated by physical methods?

Mixtures

b) Chemical methods of separation (decomposition, electrolysis) require a chemical change. In other words, chemical bonds are broken and/or formed during the separation. Which type(s) of matter (mixtures/compounds/elements) would need to be separated by chemical methods?

Compounds

15. Students in a chemistry course were asked the following question on a unit exam:

“Draw a diagram representing an element using circles as atoms.”

a) The following diagrams represent the two types of answers given by students. Which drawing is the best representation of an element? Explain.

Drawing A is a better representation because it shows several particles that are all identical, making it a pure substance. A single atom could be a very small sample of a mixture. You can't be sure without seeing the other molecules it is with.

b) Imagine that the atom in Drawing B had been removed by physical separation from one of the substances in Model 1. What substances could have been the source of the atom in Drawing B? Is Drawing B a good representation of any of those substances?

Drawing B could represent R, Sq₂ & R or T & RSq & R. Drawing B is not a good representation of any of them because the surrounding particles are not represented.