Classification of Matter (Topic 4)

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.

Learning Objectives:
- Read chemical formulas for elements and compounds, determining the numbers of atoms in a molecule.
- Classify matter as a pure substance or a mixture based on particle diagrams or chemical formulas.
- Classify pure substances as elements or compounds based on particle diagrams or chemical formulas.

SUCCESS will be Measured by YOUR Ability to:
- Identify an element, compound, or mixture based on a particle diagram.
- Identify an element, compound, or mixture based on a chemical formula.
- Determine which characteristics belong to pure substances (elements & compounds) and mixtures.

Prerequisites:
- Matter has mass and takes up space.
- Atoms are held together by bonds in a molecule.
Model 1:

- **R**
  - atom
  - 8 particles

- **T & RSq & R**
  - molecule
  - atoms
  - 5 particles

- **SqR_3**
  - 2D structure
  - molecule

- **RSq**
  - 2D structure
  - atoms

- **Sq_2**
  - 2D structure
  - molecule

- **R & Sq_2**

- **TSq_2R**
  - 2D structure

- **SqR_3 & TSq**
  - 2D structure
  - 5 particles
**Key Questions:**

1. Circle a molecule of RSq in Model 1. How many atoms are in a molecule of RSq? 2

2. Circle a molecule of TSq₂R in Model 1.  
   a) How many different types of atoms are found in a molecule of TSq₂R? 3  
   b) How many Sq atoms are in a molecule of TSq₂R? 2

3. a) How many different types of atoms are found in a sample of SqR₃ & TSq? 3  
   b) How many different types of molecules are found in a sample of SqR₃ & TSq? 2

4. a) What does is mean when two atoms are touching in the drawing of Model 1?  
   **The atoms are chemically bonded into a molecule (compound).**  
   b) What does it mean when two atoms or molecules are not touching in the drawings of Model 1?  
   **The atoms or molecules are a mixture and are not chemically combined.**

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? 8

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?  
   **They represent different elements. R = circle, 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?

The letters are listed in one code together.

d) In Model 1, there are three drawings that are labeled "?". Write codes to properly label these drawings.

Model 2:

Obtain an envelope from your teacher, which contains the nine drawings from Model 1 (only now they're cut apart). As a team, sort the drawings into those where all the particles in the drawing are identical, and those that have more than one type of particle in the drawing.

Information:

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

Key Questions:

1. Identify which drawings from Model 2 are pure substances and which set are mixtures. List the codes for each set here.

<table>
<thead>
<tr>
<th>Pure Substances</th>
<th>Mixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>T + RSq + R</td>
</tr>
<tr>
<td>SqR₃</td>
<td>Sq₂ + R</td>
</tr>
<tr>
<td>Sq₂</td>
<td>SqR₃ + TSq</td>
</tr>
</tbody>
</table>

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

Pure substances do not have a plus sign (+) in their formula while mixtures do.
Model 3:

As a team, take the set of pure substances from Model 2 (Question #1) and sort them into those containing only one type of atom and those with two or more types of atoms.

Information:

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

Key Questions:

1. Identify which drawings from Model 3 are elements and which are compounds. List the codes for each set here.

<table>
<thead>
<tr>
<th>Elements</th>
<th>Compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>SqR3</td>
</tr>
<tr>
<td>T</td>
<td>RSq</td>
</tr>
<tr>
<td>Sq2</td>
<td>TSq2R</td>
</tr>
</tbody>
</table>

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

   Elements are made up of only one letter, while compounds are made up of two or more.

3. Use what you have just learned about chemical formulas to identify the following as element (E), compound (C), or mixture (M).

   a) Br₂  E
   b) C₆H₁₂O₆ & H₂O  M
   c) NaHCO₃  C
   d) CO₂  C
   e) Cu & Zn  M
   f) Al  E

Extension Questions:

1. 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) Which type of matter can be separated by physical methods (no bonds needed to break) such as filtering or distillation?

   Mixtures can be separated by physical methods.
b) Which type of matter needs to be separated by chemical methods (breaking of bonds required) such as electrolysis or decomposition?

**Compounds need to be separated by chemical means.**

2. 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.

![Drawing A](image1)

![Drawing B](image2)

Which drawing is the best representation of an element? Explain.

**Drawing A is better because it contains several particles (atoms) showing that it is a pure substance. An element does not contain only one atom. A sample is usually made up of multiple atoms.**

b) If Drawing B was a sample from the substances in Model 1, which substance(s) could be represented? Is a single atom a good representation of any of them?

**Drawing B could represent R or T. A single atom is not a good representation of any of the samples.**
Chemistry Crunch #1.2:
Check for Understanding

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

   ![Element Drawing]
   ![Mixture Drawing]
   ![Compound Drawing]

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

   a) Sugar ($C_6H_{12}O_6$)  
   b) Phosphorous ($P_4$)  
   c) Battery Acid ($H_2SO_4$)  
   d) Air ($N_2$ & $O_2$ & $Ar$ & $CO_2$ ...)  
   e) Oxygen ($O_2$)  
   f) Milk ($C_6H_{12}O_6$ & $H_2O$ ...)  
   g) Gold (Au)  
   h) Granite ($SiO_2$ & $KAlSi_3O_3$ ...)  
   i) Drain Cleaner ($Al$ & $NaOH$ ...)  
   j) Sodium (Na)  
   k) Water ($H_2O$)  
   l) Salt Water ($NaCl$ & $H_2O$)

   **Answer Key:**
   
   a) C  
   b) E  
   c) C  
   d) M  
   e) E  
   f) M  
   g) E  
   h) M  
   i) M  
   j) E  
   k) C  
   l) M

3. Which of the following is NOT a true statement?

   a) Two or more atoms held together with bonds make up a molecule.
   b) Pure substances are made of only one type of atom.  **Corrected:**
   c) At least two types of atoms are required to make a compound.
   d) Mixtures can be made of two elements, two compounds, or an element & a compound.