YOU ARE LIVING, YOU OCCUPY SPACE, YOU HAVE A MASS

YOU MATTER

BOOK 1: THE NATURE OF MATTER, CLASSIFICATION MIXTURES & SEPARATION TECHNIQUES

Name:______________       Block:_______
Properties of Matter

Chemistry is the science concerned with the properties, composition, and behaviour of matter. Matter is anything that has mass and occupies space.

Mass is the amount of matter contained in a thing. Usually the mass of common things is measured in grams (g) or kilograms (kg).

Properties are the qualities of a thing, especially those qualities common to a group of things. The relationship between matter and its properties is a very important aspect of chemistry.

A physical property of a substance is a property that can be found without creating a new substance.

For example:
- Colour, shape, (odour), hardness, texture, melting point/bubbling point.

A chemical property is the ability of a substance to undergo chemical change and change into a NEW substance.

For example:
- Flammability, solubility, reactivity, oxidation state, toxicity, radioactive, etc.

Physical properties are classified as being extensive or intensive.

Extensive properties are qualities that are or depend on the amount of the material.

Examples are:
- Mass
- Volume
- Flexibility
- Electrical resistance

Intensive properties are qualities that do not depend on the amount of the material.

Melting point (BP) and density are examples of intensive properties. The gold in Figure 2.1.1 has a melting point and density that are the same for all samples of gold. These properties can therefore be used to identify that material.

Other intensive properties such as temperature (mp/BP), concentration, and tension differ from sample to sample of the same material.
The properties of matter are also classified as being either physical properties or chemical properties. Recall, Physical properties describe which are changes of state or form. Physical properties also describe the physical characteristics of a material.

Chemical properties describe chemical changes. Chemical changes are those in which a new substance(s) or species is formed (Figure 2.1.2). Chemical properties also describe the tendency of a chemical to react (with other substance) (Evidence).

They include a chemical's:
- Reactivity
- Toxicity
- Flammability
- Stability

Most physical properties describe relationships or interactions between matter and energy.

- Hardness: ability to resist scratching/abrasion (Mohs hardness scale)
- Malleability: can be rolled/hammered into thin sheets
- Ductility: can be stretched/rolled into fine wires
- Lustre: "shininess" of a solid surface which reflects light (glossy, dull)
- Viscosity: the intermingling of fluids or gases as a result of motion in the fluid or gas ("spreading out")

For example, a material can be classified as opaque, transparent, or translucent by how it interacts with light.

Other physical properties you may have learned about include temperature, density, viscosity, and surface tension.

Physical properties describe physical changes.

Chemical properties describe interactions between different forms of matter.
PHYSICAL AND CHEMICAL PROPERTIES AND CHANGES

Part A: Physical or Chemical?

Identify the following as a chemical (C) or physical property (P):

1. blue color  
2. density  
3. flammability (burns)  
4. solubility (dissolves)  
5. reacts with acid  
6. supports combustion  
7. sour taste  
8. melting point  
9. reacts with water  
10. hardness  
11. boiling point  
12. **s** **m** **a** **l** **l**  
13. odor  
14. reacts with air

Identify the following as chemical (C) or physical (P) changes.

1. NaCl (Table Salt) dissolves in water.  
2. Ag (Silver) tarnishes.  
3. An apple is cut.  
4. Heat changes H$_2$O to steam.  
5. Baking soda reacts to vinegar.  
6. Fe (Iron) rusts.  
7. Alcohol evaporates.  
8. Ice melts.  
10. Sugar dissolves in water.  
11. Wood rots.  
12. Pancakes cook.  
14. A tire is inflated.  
15. Food is digested.  
17. An ice cube is placed in the sun.  
18. Two chemicals are mixed together and a gas is produced.  
19. A bicycle changes colour as it rusts.  
20. A solid is crushed into a powder.  
21. Two substances are mixed and light is produced.  
22. A piece of ice melts and reacts with sodium.  
23. Mixing salt and pepper.  
24. Chocolate syrup is dissolved in milk.  
25. A marshmallow is toasted over a campfire.  
26. A marshmallow is cut in half.

**Assignment #2- Physical & Chemical Properties & Changes Worksheet Part A + Part B + Part C**

This assignment is to be completed on THIS PAGE in the space provided below.

Name: **KEY**

ES
Part B

Read each scenario. Decide whether a physical or chemical change has occurred and give evidence for your decision. The first one has been done for you to use as an example.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Physical or Chemical Change?</th>
<th>Evidence...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Umm! A student removes a loaf of bread hot from the oven. The student cuts a slice off the loaf and spreads butter on it.</td>
<td>Physical</td>
<td>No change in substances. No unexpected color change, temperature change or gas given off.</td>
</tr>
<tr>
<td>2. Your friend decides to toast a piece of bread, but leaves it in the toaster too long. The bread is black and the kitchen is full of smoke.</td>
<td>Chemical</td>
<td>New substance produced by colour change, smell</td>
</tr>
<tr>
<td>3. You forgot to dry the bread knife when you washed it and reddish brown spots appeared on it.</td>
<td>Chemical</td>
<td>New substance produced (rust)</td>
</tr>
<tr>
<td>4. You blow dry your wet hair.</td>
<td>Physical</td>
<td>No new substance produced</td>
</tr>
<tr>
<td>5. In baking biscuits and other quick breads, the baking powder reacts to release carbon dioxide bubbles. The carbon dioxide bubbles cause the dough to rise.</td>
<td>Chemical</td>
<td>Reaction takes place</td>
</tr>
<tr>
<td>6. You take out your best silver spoons and notice that they are very dull and have some black spots.</td>
<td>Chemical</td>
<td>New substance produced</td>
</tr>
<tr>
<td>7. A straight piece of wire is coiled to form a spring.</td>
<td>Physical</td>
<td>Just changed the shape</td>
</tr>
<tr>
<td>8. Food color is dropped into water to give it color.</td>
<td>Physical</td>
<td>Chemical make-up of H₂O and food colouring not changed.</td>
</tr>
<tr>
<td>9. Chewing food to break it down into smaller particles represents a ( ) change, but the changing of starch into sugars by enzymes in the digestive system represents a ( ) change.</td>
<td>Physical</td>
<td>Just breaking food down</td>
</tr>
<tr>
<td>10. In a fireworks show, the fireworks explode giving off heat and light.</td>
<td>Chemical</td>
<td>Reaction takes place</td>
</tr>
</tbody>
</table>

Part C: True (T) or False (F)?

1. F Changing the size and shapes of pieces of wood would be a chemical change.
2. F In a physical change, the makeup of matter is changed.
3. T Evaporation occurs when liquid water changes into a gas.
4. T Evaporation is a physical change.
5. F Burning wood is a physical change.
6. F Combining hydrogen and oxygen to make water is a physical change.
7. F Breaking up concrete is a physical change.
8. T Sand being washed out to sea from the beach is a chemical change.
9. F When ice cream melts, a chemical change occurs.
10. F Acid rain damaging a marble statue is a physical change.
1. What is matter?

_____________________________________________________________

2. What is a property?

____________________________________________________________

3. What is an extensive property?

___________________________________________________________

4. What is a chemical property?

___________________________________________________________

---

Matter is composed of basic units or ___________ that move independently. In some forms of matter, these particles are ___________ while in others these particles are groups of atoms called ___________. ___________ changes involve the rearrangement of a material's own particles. ___________ changes involve the reorganization of two or more substances' atoms in relation to each other. Physical changes alter ___________ molecular relationships (those between the molecules) while chemical changes alter ___________ molecular relationships (those within molecules). Physical changes generally involve ___________ than chemical changes.

**Kinetic Energy**

Kinetic Energy is any form of energy that cannot be stored. The greater an object's ___________ and ___________, the greater ___________ its kinetic energy. The particles of matter possess a type of kinetic energy called ___________.

Independent atoms and molecules have three forms of mechanical energy or types of motion:

- **Translational** (movement from place to place) -
- **Rotational** (movement about an axis) -
- **Vibrational** (a repetitive “back and forth” motion).

NOT bond rotation

**Thermal energy** is the total mechanical energy of an object's or a material's particles. It is an ___________ property as it depends on the size of the object or the amount of the material. **Temperature** is the average mechanical energy of the particles that compose a material and is therefore an ___________ property. An increase in a material's temperature increases the kinetic energy and indicates that the average speed of its particles has increased.
The differences between solids, liquids and gases can be explained by looking at the ___________.

All substances are made up of particles. The particles are __________ attracted to each other. Some particles are attracted strongly to each other, and others weakly.

The particles move around. They are described as having __________.

The kinetic energy of the particles __________ with temperature.

**What are the properties of solids?**

- **Solids:**
  - have a **high density** as the particles are packed very closely together.
  - **cannot** be compressed because there is very little empty space between particles.
  - have a **fixed shape** because the particles are held tightly together.
  - **cannot** diffuse because the particles are not able to move.

**What are the properties of liquids?**

- **Liquids:**
  - have a fairly high density because the particles are close together.
  - **can** be compressed because there is very little empty space between particles.
  - take up the shape of the **container** because the particles can move (spread out).
  - **can** diffuse because the particles are able to change places.

**What are the properties of gases?**

- **Gases:**
  - have a low density because the particles are spaced very far apart.
  - **can** be compressed because there is space between particles.
  - have no fixed shape because the particles move about rapidly in all directions.
  - **can** diffuse because the particles are able to move in all directions.

**Physical Properties VOCAB:**

- **Vapour:**
  - the gaseous material (properties like a gas) formed by evaporation of a substance which boils above room temp.
  - the pressure created by the vapor evaporating from the liquid.

- **Vapour Pressure:**

- **Boiling Temperature (boiling point):**
  - a temperature where a liquid changes into a gas. @ the boiling point, liquid + gas coexist.

- **Melting Temperature (melting point):**
  - the temperature where a solid changes to the liquid phase. @ the melting point, solid + liquid coexist.
### The States of Matter

#### Table 2.1.1 The States of Matter

<table>
<thead>
<tr>
<th>State</th>
<th>Operational Definition</th>
<th>Conceptual Definition (explanation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>solid</td>
<td>fixed (defined)</td>
<td>- particles have vibrational energy.</td>
</tr>
<tr>
<td></td>
<td>fixed (defined)</td>
<td>- push surrounding particles outward.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- strong bonds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- structure intact</td>
</tr>
<tr>
<td>liquid</td>
<td>adapt to container</td>
<td>- more KE.</td>
</tr>
<tr>
<td></td>
<td>fixed</td>
<td>- particles are moving faster and in more ways.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- collide with greater force.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- particles are spread (further) apart.</td>
</tr>
<tr>
<td>gas</td>
<td>spread to fill container “undefined”</td>
<td>- much larger KE.</td>
</tr>
<tr>
<td></td>
<td>(or space)</td>
<td>- higher force of collision.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- particles are so far apart and moving with great speed, intermolecular forces (attractive forces) do not impede motion.</td>
</tr>
</tbody>
</table>

### The 6 Physical Changes of State:

1. Evaporation (vaporization)
2. Condensation
3. Melting
4. Freezing
5. Sublimation
6. Deposition

[Diagram of physical changes of state with arrows indicating the processes and energy changes (decreasing heat energy and increasing heat energy).]
The **kinetic molecular theory** explains what happens to matter when the kinetic energy of particles changes. The key points of the kinetic molecular theory are:

1. **All matter is made up of tiny particles.**
2. **There is empty space between the particles.**
3. Particles are always **moving**. Their freedom to move depends on whether they are in a solid, liquid, or gas.
4. The particles move because of **energy**. The amount of energy the particles have determines how fast the particles move and how much or far they move.

**Practice**

1. Explain the difference between

   ____________

2. Describe the differences in heat

   ____________

3. How does heat contribute to

   ____________

**Assignment #4 Review Questions #1-2, 6-7**

This assignment may be completed in the space provided below.
Melting Point

A material’s melting point is the temperature of its solid as it changes to a liquid. Melting occurs because the independent particles have spread far enough apart so that they can just slip through the gaps between the atoms surrounding them. The melting point of a substance depends on the strength of the attractive forces between the particles as well as the mass and symmetry of the particles. The freezing point and melting point of most substances are the same.

Boiling Point

Boiling is a special case of evaporation. Any particle in the liquid state may evaporate. The puddles on your street evaporate but you’ve never seen a puddle boil. The gas formed by a substance that boils above room temperature is called vapour. Evaporation is the vigorous bubbling that occurs within the body of a liquid as it internally. A bubble is a quantity of gas or vapour surrounded by liquid.

Boiling point is also defined as a substance’s highest possible temperature in the liquid state at any given atmospheric pressure. It therefore represents the highest kinetic energy of the substance’s particles can possess in the liquid state. As the temperature of the water approaches 100°C, more and more of the molecules have their kinetic energy in the liquid state until at 100°C all the molecules are at the same maximum speed in the liquid state.

Boiling point, vapour pressure, and volatility are three closely related properties that are all relevant to boiling. Volatile substances are substances that evaporate at high rates. They have vapour pressures and boiling points.

Heat of Fusion ($H_f$)

The heat of fusion is the amount of heat required to melt a specified amount of a substance at its melting point. It represents the difference in potential energy between the solid and liquid states since only the substance’s state, not its temperature, is changing. Potential energy is stored energy in the bonds. The heat of fusion is released when the specified quantity of the substance freezes. Heat of fusion is measured in joules/gram.

Heat of Vaporization ($H_v$)

The heat of vaporization is the amount of heat required to evaporate a specified amount of a substance at its boiling point. It represents the difference of potential energy between the liquid and gas states since only the substance’s state, not its temperature, is changing. The heat of vaporization is released when the specified quantity of the substance condenses. The heat of vaporization indicates the strength of the force holding the liquid particles together in the liquid state.
1. What is melting? _______________________________________________________________________

2. What is boiling? _____________________________________________________________________

3. What is the heat of fusion? ___________________________________________________________________

---

**Quick Check**

1. The process of changing from a solid to a liquid
2. The vigorous bubbling that occurs within the body of a liquid as it vaporizes internally
3. The amount of heat energy required to melt a specified amount of a substance at its melting point
8. State whether each of the following properties is physical or chemical.

(a) heat of vaporization — physical

(b) heat of formation — chemical

(c) corrosion resistance — physical

(d) electrical resistance — physical

(e) flammability (how easily something will burn or ignite) — chemical

(f) speed of sound through the material — physical

9. Composite materials (or just composites) consist of two or more constituent materials that adhere to each other but remain separate and distinct (e.g. the materials could be layered on each other). Why do you think manufacturers sometimes use composite materials in their products?

10. What two properties of particles affect the temperature of the material they compose?

11. Density is mass per unit volume, commonly the amount of matter in one cubic centimetre of the material. What two properties of particles affect the density of the material they compose?

12. Briefly explain what causes materials to expand at the particle level when heated.

13. List the defining physical properties of each phase of matter; solids, liquids, and gases.

14. Does an individual atom or molecule have a melting point? Explain.

15. Describe what is occurring at the molecular level when a material melts.

16. Why doesn't the temperature of an ice water bath (a mixture of ice and water) increase as it absorbs heat from a classroom?
17. Under what condition do all the particles of a liquid have the same kinetic energy?

18. Provide an operational (what to look for) and a conceptual (an explanation) definition of boiling point.

19. (a) Which is greater, a substance's heat of fusion or its heat of vaporization?
   (b) Explain in terms of relationships why this would be expected.

20. (a) Which is greater, a substance's heat of vaporization or its heat of combustion?
   (b) Explain in terms of relationships why this would be expected.

21. Sensorial properties describe our senses of a material. Rather than being the properties of something, they are the properties of our interaction with that thing. Are sensorial properties such as taste and odour physical properties or are they chemical properties?

22. Label and describe briefly a physical change and a chemical change on the drawing of the lit candle.

23. Students change classes at designated times throughout the day in most secondary schools. How is this event like a chemical change or reaction?
Kinetic Theory of Matter:
- Molecules are always moving. This is known as the kinetic theory of matter.
- We measure this kinetic energy with a thermometer as temperature.
- The greater the material's internal energy, the higher the temperature of that material.
- Heat is the energy flow between objects of different temperature.
- Heat and temperature are NOT the same.
- Brownian motion describes how visible particles are seen moving due to invisible molecules bumping into them.

Phases of Matter:
**Solid**
- matter that has definite volume and shape.
- The molecules are packed together tightly and move slowly.

**Liquid**
- matter that has definite volume but not shape.
- Since the molecules of a liquid are loosely packed and move with greater speed,
- a liquid can flow and spread.

**Gas**
- matter that has indefinite volume or shape.
- Molecules of a gas are so loosely arranged and move so rapidly that they will fill their container.

Phase Change Descriptions:
**Melting**
the change from **solid** to **liquid**.

**Freezing**
the change from **liquid** to **solid**.

**Evaporation**
the change from **liquid** to **gas**.

**Condensation**
the change from **gas** to **liquid**.

**Sublimation**
the change from **solid** to **gas**.

**Deposition**
the change from **gas** to **solid**.
Fill in the phase changes in the blank provided.

**Phase Change Concept Map**

1. **Melting**
2. **Freezing**
3. **Sublimation**
4. **Deposition**
5. **Condensation**
6. **Evaporation**

**Phase Change Diagram**

- **A** Solid
- **B** Melting
- **C** Sublimation
- **D** Condensation
- **E** Gas
- **8** Freezing
- **9** Melting
- **10** Condensation
- **11** Evaporation
Phase Change Worksheet
The graph was drawn from data collected as a substance was heated at a constant rate. Use the graph to answer the following questions.

At point A, the beginning of observations, the substance exists in a solid state. Material in this phase has **definite** volume and **definite** shape. With each passing minute, **energy** is added to the substance. This causes the molecules of the substance to **vibrate** more rapidly which we detect by a **steady** rise in the substance. At point B, the temperature of the substance is **70 °C**. The solid begins to **melt**. At point C, the substance is completely **melted** or in a **liquid** state. Material in this phase has **definite** volume and **indefinite** shape. The energy put to the substance between minutes 5 and 9 was used to convert the substance from a **solid** to a **liquid**. This heat energy is called the **latent heat of fusion**. (An interesting fact.)

Between 9 and 13 minutes, the added energy increases the **temperature** of the substance. During the time from point D to point E, the liquid is **boiling**. By point E, the substance is completely in the **gas** or **vapor** phase. Material in this phase has **indefinite** volume and **indefinite** shape. The energy put to the substance between minutes 13 and 18 converted the substance from a **liquid** to a **gas** state. This heat energy is called the **latent heat of vaporization**. (An interesting fact.) Beyond point E, the substance is still in the **gas** phase, but the molecules are moving **rapidly** as indicated by the increasing temperature.

Which of these three substances was likely used in this phase change experiment?

<table>
<thead>
<tr>
<th>Substance</th>
<th>Melting point</th>
<th>Boiling point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolognium</td>
<td>20 °C</td>
<td>100 °C</td>
</tr>
<tr>
<td>Unobtainium</td>
<td>40 °C</td>
<td>140 °C</td>
</tr>
<tr>
<td>Foosium</td>
<td>70 °C</td>
<td>140 °C</td>
</tr>
</tbody>
</table>

BONUS: For water, the value for the latent heat of vaporization is 6.8 times greater than the latent heat of fusion. Imagine we were adding heat at a constant rate to a block of ice in a beaker on a hot plate, and it took 4 minutes for the ice to melt completely. How long would it take, after the water started boiling, for the beaker to be completely empty (the liquid water totally converted to water vapor)?
The Classification of Matter

Warm Up

Most sentences or paragraphs in your textbooks could be classified as a definition, a description, an explanation, a comparison, a sequence, an example, or a classification.

1. Give an example of a sport.
2. Name a class of sports.
3. What is the difference between an example of something and a class of something?

Classifying Matter

We currently classify everything in the physical world as either a form of ____________ or a form of ____________.

Any solid, liquid, or gas is a form of matter. Matter can be further classified as shown:

Figure 2.2.1 Classification of matter

<table>
<thead>
<tr>
<th>Material</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>pure substance</td>
<td>all samples have the same properties and components; material with only 1 set of properties</td>
<td>sugar (C_{6}H_{12}O_{6}), oxygen gas (O_{2}), copper (Cu)</td>
</tr>
<tr>
<td>mixture</td>
<td>a system/sample made up of 2+ substances; amounts can vary</td>
<td>salt water (NaCl and H_{2}O), air (O_{2}, N_{2}, CO_{2}, H_{2}O), fuel mix</td>
</tr>
<tr>
<td>atom</td>
<td>smallest unit of an element, which retains the properties of the larger sample</td>
<td>Cu atom, Al atom, oxygen atom = O</td>
</tr>
<tr>
<td>Molecule</td>
<td>a cluster of atoms; chemically bonded; 2+ atoms</td>
<td>oxygen gas - O_{2}, water - H_{2}O, ethane - CH_{3}CH_{2}OH</td>
</tr>
<tr>
<td>Ion</td>
<td>atoms or polyatomic (molecule) have an electric charge(s)</td>
<td>Na^{+}, Cl^{-}, “cations” → NH_{4}^{+}, “anions” → NO_{3}^{-}</td>
</tr>
<tr>
<td>element</td>
<td>a pure substance which cannot be simplified into smaller (or diff.) substances</td>
<td>H, He, Ag, Cu, ... (all atoms of the same type)</td>
</tr>
<tr>
<td>Compound</td>
<td>a pure substance made up of 2+ different types of atoms</td>
<td>salt - NaCl, water - H_{2}O</td>
</tr>
<tr>
<td>Particle</td>
<td>a general term used to describe a “piece of something”, 3 atom, compound, or molecule</td>
<td></td>
</tr>
</tbody>
</table>
The particles that make up materials are also forms of matter. Chemists refer to all the particles of matter collectively as chemical species. Just as materials are classified, so are chemical species. Chemical species can be classified as neutral atoms, molecules, or ions or compounds. Atoms are composed of particles that can be classified as well.

### Figure 2.2.2 Classification of elements

<table>
<thead>
<tr>
<th>Elements</th>
<th>Metals</th>
<th>Metalloids</th>
<th>Non-metals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-metals</td>
<td>1 H</td>
<td>2 He</td>
<td>Alkali metals</td>
</tr>
<tr>
<td>Metals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-metals</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The elements are further classified as metals, non-metals, and metalloids. About **80%** of the elements are metals.

**Hydrogen** has properties that are in-between those of the metals and the non-metals. Although it has some chemical properties of metals, it has more in common with non-metals and is classified as a non-metal for most purposes. Hydrogen is such a unique element that it is usually considered to be in a group of its own.

Metals are good conductors of both heat and electricity. They are also **malleable** (can be pounded into thin sheets), **ductile** (can be drawn into wires), and **hard**. Metal oxides react with water to form **bases** (hydroxides). For example:

\[
\text{Na}_2\text{O} + \text{H}_2\text{O} \rightarrow 2 \text{NaOH}
\]

Non-metals are **poor** conductors of both heat and electricity. Many are **gases** at room temperature but in the solid phase their crystals are **brittle** and shatter easily. Non-metal oxides react with water to form **acids**. For example:

\[
\text{CO}_2(g) + \text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{CO}_3(aq) \quad \text{(carbonic acid)}
\]

Moving up and to the **right** in the periodic table, there is a general trend toward decreasing **metallic character** from one element to the next. As a consequence, there is no sharp demarcation between the metals and non-metals. Instead, there is a group of elements called **metalloids** that exhibit some metallic properties (although weakly) and some non-metallic properties. For example, **Si** (silicon) is a semiconductor meaning that it conducts electricity but poorly.
Practice Problems — Classifying a Compound as Ionic or Molecular

1. State whether each of the following is an ionic compound or a molecular compound:
   (a) CO₂
   (b) NaCl
   (c) CaF₂
   (d) Mg₃(PO₄)₂
   (e) Li₄CrO₄
   (f) NH₄Cl

What to Think about
If the compound contains a metal or the ammonium ion then it is ionic, otherwise it is molecular.
(a) Na is a metal
(b) Cu is a metal
(c) P and O are both non-metals

How to Do It
a) ionic compound
b) ionic compound
c) covalent/molecular compound
Elements, Mixtures and Compounds

A. Link each particle or substance with the correct diagram and description. The first has been completed for you.

<table>
<thead>
<tr>
<th>Particle/substance</th>
<th>Diagram</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>An atom</td>
<td><img src="image1.png" alt="Diagram" /></td>
<td>Two or more elements chemically combined</td>
</tr>
<tr>
<td>A molecule</td>
<td><img src="image2.png" alt="Diagram" /></td>
<td>A charged particle</td>
</tr>
<tr>
<td>An ion</td>
<td><img src="image3.png" alt="Diagram" /></td>
<td>A single particle (no charge)</td>
</tr>
<tr>
<td>An element</td>
<td><img src="image4.png" alt="Diagram" /></td>
<td>A collection of atoms or molecules of the same kind</td>
</tr>
<tr>
<td>A compound</td>
<td><img src="image5.png" alt="Diagram" /></td>
<td>2 or more atoms chemically joined together</td>
</tr>
<tr>
<td>A mixture</td>
<td><img src="image6.png" alt="Diagram" /></td>
<td>Different elements or compounds mixed together</td>
</tr>
</tbody>
</table>

B. Study the diagrams, and decide which one each statement below is describing.

1. Atoms of a single element
2. Molecules of a single element
3. A mixture of 2 elements, both of which are made of atoms
4. A mixture of 2 elements, both of which are made of molecules
5. A mixture of 2 elements, one of which is made of atoms, the other molecules
6. A pure compound made of molecules
7. A pure compound made of ions
8. A mixture of 2 compounds
Classifying Matter Worksheet

Classify each of the materials below. In the center column, state whether the material is a pure substance or a mixture. If the material is a pure substance, further classify it as either an element or compound in the right column. Similarly, if the material is a mixture, further classify it as homogeneous or heterogeneous in the right column.

<table>
<thead>
<tr>
<th>Material</th>
<th>Pure Substance or Mixture</th>
<th>Element, Compound, Homogeneous, Heterogeneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>concrete</td>
<td>Mixture</td>
<td>Heterogeneous</td>
</tr>
<tr>
<td>sugar + pure water (C_{12}H_{22}O_{11} + H_{2}O)</td>
<td>Mixture</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>iron filings (Fe)</td>
<td>Pure Substance</td>
<td>Element</td>
</tr>
<tr>
<td>limestone (CaCO_{3})</td>
<td>Pure Substance</td>
<td>Compound</td>
</tr>
<tr>
<td>orange juice (w/pulp)</td>
<td>Mixture</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>Pacific Ocean</td>
<td>Mixture</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>air inside a balloon</td>
<td>Mixture</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>aluminum (Al)</td>
<td>Pure Substance</td>
<td>Element</td>
</tr>
<tr>
<td>magnesium (Mg)</td>
<td>Pure Substance</td>
<td>Element</td>
</tr>
<tr>
<td>acetylene (C_{2}H_{2})</td>
<td>Pure Substance</td>
<td>Compound</td>
</tr>
<tr>
<td>tap water in a glass</td>
<td>Mixture</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>soil</td>
<td>Mixture</td>
<td>Heterogeneous</td>
</tr>
<tr>
<td>pure water (H_{2}O)</td>
<td>Pure Substance</td>
<td>Compound</td>
</tr>
<tr>
<td>chromium (Cr)</td>
<td>Pure Substance</td>
<td>Element</td>
</tr>
<tr>
<td>Chex mix</td>
<td>Mixture</td>
<td>Heterogeneous</td>
</tr>
<tr>
<td>salt + pure water (NaCl + H_{2}O)</td>
<td>Mixture</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>benzene (C_{6}H_{6})</td>
<td>Pure Substance</td>
<td>Compound</td>
</tr>
<tr>
<td>muddy water</td>
<td>Mixture</td>
<td>Heterogeneous</td>
</tr>
<tr>
<td>brass (Cu mixed with Zn)</td>
<td>Mixture</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>baking soda (NaHCO_{3})</td>
<td>Pure Substance</td>
<td>Compound</td>
</tr>
</tbody>
</table>
**Classification of Mixtures**

![Diagram of Classification of Mixtures]

**Figure 2.2.6 Classification of mixtures**

<table>
<thead>
<tr>
<th>Material</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homogeneous mixture</td>
<td>appears the same throughout (uniform)</td>
<td>CuSO₄, acids/bases, milk</td>
</tr>
<tr>
<td>Heterogeneous mixture</td>
<td>do not appear the same throughout (nonuniform)</td>
<td>CaCO₃ in H₂O, trail mix, salad dressing</td>
</tr>
</tbody>
</table>

---

### 1) HOMOGENEOUS MIXTURES

**Solutions**

A ______________ is a type of homogeneous mixture in which the constituent chemical species do not aggregate to form any particles greater than 1 nm (nanometre).

A ______________ is a minor component of the mixture, generally what has been dissolved.

The ______________ is the major component of the mixture, generally what the solute was dissolved in.

Many chemicals are in ______________ solution (dissolved in water).

Our lakes and rivers, our oceans, our drinks, our bodily fluids, and the bottles on the shelves of your laboratory are all aqueous solutions. Chemists denote that a chemical is in aqueous solution with "_______" in brackets after the formula (e.g., NaCl(aq)).

Solutions can be produced from materials in ______________________________________ (e.g., a solid can dissolve in a liquid). Regardless of the constituents' phases when undissolved, a solution is a ______________ phase, usually that of the solvent. If the solvent is a ______, it is melted to allow for mixing and then cooled to solidify the mixture.

**Table 2.2.3 Examples of Solutions**

<table>
<thead>
<tr>
<th>Solute</th>
<th>Solid</th>
<th>Liquid</th>
<th>Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid</td>
<td>steel, bronze</td>
<td>mercury in gold</td>
<td>hydrogen in palladium</td>
</tr>
<tr>
<td>Liquid</td>
<td>salt water</td>
<td>gasoline</td>
<td>oxygen in water</td>
</tr>
<tr>
<td>Gas</td>
<td>-</td>
<td>-</td>
<td>air</td>
</tr>
</tbody>
</table>

**Colloids**

A colloidal system consists of ______________ between 1 nm and 1 µm dispersed throughout a ______________ medium (Table 2.2.5). The particles of the ______________ phase are large molecules (______________) or aggregates of molecules that are invisible to the naked eye.

Unlike a solution, the colloid particles can be in a ______________ phase than the dispersion medium in which they are suspended. Any mixture of ______________ particles in a ______________ regardless of how small the solid particles are, is a colloid or a ______________ mixture.

If a liquid is translucent (cloudy) then it is a colloid or a ______________ mixture.

---

**Table 2.2.2 Distinguishing Between Homogeneous and Heterogeneous Mixtures**

<table>
<thead>
<tr>
<th>Material</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homogeneous mixture</td>
<td>appears the same throughout (uniform)</td>
<td>CuSO₄, acids/bases, milk</td>
</tr>
<tr>
<td>Heterogeneous mixture</td>
<td>do not appear the same throughout (nonuniform)</td>
<td>CaCO₃ in H₂O, trail mix, salad dressing</td>
</tr>
</tbody>
</table>
**Heterogeneous Mixtures**

If one or more of the components of a mixture is visible then it is a **heterogeneous mixture**. The term, “mechanical mixture” is often misused as an intended synonym for “heterogeneous mixture.”

A **mechanical** mixture is a mixture of components that **can be separated by mechanical means**, i.e. by picking, sifting, shaking, spinning, pouring, skimming, etc.

This definition includes at least some mixtures of every class. For example, the components of colloids can be separated by mechanical means such as centrifugation (spinning) and ultra-filtration.

If the heterogeneous mixture has a **dispersed** phase and a continuous medium then, it is a **coarse** suspension or just a suspension.

Colloids remain suspended **indefinitely** but the larger mass of the suspended particles in suspensions causes them to settle out or **sediment upon standing**. The dispersed phase in a suspension is usually a **solid**.

**Examples of suspensions**: silt in water, dust in air, and paint (pigments in a solvent).

The component particles are all visible in some heterogeneous mixtures such as gravel.

---

### Table 2.2.4 Names and (Examples) of Colloids

<table>
<thead>
<tr>
<th>Medium</th>
<th>Solid (grains)</th>
<th>Liquid (droplets)</th>
<th>Gas (bubbles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid</td>
<td>solid sol (some stained glass)</td>
<td>blood</td>
<td>solid foam (styrofoam)</td>
</tr>
<tr>
<td>Liquid</td>
<td>blood</td>
<td>liquid aerosol (fog)</td>
<td>foam (whipped cream)</td>
</tr>
<tr>
<td>Gas</td>
<td>solid aerosol (smoke)</td>
<td>liquid aerosol (fog)</td>
<td>X</td>
</tr>
</tbody>
</table>

**Extension:** The Tyndall effect, also known as Willis–Tyndall scattering, is **light scattering by particles in a colloid** or else particles in a very fine suspension.

---

### Type of Mixture

<table>
<thead>
<tr>
<th>Type of Mixture</th>
<th>Operational Definition*</th>
<th>Conceptual Definition**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution</td>
<td>no</td>
<td>All particles are &lt; 1 nm.</td>
</tr>
<tr>
<td>Colloid</td>
<td>yes</td>
<td>Dispersed particles are between 1 nm and 1 μm. Particles comprising the medium are &lt; 1 nm.</td>
</tr>
<tr>
<td>Suspension</td>
<td>yes</td>
<td>Dispersed particles are &gt; 1 μm.</td>
</tr>
</tbody>
</table>

* The operational definitions only provide methods of differentiating mixtures that have a liquid continuous medium.

** The sizes cited for the particles are only rough guidelines, not steadfast rules.
Review Questions

1. Name an element, a compound, and a mixture found in your home.

2. Is it easier to prove that an unknown substance is an element or a compound? Explain.

ANSWERS

1. e.g. copper (in wires), water, milk
2. A compound. It’s easy to demonstrate that you can decompose a substance but difficult to prove that you can’t.
3. a. properties
   b. composition
   c. properties (the particle sizes are only rough guidelines)
4. element
   molecular compound
   ionic compound
   a mixture of elements
   a mixture of compounds
5. a. compound
   b. mixture
   c. compound
   d. mixture
   e. element
   f. mixture
6. a. semi-metal
   b. metal
   c. non-metal
   d. non-metal
7. conduct heat and electricity, malleable, ductile, lustrous

7. Give four examples of physical properties of metals.
8. Complete the following table by classifying each of the compounds.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Organic or Inorganic</th>
<th>Binary or Non-Binary</th>
<th>Molecular or Ionic</th>
<th>Acid, Base, Salt or None of these</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaCl₂</td>
<td>Inorganic</td>
<td>Binary</td>
<td>Ionic</td>
<td>Salt</td>
</tr>
<tr>
<td>CH₃CH₂OH</td>
<td>Organic</td>
<td>Non-binary</td>
<td>Molecular</td>
<td>None of these</td>
</tr>
<tr>
<td>NH₄ClO₃</td>
<td>Inorganic</td>
<td>Non-binary</td>
<td>Ionic</td>
<td>Salt</td>
</tr>
<tr>
<td>KOH</td>
<td>Inorganic</td>
<td>Non-binary</td>
<td>Ionic</td>
<td>Base</td>
</tr>
<tr>
<td>C₂H₆</td>
<td>Organic</td>
<td>Binary</td>
<td>Molecular</td>
<td>None of these</td>
</tr>
<tr>
<td>H₃PO₄</td>
<td>Inorganic</td>
<td>Non-binary</td>
<td>Molecular</td>
<td>Acid</td>
</tr>
<tr>
<td>Ba(NO₃)₂</td>
<td>Inorganic</td>
<td>Non-binary</td>
<td>Ionic</td>
<td>Salt</td>
</tr>
<tr>
<td>CO₂</td>
<td>Inorganic</td>
<td>Binary</td>
<td>Molecular</td>
<td>None of these</td>
</tr>
<tr>
<td>Al(OH)₃</td>
<td>Inorganic</td>
<td>Non-binary</td>
<td>Ionic</td>
<td>Base</td>
</tr>
</tbody>
</table>

9. A mixture of metals (alloy). The same components could be mixed in different proportions. Any material having atoms that are not chemically combined in a fixed ratio is a chemical mixture and would be so even if those atoms were organized in a uniform pattern.

10. Atoms are not homogeneous (the same throughout) and therefore nothing composed of atoms is truly homogeneous.

11. Yes. The different allotropes of an element are different substances. Even though they are composed of the same type of atom, the atoms are grouped or arranged differently resulting in the allotropes having different physical and chemical properties.

12. a. molecule  d. neutral atom
b. neutral atom  e. molecule
13. Complete the following table by checking \( \checkmark \) the correct type(s) of mixture each statement describes.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Solution</th>
<th>Colloid</th>
<th>Heterogeneous Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>All particles are less than 1 nm in size</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravel</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Does not appear the same throughout</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Forms a sediment if left undisturbed</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Has a solute and a solvent</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Exhibits the Tyndall effect</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Homogeneous mixture</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

14. When diagnosing an ulcer, a doctor may have the patient drink a suspension of barium sulphate which coats the patient’s gastrointestinal tract allowing it to be imaged by X-rays. What is the difference between a suspension and a colloid?

15. Is dust a colloid or a suspension? Explain.

16. Correct each of the following sentences by replacing the underlined word.

(a) Salt water is a denser substance than fresh water.

(b) The colloid particles were dispersed in water.
Separating the Substances of a Mixture

Most naturally occurring objects and materials are **mixtures**. Our atmosphere, our natural water systems, and the ores and petroleum products (such as crude oil and natural gas) that we extract from the ground are mixtures. Just as a compound can be decomposed [**decomposed**], a mixture can be **unmixed**. Since the ingredients of a mixture are **NOT chemically combined**, they retain their individual identities. The trick to separating the substances in a mixture is to pick a property that clearly differentiates the substances.

Laboratory technicians perform a tremendous number of separations daily in medical, forensic, and analytical chemistry laboratories to allow the substances in the mixtures to be identified. Large industrial-scale separations are performed around the world in commercial refineries (for sugar, oil, metal, etc.) to obtain the target substances for their useful properties, their intrinsic values, or more commonly to use the substances to produce useful mixtures of our own design.

In Chemistry 12, you’ll examine a chemical separation technique called **selective physical separations**: those **NOT involving chemical reactions to separate**.


Physical separations may be classified as **mechanical** or **non-mechanical**.

**Non-mechanical** means of separation include techniques that use **heat**, **electricity**, **magnetism**, **dissolving** or sticking to separate a mixture’s components.

**Mechanical means of separation** use **contact forces**, or motion to sort the components of a mixture. Terms such as **picking**, **sifting**, **filtering**, **shaking**, **spinning**, **pouring**, and **skimming** describe the type of actions involved in mechanical separations.

**Density Separation**

To **sediment** (verb) means to fall or sink to the bottom of a liquid. Sediment (noun) is matter that has fallen or sunk to the bottom of a liquid. A **medium** exerts an upward force called **buoyancy** on all objects immersed in it. As an object enters a fluid, it lifts the fluid it displaces. If the object is **less dense** than the fluid, then the object will float because it will displace a weight of fluid greater than its own weight. Density separation can be used to separate **solid** with different densities. The solids must be **insoluble** in the liquid media used to separate them. This technique is used to separate **plastics** of different densities. Although density separation separates the solid particles from each other, they are now mixed with the liquid used to separate them. The particles that **float** can be skimmed off the **top** of the liquid and dried. The particles that **sediment** can be separated from the liquid by **decanting** off the liquid or by **filtering** out the sediment.

**Decanting** is carefully pouring off the liquid and leaving the sediment in the bottom of the original container.
Centrifugation
Another mechanical means of separation is centrifugation or spinning. Centrifugation enhances density separation. Particles that would normally sink or rise still do so, just more rapidly.
When you are in a car that turns a sharp corner you may be "thrown" sideways.
It might seem as though a force pushed you against the door. This property is called inertia. The suspended particles in a mixture behave similarly in a centrifuge. As the tube changes its direction, the suspended particles initially maintain their linear motion. This process occurs continuously as the tube spins, directing the suspended particles to the bottom of the tube. (more dense)

Non-Mechanical Means of Separation

Chromatography
Chromatography is one of the most widely used techniques in scientific research today. Researchers have been able to devise a chromatographic method for separating all but a few mixtures.

Chromatography separates the substances in a solution by having a flowing liquid or gas carry them at different rates through a stationary phase. The flowing liquid or gas is called the mobile phase. Each substance travels through the stationary phase at its own characteristic rate, according to its relative affinities for the two phases. A substance that adheres strongly to the stationary phase but isn't very soluble in the mobile phase travels slowly through the chromatogram. Conversely, a substance that adheres weakly to the stationary phase but is very soluble in the mobile phase travels quickly through the chromatogram.
There are many forms of chromatography: gas chromatography, column chromatography, thin layer chromatography, and paper chromatography.

In paper chromatography, the stationary phase is a strip or sheet of paper. The mobile phase in both forms of chromatography could be water, an organic solvent such as alcohol, or a mixture of solvents.
A drop of the solution to be separated is placed near the bottom of the sheet or plate and allowed to dry. Another drop of the solution is then placed on top of the first and also allowed to dry.

This process is repeated many times until there is a sufficient amount of each solute to produce a clear chromatogram.
The bottom of the chromatogram is lowered into a pool of the solvent. Capillary action is the tendency of a liquid to rise in narrow tubes or to be drawn into small openings. Capillary action results from the adhesive forces between the solvent molecules and those of the wicking material in combination with the cohesive forces between the solvent molecules themselves. Capillary action causes the solvent to rise up the stationary medium, between the paper fibres, past the deposit of solutes, and up the remainder of the paper or glass plate.

A substance's $R_f$ may help identify it, or at least support its identification by more definitive means. A substance's $R_f$ is a homogeneous mixture.
**Distillation** is any process that separates a mixture of substances by using their different vapor pressures or boiling points. Distillations require a heating device, a flask containing the original mixture, a condenser to cool and condense the vapours, and something to collect the condensed substances as they leave the condenser one after the other. Distilled water is produced by boiling tap water, cooling its vapours, and then collecting the condensate or distillate. The impurities that were dissolved in the water remain as residue in the original flask.

Scientists have devised a method called fractional distillation in which the simple distillation (vaporizing and condensing) is repeated many times within the one device. After evaporating, the vapour enters a fractionating column. This may be a tube packed with glass fibres, a tube containing overlapping glass lips or plates, or simply coiled tubing as popularized by backwoods stills.

**FYI...ADDITIONAL INFORMATION for the "KEEN BEANS":**

The idea is to provide surfaces on which the vapours can condense. As the hot vapours from below reheat the distillate, some compounds re-vaporize and travel farther up the column. At the same time, others with higher boiling points drip back in the opposite direction. This process is called reflux. The plates become progressively cooler as you move up the column. Each time the process is repeated, the distillate becomes richer in the liquid with the lower boiling point. The component liquids thus proceed at different rates up the fractionating column so as you move higher up, the mixture becomes increasing richer in the liquid with the lower boiling point. If the column is long enough, the liquid components may separate completely and enter the condenser one after the other. There are of course several variations on this same technique.

Distillation is an important laboratory and industrial process (Figure 2.3.6). Oil refineries employ distillation to separate the hundreds of different hydrocarbons in crude oil into smaller groups of hydrocarbons with similar boiling points. **Chevron has an oil refinery in Burnaby and Husky has an oil refinery in Prince George.** When distilling a single batch, as described and illustrated above, the temperatures within the column continuously change as the chemicals travel through the column much like solutes travelling up a piece of chromatography paper. By contrast, oil refineries continuously feed the vaporized crude oil mixture into large steel fractionating towers that electronically monitor and maintain a steady range of temperatures from 400°C at the bottom to 40°C at the top. Each compound rises until it reaches a section of the column that is cool enough for it to condense and be withdrawn from the column. For example, the gasoline fraction (meaning the fraction containing gasoline, itself a mixture) exits near the top of the tower at the 40°C to 110°C level.
Separating an **insoluble solid**

How could you separate an insoluble solid like sand from a mixture of sand and water?

It is easy to separate an **insoluble** solid by **filtering** the mixture. The insoluble solid cannot pass through the filter paper but the water can. The sand that is trapped by the filter paper is called the **residue**. The water that passes through the filter paper is called the **filtrate**.

Separating a **soluble solid**

How could you separate a soluble solid, like salt, from a seawater solution?

To separate a **soluble** solid from a solution, **evaporation** can be used. The solution is **heated** so that the water evaporates and leaves the dissolved solid behind. (**Recrystallization**)

Separating **immiscible liquids**

Liquids that **DO NOT MIX** together are described as **immiscible**.

Can you think of any examples of immiscible liquids?

On a small scale, immiscible liquids can be separated by simply removing the top layer using a **pipette**. In laboratories, chemists use a **separatory funnel** to separate immiscible layers.

Separating **miscible liquids**

Liquids that **DO MIX** together are described as **miscible**.

An example of this is water and alcohol – these two liquids mix together easily.

Can you think of any more examples of miscible liquids?

How could you separate a mixture of miscible liquids? **Distillation**.
Distillation
The technique used to separate a liquid from a mixture is called distillation.

Distillation has three steps:
1. Evaporation
2. Condensation
3. Collection (of the distillate)

The solution is heated so that the liquid evaporates and is turned into a gas. Everything else is left behind. The gas cools in the condenser and turns back into a liquid, which can then be collected.

Could distillation be used to make seawater safe to drink? Yes.

Chromatography
Chromatography is used to separate the components of coloured or non-coloured substances that are soluble in the same solvent. A spot of the mixture is placed on some filter paper.

<table>
<thead>
<tr>
<th>How is a Chromatogram Produced?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage 1</strong></td>
</tr>
<tr>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td><strong>Stage 2</strong></td>
</tr>
<tr>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td><strong>Stage 3</strong></td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td><strong>Stage 4</strong></td>
</tr>
<tr>
<td><img src="image4.png" alt="Image" /></td>
</tr>
</tbody>
</table>
Identifying dyes in a mixture
Dots of single dyes are placed alongside a dot of ________________mixture.
The solvent washes up the paper, and then the pattern of the dyes in the mixture can be compared with
the single dyes.
Which dyes do the the following mixtures contain?
Example 1:  
Example 2:

Match each technique to the substances it is used to separate

<table>
<thead>
<tr>
<th>Technique</th>
<th>Substance to separate</th>
</tr>
</thead>
<tbody>
<tr>
<td>sieving</td>
<td>separating an insoluble solid from a liquid</td>
</tr>
<tr>
<td>filtering</td>
<td>separating solids of different sizes</td>
</tr>
<tr>
<td>distillation</td>
<td>separating a soluble solid from a liquid</td>
</tr>
<tr>
<td>evaporation</td>
<td>separating a mixture of two liquids</td>
</tr>
<tr>
<td>chromatography</td>
<td>separating a mixture of dyes</td>
</tr>
</tbody>
</table>

Which method could be used to separate each mixture?

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Substance to collect</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>glass and water</td>
<td>glass</td>
<td></td>
</tr>
<tr>
<td>sea water</td>
<td>salt</td>
<td></td>
</tr>
<tr>
<td>sea water</td>
<td>water</td>
<td></td>
</tr>
<tr>
<td>cooking oil and water</td>
<td>cooking oil</td>
<td></td>
</tr>
<tr>
<td>alcohol and water</td>
<td>alcohol</td>
<td></td>
</tr>
</tbody>
</table>

Assignment #8- Hebden pg 58-59 Questions #45-58 (odd)
All assignments are to be completed on a separate page with the assignment number & heading. Be sure to show ALL WORKING OUT for all homework.