Chapter 7: Kinetic Molecular Theory

7.1 States of Matter
7.1 KMT and Changes in State

Matter: anything with mass and volume

- **Mass**: quantity of matter that a substance or object contains (g or kg)
- **Volume**: amount of space taken up by a substance (mL, L, or cm³)
Circle the items below that are made up of matter.
Three States of Matter

Solid – *definite* volume and shape

Liquid – *definite* volume and *changing* shape

Gas – *changing* volume and shape
I. Particle Model of Matter

1) All matter is made up of very small particles

2) There are spaces between the particles

3) The particles in matter are always moving

4) The particles are attracted to one another
II. Kinetic Molecular Theory

• Matter, chemical changes and the states of matter are all part of chemistry

KMT...

• explains what happens to matter when the kinetic energy of particles changes

* Kinetic Energy is the energy of motion
Kinetic Molecular Theory...

1. All matter is made up of small particles

2. There is empty space between the particles

3. Particles are constantly moving. The particles are colliding with each other and the walls of their container.
SOLIDS: particles are tightly **packed**; particles **cannot** move around freely, **vibrating** in place

LIQUIDS: particles are slightly **further** apart; particles can **slide** by each other

GASES: particles are further **apart** and **moving** quickly; particles can move **freely**
Kinetic Molecular Theory...

4. **Energy** makes particles move. The more energy the particles have, the **faster** they can move and the **farther** apart they get.
IV. Thermal Expansion and Contraction

- When **temperature** increases, **kinetic** energy increases
- Particles move **faster** and over a **larger** region requiring more **space** between particles
- Substance “**expands**” – increasing in **volume**
- When temperature **decreases**, kinetic **energy** decreases
- Particles **slow down** and take up less **space**
- Substance “**contracts**” – decreasing in **volume**
V. Temperature vs. Heat

- **Thermal Energy**: total energy of all the particles in a substance
- **Heat**: the **transfer** of thermal energy from a **hotter** material to a **cooler** one
- **Temperature**: **average** kinetic energy of the particles
VI. Change of State
• **Melting point** is the temperature at which **solid** turns to **liquid**.

• **Boiling point** is the temperature at which **liquid** turns into **gas**.
7.2 Fluids and Density
I. Solid, Liquid and Gas Density

- **Fluid:** matter than can **flow** (liquids or gases – not **solids**)!

- **Density:** **mass** of a given **volume** (how closely packed particles are)
• Most substances are more dense in solid form than liquid form...except water
• Water molecules move slightly apart when they lock into place in ice crystals
• This is why ice floats on water
II. Layering and Measuring Density

• Less dense material **floats** on top of more dense material

• If an object:
  o floats in a fluid – **less** dense
  o hovers in place – **same** density
  o sinks in a fluid – **more** dense
III. Measuring volume

Use a ruler for regularly shaped objects

Volume = length \times width \times height

(measured in cm^3)
Use Displacement for irregularly shaped objects

- **submerge** object in a fluid and measure the change of **volume** in the fluid
- the volume of the object is the same as the **change** in fluid volume
IV. Calculating Density

\[
\text{density} = \frac{\text{mass}}{\text{volume}}
\]

or, in short form:

\[
d = \frac{m}{V}
\]
1) A 5 mL sample of motor oil has a mass of 4.5 g. What is the density of the motor oil?
2) A carver begins work on a block of granite that measures 20 cm by 10 cm by 5 cm. If the block of granite has a mass of 2700g, what is the density of the granite?
3) Aluminum has a density of 2.7 g/cm³. What is the mass of a 15 cm³ block of aluminum?
4) Table salt has a density of 2.16 g/mL. How many millilitres of salt would you have in a 500 g package?
Section 7.3 Describing Matter

I. Properties of Matter

• **Properties** (or characteristics) are used to differentiate one type of matter from another.
  
  – **PHYSICAL** properties can be observed or measured and are broken down into two groups: **qualitative** and **quantitative**.
• **QUALITATIVE**: properties that can be described but not measured
e.g. state, colour, **malleability** (pound into sheets), **ductility** (pull into wires), crystallinity, magnetism
• **QUANTITATIVE**: properties that can be measured using numbers
  
e.g. solubility (dissolves in water), conductivity, viscosity, density, melting/freezing point, boiling/condensing point
• Matter can be organized in different types.

• A **PURE SUBSTANCE** is a substance made up of only one kind of matter.
  
  Ex. gold, water, and oxygen.
• An **element** is a pure substance that cannot be broken down or separated into simpler substances.
  
  Ex. gold and oxygen. Water is NOT an element because it can be broken down into hydrogen and oxygen

• A **compound** is a pure substance composed of at least two elements combined in a specific way.
  
  Ex. water.
• A **mixture** is more than one substance combined together

Either

• Element and element
• Element and compound
• Compound and compound
State whether the following are an element, a compound, a mixture of two elements, a mixture of two compounds, or a mixture of an element and a compound.
II. Matter can also change:

**Physical Change**

- The properties will remain the same (or can return to the original)
- No new substance is produced
- Can easily change back
- Examples: change of state, dissolving, mixing
Chemical Change

- Product (what you end with) is **different** from the reactant (starting matter)
- Hard or impossible to **reverse**
- Examples: new **colour**, heat or **light** given off, **bubbles**
• Circle the physical changes: