

# Unit 6: Stuff (Physical Properties of Matter)

## Essential Questions

How is matter characterized?

How do properties provide evidence of the identity of materials?

How do changes affect the properties, identities, and interactions of matter?

How do the various atomic models compare with current scientific evidence?

How do models in science change over time?

## Instructional Goals

*By the end of this unit, you should be able to do the following:*

### 1. Mass

Develop a definition for mass of an object.

Use a multiple beam or double-pan balance to determine the mass of various objects.

Record the value of an object's mass in a manner consistent with the limit of precision of the balance.

Develop, from experimental evidence, the law of conservation of system mass.

### 2. Volume

Develop an operational definition for the volume of an object.

Given a regular solid object, determine its volume by measuring lengths and using the mathematical models ( $V = l \cdot w \cdot h$ ,  $V = A \cdot h$ ).

Given an irregular solid, determine its volume by water displacement.

Relate the various units (mL,  $\text{cm}^3$ , and  $\text{m}^3$ ) for volume.

Relate the volume of a container (in  $\text{cm}^3$ ) to the volume of liquid it contains (in mL).

### 3. Density

Define mass as the measure of “stuff” or amount of matter in object; contrast with volume - the amount of space an object occupies.

Given a graph of mass vs. volume of a various substances, relate the slope to the density of the substances.

Recognize that density is a characteristic property of matter (i.e., it can be used to help identify an unknown substance).

Use differences in density of solids, liquids and gases as evidence for differences in the structure of matter in these phases.

### 4. Particle model of matter

Visualize matter as composed of tiny BB-like particles.

State the basic tenets of Kinetic Molecular Theory (KMT) as they relate to gases:

Particles of a gas:

- are in constant motion, moving in straight lines until they collide with another particle or a wall of the container in which they are enclosed.
- experience elastic collisions; i.e., they do not eventually “run down”.
- do not stick to other particles.

Recognize that differences in density are due to different *kinds* of particles (with roughly the same size) rather than by greatly different *numbers* of them in a sample.

### 5. Physical properties of matter

Relate the physical properties of solids, liquids and gases to the arrangement of the particles that make up the sample.

Describe the characteristics of solids, liquids and gases in terms of particles and their:

- Arrangement: use particle diagrams to account for motion and density differences; describe the process of how the arrangement of matter particles changes during phase changes.
- Attraction: infer the necessity of an attractive force between particles at close range from observations of differences in cohesiveness of the three phases;
- Behavior: describe and contrast particle motion in the three phases singly, and in phase changes.

Distinguish between pure substance and mixtures

- A pure substance has a definite set of characteristic properties (density, mp, bp), whereas a mixture exhibits properties that are a mixture of the properties of the substance they contain.
- A pure substance is composed of one kind of particle, whereas mixtures contain more than one kind of particle.

Describe how one could use differences in characteristic properties to separate the components of a mixture.

Sketch particle diagrams that distinguish compounds, elements and mixtures

## Sequence

1. Activity 1 – Mass of steel wool
2. Activity 2 – Mass of dissolved sugar
3. Activity 3 – Mass of ice and water
4. Activity 4 – Defining volume
5. Activity 5 – Volume relationships
6. Activity 6 – Volume of solids by displacement
7. Exercise 1 – Volume
8. Exercise 2 – Volume
9. Activity 7 – Density of a solid
10. Exercise 3 – Identifying Materials
11. Quiz 1 – Density of solids
12. Activity 8 – Density of liquids
13. Exercise 4 – Applied Density Problems
14. Quiz 2 – Density of liquids
14. Activity 9 – Density of gases
15. Exercise 5 – Density of gases
16. Practicum – Thickness of a thin layer
17. Test – Density
18. Demo/Discussion – Phases of matter
19. Demo/Discussion – Diffusion of gases
20. Demo/Discussion – Diffusion of liquids
21. Demo/Discussion – Particle motion in solids
22. Demo/Discussion – Substance vs mixture
23. Exercise 6 – Substance vs. Mixture
24. Demo/Discussion – Definite composition of compounds
25. Quiz 3