6th Grade
Introduction to Chemistry

Chapter 1: Introduction to Matter

Lesson 1 (Describing Matter)

Matter – anything that has mass and takes up space
– All the "stuff" in the natural world is matter.

Chemistry – the study of matter and how matter changes

Substance – a single kind of matter that is pure, meaning it always has a specific makeup, or composition.
– That composition gives it specific properties.

Examples: *Table salt has the same composition and properties whether it comes from seawater or salt mines.*

Water, sugar, baking soda, iron, lead are other examples.

Every form of matter has two kinds of properties.

Physical property – a characteristic of a pure substance that can be observed or measured without changing it into another substance.

Examples:

boiling point	freezing point	melting point
density	color	shape
weight	mass	size
texture	hardness	flexibility
temperature	state of matter (solid, liquid, or gas)	
ability to conduct heat or electricity		

Chemical property – a characteristic of a substance that describes its ability to change into different substances.
– To observe the chemical properties of a substance, you must try to change it into another substance. (They cannot be observed just by looking at the substance.)

Examples: rusting
tarnishing
flammability
light sensitivity

Lesson 2 (Classifying Matter)

All matter in the universe is made of more than 100 different substances called elements.

Element – a pure substance that cannot be broken down into any other substance by chemical or physical means (methods)
– They are the simplest substances.
– Each element has different physical and chemical properties which can be used to identify it..
– Elements are represented by 1 or 2 letter **chemical symbols**. (C, O, Na, Cl, etc.)

Examples: Iron, Carbon, Hydrogen, Lead, Nitrogen, chlorine

Atom – the basic particle from which all elements are made

– Different elements have different properties because their atoms are different.

– Atoms of most elements can combine with other atoms by forming **chemical bonds**.

Chemical bond – a force of attraction between two or more atoms to form a **molecule**.

Molecule – a group of 2 or more atoms held together by chemical bonds

– A molecule can be made of different elements or atoms of the same element.

Examples: A molecule of water (H_2O) is an oxygen atom bonded with 2 hydrogen atoms.

An oxygen molecule is 2 oxygen atoms bonded together (O_2).

Compound – a pure substance made of 2 or more elements that are chemically combined in a set ratio

Chemical formula – a combination of symbols that shows the elements in a compound and their proportions (or ratios).

Examples: H_2O has a 2:1 hydrogen to oxygen ratio.

CO has a 1:1 ratio.

H_2SO_4 has a 2:1:4 ratio.

H_2O_2 has a 1:1 ratio.

When elements combine, they form compounds having different properties than the original elements.

Example: Hydrogen and oxygen are both gases, but water (H_2O) is a liquid.

Mixture – made of two or more substances that are together in the same place but whose atoms are not chemically combined.

– Each substance in a mixture keeps its own properties (no new substances are formed) and is not combined in a fixed ratio.

– Mixtures can be easily separated back into the original substances: compounds are hard to separate back into elements.

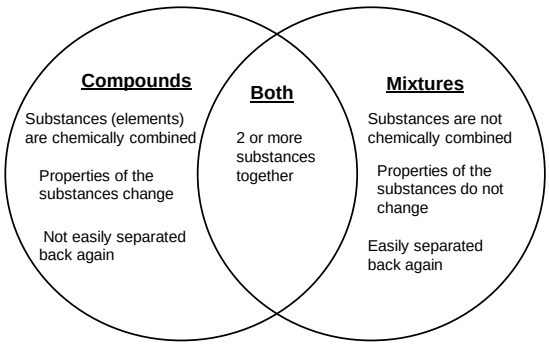
Heterogeneous mixture – you can usually see the different parts and they can be easily separated out.

Examples: sand
spaghetti sauce
soil
a salad

Homogeneous mixture – the pure substances are so evenly mixed that you cannot see the different parts.

Examples: air
stirred salt water
stirred Kool Aid
smooth ice cream

Comparing Compounds and Mixtures:



Separating Mixtures:

evaporation – process by which molecules at the surface of a liquid absorb enough thermal energy (heat) to change to a gas, leaving any solids behind.

distillation – process of evaporating water from a solution and condensing the vapor back into a liquid.

filtration – separating solids from a liquid by pouring the mixture through a porous material (filter).

magnetic attraction – using a magnet to remove iron-containing particles from a mixture.

physical separation – picking the objects out of a heterogeneous mixture by hand.

Lesson 3 (Measuring Matter)

International System of Units (SI) – the metric system (based on units of ten)

Length – the distance between two points

measured in: millimeters (mm)
centimeters (cm)
decimeters (dm)
meters (m)
decameters (dam)
hectometers (hm)
kilometers (km)

largest → *smallest*

km ***hm*** ***dam*** ***m*** ***dm*** ***cm*** ***mm***

Converting SI Units (sample problems)

1 km = 1,000 m	1 m = 10 dm
1 m = 100 cm	1 m = 1,000 mm
1 cm = 10 mm	1 km = 100,000 cm
24 m = 2,400 cm	36,000 mm = 36 m
52,760 m = 527,600 dm	3,500 cm = 35 m
6,500 mm = 6.5 m	1 mm = 0.1 cm
56 cm = 560 mm	500 mm = 50 cm
600 mm = 0.6 m	160 m = 16,000 cm
1,200 mm = 120 cm	13.6 mL = 13.6 cm^3
160 m = 160,000 mm	240 m = 2,400 dm
1,450 kg = 1,450,000 g	350 mm = 35 cm
1dm = 100 mm	150,000 g = 150 kg
111cm = 1,110 mm	112 mm = 11.2 cm
1,660 m = 166,000 cm	44,000 mL = 44 L

Weight – the force of gravity on an object
– measured with a scale
– Earth has more mass than the moon, therefore has a greater gravitational pull than the moon – making you weigh more on Earth than on the moon.

Mass – the amount of matter in an object
– measured on a **triple beam balance**
– Mass is constant. (Does not change with location).
– The most common units are grams and kilograms. (Also have *hg*, *dag*, *dg*, *cg*, *mg.*).

Volume – the amount of space matter takes up
– Common units **for solids** are cubic meters (***m^3***) and cubic centimeters (***cm^3***).
– Common units **for liquids** are liters (***L***) and milliliters (***mL***).

Finding the volume of rectangular solids:
volume = length x width x height

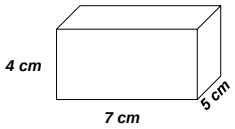
Finding the volume of a liquid:
Use a **graduated cylinder**.

One *mL* of liquid takes up the same amount of space as a 1 cm^3 solid. (A milliliter and a cubic centimeter are equal volumes.)

1 *mL* = 1 cm^3

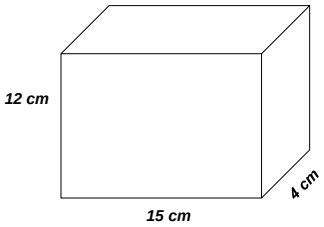
Calculating Volume: (sample problems)

A box is 4 cm high, 7 cm long, and 5 cm wide. What is the volume inside the box?



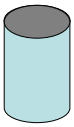
4 x 7 x 5 = 140 cm^3

A box is 12 cm high, 15 cm long, and 4 cm wide. What is its volume?



12 x 15 x 4 = 720 cm^3

A glass has a volume of 144 cm^3. What is its volume in mL?

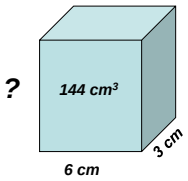


1 cm^3 = 1 mL

so

144 mL

A box has a volume of 144 cm^3, a length of 6 cm, and a width of 3 cm. What is its height?



6 x 3 x h = 144 ⟶ 18 x h = 144 ⟶ 144÷18 = h = 8 cm

Finding the Volume of an odd-shaped object:

– Submerge the object in water and record how much the water level changes.

– This will be the volume of the object in *mL*.

– This must be converted to cm^3 for a solid object.

1 *mL* = 1 cm^3

Density – a measure of the mass of a material in a given volume

– describes the number of grams in one cubic centimeter – or ***g/cm³***.

$$density = \frac{mass}{volume}$$

Calculating Density: (sample problems)

An object has a mass of 16 g, and a volume of 10 cm^3. What is its density?

d = m/v d = 16g/10cm³ d = 1.6 g/cm³

An object has a density of 6 g/cm^3 and a volume of 36 cm^3. What is its mass?

d = m/v 6 g/cm³ = m/36 cm³ 6 x 36 = m m = 216 g

An object has a density of 12 g/cm^3 and a mass of 132 g. What is its volume?

d = m/v 12 = 132/v v = 132/12 = 11 cm³

Density: 26 g/cm^3 Mass: 364 g

What is its volume if it is a liquid?

d = m/v 26 = 364/v v = 364/26 = 14 mL

(mL because it is a liquid)

Mass: 28 g Volume: 3 cm^3 What is its density?

d = m/v d = 28g/3cm^3 = 9.3 g/cm^3

Mass: 36 kg Volume: 12 cm^3 What is its density?

d = m/v d = 36,000g/12cm^3 = 3,000 g/cm^3

Float or Sink?

– The density of water is **1 *g/cm^3*** (or **1 *g/mL***).

– Objects with densities greater than that will sink.

– Objects with densities less than 1 *g/cm^3* will float.

Lesson 4 (Changes in Matter)

Physical change – alters the form or appearance of matter, but does not turn any substance in the matter into a new substance.

– A substance that undergoes a physical change is still the same substance after the change.

Examples: melting, bending, freezing, evaporating, breaking, dissolving,

Chemical change – a change in matter that produces one or more new substances.

– The new substances have new and different properties.

Examples:

Combustion – lighting of a fuel that produces new substances.

Electrolysis – use of electrical current to break apart a compound.

Oxidation – combining with oxygen to create a new substance.

Tarnishing – a bright metal slowly combining with sulfur in the air to create a new substance that results in a dark coating on the metal.

Law of Conservation of Mass (or matter)

– Matter is not created or destroyed in any physical or chemical change.

– During a chemical change, atoms are not lost or gained, only rearrange to make new substances.

Energy – the ability to do work or cause change

– Every chemical or physical change in matter involves a change in energy because energy is required for the change or energy is produced during the change.

Temperature – a measure of how hot or cold something is

– Particles of a warmer object are moving faster (have more energy) than the particles in a cooler object.

Thermal energy – the total energy of all the particles in an object

– not the same as temperature

– is often released (given off) or absorbed (taken in) when matter changes

– Thermal energy flows from warmer matter to cooler matter.

Endothermic change – a change in which energy is taken in, or absorbed

Example: When ice melts, the ice is absorbing heat, or thermal energy.

Exothermic change – a change in which energy is given off, or released

Example: When paper is burned, heat (thermal energy) is given off (released).

Chemical energy – the energy stored in the chemical bonds between atoms

– Chemical energy can change into other forms of energy, and other forms of energy can change into chemical energy.

Law of Conservation of Energy – Energy cannot be created or destroyed, only changed to other forms.