

You have mastered this topic when you can:

- 1) define the terms CHEMISTRY, ELEMENT, ATOM, COMPOUND, MOLECULE, ION, MATTER, MASS, WEIGHT and INERTIA.
- 2) define the terms EMPIRICAL KNOWLEDGE, THEORETICAL KNOWLEDGE and PURE SUBSTANCE.
- 3) describe and give examples of the variety of forms that MATTER can exhibit.
- 4) classify ELEMENTS as METAL, NON-METAL or METALLOID, and locate them and each category on the PERIODIC TABLE.
- 5) predict the METALLIC character of an ELEMENT based upon its position in the PERIODIC TABLE.

WHAT IS CHEMISTRY? [pg. vii]

1) **CHEMISTRY is the science devoted to the study of the composition (structure) of, properties of, and interactions of MATTER.** Matter consists of varying combinations of four kinds of *particles*: ATOMS, COMPOUNDS, MOLECULES and IONS. At its essence, *chemistry is the study of these four particles.* Chemistry is a science therefore everything a chemist has learned about *matter* was discovered through experimentation and explanation of the experimental results. Experiments require scientists to make detailed observations, which are then used to explain the nature of *matter*.

A) Chemists gain knowledge by conducting experiments. There are two kinds of knowledge: EMPIRICAL and THEORETICAL.

1) **EMPIRICAL KNOWLEDGE** _____.
Empirical knowledge consists of the *observations* and *results* scientists collect by conducting experiments. *Empirical knowledge* is *observable* which means it can be seen and measured.
 i.e. Cooking liquid egg whites causes them to become a white solid. This knowledge can be observed.

2) **THEORETICAL KNOWLEDGE** _____.
 _____.
Theoretical knowledge is *not observable* which means it cannot be seen and measured.
 i.e. Egg whites turn solid when heated because the heat breaks apart its protein molecules. Chemists cannot see a molecule, which means they are theorizing that the molecules break apart when the egg is cooked.

3) **Required Practice 1:** Classify these statements as *empirical* or *theoretical knowledge*. {Answers are on page 4 of these notes.}

1. Carbon atoms are composed of subatomic particles called protons, electrons and neutrons.
2. Carbon is found in several forms in nature: e.g. Charcoal, graphite and diamond.
3. Graphite conducts electricity while diamond does not.
4. Graphite conducts electricity because its electrons are not tightly bound to their atoms.

B) For convenience, most experiments are conducted at SATP = *Standard Ambient Temperature and Pressure* = 25°C and 100.00 kPa ← **MEMORIZE THESE CONDITIONS!!** SATP is sometimes called RTP = Room Temperature and Pressure. Chemists sometimes use a set of conditions known as STP = *Standard Temperature and Pressure* = 0°C and 100.00 kPa ← **MEMORIZE THESE CONDITIONS!!**

ELEMENTS AND THE PERIODIC TABLE [VIII.2, pgs. 158 – 165]

1) **Matter** exists in an infinite variety of forms, shapes and structures, the most basic and important of which are ELEMENTS [IV.1, pgs. 65 – 67]. People have used *elements* for many thousands of years: e.g. copper, gold and silver were used to make jewelry; tin, copper and iron were used to make tools and weapons.

A) **Elements** are PURE SUBSTANCES. *A PURE SUBSTANCE is a substance that is composed of one kind of particle* (this is a *theoretical* definition because it is a non-observable *explanation*). Since *elements* are *pure substances*, and a *pure substance* is composed of one kind of particle, *elements* are composed of one kind of *particle* (this is a *theoretical* definition it is a non-observable *explanation*) that cannot be broken down into simpler particles by chemical processes (this is an *empirical* definition it can be observed). *Elements* are

composed of *particles* called the *ATOMS*. To date more than 100 *elements* have been identified and studied, each with its own uniquely structured *atom*. *Elements* have been organized according to their structure and properties in one of the most useful tools in science: The **PERIODIC TABLE of ELEMENTS** [Bottom of pg. 161]. **Your periodic table is at the end of these notes.** Do not use any other for this course. **NUMBER THE TOP OF EACH COLUMN OF YOUR PERIODIC TABLE 1 – 18.**

B) There are four major categories of *elements*: **METALS, NON-METALS, METALLOIDS** and **NOBLE GASSES**. Each category is identified by its unique combination of *physical properties*. **PHYSICAL PROPERTIES** are characteristics such as hardness, state at SATP or STP, melting point, boiling point, density, volume at SATP or STP, electrical conductivity, etc.

1) **METALS** are located to the left of the thick highlighted ‘staircase’ on your periodic table.

Physical Properties (MEMORIZE THESE PROPERTIES!!):

2) **NON-METALS** are located *between* the staircase and the most right hand column of the periodic table.

Physical Properties (MEMORIZE THESE PROPERTIES!!):

3) **METALLOIDS** (aka *semi-metals*) are B, Si, Ge, As, Sb, Te, & Po.

Physical Properties (MEMORIZE THESE PROPERTIES!!):

4) **NOBLE GASSES** are the elements in the far right column of the *periodic table*: He, Ne, Ar, Kr, Xe & Rn.

Physical Properties (MEMORIZE THESE PROPERTIES!!):

C) **Required Practice 2:** Answer these questions on your own paper. {Answers are on pages 4 & 5 of these notes.}

1. Explain the terms *SATP* and *STP*.
2. Define the term **pure substance**. Is yours an *empirical* or *theoretical* definition? Explain.
3. List the names and symbols of any three *metals* and state their common *physical properties*.
4. Which *metal* is not a solid at *SATP*?
5. List the names and symbols of any three *non-metals* and state their common *physical properties*.
6. Identify which *non-metals* are solids, which are liquids and which are gasses at *SATP*?
7. List the names and symbols of any three *noble gasses* and state their common *properties*.

III) BY DEFINITION MATTER IS _____.

A) **VOLUME** _____.B) **MASS** _____.

(this is an **empirical** definition because it can be observed). The more material an object is composed of the more **mass** it has, similarly, the more **mass** an object has the more material it is composed of. An elephant has more **mass** than a mouse because it contains more material. **Mass is the property of matter that gives an object WEIGHT and INERTIA** (this is a **theoretical** definition because it is a non-observable explanation).

1) **WEIGHT** _____.

(this is a **theoretical** definition). Essentially, an object has **weight** because gravity pulls its **mass** (material) toward the centre of the earth. **Mass** is measured with the unit **grams** symbolized **g**, while **weight** is measured with the unit **dyne**: **i.e.** A 1.0 g mass has a weight of 1.0 dyne. **Weight** and **mass** are so closely related to each another that they are often mistaken as the same thing. **THEY ARE NOT. REMEMBER: Mass is the amount of material an object is composed of. Weight is the force of gravity (pull) on an object's mass. i.e.** On earth, a chocolate bar has a **mass** of 60 g and its **weight** is 60 dyne. **NOTICE** that the chocolate bar's **mass** and its **weight** share the same number, 60. If an astronaut takes the chocolate bar to the moon, it has not lost or gained any material thus its **mass** is still 60 g. However, the moon's gravity is 1/6 that of the Earth's, which means the chocolate bar's **weight** is 10 dyne: **i.e.** 60 dyne • 1/6 = 10 dyne.

2) **INERTIA** _____.

This means a moving object will continue to move at a constant speed in a straight line until a force (push or pull) causes its speed or direction to change. **e.g.** A car traveling at 100 km/h on highway 1 will continue to move at 100 km/h in a straight line until its breaks are applied causing its speed to decrease, or the accelerator is applied causing its speed to increase, or the steering wheel is moved causing its direction to change. An object sitting motionless will remain sitting motionless until a force (push or pull) causes its lack of motion to change. **e.g.** Your text sitting motionless on the table will remain sitting motionless on the table until you apply a force to pick it up or push it away.

C) **Required Practice 7:** Answer these questions on your own paper. {Answers are on page 5 of these notes.}

1. Define or describe the term **matter**.
2. How are **mass** and **weight** different and how are they similar?
3. Use examples not given in the notes to explain the term **inertia**.

IV) **Required Practice 8:** Colour your periodic table as indicated below.

1. Colour the **hydrogen = H** yellow.
2. Colour the **metalloids** purple.
3. Colour the **metals** in columns 3 – 17 a shade of blue.
4. Colour the **metals** in columns 1 & 2 different shades of blue.
5. Colour the **non-metals** in columns 13 – 16 a shade of green.
6. Colour the **non-metals** in column 17 a different shade of green.
7. Colour the **noble gasses** in column 18 orange.
8. Colour the **lanthanides and actinides** rows red.

V) **Required Practice 9:** Complete the **Self-Test** at the bottom of page 66 of Hebden. {Answers are on page 263 of Hebden.}**ANSWERS TO THE REQUIRED PRACTICE****Required Practice 1 from page 1:** 1. Theoretical. 2. Empirical. 3. Empirical. 4. Theoretical.**Required Practice 2 from page 2**

1. SATP means standard ambient temperature and pressure which is 25°C and 100.00 kPa. STP means standard temperature and pressure which is 0°C and 100.00kPa. 2. A pure substance is a substance composed of one kind of

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particle. This is a theoretical definition because it is not based on observation. **3.** Any element found to the left of the bold staircase on the periodic table. Metals have these properties: solid at SATP (except Mercury which is a liquid at SATP), have relatively high melting and boiling points, good conductors of electricity, malleable, ductile and lustrous. **4.** Mercury, symbolized Hg. **5.** Any element found between the bold staircase and the most right hand column on the periodic table. Non-metals have these properties: they exist as gasses (N, O, F & Cl), liquids (Br) or solids (C, P, S, Se, I & At) at SATP, have relatively low melting and boiling points, tend to be dull, brittle and poor conductors of electricity. **6.** At SATP N, O, F, & Cl are gasses, Br is a liquid, and C, P, S, Se, I & At are solids. **7.** Noble gasses are the elements in the right hand most column of the periodic table: He, Ne, Ar, Kr, Xe & Rn. They have extremely low melting and boiling points, are all gasses at SATP and they are non-reactive.

Required Practice 4 from page 3

1. Neon. 2. Aluminum. 3. Lithium. 4. Phosphorus. 5. Potassium. 6. Mercury.

Required Practice 4 from page 3

1. Lithium is a metal; Fluorine is a non-metal. 2. Nitrogen is a non-metal; Sulphur is a non-metal. 3. Carbon is a non-metal Hydrogen is a non-metal; Oxygen is a non-metal. 4. Copper is a metal; Iodine is a non-metal. 5. Sodium is a metal; Phosphorus is a non-metal; Oxygen is a non-metal. 6. Cobalt = M; Chromium = M; Oxygen = N-M.

Required Practice 5 from page 3

1. Molecule; composed of one kind of non-metal element. 2. Molecule and compound; composed of two different non-metal elements. 3. Compound; composed of three different elements; Not a molecule because it contains a metal element. 4. Molecule and compound; composed of two different non-metal elements. 5. Molecule; composed of one kind of non-metal element. 6. Compound; composed of three different elements; Not a molecule because it contains a metal element.

Required Practice 6 from page 3

1a. Atoms are defined as the smallest particles of matter that can interact chemically. 1b. Compounds are particles composed of atoms of two or more different kinds of elements. 1c.) Molecules are particles composed of two or more non-metal atoms. 1d. An ion is a positively or negatively charged particle. 2a. atom 2b. molecule 2c. ion 2d. compound 2e. molecule & compound 2f. molecule 2g. molecule & compound 2h. ion 2i. compound 2j. compound 2k. ion 2l. molecule & compound

Required Practice 7 from page 4

1. Matter is anything that has mass and volume. 2. Mass and weight are different in that Mass is the amount of material in an object while weight is the force of gravity on the material in an object. Mass and weight are similar in that they are dependent upon the amount of material of which an object is composed: i.e. the more material in an object the more mass and weight it has. 3. See your teacher.
