Matter and Changes

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Section A

Chemistry: explains matter and the changes it undergoes.

Technology: is the application of science to solve practical problems.

Matter: is defined as anything which occupies space and has mass. All types of matter can be classified under the three headings: **solids, liquids and gases.** These three headings are known as the **three states** of matter.

$solid_{(s)}$, $liquid_{(l)}$, $gas_{(g)}$

We may consider the properties of a material to help us to decide in which state the material is:

- molecular model
- structure
- shape
- strength of attractive forces

The **macroscopic** level refers to how we perceive matter with our eyes, however, the **microscopic** level describes matter in terms of atoms and molecules and their behaviour.

Section B

The Scientific Method

Science uses a unique method to investigate nature. The method is called the scientific method and can be summarized in **five steps**:

1. **Observation:** The first step in the scientific method consists of observation.
   a. Qualitative: Consists of observation without any measurement, only appearance, odour, colour, etc. is involved.
   b. Quantitative: Consists of measurement with numbers that indicate how much, how fast, how small, etc.

2. **Experimentation:** Makes it possible to "observe" the facts.

3. **Hypothesis:** Form an opinion (or a supposition) based on the observed facts, as to why things work the way they do. Often, the hypothesis is "an educated guess", a tentative explanation of the observed facts.

4. **Theorization:** Make a theory out of the hypothesis. The theory explains a set of observed results which are always the same regardless of how many times an experiment is performed. After a sufficient time (many years), the theory becomes a "law" of science.

5. **Communication:** Dissemination of the knowledge gained is important so that other scientists can test out the new theory thereby proving or disproving it. This communication is usually done through lab reports, journals, and periodicals.

Section C
Physical and Chemical Properties

Physical Property: can be determined without causing a change in the composition of a substance, e.g. state (gas, solid, liquid), density, bp, colour, etc.

Chemical Property: the behaviour of a substance during a chemical (i.e. those changes which involve changing various kinds of matter into other substances with different compositions, different structures and different properties).

Characteristic:

Intensive:

Extensive:

Solution:

Catalyst:

Inhibitor:

Crystalline:

Amorphous:

Section D
Physical and Chemical Changes in Matter

It is possible to change matter from one state into another.

Physical changes:

- Change of state, (solid, liquid, gas) or change of appearance without a change in chemical composition.
- Original materials retained.
- No heat liberated (*exothermic*) or absorbed (*endothermic*), but heat can be added or removed to change state, e.g. evaporation, freezing, etc.
- Physical means of separation, e.g. magnetism, sedimentation, flotation, solution, etc.
- Use terms such as: melting, freezing, condensation, dissolving, boiling, mixing, cutting, grinding, tearing, chopping, etc.
- Change is reversible, e.g.: ice $\longrightarrow$ water $\longrightarrow$ ice

Chemical Changes:

- Change in appearance **with** a change in chemical composition.
- Formation of new materials.
- Heat either absorbed or liberated in chemical reaction.
- Chemical means of separation, e.g. synthesis, decomposition, etc.
- Use terms and descriptions such as: burning, cooking, digesting, rusting, corroding, growing, reacts with, tarnishing, etc.
- Change is irreversible, e.g.: burning log $\longrightarrow$ ashes

When a chemical change occurs, there is usually some evidence such as a change in colour, change in temperature or mass of the reacting substances, evolution of a gas, or formation of a precipitate (insoluble solid produced after chemical reaction).

Section E
Classification of Matter

As there are many different kinds of matter, it seems sensible to divide them up into groups on the basis of their properties.

System: the particular collection of materials which is isolated for experimental study.

Phase: is a physically separate part of a material having a uniform set of properties.

Composition: refers to the parts or components of a sample of matter and their relative proportions.

Properties: are those qualities or attributes that we can use to distinguish one sample of matter from another.

Pure Substance: is a homogeneous (uniform) material consisting of one particular kind of matter (one phase). Elements and compounds are pure substances.

Atoms: matter is built up from very tiny units called atoms, presently there are there are 114 different types of atoms and all matter is made up of just these 114 types!

Elements: are pure substances that cannot be decomposed into anything simpler by chemical means - they contain just one type of particle (atoms). An element is represented by a symbol and can be in any phase. There are 114 elements known so far. The elements are classified as metals and non-metals.

Compounds: are substances in which atoms of different elements are combined with one another.

Elements and compounds are often called substances.

Molecule: is the smallest entity having the same proportions of the constituent atoms as does the compound as a whole.

Mixtures: are composed of two or more substances each of which retains its own characteristic

properties- i.e. they contain different types of particles which are physically mixed (each of the components of a mixture retain their properties), rather than chemically joined. A mixture is a heterogenous blending of two or more substances, e.g.: sand and salt. A mixture can be separated by simple physical changes. The constituents of a mixture join in variable proportions. Mixtures can exist in one or more phases (heterogeneous).

Homogeneous Mixtures: substances are composed of a single phase, and are uniform in composition and properties throughout a given sample.

Heterogeneous: substances are composed of more than one phase - the components separate into distinct regions. Thus, the composition and physical properties vary from one part of the mixture to another.

Section F

The Law of Constant Composition

The Law of Constant Composition states that in a particular compound the elements are always present in the same proportion by mass.

The composition of a compound is often given in terms of percentages by mass.

Sample Problem

Two students, Jill and Jack, each prepared a compound in the Colonel By Reaction Machine, containing only the elements copper and oxygen. A sample of each compound was then analysed and the results are shown in **Table I**.

Data Collection: Table I

Student	Mass of copper in sample (g)	Mass of oxygen in sample (g)	Total mass of copper oxide (g)
Jill	1.250	0.310	1.560
Jack	2.880	0.360	3.240

Data Analysis: To calculate the percentage composition by mass in each sample.

Jill:

$$\%\ \text{copper} = \frac{\text{mass of copper}}{\text{total mass of sample}} \times 100$$

$$= \frac{1.250\text{g}}{1.560\text{g}} \times 100$$

=

$$\%\ \text{oxygen} = \frac{\text{mass of oxygen}}{\text{total mass of sample}} \times 100$$

$$= \frac{0.310\text{g}}{1.560\text{g}} \times 100$$

=

Jack:

% copper =

% oxygen =

Examine the results of your calculations. Do you believe that these were samples of the same compound? Explain.

Answer the following questions. Show all your work and pay attention to sig figs.

1. A 275.00 g sample of a compound containing sodium, nitrogen and oxygen was found to contain 74.42 g of sodium and 155.29 g of oxygen. A second sample, also containing sodium, nitrogen and oxygen was found to consist of 147.21 g of sodium, 89.60 g of nitrogen and 307.20 g of oxygen. Determine if these were samples of the same compound.

2. A chemist was analysing two different samples of a K, Cl, and O compound. In the first sample, having a mass of 367.80 g, she found 117.30 g of K and 106.50 g of Cl. In the second sample, she found 117.30 g of K, 106.50 g of Cl and 96.00 g of O, so she decided they were, in fact the same compound. Was she correct? Prove it!