IDX G9 Chemistry N
Study Guide Issue 2
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Contents:

Chapter 1: Introduction to Chemistry

The Scope of Chemistry

- **Chemistry** is the study of the **composition** of **matter** and the **changes** that matter undergoes.
    - Chemistry is also known as the central science, because it is fundamental to the understanding of the other sciences.
        - Biology, agriculture, geology, archaeology, ecology, engineering
    - There are many jobs related to chemistry
        - Wetland ecologists, engineers, archaeologists, biologists, food scientist, artist, hair stylist, geologist, firefighter, policeman, farmer
- **Matter** is anything that has mass and occupies space.
- **Composition** is the chemical identity of the substance.
- **Changes** that matter undergo can be physical change or chemical change.
    - (Concepts about physical change and chemical change are in Chapter 2)

Areas of Chemistry Study

- **Organic chemistry** — the study of all chemicals containing **carbon**.
    - Examples: Pharmaceuticals, plastics
    - Exceptions: Everything contain carbonate (carbon dioxide)
- **Inorganic chemistry** — The study of chemicals that, in general, do **not** contain **carbon**.
    - Examples: Minerals, metals and nonmetals, semiconductors
    - Everything contain carbonate = inorganic
        - Example: Carbon dioxide
- **Biochemistry** — The study of **processes** that take place in living organisms.
    - Examples: Metabolism, fermentation
- **Analytical chemistry** — the study that of uses on the **composition** of matter.
    - Examples: Food nutrients, quality control
- **Physical chemistry** — The area that deals with the **mechanism**, **rate**, and **energy transfer** that occurs when matter undergoes a change.
    - Examples: Reaction rates, reaction mechanisms

Scientific Method

- The **scientific method** is a logical, systematic approach to the solution of a scientific problems.
- Making observations
    - When you use your **senses** to obtain information, you make an **observation**.
- Testing hypothesis

- A **hypothesis** is a **proposed explanation** for an observation.
- A hypothesis can never be proven. If further evidence does not support it, then the hypothesis must be discarded or modified.

- Doing experiment
  - An experiment is a **procedure** that is used to test a hypothesis.
  - In many experiments, it is valuable to have a **control**, a standard for comparison, to prove the experimental procedure or reagent can work.
  - Once a hypothesis meets the test of repeated experimentation, it may be raised to a higher level of ideas (**theory** or **scientific laws**).

- Developing theories and scientific laws
  - A **theory** is a well-tested explanation for a broad set of observations that has been supported by many experiments.
    - The theory is open to revision.
    - The theory can predict the results of further experiments.
    - Example: atomic theory
  - A **scientific law** is a concise statement that summarizes the results of many observations and experiments and shows the **relationship** in nature.
    - Examples: gas law, law of universal gravitation, law of conservation of matter.

- Conclusion
  - A **conclusion** is a judgment based on the information obtained.

Variable

- **Variable** is a quantity which is not fixed and the factor being tested.
  - **Independent variable**: the variable that you **plan** to change.
  - **Dependent variable**: changes in **response** to a change in the independent variable.

- **Controlled variable**: the other variables which should be controlled as constants.

Data

- **Qualitative data:** properties or occurrences in ways that do **not** rely on **numbers**.
- **Quantitative data**: measurements consisting of both a **number** and a **unit**.
- A **model** is a visual, verbal, and/or mathematical explanation of experimental data.
  - Examples: atomic model——Dalton's model, JJ Thomson's model.

Graph

- Clear title, labeled axis, appropriate and unified scale and unit

Data Table

- Clear title and category column, appropriate and unified unit

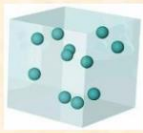
Chapter 2: Matter and Change

- **2.1 Properties of Matter&2.4 Chemical Reactions**
  - Describing Matter
    - **Property**: The characteristic of matter that helps us to identify matter
      - Physical Property: characteristic that can be observed w/o changing substance composition.
      - Chemical Property: ability of a substance to undergo chemical change, chemical change required to observe.
      - Some physical properties include melting points, **conductivity**, density. Some chemical properties include **flammability, stability**, toxicity, tendency to rust, etc.
    - **Change**

- Physical Change: w/o change in composition like cutting, sewing, phase changes.
- Chemical Change: w/ change in composition like combustion, oxidation, and decomposition.
  - Reactants → Products
  - Possible clues to chemical change include a transfer of energy, a change in color, the **production of a gas**, or the **formation of a precipitate**.

- States of Matter

State is a physical property of matter.

The state	characteristic	Attraction force	Motion of particles
	incompressible, definite shape and volume. High density	very strong	Vibrate in fixed position
	slightly compressible, no definite shape; has definite volume; High density	Weaker than in solid but still strong.	move freely but can't move far away.
	highly compressible, no definite shape or volume; Low density	very weak	move as far away as it can.

- **Vapor**: gaseous state of liquid/solids at room temperature (25°C).

- **The Law of Conservation of Mass**: matter cannot be created nor be destroyed.
  - $2H_2+O_2 \rightarrow 2H_2O$ 4(2x2)H atoms+2O atoms→4H atoms and 2O atoms
  - A+B+C→D $\mathbf{m_{reacted\ A}:m_{yield\ D}}$ would be a constant mass ratio. Remember this, it will be helpful!

- **2.2 Mixtures**
  - A **mixture** is a physical blend of two or more components.

- This means that **proportions can be changed** w/o changing the identity of the mixture. As for pure substances, as we will later cover, has a **fixed proportion** of components.

- Classify Mixtures
  - Homogenous mixture: uniform composition throughout the mixture (**NO** layers, concentrated or diluted areas, and suspending solids)
    - Also called solutions.
  - Heterogenous mixture: not uniform composition.
    - For example: freshly squeezed apple juice.
  - **Phase**: any part of a mixture with uniform composition and properties.
    - Homogenous=1 phase, heterogenous=2 or more phases.
- **Separating Mixtures** (Review for this one!)
  - **1.Filtration**: separate solid from liquid in heterogenous mixture. Larger particles are trapped in the funnel as **residue**, and the remaining liquid would be the **filtrate**.
    - Tools: Filter paper, funnel, beaker, iron stand.
  - **2.Distillation**: separate liquid from liquid in homogenous mixture. The solution is heated until one liquid vaporized and flows into the condenser while the other is remained at the original beaker. The liquid vapor is cooled then transferred into another beaker.
    - Tools: tripod, wire gauze, Bunsen burner, thermometer, condenser.
    - Condenser: water comes in at bottom to **counterflow vapor**, absorbs heat efficiently.
    - Thermometer: placed on top of beaker to **measure vapor temperature.**

        - **3.Dissolution**: separate solid from solid in heterogenous mixture. Dissolving an aqueous substance into a solvent. **Usually followed by filtration then distillation.**
            - Tools: beaker
        - **4.Crystallization**: separate solute from solvent. The solution is heated gradually until water vaporized and the remaining substance crystallizes and forms small crystals.
            - Tools: Bunsen burner, beaker
        - **5.Chromatography**: separate multiple components from a homogenous mixture. A mobile phase and a stationary phase, usually water and paper respectively.
            - Tools: beaker, paper, water(solvent).
            - High affinity components to mobile phase "sticks" to the water, being carried up a longer distance. High affinity components to stationary phase "sticks" to the paper, so it moves slower.
        - **6.Magnetism**: separate metals using magnets to see if they are attracted to magnets.
            - Tools: magnets
    - Properties used by different methods:
        - **Filtration**- particle size, **Distillation**: different b.p., **Dissolution**: different solubility, **Crystallization**: different b.p. **Chromatography**: affinity, solubility, density. **Magnetism**: Magnetic forces.

- **2.3 Elements and Compounds**
    - **Substance** is matter that has a uniform and definite composition.
    - Identifying Elements and Compounds
        - Element: simplest form of matter that has unique set of properties, made by atoms of one kind.

        - Diatomic Particles: H_2, O_2, F_2, Cl_2, Br_2, N_2, I_2

    - Compound: a substance that contains two or more elements chemically combined in a fixed proportion.

        - e.g. table sugar (C12H22O11), carbon dioxide (CO2)

    - Compounds can be broken down by chemical means but not physical means. Elements cannot be broken down by chemical means, but can be via nuclear means (nuclear fission).

        - H_2O →(electrolysis) $H_2 + O_2$

- Mixture VS Substance

    - Fixed composition(you cant find water with 3H atoms and 2O atoms, each water molecule must be 2H atoms and 1O atom)→Substance

    - Variable composition(you can find different brands of milk)→Mixture

- Symbol and Representation

    - Each element is represented by a one- or two-letter chemical symbol.

    - First letters of chemical symbols are capitalized. When a second letter is used, it is lowercase.

    - The **chemical formula** tells you which elements make up a compound as well as how many atoms of each element are present.

        - E.g. $CaCl_2$ 2 is the **subscript**. This example indicate 1 Ca atom and 2 Cl atoms.

- **The Periodic Table**: an arrangement of elements in which the elements are separated into groups based on a set of repeating properties.

    - 7 periods horizontally organized, 18 groups vertically organized.

    - Ordered from left to right from up to down by atomic number.

    - **Period**: properties change gradually and predictably.

- **Group**: similar chemical characteristics.
- Metals
  - Metals are elements that are generally **shiny, good conductors** of heat and electricity, **malleable and ductile**.
  - Solid at room temperature.(except for Hg)
  - Most elements are metals.
- Nonmetals
  - Nonmetals occupy the upper right side of the periodic table.
  - They are generally gases or **brittle, dull-looking solids, poor conductors** of heat and electricity (graphite is exception). **Br_2 is the only liquid nonmetal at room temperature.**
- Metalloids
  - Element between metals and nonmetals.
  - They are the elements with physical and chemical properties of both metals and nonmetals.
  - E.g. Si works as a semiconductor.

Remember the first 20 elements of periodic table:

The Periodic Table

H 1 Hydrogen $A_r = 1$							He 2 Helium $A_r = 4$
Li 3 Lithium $A_r = 7$	Be 4 Beryllium $A_r = 9$	B 5 Boron $A_r = 11$	C 6 Carbon $A_r = 12$	N 7 Nitrogen $A_r = 14$	O 8 Oxygen $A_r = 16$	F 9 Fluorine $A_r = 19$	Ne 10 Neon $A_r = 20$
Na 11 Sodium $A_r = 23$	Mg 12 Magnesium $A_r = 24$	Al 13 Aluminium $A_r = 27$	Si 14 Silicon $A_r = 28$	P 15 Phosphorus $A_r = 31$	S 16 Sulphur $A_r = 32$	Cl 17 Chlorine $A_r = 35$	Ar 18 Argon $A_r = 40$
K 19 Potassium $A_r = 39$	Ca 20 Calcium $A_r = 40$						