M5 Science (Chemistry)

Unit 4. Chemical reactivity

This unit will serve not only as an introduction to the whole of the M5 Chemistry program by looking at how Chemical reactions are classified into groups based on similarities, but also cover acid-base reactions. They students will be able to classify chemicals as an acid or base or salt and be able to describe some of their properties. They will learn the significance of the three classes of compounds in daily lives and how salts can be prepared. Additionally, the quantitative aspect of chemistry will also be considered.

Concepts to be mastered

To master a concept, you must be able to do three things:

1. define the concept,
2. explain the concept, and
3. give an example of the concept.

- Ion, hydrogen ion, anion, concentration, concentrated, dilute, indicator, blue litmus paper, red litmus paper, universal indicator paper, pH scale,
- neutralization, base, alkali, salt, limestone ($CaCO_3$)
- Oxide, basic oxide, acidic oxide, amphoteric oxide, neutral oxide, metallic oxide, nonmetallic oxide, ionic equation,
- Hydrogen ion, proton donor, anion, strong acid, weak acid, dissociation, concentration, concentrated, dilute,
- Proton donor, proton acceptor
- Salt, filtration, crystallization, titration, indicator, anhydrous, hydrated, crystal, crystal hydrates, water of crystalization
- Relative atomic mass, relative molecular mass, relative formula mass
- mole, Avogadro's number, molar mass
- relative atomic mass, relative molecular mass, relative formula mass
- chemical equations, balancing equations, reactants, products, state symbols
- Limiting reagent, excess reagent, experimental yield, theoretical yield, experimental yield, percent (%) yield,
- solution, solute, solvent, types of solutions, concentrated, dilute, concentration, solubility
- volumetric flask, titration, indicator, buret, pipet, end-point

Skills to be mastered

To master a skill, you must be able to

1. recognize when the skill is needed,
2. recognize what information is needed to execute the skill,
3. execute the skill, and
4. assess whether the skill has been executed correctly.

- Be able to describe the characteristic macroscopic properties of acids
- When given the chemical formula of simple acids and bases name them and when given the name write the chemical formula
- Be able to describe the characteristic macroscopic properties of bases as reactions with acids and with ammonium salts and effect on litmus

- When given the chemical formula of simple acids and bases name them and when given the name write the chemical formula
- Be able to explain that the pH scale is a measure of H^+ ion concentration in solution
- Be able to describe neutrality and relative acidity and alkalinity in terms of pH (whole numbers only) measured using Universal Indicator paper
- Explain the term neutralization and explain that salts are formed when acids are neutralized by bases
- Be able to classify oxides as either acidic, amphoteric or basic
- Be able to define the Bronsted-Lowry theory of acids and bases.
- Be able to differentiate between strong and weak acids and bases, and give examples of the common ones
- Be able to explain difference between strong and weak acids and bases using equilibrium principles
- Describe the consequences of acid rain
- Be able to give examples of reactions that form salts.
- Be able to give several examples of common salts and what materials they are used in.
- Be able to describe the term crystals hydrates and explain how they are formed.
- Be able to explain the importance of titrations in the study of acids and bases.
- Explain what relative atomic mass (A_r) represents
- Given relative atomic masses determine relative molecular mass or relative formula mass of a compound
- Given a chemical formula be able to state the elements present and their proportion
- Be able to calculate the molar mass of a substance given its formula and table of relative atomic masses
- Given moles of a certain substance (element or compound) determine the mass of the substance and vice versa
- Given moles of a certain gaseous substance (element or compound) determine the volume of the substance and vice versa
- Given moles of a certain substance (element or compound) determine the number atoms/molecules of the substance and vice versa
- Given mass or mole or volume information about the reactants in a chemical reaction, be able to determine
    - mass of another reactant required
    - mole of another reactant required
    - mole of product formed
    - mass of a product formed
    - volume of gases given that a mole occupies 24 dm^3 at room temperature and pressure
- Determine limiting and excess reagent in a chemical reaction
- Determine percent yield of a product in a reaction
- Be able to define solution, solute and solute
- Given mass of solute and volume of solution, determine concentration of solution
- Given two of moles of solute, volume of solution, and concentration of the solution, determine the third

- Perform simple calculations for titration reactions: reactions involving two solution where three of the four variables (concentrations and volumes of the reacting chemicals) are given

Unit 5. Redox Reactions

This unit will look at reduction-oxidation reactions (redox) in everyday life starting with the role of oxygen in this very important category of reactions. The students will also be able to define and explain redox reaction from a couple of different angles enabling them to describe the patterns in the reactivity of metals. The students will be able to explain the application of redox reaction in the extraction and use of metals. They will also be able to describe the commercial interests of metal industries in redox reactions to minimize or prevent rusting and the beauty industries in slowing down the process of aging.

Concepts to be mastered

To master a concept, you must be able to do three things:

1. define the concept,
2. explain the concept, and
3. give an example of the concept.

- Reactivity, displacement, reduction, metal, order of reactivity
- redox reaction, reduction, oxidation, oxidizing agent, reducing agent, half-equation, ionic equation
- Charge, oxidation state (number), oxidation, reduction, oxidizing agent, reducing agent
- Molecular ion (polyatomic ion)
- reaction, reactivity, acidic, basic, metallic, nonmetallic
- Reactivity, displacement, reduction, metal, order of reactivity
- redox reaction, reduction, oxidation, oxidizing agent, reducing agent, half-equation, ionic equation
- reaction, reactivity, acidic, basic, metallic, nonmetallic
- Reactivity, displacement, reduction, metal, order of reactivity
- redox reaction, reduction, oxidation, oxidizing agent, reducing agent, half-equation, ionic equation
- Reactivity, displacement, reduction, metal, thermal decomposition, order of reactivity

Skills to be mastered

To master a skill, you must be able to

5. recognize when the skill is needed,
6. recognize what information is needed to execute the skill,
7. execute the skill, and
8. assess whether the skill has been executed correctly.

- Define oxidation and reduction in terms of oxygen loss/gain
- Identify reduction, oxidation, reducing agent, oxidizing agent
- Describe methods of rust prevention: paint and other coatings to exclude oxygen
- Define oxidation and reduction in terms of electron gain/loss
- Identify reduction, oxidation, reducing agent, oxidizing agent using electron gain/loss definition
- Assign oxidation states to elements in a chemical species

- Define and identify oxidation and reduction reaction in terms of changes in oxidation state change
- Identify reduction, oxidation, reducing agent, oxidizing agent using oxidation state change definition
- Describe and explain group reactivity trends for groups 1 in their reaction with water
- Predict properties of other elements in the group given data where appropriate
- Deduce an order of reactivity from a given set of experimental results
- Place the following metals in order of reactivity: calcium, copper, (hydrogen), iron, magnesium, potassium, sodium and zinc by reference to the reactions, if any, of the metals with water or steam, dilute hydrochloric acid and the reaction of their oxides with carbon
- Deduce an order of reactivity from a given set of experimental results
- Place carbon and hydrogen in the reactivity series.
- Account for the apparent unreactivity of aluminum in terms of the oxide layer which adheres to the metal
- Describe and relate the reactivity series to the action of heat on the hydroxides and nitrates of the metals in the series

Unit 6. Rate of Reaction

This unit will explain how the rates of various reactions can be controlled and why they need to be controlled. They will be able to describe the various factors which affect how fast or slow a chemical reaction proceeds. They will be able to describe the importance of controlling speed of reaction by manipulating one or more these factors in different industries and fields.

Concepts to be mastered

To master a concept, you must be able to do three things:

1. define the concept,
2. explain the concept, and
3. give an example of the concept.

- Reaction, speed (rate) of reaction, collision theory, concentration, catalyst, surface area, temperature, activation energy
- Photochemical reaction, photosynthesis, photography
- speed (rate) of reaction, concentration, catalyst, surface area, temperature, activation energy

Skills to be mastered

To master a skill, you must be able to

1. recognize when the skill is needed,
2. recognize what information is needed to execute the skill,
3. execute the skill, and
4. assess whether the skill has been executed correctly.

- Describe the effect of the four factors—concentration, catalyst (including enzyme), particle size (surface area) and temperature—on the speed of reaction.
- Explain the effects of these factors in terms of collisions between reacting particles (collision theory)
- Give several practical examples of chemical reactions used in daily life that react very slowly and how they can be speeded up.

- Describe the application of the above factors to the danger of explosive combustion with fine powders (e.g. flour mills) and gases (e.g. mines)
- Describe the effect of light on the speed of photochemical reactions (such as that occur in photography and photosynthesis)
- Give several practical examples of chemical reactions used in daily life that react very quickly and how they can be slowed down
- Describe a practical method for investigating the speed of a reaction involving gas evolution by collecting and recording volume of gas data over time and graphing the result.
- Analyze and interpret data obtained from experiments on speed of reaction
- Devise experiments to test the effect of any four of the factors on speed of reaction
- Describe a practical method for investigating the speed of a reaction involving gas evolution by collecting mass data over time and graphing the result.
- Analyze and interpret data obtained from experiments on speed of reaction
- Devise experiments to test the effect of any four of the factors on speed of reaction