SS3 CHEMISTRY LESSON NOTES

FIRST TERM

1. Food Chemistry – Carbohydrates, proteins, fats.
2. Drugs and Their Effects – Medicinal and harmful chemicals.
3. Chemistry in Industry and Everyday Life – Applications.
4. Environmental Chemistry – Pollution, remediation.
5. **Midterm Examination - Comprehensive WAEC/NECO Syllabus Review** – Overview of topics.
6. Industrial Chemistry – Chemical industries in Nigeria
7. **Midterm break**
8. Revision of Organic Chemistry – Practicals and past questions.
9. Revision of Inorganic Chemistry – Periodic table, elements.
10. Revision of Physical Chemistry – Rates, equilibrium, gases.
11. Chemical Calculations Practice – Moles, titrations, stoichiometry.
12. Examination
13. Closing

WEEK 1: FOOD CHEMISTRY

Carbohydrates, proteins, and fats

Food chemistry is the branch of chemistry that deals with the study of the chemical nature of food substances, their composition, reactions, and roles in nutrition. It explains how the nutrients in food support life processes, provide energy, repair tissues, and regulate body functions. The three most important classes of food molecules are **carbohydrates, proteins, and fats (lipids)**.

Carbohydrates

Carbohydrates are polyhydroxy aldehydes or ketones, or substances that yield such compounds on hydrolysis. Their general formula is **Cx(H2O)y**, showing that they are hydrates of carbon.

Classification of carbohydrates:

1. **Monosaccharides (simple sugars):**
    - Smallest unit of carbohydrates that cannot be hydrolyzed into simpler sugars.
    - Examples: Glucose (grape sugar), fructose (fruit sugar), galactose (milk sugar).
    - They are crystalline, soluble in water, and sweet-tasting.
2. **Disaccharides:**
    - Formed by condensation of two monosaccharides with elimination of water.
    - Examples:
        - Sucrose (cane sugar) = Glucose + Fructose
        - Maltose = Glucose + Glucose
        - Lactose = Glucose + Galactose
    - They are soluble and sweet but need to be hydrolyzed to monosaccharides before absorption.
3. **Polysaccharides:**

- Macromolecular carbohydrates consisting of many monosaccharide units linked by glycosidic bonds.
- Examples: Starch, glycogen, cellulose.
- They are insoluble in water, tasteless, and serve as storage or structural materials.

Properties of carbohydrates:

- **Solubility:** Monosaccharides and disaccharides are soluble in water, while polysaccharides are insoluble.
- **Reducing nature:** Some carbohydrates (e.g., glucose, maltose) reduce Fehling's solution or Benedict's solution due to free aldehyde or ketone groups.
- **Fermentation:** Glucose and fructose undergo fermentation by yeast to produce ethanol and carbon dioxide.
- **Hydrolysis:** Disaccharides and polysaccharides can be broken down to monosaccharides by acids or enzymes.
- **Reaction with iodine:** Starch gives a characteristic blue-black color with iodine solution.

Nutritional importance of carbohydrates:

- Major source of energy (1 g yields about 17 kJ or 4 kcal).
- Serve as raw materials in respiration.
- Stored as glycogen in animals for energy reserve.
- Structural role (cellulose in plant cell walls).

Proteins

Proteins are high-molecular-weight natural polymers made of amino acids linked by peptide bonds. They contain carbon, hydrogen, oxygen, nitrogen, and sometimes sulfur, phosphorus, or trace metals.

Structure:

- **Primary structure:** Sequence of amino acids in a polypeptide chain.
- **Secondary structure:** Coiling or folding (e.g., α-helix, β-pleated sheets).
- **Tertiary structure:** 3D arrangement due to further folding and interactions.
- **Quaternary structure:** Combination of multiple polypeptide chains (e.g., hemoglobin).

Types of proteins:

- **Simple proteins:** Yield only amino acids upon hydrolysis (e.g., albumins, globulins).
- **Conjugated proteins:** Contain a non-protein part (prosthetic group) in addition to amino acids (e.g., glycoproteins, hemoglobin).
- **Derived proteins:** Products of partial hydrolysis or denaturation of proteins.

Properties of proteins:

- **Denaturation:** Loss of structure and function due to heat, acids, alkalis, or chemicals.
- **Hydrolysis:** Proteins can be hydrolyzed into amino acids by enzymes or acids.
- **Amphoteric nature:** Proteins can act as both acids and bases due to amino and carboxyl groups.
- **Precipitation:** Proteins coagulate when heated or treated with heavy metals.

Tests for proteins:

- **Biuret test:** Violet coloration with NaOH and $CuSO_4$ solution indicates peptide bonds.
- **Xanthoproteic test:** Yellow color with concentrated HNO_3 indicates aromatic amino acids.
- **Millon's test:** Red coloration indicates the presence of tyrosine.

Nutritional importance of proteins:

- Essential for growth, repair, and replacement of worn-out tissues.
- Form enzymes, hormones, and antibodies.

- Can provide energy (1 g yields 17 kJ or 4 kcal).
- Help in the maintenance of osmotic balance.

Fats and Oils (Lipids)

Fats and oils are esters of glycerol with long-chain carboxylic acids (fatty acids). They are non-polar molecules, insoluble in water but soluble in organic solvents.

Differences between fats and oils:

- **Fats:** Solid at room temperature, usually of animal origin, rich in saturated fatty acids.
- **Oils:** Liquid at room temperature, usually of plant origin, rich in unsaturated fatty acids.

Properties of fats and oils:

- **Hydrolysis (Saponification):** Reaction with alkali (NaOH or KOH) produces soap and glycerol.
- **Hydrogenation:** Unsaturated oils can be converted into saturated fats (e.g., margarine production).
- **Rancidity:** Oxidation of fats/oils produces unpleasant odor and taste.
- **Emulsification:** Fats can be broken into small droplets with the aid of emulsifiers (e.g., bile salts).

Tests for fats and oils:

- **Grease spot test:** Leaves a permanent translucent spot on paper.
- **Solubility test:** Insoluble in water but soluble in organic solvents like ether.
- **Saponification test:** Reaction with alkali to form soap.

Nutritional importance of fats and oils:

- Rich source of energy (1 g yields about 37 kJ or 9 kcal).
- Provide essential fatty acids (e.g., linoleic acid).

- Aid absorption of fat-soluble vitamins (A, D, E, K).
- Provide insulation and protection to internal organs.
- Help in maintaining cell membrane structure.

General Importance of Carbohydrates, Proteins, and Fats

- They form the three basic classes of macronutrients essential for life.
- They supply energy for metabolism.
- They aid in growth, repair, and development of body tissues.
- They help regulate metabolic processes (enzymes, hormones, and energy carriers).
- Imbalance causes diseases:
    - Lack of protein causes **kwashiorkor**.
    - Excess fat causes **obesity, arteriosclerosis, and heart disease**.
    - Poor utilization of carbohydrate leads to **diabetes mellitus**.

EVALUATION

1. Define carbohydrates, proteins, and fats, stating their elemental compositions.
2. Differentiate between monosaccharides, disaccharides, and polysaccharides with examples.
3. Explain peptide bonds and describe the different levels of protein structure.
4. List and explain three chemical tests for proteins and the expected observations.
5. Distinguish between fats and oils, giving two chemical properties of each.

ASSIGNMENT

1. Draw the structures of glucose, sucrose, and a triglyceride molecule.
2. Explain why fats yield more energy per gram than carbohydrates or proteins.
3. Discuss three nutritional deficiency diseases associated with carbohydrates, proteins, and fats.

WEEK 2: DRUGS AND THEIR EFFECTS

Medicinal and Harmful Chemicals

MEANING OF DRUGS

- A **drug** is a chemical substance (natural, semi-synthetic, or synthetic) that, when introduced into a living organism, modifies or alters **normal biochemical and physiological functions**.
- The word comes from the French *drogue* (meaning "dry herb"), since early medicines were mainly plant extracts.
- Drugs can act as:
    - **Medicines** → beneficial, cure or prevent diseases.
    - **Poisons** → harmful, depending on dosage.
    - **Abused substances** → taken for pleasure, leading to addiction and health damage.

SOURCES OF DRUGS

- **Plants:** Morphine (from poppy plant), Quinine (from cinchona bark), Caffeine (from coffee/tea).
- **Animals:** Insulin (from pig/cow pancreas), Cod liver oil (from fish).
- **Minerals:** Iron tablets, Iodine solution, Magnesium salts.
- **Synthetic/Chemical:** Aspirin, Paracetamol, Antibiotics, Sedatives.

CHARACTERISTICS OF AN IDEAL DRUG

- High effectiveness in small doses.
- Minimal or no side effects.

- Easy to administer (tablet, syrup, injection).
- Stable (long shelf-life, not easily decomposed).
- Non-addictive and non-toxic at therapeutic dose.

CLASSES OF DRUGS

a) Medicinal (Therapeutic) Drugs

- Properly manufactured and administered drugs.
- Used to cure, prevent, or manage diseases.
- Their chemical action is often linked to their **functional groups** (e.g., hydroxyl group in alcohol-based antiseptics, ester group in aspirin).

b) Harmful/Abused Drugs

- Substances taken in **excessive or non-medical ways**.
- Interfere with brain chemistry, leading to **addiction, tolerance, withdrawal symptoms, and eventual health breakdown**.

TYPES OF MEDICINAL DRUGS

Category	Examples	Mode of Action / Use
Analgesics (pain relievers)	Aspirin (acetylsalicylic acid), Paracetamol	Inhibit prostaglandins (pain-causing chemicals).
Antibiotics	Penicillin, Streptomycin, Ampicillin	Kill or inhibit growth of bacteria by attacking cell walls/proteins.
Antimalarials	Quinine, Chloroquine,	Destroy *Plasmodium* parasite in

	Artemisinin	blood.
Antiseptics/Disinfectants	Dettol, Hydrogen peroxide, Lysol	Kill microorganisms on wounds, skin, or surfaces.
Anaesthetics	Chloroform, Ether, Lidocaine	Block nerve signals to induce loss of sensation during surgery.
Sedatives/Tranquilizers	Diazepam (Valium), Barbiturates	Depress CNS activity, reduce anxiety, promote sleep.
Stimulants (medicinal use)	Caffeine, Amphetamine	Stimulate CNS, reduce fatigue, increase alertness.
Vaccines	Polio vaccine, COVID-19 vaccine	Introduce antigens to trigger antibody production for immunity.

DRUG MISUSE AND ABUSE

- **Drug Misuse:** Wrong use of prescribed drugs (e.g., taking antibiotics without completing dosage, overdose of paracetamol).
- **Drug Abuse:** Deliberate excessive use of drugs for **pleasure or mood alteration** (e.g., cocaine, heroin, marijuana).
- Consequences: addiction, poor academic performance, mental illness, accidents, family breakdown.

EXAMPLES OF HARMFUL/ABUSED DRUGS

- **Stimulants:** Cocaine, Nicotine, Excess Caffeine – increase heart rate, euphoria, but cause cardiovascular collapse.
- **Depressants:** Alcohol, Barbiturates – slow CNS, impair judgment, cause liver damage.
- **Narcotics:** Opium, Heroin, Morphine – relieve pain but highly addictive.

- **Hallucinogens:** LSD, Marijuana – cause distorted perception, hallucinations.
- **Volatile Solvents:** Petrol, Glue, Paint thinner – inhaled for temporary "high," damage brain and lungs.

BIOCHEMICAL ACTION OF DRUGS IN THE BODY

- Drugs interact with **receptor sites** in cells or enzymes.
- They may act as:
    - **Agonists** (stimulate a biological response).
    - **Antagonists** (block or reduce a biological response).
- Example: Aspirin blocks prostaglandin synthesis → pain relief.
- Example: Antibiotics prevent bacterial protein synthesis.

DISTINCTION BETWEEN MEDICINES AND POISONS

- "**The dose makes the poison**" – coined by Paracelsus.
- Small, controlled amounts → medicinal effect.
- Excessive amounts → toxic/poisonous effect.
    - Example: Paracetamol (500 mg relieves headache; overdose → liver failure).
    - Example: Alcohol (small → relaxant; large → intoxication, coma, death).

SOCIAL, ECONOMIC, AND HEALTH IMPLICATIONS OF DRUG ABUSE

- **Health:** Cancer, HIV/AIDS from needle sharing, brain damage, premature death.
- **Social:** Violence, domestic abuse, road accidents, broken homes, moral decadence.

- **Economic:** High medical costs, low productivity, rehabilitation expenses, national manpower loss.

GOVERNMENTAL AND SOCIETAL CONTROL MEASURES

- **NDLEA (National Drug Law Enforcement Agency):** Tracks and punishes illegal drug trafficking/use.
- **NAFDAC (National Agency for Food and Drug Administration and Control):** Regulates safety and quality of drugs/foods.
- **WHO (World Health Organization):** Provides international standards for safe drug use.
- **Community/Society:** Counseling, awareness campaigns, rehabilitation centers.
- **Schools:** Anti-drug education, peer mentoring.

EVALUATION

1. Define a drug and distinguish between medicinal and harmful drugs.
2. State four characteristics of an ideal drug.
3. Differentiate between **drug misuse** and **drug abuse** with one example each.
4. Write short notes on:
   a) Analgesics
   b) Antibiotics
   c) Antimalarials
5. List five socio-economic consequences of drug abuse in Nigeria.
6. Explain why "the dose makes the poison." Give **two drug examples**.

ASSIGNMENT

1. Classify the following as **medicinal** or **harmful**: Aspirin, Marijuana, Chloroquine, Alcohol, LSD, Morphine.
2. Write a short essay on the **role of NDLEA and NAFDAC** in controlling drug use in Nigeria.
3. Research and report on **two modern scientific methods used in rehabilitation of drug addicts**.
4. Explain, with chemical reasoning, why aspirin can act both as a **medicine and a poison**.

WEEK 3: CHEMISTRY IN INDUSTRY AND EVERYDAY LIFE – APPLICATIONS

Chemistry is often referred to as the **"central science"** because it connects physics, biology, agriculture, engineering, medicine, and environmental studies. Its impact is both **industrial** (large-scale production and technological advancement) and **domestic** (everyday activities that sustain life).

Chemistry in Industry

Chemistry drives industrialization and provides raw materials and products that support economic growth. Some major areas include:

a. Petrochemical Industry

- Based on crude oil and natural gas as raw materials.
- Processes: fractional distillation, cracking, reforming, polymerization.
- Products: fuels (petrol, diesel, kerosene, LPG), lubricants, and petrochemicals used in plastics, synthetic fibres, detergents, fertilizers, and pharmaceuticals.
- Importance: Provides energy, transport fuels, and materials for modern life.

b. Fertilizer Industry

- Manufacture of **nitrogenous fertilizers** (urea, ammonium nitrate, ammonium sulphate), **phosphatic fertilizers** (superphosphate, triple superphosphate), and **potassic fertilizers** (potassium chloride, potassium nitrate).
- Chemistry processes: Haber process (NH_3 production), Contact process (H_2SO_4 for fertilizers), neutralization reactions.
- Importance: Increases soil fertility, boosts crop yield, and ensures food security.

c. Textile and Polymer Industry

- Use of organic chemistry in producing synthetic fibres: nylon, terylene, rayon, polyester, acrylics.
- Polymerization processes (addition and condensation).

- Dyes and pigments produced through organic synthesis give fabrics long-lasting colours.
- Importance: Provides materials for clothing, packaging, ropes, and nets.

d. Metallurgical Industry

- Extraction and refining of metals from ores (e.g., electrolysis for aluminium, blast furnace for iron, froth flotation for copper).
- Alloy formation (e.g., brass, bronze, steel) for improved properties.
- Importance: Used in construction, transport, machines, electronics, and weaponry.

e. Pharmaceutical and Medical Industry

- Synthesis of life-saving drugs: antibiotics (penicillin, tetracycline), analgesics (aspirin, paracetamol), antimalarials (chloroquine, artemisinin), vaccines.
- Role of chemistry in drug design, testing, and quality control.
- Importance: Prevents and treats diseases, prolongs life, and improves public health.

f. Cement and Glass Industry

- **Cement production**: heating limestone ($CaCO_3$) and clay to form clinker, then grinding into cement.
- **Glass production**: fusing silica (SiO_2), sodium carbonate (Na_2CO_3), and calcium oxide (CaO) at high temperature.
- Importance: Used in building, construction, optics, laboratory ware, and vehicles.

Chemistry in Everyday Life

Chemistry is not restricted to industries; it is part of our **daily activities**, often unnoticed.

a. Food and Nutrition

- Knowledge of carbohydrates, proteins, fats, vitamins, and minerals ensures balanced diets.

- Food preservation: use of salt, sugar, vinegar, refrigeration, and chemical preservatives like sodium benzoate.
- Fermentation: chemical breakdown of sugars by microbes in bread making, yoghurt, beer, and wine production.

b. Health and Medicine

- Everyday use of antiseptics (Dettol, iodine tincture), disinfectants (chlorine, phenol), and antibiotics.
- Use of analgesics (paracetamol, aspirin) and antacids (magnesium hydroxide, aluminium hydroxide) for common ailments.
- Cosmetics, soaps, creams, and deodorants are formulations of applied chemistry.

c. Agriculture

- Application of fertilizers to replenish soil nutrients.
- Use of pesticides, herbicides, and fungicides to protect crops.
- Veterinary medicines and feed additives sustain livestock farming.

d. Energy and Power

- Fuels (coal, petrol, diesel, natural gas, LPG) derived from chemistry-based refining.
- Batteries (dry cell, lead-acid, lithium-ion) provide portable power.
- Renewable energy: biofuels (ethanol, biodiesel), hydrogen fuel, solar cells based on chemical processes.

e. Household Applications

- **Cleaning agents**: soaps and detergents (saponification and sulphonation).
- **Bleaching agents**: sodium hypochlorite, hydrogen peroxide for whitening fabrics and disinfecting.
- **Cooking gas** (LPG) as a domestic fuel.

- **Fire extinguishers**: CO_2-based extinguishers prevent combustion.

Importance of Chemistry in National Development

- **Industrial growth**: Supplies raw materials for manufacturing.
- **Technological advancement**: Fuels innovations in electronics, agriculture, health, and environment.
- **Employment generation**: Provides jobs in oil, food, pharmaceutical, and chemical industries.
- **Improved living standards**: Through food, health, housing, and transport.
- **Environmental protection**: Chemistry develops green technologies, recycling, and pollution control methods.

EVALUATION

1. Explain why chemistry is called the central science.
2. List and describe five major industries where chemistry plays a key role, giving one example of a product from each.
3. Identify three ways chemistry contributes to food preservation and three to health care.
4. Differentiate between industrial and everyday applications of chemistry with at least two examples each.
5. Discuss three roles of chemistry in environmental management and national development.

ASSIGNMENT

1. Write comprehensive notes on the importance of the **fertilizer industry** and the **pharmaceutical industry** in Nigeria's development.

2. List and explain five examples of chemistry in your everyday life (excluding food and medicine).
3. Discuss in detail how chemistry contributes to **agriculture**, **construction**, and **energy production**.

WEEK 4: ENVIRONMENTAL CHEMISTRY

Pollution and Remediation

MEANING AND SCOPE OF ENVIRONMENTAL CHEMISTRY

Environmental Chemistry is the **scientific study of chemical processes** occurring in the environment (air, water, soil, and living organisms) and how human activities impact these natural systems.

It involves:

- Analysis of **pollutants**, their **sources**, and **chemical transformations** in the environment.
- Study of **toxicology** (harmful effects of chemicals).
- Development of **remediation strategies** to restore environmental balance.

Concept of Pollution

Pollution is the **undesirable alteration of the environment** by introducing harmful substances (pollutants) or energy, resulting in damage to living organisms, properties, or natural resources.

Key Terms:

- **Pollutants:** Harmful substances that cause pollution.
- **Contaminants:** Substances present in harmful concentrations.
- **Toxicants:** Substances causing harmful effects even in small quantities.

Classification of Pollutants

Type of Pollutant	Description	Examples
Primary Pollutants	Emitted directly into the environment	CO, SO_2, NO, CH_4

Secondary Pollutants	Formed from chemical reactions of primary pollutants	O_3, smog, HNO_3, H_2SO_4
Biodegradable Pollutants	Decomposed naturally by microorganisms	Food waste, sewage
Non-biodegradable Pollutants	Persist in the environment for long periods	Plastics, DDT, heavy metals

TYPES OF POLLUTION

Air Pollution

Definition: Contamination of the atmosphere with substances harmful to health, vegetation, or climate.

Major Sources:

- **Industrial emissions:** SO_2, NOx, particulate matter.
- **Automobile exhaust:** CO, hydrocarbons.
- **Agriculture:** Methane (CH_4) from livestock.
- **Combustion of fossil fuels:** Coal, oil, natural gas.

Major Air Pollutants and Their Effects:

Pollutant	**Chemical Formula**	**Source**	**Effect**
Carbon monoxide	CO	Incomplete combustion of fuels	Interferes with oxygen transport in blood
Sulphur dioxide	SO_2	Burning coal, industries	Acid rain, respiratory diseases

Nitrogen oxides	NO, NO_2	Vehicle exhausts, power plants	Acid rain, smog
Chlorofluorocarbons	CFCs	Refrigerants, aerosols	Ozone layer depletion
Particulates	$PM_{2.5}$, PM_{10}	Dust, smoke	Respiratory illnesses

Key Environmental Reactions:

1. **Acid Rain Formation:**

$$SO_2 + H_2O \rightarrow H_2SO_3$$

$$2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$$

2. **Ozone Layer Depletion (by CFCs):**

$$CF_2Cl_2 \xrightarrow{UV} CF_2Cl + Cl$$

$$Cl + O_3 \rightarrow ClO + O_2$$

3. **Photochemical Smog Formation:**

$$NO_2 + hv \rightarrow NO + O$$

$$O + O_2 \rightarrow O_3$$

Water Pollution

Definition: Presence of harmful substances in water bodies beyond permissible levels.

Sources:

- Industrial effluents containing heavy metals (Pb, Hg, Cd).
- Domestic sewage rich in pathogens and organic waste.
- Agricultural runoff containing pesticides and fertilizers.
- Oil spills.

Effects:

- Spread of diseases (cholera, typhoid).
- **Eutrophication:** Excess nutrients → algal bloom → oxygen depletion.
- Bioaccumulation of toxic substances (e.g., mercury poisoning in fish).

Soil Pollution

Definition: Contamination of soil by hazardous substances, reducing fertility and biodiversity.

Sources:

- Overuse of pesticides and herbicides (DDT, glyphosate).
- Oil spills, industrial waste dumping.
- Acid rain altering soil chemistry.

Effects:

- Reduced agricultural productivity.
- Entry of heavy metals into food chains.
- Long-term desertification.

Noise Pollution

Definition: Excessive and harmful sound levels.

Sources: Road traffic, loudspeakers, industrial machinery.

Effects: Stress, hearing impairment, sleep disorders.

Thermal Pollution

Definition: Rise in temperature of water bodies due to discharge of heated water from industries.
Effects: Reduced dissolved oxygen levels, disruption of aquatic ecosystems.

Control and Remediation of Pollution

Type of Pollution	Control Strategies
Air Pollution	- Catalytic converters in vehicles - Switching to clean energy (solar, wind) - Industrial scrubbers & electrostatic precipitators - Ban on CFCs
Water Pollution	- Sewage treatment plants - Wastewater recycling - Use of oil booms for spills - Strict effluent discharge laws
Soil Pollution	- Bioremediation & phytoremediation - Organic farming - Proper waste disposal
Noise Pollution	- Noise barriers - Soundproofing machinery - Regulation of loudspeakers
Thermal Pollution	- Cooling towers - Closed-cycle cooling systems

Remediation Techniques

1. **Bioremediation:** Use of bacteria/fungi to break down pollutants. Example: *Pseudomonas* bacteria degrade hydrocarbons in oil spills.
2. **Phytoremediation:** Plants like *water hyacinth* absorb heavy metals.
3. **Chemical Neutralization:** Adding lime ($Ca(OH)_2$) to neutralize acidic soils.
4. **Adsorption:** Activated carbon removes toxins from water.
5. **Advanced Oxidation:** Using ozone (O_3) or hydrogen peroxide (H_2O_2) to degrade organic pollutants.

6. **Green Chemistry:** Designing chemical processes that minimize environmental impact, e.g., biodegradable plastics.

Role of Chemists in Environmental Protection

- Developing **renewable energy** solutions.
- Inventing **eco-friendly pesticides and fertilizers**.
- Designing **low-emission industrial processes**.
- Monitoring environmental quality using spectroscopy, chromatography.
- Producing **biodegradable materials**.

Evaluation

1. Define environmental chemistry and explain its importance in modern society.
2. Differentiate between primary and secondary pollutants with equations.
3. List and explain three chemical reactions leading to acid rain.
4. What is eutrophication? Discuss its causes and consequences.
5. Suggest three control measures for each type of pollution.
6. Define bioremediation and phytoremediation. Give two real-life examples.
7. Explain green chemistry and its relevance in pollution control.
8. Describe ozone layer depletion with chemical equations.

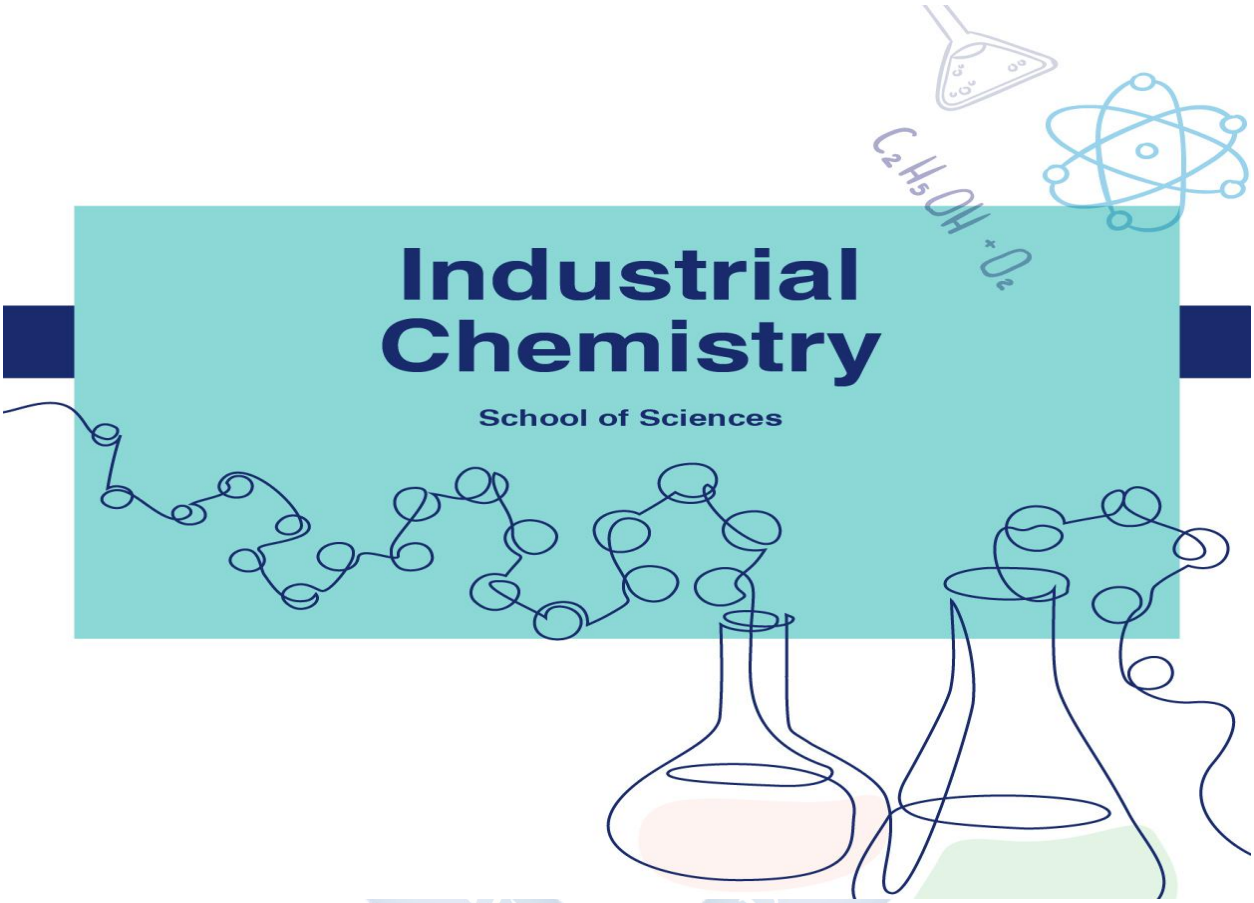
Assignment:

1. Draw a labeled diagram of a sewage treatment plant and explain each stage.

2. Write a case study on a recent oil spill or industrial pollution incident, highlighting its chemical effects.
3. Create a table of 10 pollutants, their chemical formulas, sources, and effects.
4. Explain three roles of chemistry in controlling environmental hazards.
5. Research and present five modern environmental remediation technologies (e.g., nanotechnology in water treatment).

WEEK 6: INDUSTRIAL CHEMISTRY

Chemical Industries in Nigeria



MEANING OF INDUSTRIAL CHEMISTRY

- **Industrial Chemistry** is the branch of chemistry that deals with the large-scale production of chemical substances and useful products by applying principles of chemistry and chemical engineering.
- It involves the **conversion of raw materials (natural or synthetic)** into valuable goods through systematic chemical processes.

Key Point: Industrial chemistry is the bridge between **scientific research** and **commercial production**.

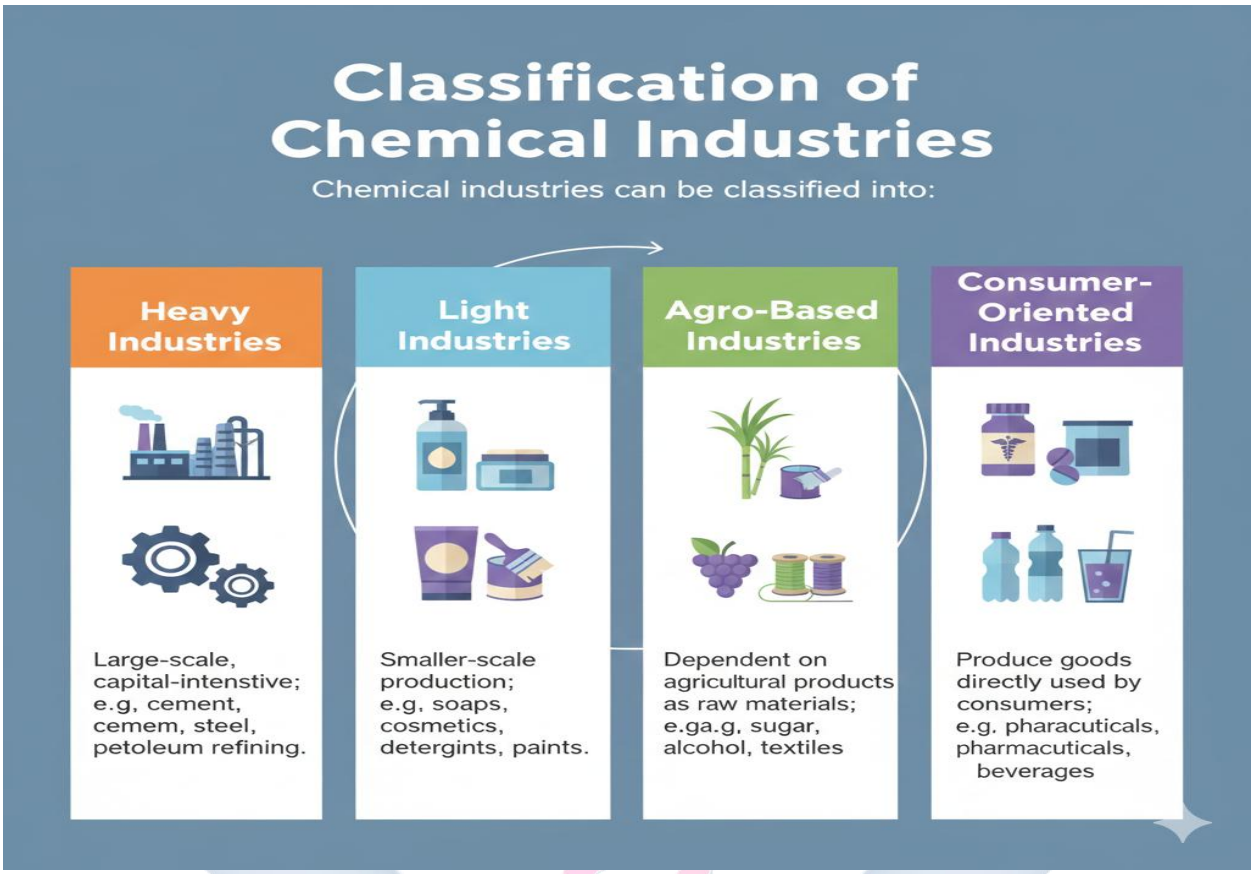
Importance of Industrial Chemistry in National Development

- Provides **raw materials** for agriculture, medicine, construction, and other industries.
- Generates **employment** for thousands of workers in various sectors.
- Enhances **technological advancement** through research and industrial training.
- Reduces dependence on **imported goods** by encouraging local production.
- Contributes to **foreign exchange earnings** through export of petroleum, cement, fertilizers, etc.
- Provides essential **infrastructure materials** (cement, steel, glass, paints) needed for urban development.

Classification of Chemical Industries

Chemical industries can be classified into:

1. **Heavy Industries:** Large-scale, capital-intensive; e.g., cement, steel, petroleum refining.
2. **Light Industries:** Smaller-scale production; e.g., soaps, cosmetics, detergents, paints.
3. **Agro-Based Industries:** Dependent on agricultural products as raw materials; e.g., sugar, alcohol, textiles.
4. **Consumer-Oriented Industries:** Produce goods directly used by consumers; e.g., pharmaceuticals, plastics, beverages.



Major Chemical Industries in Nigeria

(a) Cement Industry

- **Raw Materials:** Limestone ($CaCO_3$), clay, gypsum.
- **Process (simplified):**
    1. Crushing and grinding limestone and clay.
    2. Heating in kiln → produces **clinker** (CaO + SiO_2 + Al_2O_3 compounds).
    3. Grinding clinker with gypsum → cement powder.
- **Locations:** Shagamu, Ewekoro (Ogun), Nkalagu (Enugu), Sokoto, Calabar.
- **Products:** Ordinary Portland Cement (OPC).
- **Uses:** Construction, road building, bridges, housing.

(b) Soap and Detergent Industry

- **Raw Materials:** Fats/oils (palm oil, coconut oil), NaOH, sulphuric acid, sodium carbonate.
- **Process: Saponification reaction** (oil/fat + NaOH → soap + glycerol).
- **Locations:** Lagos, Ibadan, Aba, Onitsha.
- **Products:** Laundry soap, toilet soap, detergents, cosmetics.

(c) Fertilizer Industry

- **Raw Materials:** Ammonia, phosphates, sulphur, potassium salts, natural gas.
- **Products:** Urea [$(NH_2)_2CO$], NPK fertilizers, ammonium sulphate, ammonium nitrate.
- **Locations:** Onne (Rivers), Kaduna, Kano.
- **Uses:** Increases agricultural productivity and food security.

(d) Petroleum and Petrochemical Industry

- **Raw Material:** Crude oil.
- **Process: Fractional distillation** → separates crude oil into fractions (LPG, petrol, kerosene, diesel, lubricating oil, bitumen).
- **Petrochemicals:** Plastics, synthetic fibres, detergents, resins.
- **Locations:** Warri, Kaduna, Port Harcourt.
- **Uses:** Fuel for transport, power generation, plastics, pharmaceuticals.

(e) Alcohol and Beverage Industry

- **Raw Materials:** Sugarcane, maize, sorghum, yeast.
- **Process: Fermentation** of glucose by yeast:

$$C_6H_{12}O_6 \xrightarrow{Yeast} 2C_2H_5OH + 2CO_2$$

- **Products:** Ethanol, beers, wines, spirits, soft drinks.
- **Locations:** Lagos, Aba, Ibadan, Kaduna.

(f) Paint Industry

- **Raw Materials:** Pigments, resins, solvents, additives.
- **Products:** Emulsion paints, gloss paints, varnishes, enamels.
- **Locations:** Lagos, Aba, Port Harcourt.

(g) Textile Industry

- **Raw Materials:** Cotton, wool, synthetic fibres, dyes.
- **Products:** Clothing materials, uniforms, industrial fabrics.
- **Locations:** Kano, Kaduna, Aba, Lagos.

(h) Glass Industry

- **Raw Materials:** Silica sand (SiO_2), soda ash (Na_2CO_3), limestone ($CaCO_3$).
- **Products:** Bottles, glass sheets, windows, laboratory glassware.
- **Locations:** Aba, Lagos, Port Harcourt.

(i) Pharmaceutical Industry

- **Raw Materials:** Organic chemicals, plant extracts, minerals.
- **Products:** Drugs, vaccines, antibiotics, antiseptics.

- **Locations:** Lagos, Ogun, Anambra.

Location of Major Industries in Nigeria

Industry	Major Locations
Cement	Ogun, Enugu, Sokoto, Calabar
Fertilizer	Onne, Kaduna, Kano
Petroleum	Warri, Port Harcourt, Kaduna
Soap/Detergent	Lagos, Aba, Ibadan
Paints	Lagos, Aba, Port Harcourt
Glass	Aba, Lagos, Port Harcourt
Textiles	Kano, Kaduna, Aba

Flow Diagram Examples (Simplified)

(a) Cement Production:

Limestone + Clay → Crushing & Grinding → Heating in Kiln → Clinker + Gypsum → Cement.

(b) Petroleum Refining:

Crude Oil → Fractional Distillation → LPG, Petrol, Kerosene, Diesel, Lubricants, Bitumen.

(c) Soap Production (Saponification):

Fats/Oils + NaOH → Soap + Glycerol.

Contributions of Chemical Industries to Nigeria's Development

- Employment generation for both skilled and unskilled workers.
- Provision of consumer goods and industrial materials.
- Agricultural support (fertilizers, pesticides, preservatives).

- Foreign exchange earnings through export.
- Boost to GDP and national income.
- Encouragement of infrastructural growth (cement, paints, glass).

Problems/Challenges Facing Chemical Industries in Nigeria

- **Power/Energy shortages:** Erratic electricity supply increases production cost.
- **High cost of raw materials:** Dependence on imported chemicals.
- **Technological backwardness:** Use of outdated equipment.
- **Poor infrastructure:** Bad roads, ports, transportation bottlenecks.
- **Pollution:** Industrial effluents, smoke, gas flaring → environmental damage.
- **Insecurity:** Oil bunkering, pipeline vandalism, militancy in Niger Delta.
- **Policy instability:** Frequent changes in government industrial policies.

Solutions and Way Forward

- Government investment in **stable electricity supply**.
- Promotion of **local sourcing of raw materials**.
- Encouraging **public-private partnerships**.
- Establishment of **research centers** for industrial innovations.
- Strict **environmental regulations** to control waste.
- Training of skilled manpower.
- Incentives (tax holidays, grants, subsidies) to attract investors.

Environmental Implications of Industrial Chemistry

- **Air Pollution:** Emission of CO_2, SO_2, NO_2 from factories.
- **Water Pollution:** Discharge of untreated effluents into rivers.
- **Soil Contamination:** Deposition of heavy metals, oil spills.
- **Global Warming:** Greenhouse gases from fossil fuels.
- **Deforestation:** Clearing of land for industrial projects.

Evaluation

1. Define industrial chemistry and explain three of its importance to Nigeria.
2. List six chemical industries in Nigeria, their raw materials, and main products.
3. Draw and describe the flow diagram for soap production.
4. State four contributions of cement industries to Nigeria's economy.
5. Highlight five major challenges of chemical industries in Nigeria.
6. Suggest four possible solutions to improve industrial growth in Nigeria.
7. Discuss the environmental problems caused by petrochemical industries in Nigeria.

Assignment

1. Prepare a **case study** on any **one chemical industry in Nigeria**, showing:
    - Its raw materials
    - Location
    - Production process (flow chart)
    - Products
    - Contributions to the economy
    - Environmental impact

2. Research and write short notes on **how fertilizer industries contribute to agricultural development in Nigeria**.
3. Draw a labeled map of Nigeria showing **at least 6 locations of major chemical industries**.

SS3 CHEMISTRY SCHEME OF WORK

SECOND TERM

1. Practical Chemistry Techniques – Titration, qualitative analysis.
2. Summary of Major Topics – Key points across SS1–SS3.
3. Chemistry in Everyday Life – Food, medicine, industry.
4. Exam Strategy and Time Management – Techniques.
5. **Midterm Examination**
6. WAEC/NECO Past Questions Review – Analysis.
7. **Midterm break**
8. Practical Chemistry Review – Indicators, gases.
9. Data Interpretation and Report Writing – For practicals.
10. Final Tips and Revision – Preparation strategies.
11. Revision
12. Mock Examination
13. Closing

SS3 CHEMISTRY SCHEME OF WORK

THIRD TERM *(Pre-exam/Break Term)*

1. Intensive Revision – All Chemistry topics.
2. Individual Support Sessions – Remediation.
3. Final Exam Strategies – Speed, accuracy.
4. Past Exam Correction Sessions – WAEC/NECO.
5. **Midterm Examination**
6. Group Discussion and Peer Review – Exam-focused.
7. **Midterm break**
8. Last-Minute Revision – Summary sheets.
9. Mock Final Exams – Timed conditions.
10. Performance Review and Feedback – Targeted help.
11. Final Preparations – Confidence building.

12. Examination
13. Closing