UGANDA NATIONAL EXAMINATIONS BOARD (UNEB)

Official Solutions & Marking Scheme (2024 & 2025 Compilation)

Subject Code: 545/1 (Paper 1) | **New Lower Secondary Curriculum (NLSC)** | **Total: 50 Marks Covered**

OFFICIAL EXAMINER EVALUATION GUIDE

2024 UCE Chemistry Paper Solutions

Item 1: Water Quality and Detergent Assessment (10 Marks total)

(a) Chemical Cause of Scum Formation [4 Marks]

- Borehole water contains dissolved salts of calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions, which makes it "hard water". **[1 Mark]**
- Soapy detergents are made of sodium stearate (or sodium salts of long-chain fatty acids). **[1 Mark]**
- When soap is introduced, a chemical displacement reaction occurs where the calcium or magnesium ions replace sodium ions to form an insoluble precipitate called **calcium stearate** or **magnesium stearate** (scum). **[1 Mark]**
- Word or ionic representation: $Ca^{2+}(aq) + 2C_{17}H_{35}COO^{-}(aq) \rightarrow (C_{17}H_{35}COO)_2Ca(s)$ **[1 Mark]**

(b) Contrast and Recommendation [6 Marks]

- **Soapy Detergents:** React with hard water ions to form scum first. Lathering will not take place until all Ca^{2+}/ Mg^{2+} ions have been precipitated out, resulting in massive waste of soap. **[2 Marks]**
- **Soapless Detergents:** Formed from hydrocarbon derivatives with a sulfonic acid group (e.g., sodium alkylbenzene sulfonate). They form soluble salts with calcium and magnesium ions, meaning they form an excellent lather immediately without generating scum. **[2 Marks]**
- **Recommendation:** Onyera should use the synthetic soapless liquid detergent because it is highly efficient, lathering immediately to save both time, water, and money. **[2 Marks]**

Item 2: Industrial Gaseous Safety & Protection (10 Marks total)

(a) Chemical Neutralization of Leaking Chlorine [5 Marks]

- **Substance Chosen:** Soak the cloth in a **weak alkaline solution**, such as dilute **sodium hydrogencarbonate ($NaHCO_3$)** or dilute **sodium thiosulfate ($Na_2S_2O_3$)** solution. *(Accept weak ammonia or sodium carbonate solutions; reject concentrated sodium hydroxide as it burns skin)*. **[1 Mark]**
- **Mechanism:** Chlorine gas is acidic and a powerful oxidizing agent. When drawn through the alkaline cloth, it reacts and neutralizes to form harmless salts. **[2 Marks]**
- If thiosulfate is used, chlorine is reduced into harmless chloride ions (Cl^-) while thiosulfate is oxidized. **[1 Mark]**
- Scientific cohesion showing safety to respiratory passage. **[1 Mark]**

(b) Socio-Economic & Environmental Impacts [5 Marks]

- **Socio-Economic Impacts:** Positive: Provides jobs for local residents and reduces transport costs for downstream plastic/bleach manufacturers. Negative: Increases health risks, medical treatment costs, and drops local real estate values due to potential hazard zones. **[2.5 Marks]**
- **Environmental Impacts:** Accidental gas leaks harm urban vegetation, corrode metallic roofing sheets due to acidic properties when reacting with humidity, and pollute nearby community drainage lines. **[2.5 Marks]**

2025 UCE Chemistry Paper Solutions

Item 1: Food Additives & Biochemistry in Local Sauces (10 Marks total)

(a) Ingredient Class and Specific Roles [4 Marks]

- **Classification:** These ingredients are classified as **Food Additives** (specifically flavor enhancers, preservatives, and coloring agents). **[1 Mark]**
- **Onions:** Act as structural flavor enhancers and release aromatic sulfur compounds upon cooking to enrich the smell. **[1 Mark]**
- **Tomatoes:** Provide natural acidic texture (lycopene), add aesthetic color, and thicken the sauce consistency. **[1 Mark]**
- **Curry Powder:** A blend of dried spices acting as a highly concentrated flavor and aromatic coloring agent. **[1 Mark]**

(b) Scientific Comparisons & Chemical Differences [6 Marks]

- **Similarities:** Both common salt and biological ingredients function as food additives to improve flavor profile and palatability, and both can possess preservation qualities by restricting bacterial moisture access. **[2 Marks]**
- **Chemical Differences (Composition):** Common salt ($NaCl$) is an inorganic, simple crystalline mineral composed of ionic bonds. The biological components (onions, tomatoes) are complex mixtures of organic compounds (vitamins, proteins, carbohydrates) containing covalent bonds. **[2 Marks]**
- **Chemical Differences (Solubility/Volatility):** Salt is a non-volatile compound that dissolves completely in water to yield mobile ions. Biological additives contain volatile essential oils that give off distinct aromas when heated. **[2 Marks]**

Item 2: Periodic Table Predictions & Medical Geology (10 Marks total)

(a) Chemical Identification and Bond Nature [5 Marks]

- **Element X Identification:** Group II, Period 4 corresponds to **Calcium (Ca)** (Atomic Number 20). **[1 Mark]**
- **Element Y Identification:** Group VII, Period 2 corresponds to **Fluorine (F)** (Atomic Number 9). **[1 Mark]**
- **Compound Identification:** The formula XY_2 is **Calcium Fluoride (CaF_2)**. **[1 Mark]**
- **Bonding/Physical Nature:** It is a highly stable **ionic compound**. It forms a solid crystalline lattice with a very high melting point, and it is soluble in groundwater, where it dissociates into mobile ions (Ca^{2+} and F^-). **[2 Marks]**

(b) Physiological Treatment Mechanism & Eco-Impact [5 Marks]

- **Addressing Dental Caries:** Fluoride ions (F^-) replace hydroxyl groups in tooth enamel to form fluorapatite, which resists acid erosion and stops dental decay. **[1.5 Marks]**
- **Addressing Pains/Cramps:** Calcium ions (Ca^{2+}) are essential minerals needed to repair bone density and support smooth muscle contractions. **[1.5 Marks]**
- **Environmental Excess Impact:** Excessive environmental intake of fluoride ions causes a pathological condition known as **fluorosis**, which presents as ugly brown mottling/staining of teeth and severe bone deformation (skeletal fluorosis). **[2 Marks]**

Item 3: Soil Nitrogen Management & Ecosystem Impact (10 Marks total)

(a) Soil Fertility and Ion Dissolution [5 Marks]

- **Soil Action:** Plants require nitrogen to synthesize essential amino acids, proteins, and chlorophyll molecules. High levels of available nitrogen stimulate vegetative growth and green leaf expansion, boosting photosynthetic yield. **[2 Marks]**
- **Chemical Nature:** Ammonium nitrate is highly soluble in damp soil moisture. **[1 Mark]**
- **Ionic Dissolution representation:** $NH_4NO_3(s) \rightarrow NH_4^+(aq) + NO_3^-(aq)$ **[2 Marks]**

(b) Runoff Damage Mechanisms & Solutions [5 Marks]

- **Fertilizer Runoff Mechanism:** Excess nitrate fields drain into the river, causing **eutrophication** (rapid multiplication of algae blocks sunlight and depletes oxygen when they die/decay, suffocating fish). **[2 Marks]**
- **Washing Bay Waste Mechanism:** Oil and grease float on the water surface, forming an impermeable layer that blocks atmospheric oxygen from dissolving into the river water, choking aquatic organisms. **[1 Mark]**
- **Mitigation Measures:** (1) Build a dedicated retention pond and oil interceptor at the washing bay to catch oil and grease before discharging clean water. (2) Practice precision fertilizer application techniques (e.g., micro-dosing) or plant a thick grass buffer strip along the riverbank to trap runoff. **[2 Marks]**