



ELITE HIGH SCHOOL

S.4 CHEMISTRY SEMINAR 28th JUNE 2025

SUGGESTED SOLUTIONS

ITEM 1: DETERGENTS

Mr Lukas and his family, being new in Moroto town areas, resorted in buying borehole water from one of the local water suppliers for laundry work. While his wife was washing, she noticed that despite several rinsing of the water with the detergent, the less the volume of lather formed and later, several lines of brown stain were formed on the white cloth she hanged on a wire. This left her stressed with what was really wrong with the water. You have been approached to give advice.

Task: As a chemistry student

- Identify the mistake she made while choosing the product.
- Guide his wife on how the product works.
- Advise them on the change that may come from the long-term use of the detergents.

(Expected Response to ITEM 1)

a) **Category of the products used**

The mistake she made was to use **Soapy Detergents** instead of **Soapless Detergents** when washing with hard water **C**

2Scores

b) **How the products work**

Lukas's wife should know that both Soapy and Soapless detergents have polar heads, the hydrophilic heads as the water loving groups and non-polar groups, the hydrophobic tails as the water hating groups that attract stains. **F** Due to mechanical action, the soap head moves towards layers of water molecules, lowering the surface tension of water molecules, and allowing formation of lather with water. The hydrophobic tails bind themselves on the stains, causing them to break down into tiny droplets of particles that move away from the clothe **F**

3F = F₃ = 05Scores

c) **Danger arising from prolonged use of soapless detergents**

The family should know that soapless detergents contain non-biodegradable components like phosphate and Sulphate groups that cause, Water pollution (**Di**) leading to excessive algae growth hence harms to aquatic life and ecosystems. (**De**). This can be mitigated by encouraging the users to avoid pouring the leftover soapless waste water used directly into the water bodies (**Dm**)

Di + De + Dm = D₃ = 03Scores

C + F₃ + D₃ = (02+05+03) = 10Scores

ITEM 2: DETERGENTS

Mr Obonyo, a laundry worker in one of the busy towns in Kampala suburbs, has doubts about the effectiveness

of the surfactants X and Y he just bought with the aim to do his daily laundry work. His customers on their white clothes, despite his several attempt to rinse surfactant X with water, compared to when he used surfactant Y . This left him confused, and has come to you for guidance.

Task: As a chemistry student;

- Identify the category of the products used.
- Explain how the products works.
- Point out some of the danger(s) arising while using the products.
- Help him to evaluate the products.

(Response to ITEM 2)

a) **Category of the products used**

Mr Obonyo should know that the surfactants X he used is **Soapy** detergent and surfactant Y is **Soapless** detergent **C** **C = 02Scores**

b) **How the Detergents work**

Mr Obonyo should know that both Surfactants X or Y have polar heads, the hydrophilic heads as the water loving groups and non – polar groups, the hydrophobic tails as the water hating groups that attract stains. **F** Due to mechanical action, the soap head moves towards layers of water molecules, thus lowering the surface tension of water molecules, allowing formation of lather with water **F**. The hydrophobic tails bind themselves on the stains, causing them to break down into tiny droplets of particles and move away from the clothe **F**.

3F = F₃ = 05Scores

c) **Danger arising from prolong use of soapless detergents**

-Mr Obonyo should know that pouring Soapless detergents containing non – biodegradable components like phosphates causes Water pollution (**Di**) hence leading to excessive algae growth that pose potential harms to aquatic life and water ecosystems. (**De**). This can be mitigated by encouraging the users to avoid pouring the leftover soapless water used into the water bodies (**Dm**) **Di + De + Dm = D₃ = 03Scores**

-Mr Obonyo should know that too much exposure of the body to soapless detergents can cause potential health risks like skin and eyes irritations causing discomforts to the affected body parts. This is mitigated by washing the affected body parts with plenty of clean water.

d) **Evaluations between Soapy and Soapless detergents:**

Difference: Mr Obonyo should know that Soapy detergents are always less effective with hard water compared to Soapless detergents. **Ev₁**

Similarity: Both detergents, contain the hydrophilic heads and hydrophobic tails. **E**

2Ev₁ = Ev₂ = 02Scores + F₃ + D₃ + Ev = (02+05+03+02) = 12Scores

ITEM 1: FOOD ADDITIVES

In one of the wedding parties that was organized in Kasese District, western Uganda last month, where you and other guests were invited, got excited by the aroma and taste of the food served before them. The

preliminary report from the Head catering service provider shows that they used some of the ingredients like Onions, table salt, garlics, Carrots, tomatoes, turmeric, gingers, and cooking oil.

However, the Master of ceremony (MC) reminded the guests that the food was prepared with the knowledge of chemistry, but still some of the guests didn't understand what the MC meant. You have been asked to give guidance.

Task: As a chemistry student;

- Identify the category of the ingredients used.
- Explain the suitability of the ingredients used that make them useful during food preparation.
- Explain some of the danger(s) arising from the long – term use of the products with mitigation.

(Response to ITEM 1)

a) Category of the ingredients used

The guests should know that the ingredients the catering service providers used, are either **Natural or Synthetic** food additives **C** like Antioxidants, preservatives, Colourants, Flavourings and Enhancers **C = 02Scores**

b) How the Food additives work

Preservatives; such as table salts prevent food fermentation and any microbial growth hence increasing the shelf – life of food. **F**

Antioxidants; such as gingers prevent oxidation and discolorations of oily foods.

Colourants such as turmeric, tomatoes are used to enhance the physical appearance, textures of food **F**

2F = F₂ = 04Scores

c) Danger arising from prolong use of synthetic food additives

The guests should know that some food additives like preservatives, Stabilizers and antioxidants contain chemicals **(Di)** that are agents to organ cancers, hyperactivity in children, allergic body reactions and digestive disorders especially to people who depend on them daily in their dishes. **(De)** This can be mitigated by either reading carefully through labels of packed foods or limiting their consumption rates. **(Dm)**

Di + De + Dm = D₃ = 03Scores

C + F₂ + D₃ = (02+04+03) = 09Scores

ITEM 1:

Mzee Larkana a renowned 78 years old herbalist. He is known for his treatment usually from the mixing of a variety of plant parts such as lemon peels, garlic bulbs, gingers and raw honey by getting their extracts, that he uses for treating his trusted patients with digestive related bacterial infections and flu infection among others. However, lately some of his patients he treated didn't fully recover from the diseases instead their health conditions worsened than before and they were admitted in the hospital for proper medication. You have been asked to give guidance.

Task: As a chemistry student:

- Identify the mistake they made while choosing the products.

- b) Help them understand how the product(s) works.
 c) Suggest the possible side effect(s) of the product to the users and mitigate.
 d) Evaluate the products. **Expected Response**

a) Category of the medicines used

They chose **Traditional medicines C** instead of **Modern Antibiotic medicines**.

C = 02Scores

b) How the medicines work

Antibiotic medicines; work by inhibiting multiplication of bacterial growth in the body **F** and reducing their growth hence allowing the body's immune defense system to take over and eliminate the bacterial infections permanently. **F**

2F = F₂ = 04Scores

c) Danger arising from prolong use of medicines

Antibiotics; causes body reactions such as nausea, fatigue, dizziness and skin irritation; **(Di)** hence causing body discomforts **(De)**. These effects can be mitigated by taking plenty of fluids, having enough rest and following the recommended doze **(Dm)**.

Di + De + Dm = D₃ = 03Scores

d) Evaluations between traditional and modern medicines:

Difference: Traditional medicines are less effective for serious diseases compare Modern antibiotic medicines **Ev₁**.

Traditional medicines always show slow responses to treatment while modern antibiotics are always show quick responses to healing.

Similarity: Both medicines contain natural plant, animal and microbial remedies **Ev₁**.

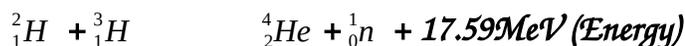
2Ev₁ = Ev₂ = 02Scores

C + F₂ + Ev₂ D₃ = (02+04 + 02+03) = 11Scores

NUCLEAR PROCESSES

ITEM 1:

The government of Uganda intends to install a new nuclear power plant despite resistance from the international bodies. The intention is to curb down power blackout in the Country energy supply. The preliminary experiment shows that the technical teams, intend to react radioactive hydrogen atoms of deuterium (${}^2_1\text{H}$) with hydrogen atoms of tritium (${}^3_1\text{H}$) to form helium (${}^4_2\text{He}$), neutron particles (${}^1_0\text{n}$) and massive energy of **17.59MeV** as shown below in the equation.



Task: As a chemistry student:



- Explain
- the type of nuclear process that took place.
- how the whole process works to generate massive energy required.
- Suggest the side effect(s) of the whole process with mitigation.

(Expected Response to ITEM 1)

a) Category of the medicines used

Atomic bombs or nuclear fusion **C**

C = 02 Scores

b) How the whole nuclear fusion works:

Nuclear fusion works when lighter stable radioactive atoms fuse together to form larger unstable heavier atomic nuclides **F** with release of massive amount of energy and radiations **F**. The energies generated is used to convert water to steam to run the water turbines that generates electricity **F**.

3 F = F₃ = 05 Scores

c) Danger arising from prolong use of medicines

High doses of radiation emitted from nuclear reactions, **(Di)** causes instant death to people as it was seen to the people who died from World War II atomic bombs in Japan. **(De)**. This is mitigated by imposing international Strick laws to countries that still make nuclear weapons. **(Dm)**.

High doses of radiation into the body, **(Di)** causes a permanent change in the genetic material (DNA) of a person and death **(De)**. This should be mitigated by using personal protective equipment such as strong metal sheets during treatment process **(Dm)**.

Di + De + Dm = D₃ = 03 Scores

C + F₂ + D₃ = (02+05+03) = 10 Scores

ITEM 2:

A team of archaeologists from Makerere University, just discovered sample remains of human skeleton that was buried under the rocks in Mount Elgon Eastern Uganda. According to the preliminary reports, it shows that the remains contain traces of carbon – 14 isotopes after the analysis.

However, the team leader wants to know how old is the skeleton containing 6.25% of carbon – 14 if its half-life is 5730 years and danger of the process responsible for the decay in nature. You have been asked to give assistance.

Task: As a chemistry student:

- Identify the type of nuclear process that took place.
- Determine how old is the skeleton containing carbon – 14
- Suggest the side effect(s) of the whole process with mitigation.

(Expected Response to ITEM 1)

a) *Category of the medicines used*

Nuclear fission **C**

C = 02 Scores

b) *How to determine the age of the skeleton:*

From $n = \sqrt[2]{\frac{N_0}{N_t}}$ **F** where $N_0 = 100\%$; $N_t = 6.25\%$; $n = \text{decay rate}??$

$n = \sqrt[2]{\frac{100}{6.25}}$ **F**; $n \sqrt[2]{16} = 4$ **A**

From $n = \frac{t}{T}$ where $t = \text{time that has passed during the decay (it's the age)}$

$T = \text{Half-life of carbon} - 14 = 5730 \text{ years}$, $t = ??$, $n = 4$

$t = n \times T$; $t = 4 \times 5730 \text{ years}$

$t = 22,920 \text{ years to decay}$ **A** **2F + 2A = 02 + 02 = Dm₂ = 04 Scores**

c) *Danger arising from prolong use of medicines*

High doses of radiation emitted from nuclear reactions, **(Di)** causes instant death to people as it was seen to the people who died from World War II atomic bombs in Japan. **(De)**. This is mitigated by imposing international Strick laws to countries that still make nuclear weapons. **(Dm)**.

High doses of radiation into the body, **(Di)** causes a permanent change in the genetic material (**DN_A**) of a person and death **(De)**. This should be mitigated by using personal protective equipment such as strong metal sheets during treatment process **(Dm)**.

C + Dm₂ + D₃ = (02+04+03) = 09 Scores

ITEM 2:

Mulago National referral Hospital, the Orthopedic Medical department, the medical specialists who focus on the diagnosis, treatment and prevention of musculoskeletal system disorders encompassing bones, joints, muscles, tendons and ligaments, has advised the government of Uganda to install a simple but more effective **MRI** (Magnetic Resonance Imaging) system.

A system that when used, allows a radioactive element to decay faster, emitting gamma rays that can be used take detailed images of the inside body in diagnosis of broken bones, ligaments and muscles of injured patients. However, many people are worried about these forms of treatments to be dangerous and life threatening. You have been asked to give assistance.

Task: As a chemistry student;

a) Identify the type of nuclear process(es) involved.

b) Suggest any other function of the form of the energy emitted.

c) Explain any other danger(s) arising from the form of energy released and give its mitigation.

d) Evaluate the nuclear processes installed

(Expected Response to ITEM 1)

a) Category of the medicines used

Nuclear process may be nuclear fission or nuclear fusion **C = 02Scores**

b) How the energy emitted from nuclear processes works:

Gamma rays emitted from radioactivity elements, can be used in treatment of cancerous cells, **F** sterilizing medical devices and diagnosis of broken bones and organ failures in medical fields. **F**

2F = F₂ = 04Scores

c) Danger arising from prolong use of medicines

High doses of radiation emitted from nuclear reactions, **(Di)** causes instant death to people as it was seen to the people who died from World War II atomic bombs in Japan. **(De)**. This is mitigated by imposing international Strick laws to countries that still make nuclear weapons. **(Dm)**.

High doses of radiation into the body, **(Di)** causes a permanent change in the genetic material (DNA) of a person and death **(De)**. This should be mitigated by using personal protective equipment such as strong metal sheets during treatment **(De)**. **(Di).+(De) + (Dm) = D₃ = 03Scores**

d) Evaluation of the nuclear processes installed

Difference: Nuclear fusion involves joining two or more lighter stable atomic nuclides to form a heavy unstable atomic nuclide while nuclear fission involves splitting a heavy unstable atomic nuclide to form stable atomic nuclides. **Ev₁**

OR Nuclear fission and its fissionable reactions can be regulated unlike nuclear fusion and its fusionable reactions. **Ev₁**

Similarity: Both processes emit radiation particles and massive energy when bombarded (by fast moving neutrons/particles). **Ev₁** **2Ev₁ = Ev₂ = 02scores**

C + F₂ + D₃ + Ev₂ = (02+04+03+02) = 11Scores

MATERIALS

ITEM 1:

The Kampala capital city authority, KCCA, in their financial budget. They intend to construct recycling plant for plastic wastes in **Kitezi** landfills with the intention to generate hydroelectric power and also to prevent the drastic leakages of the plastic wastes into the environment, following the advice from the technical team about the uniqueness of the structural properties of these materials used. However, the community members have perceived this initiative with skepticism due to some bad influence from some politicians. You have been tasked to settle this matter.

Task: As a Chemistry student:

- a) Explain the category of the materials in the landfill.
- b) Advise the community members on the suitability of the materials that make them useful in daily life activities.
- c) Advise on the danger of the materials to the environment.

(Expected Response to ITEM 1)

- category; reason and example(s)

synthetic materials; **Ci** because they are man – made materials; **Cr** polyethene bags, polypropene/plastic bottles, nylon materials **Ce**

$$\underline{C_i + C_r + C_e = C_3 = 03\text{Scores}}$$

- suitability/physical properties of:

Polyethene(plastic) materials:

- Don't absorb water **P₁**
- Are tough, elastic and flexible materials **P₁**
- Are resistant free to corrosive chemicals **P₁**
- Are poor conductors of heat/electricity. **P₁**
- Being water proof, elastic and flexible materials; make them useful as packaging containers. **U₁**

$$4P_1 + U_1 = 04 + 01 = P_3 = 05\text{Scores}$$

- Danger arising from prolong use of medicines

Plastic debris block soil pores, **(Di)**. reducing soil aeration and water infiltration and microorganisms leading to soil infertility. **(De)**. This can be mitigated by encouraging people to use reusable plastic materials and recycling them to prevent their accumulation in the environment **(Dm)**.

Plastic debris are non – biodegradable materials, **(Di)**. and when ingested by aquatic animals causes blockage of their digestive systems hence death of the wildlife and water pollution. **(De)**. This is mitigated by use of alternative containers that are biodegradable materials that can easily decompose without affecting the environment. **(Dm)**.

$$\underline{(Di) + (De) + (Dm) = D_3 = 03\text{Scores}}$$

$$\underline{C_3 + P_3 + D_3 = (03 + 05 + 03) = 11\text{Scores}}$$

ITEM 2:

Mr. Kamuntu intends to enter in his newly constructed house, but the house lacks metallic frame materials suitable for the doors and windows. He would like to purchase them from the nearby hard ware shop in the area. Although his constructors suggested that, he gets the best metal materials that have good quality structural properties. However, he remained skeptical, and he needs your guidance on the best structural

properties of the materials to be used.

Task: As a Chemistry student:

- Explain to him the category of the materials
- Advise him on how the material is suited for its uses in daily life.
- Of what danger is the material to the environment with mitigation.

(Expected Response to ITEM 1)

a) category; reason and example(s)

synthetic materials; **Cr** because they are man – made materials; **Cr**, iron metal materials, Aluminium metal materials **Ce** $Cr + Ce = C_3 = 03\text{Scores}$

b) suitability/physical properties of:

Iron metal materials:

- Are malleable **P₁**
- Have high melting point
- Are water proof materials **P₁**

Aluminium metal materials:

- Has high melting point **P₁**
- Are malleable and ductile materials **P₁**

c) Being resistant to corrosion, and malleable materials, make them useful in making door and window frames. **U₁** $4P_1 + U_1 = 04 + 01 = P_3 = 05\text{Scores}$

d) Danger arising from prolong use of medicines

Water pollution and soil pollution (**Di**) caused by iron rusts contaminating water and soil by lowering their pH. This affects soil fertility and its structures. (**De**) This is mitigated by encouraging recycling the unused metal materials to avoid their negative effect in the environment. (**Dm**) $(Di) + (De) + (Dm) = D_3 = 03\text{Scores}$

$$C_3 + P_3 + D_3 = (03 + 05 + 03) = 11\text{Scores}$$

EXAMINABLE AREA

MOLE CONCEPT

ITEM 1:

The gaseous hydrocarbon **X** is a carbon – based fuel used in racing cars formula – 01. Its internal complete engine combustion, gave out carbon dioxide gas, water vapour and heat energy according to the equation below:



The preliminary experiment shows that hydrocarbon **X** contains 80% carbon and the rest being hydrogen whose relative molecular mass is 30.

However, the ministry of games and sports wants to know how to determine the molecular formula of **X** and how much volume of the carbon dioxide gas in litres will be emitted if 80g of **X** were completely burnt to produce heat energy.

Task: Use your chemistry knowledge to:

a) Explain the:

(i) Category of the **homologous series** used as carbon – based fuel.

(ii) Suitability of the gaseous product(s) emitted.

b) Guide them on how to determine the:

(i) Empirical formula and hence molecular formula of X ($C = 12, H = 1, Mr = 30$)

(ii) Volume of carbon dioxide gas emitted into the atmosphere from a single race when hydrocarbon X in (b) (i) is burnt completely in oxygen. (1 mole of a gas occupies 24l at r.t.p; 1mole of X liberated 2moles of carbon dioxide gas)

c) Advise on the impact arising from using this fuel type to the environment.

(Expected Response to ITEM 1)

a) (i) category; reason and example(s)

X is an **alkane** carbon - based fuel **Cr** because it is a saturated carbon – carbon single bonds organic compounds; **Cr**, examples methane, ethane or butane **Ce**



03Scores

(ii) suitability/physical properties of gaseous product formed:

- It's a colourless gas **P₁**
- It's an acid gas since it turns moist blue/ red litmus paper. **P₁**
- Extinguishes combustion of materials **P₁**
- It's denser than air **P₁**
- It doesn't support combustion, making it usefully used as fire extinguisher **U₁**

$$2P_1 + U_1 = 02 + 01 = P_3 = 03Scores$$

b) (i) Determining the Empirical formula of X

Element	C	H
Percentage composition	80	20
Atomic mass	12	1
Moles	$\frac{80}{12} = 6.667 \mathbf{A_1}$	$\frac{20}{1} = 20.00$
Mole ratio	$\frac{6.667}{6.667} = 1.0$	$\frac{20.00}{6.667} = 2.999 = 3$
Ef of X	$\mathbf{CH_3 A_1}$	

Determining molecular formula of X

From (EF)_n RMM; $(CH_3)_n = 30 \mathbf{F}$

$$n = \frac{30}{15}; n = 2$$



$$(12\chi n) + (1\chi 3n) = 30$$

$$15n = 30$$

(ii) *Determining volume of Carbon dioxide gas emitted*

Molar mass of $C_2H_6 = 30g$

30g of X contain 1mole of a substance.

$$80g \text{ of X contain } \frac{1 \times 80}{30} \text{ moles} = 2.667 \text{ moles } \mathcal{A}_1$$

From the Equation,

1 mole of X gave out 2moles of carbon dioxide gas \mathcal{M}_1

$$2.667 \text{ moles of X gave } \frac{2 \times 2.667}{1} \text{ moles of carbon dioxide gas} = 5.334 \text{ moles of carbon dioxide gas } \mathcal{A}_1$$

1mole of a gas occupies 24L at r.t.p \mathcal{M}_1

$$5.334 \text{ moles of a gas occupies } \frac{5.334 \times 24 \text{ L}}{1} \text{ at r.t.p} = 128.02 \text{ L of carbon dioxide gas. } \mathcal{A}_1$$

OR

From 1mole of X produced 2 moles of CO_2

30g of X occupy $(24 \times 2) \text{ L}$ of CO_2

$$\text{Therefore, } 80g \text{ of X occupy } \frac{24 \times 2 \times 80}{30} \text{ L of } CO_2 = 128 \text{ L of carbon dioxide gas}$$

$$\underline{1\mathcal{F} + 2\mathcal{A}_1 = 01 + 02 = \mathcal{M}_3 = 03 \text{ Scores}}$$

c) *Impact arising from using carbon – based fuel to the environment:*

increased carbon dioxide gas emission into atmosphere, (\mathcal{D}_i) caused by combustion of carbon – based fuels; thus, causing global warming in the area. (\mathcal{D}_e) This is mitigated by use of alternative fuel energy like solar energy, hydroelectric power to reduce the total dependence on non – renewable carbon – based fuels. (\mathcal{D}_m)

$$(\mathcal{D}_i) + (\mathcal{D}_e) + (\mathcal{D}_m) = \mathcal{D}_3 = 03 \text{ Scores}$$

$$\mathcal{C}_3 + \mathcal{M}_3 + \mathcal{P}_3 + \mathcal{D}_3 = 03 + 03 + 03 + 03 = 12 \text{ Scores}$$

TRENDS IN THE PERIODIC TABLE

ITEM 1:

Sodium, magnesium, aluminium, silicon, phosphorous and sulphur are some of the elements in period 3 of the Periodic Table, the teacher is interested to investigate about their chemical and structural properties of the products after their combustion in air to form oxides. He burnt each element separately in plenty supply of oxygen to form respective oxides, and the preliminary results were obtained as shown in the table below:

Element	$_{11}\text{Na}$	$_{12}\text{Mg}$	$_{13}\text{Al}$	$_{14}\text{Si}$	$_{15}\text{P}$	$_{16}\text{S}$
Oxide	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_3	SO_2

However, the teacher not only wants to know the nature of the chemical compounds involved in the oxides formed but also how the structural properties affect their usefulness in daily life. You have been asked to give guidance.

Task: As a chemistry student:

a) Explain;

- (i) the type of compound(s) formed in the oxides
- (ii) the properties of any two oxides relative their usefulness in daily life.

b) Explain the impact of any one of the oxides formed to the environment.

(Expected Response)

a) (i) category; reason and example(s)

Basic oxides; **Ci** they are oxides that react with the acids to form salts and water only; **Cr** examples sodium oxide, magnesium oxide **Ce**.

Ionic compounds; **Ci** they are formed by complete transfer of electrons from metal atoms to non – metal atoms to form ions; **Cr** examples sodium oxide, magnesium oxide, aluminum oxide **Ce**.

Acidic oxides; **Ci** they dissolve in water forming acid solution; **Cr** examples sulphur dioxide, phosphorous (III) oxide **Ce**.

Simple covalent molecules; **Ci** they are formed by sharing of electrons between non – metal atoms held by weak forces between their molecules; **Cr** examples phosphorous (III) oxide, sulphur dioxide **Ce**. **Ci + Cr + Ce = C₃**

= 03Scores

Giant covalent molecules; **Ci** they are formed by sharing of electrons between non – metal atoms held by strong covalent bonds; **Cr** example silicon (IV) oxide **Ce**.

(ii) properties of any two oxides.

Basic oxides Na_2O MgO	Acidic oxides, P_2O_3 SiO_2
<ul style="list-style-type: none"> • High melting points P₁ • Are soluble in water to form basic solution • Have ionic bonds P₁ • Them being soluble bases, can be used to neutralize acidic water during water 	<ul style="list-style-type: none"> • Have covalent bonds P₁ • Low melting points P₁ • Poor electrical conductivity • Are soluble in water forming acidic solutions • SO_2 being acidic oxide; serves as raw U₁ material in the production of Sulphuric acid

treatment U_1

$$4P_1 + 2U_1 = (04 + 02) = 06 \text{ Scores}$$

Impact arising from using the oxides to the environment:

increased sulphur dioxide gas emission into atmosphere, **(Di)** caused by combustion of carbon – based fuels; causes formation of acid rain that corrode buildings and global warming in the area. **(De)** This is mitigated by use of alternative fuel energy cells like solar energy, hydroelectric power to reduce the total dependence on non – renewable carbon – based fuels. **(Dm)**

$$C_3 + 4P_1 + 2U_1 D_3 = 03 + 04 + 02 + 03 = 12 \text{ Scores}$$

ITEM 8: ALLOYS

A new factory is in the process of re – constructing the body of an old cargo aero plane that recently got destroyed resulting into several leakages. They intend to make good and strong metal materials from the available metal they have in the stocks. The preliminary report, shows that they intend to use 90% aluminium with 10% magnesium after mixing them to form the desired metal materials needed in the re – construction process. However, the factory manager is interested to know whether the products formed will be environmentally friendly beside its usefulness. You have been approached to offer guidance.

Task: As a Chemistry student:

a) Explain the;

- (i) Category of the metal product used.
- (ii) Suitability of the metal product besides its usefulness in daily life.

b) Explain the impact of using these materials to the environment.

(Expected Response)

a) (i) category; reason and example(s)

Duralumin metal material; **(Ci)** because it contains a mixture of two or more elements; **(Cr)** examples of the elements include Aluminium, magnesium metals. **Ce**

(ii) Suitability of the metal materials $Ci + Cr + Ce = C_3 = 03 \text{ Scores}$

- Corrosive resistance material P_1
- Malleable metal material P_1
- High melting point P_1
- Good electrical and thermal conductivity. P_1
- High – strength to – weight ratio; making it ideal material in metal construction that involves weight reduction. U_1 $4P_1 + U_1 = 04 + 01 = 05 \text{ Scores}$

b) Impact of using Duralumin metal materials to the environment

- Improper disposal of aluminium metal materials can lead to groundwater and soil pollution (**Di**) due to leaching; hence affecting plant growth and soil microbes. (**De**) This is mitigated by encouraging metal reusing and recycling. (**Dm**)
 $(Di) + (De) + (Dm) = D_3 = 03 \text{ Scores}$
- Groundwater pollution caused by constant leaching of aluminium metal materials; (**Di**) hence making water acidic and potentially harmful to aquatic life. (**De**) This is mitigated by ensuring proper disposal of aluminium metal wastes through recycling plant and landfill management. (**Dm**)

$$C_3 + 4P_1 + U_1 + D_3 = 03 + 04 + 01 + 03 = 11 \text{ Scores}$$

SECTION B (PART 1) ITEMS 3 & 4

ITEM 1: [Manufacture of Sulphuric acid]

The Uganda Battery limited **UBL**, one of the oldest industries in Uganda, intends to expand her production by making more of the car batteries that use Sulphuric acid with the aim of meeting its high demands in Automobile industries using the available raw materials they have in stock in Kilembe copper mine in Kasese District. However, the locals in the areas have raised their fear due to exposure to potential harmful fumes, the factory emit in to the environment besides them providing employment opportunity to the community.

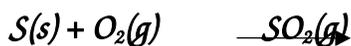
Task: As a chemistry student. Make a write up guiding message sensitizing the community on how the whole production process will be conducted.

(Expected Response)

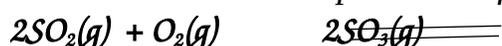
Raw materials and process of production:

Sulphuric acid is manufactured by **contact process (Cp)** using the extracted sulphur, oxygen and vanadium (V) oxide as catalyst. (**Rm**)

Sulphur extract placed in a sealed tank (**V**) is burnt in oxygen to form sulphur dioxide gas.



Sulphur dioxide gas formed (**Rm**) is further burnt in oxygen to form sulphur trioxide gas (**Cp**) in a sealed tank in the presence of Vanadium (V) oxide at 450°C and 200 atmospheres.



Sulphur trioxide gas formed is dissolved in pure concentrated Sulphuric acid to form oleum. $SO_3(g) + H_2SO_4(L) \longrightarrow H_2S_2O_7(L)$ (**oleum**) (**Cd**) The oleum formed is dissolved in controlled amount of distilled water to form pure concentrated Sulphuric acid. (**Pr**)



$$2Rm + 1Cp + 1V + 1Cd + Pr = P_3 = 06 \text{ Scores}$$

Danger identified (Di) Danger explained (De) and Danger mitigated (Dm)

There is high risk of sulphur dioxide gas emission from the plant into the atmosphere; (**Di**)

causing air pollution, acid rain and greenhouse effect, resulting into global warming, all these together affect the environment greatly. **(De)** This can be mitigated by use of fuel desulphurization system to trap and remove Sulphur dioxide gas before its emission in the air **(Dm)**

$$(Di) + (De) + (Dm) = D_3 = 06 \text{ Scores}$$

Benefit (Sb) Benefit explained (Be) Benefit impact (Si)

The plant creates job opportunity to the workers; hence **(Sb)** improved income **(Se)** and hence improved standard of living **(Si)**. **(Sb) + (Se) + (Si) = B₃ 06 Scores.**

The plant is a source of government revenue through tax; leading to improved infrastructures such as roads, schools, hospitals; hence improved standard of living

$$P_3 + D_3 + B_3 = 06 + 06 + 06 = 18 \text{ Scores}$$

ITEM 2: [Manufacture of lime]

An investor intends to produce Lime, a key chemical needed in the manufacture of paints and coatings besides glass manufacturing. He intends to use the available raw materials they have in stock in order to achieve their targets and expectations in the production process of Lime.

However, the locals in the areas are worried about the potential harm the factory could cause to the environment and how the whole production process will be conducted. You have been tasked to give guidance.

Task: As a chemistry student. Make a write up message sensitizing the community on the environmental management programs and how the whole production process will be conducted.

Expected Response:

Raw materials and production process

The locals in the areas and across the Country should know that:

Limes from limestone **(Rm)** is first grounded into fine particles, then fed into a kiln, **(V)** heated at about 900°C to form quick lime/Limes **(Cp)**



The quick lime (calcium oxide) formed **(Rm)** is then cooled shortly before water is added to it, forming slake lime (Calcium hydroxide) **(Cp)** in a sealed reactor tank.



The slake lime formed is passed through the purifiers to remove any impurities **(Pr)** and water, allowing it to be concentrated ready for packing and use **(Cd)**.

$$2Rm + 1Cp + 1V + 1Cd + Pr = P_3 = 06 \text{ Scores}$$

Danger identified (Di) Danger explained (De) and Danger mitigated (Dm)

Environmental impacts:

High level of air pollution (**Di**) from emission of sulphur dioxide gas, particulate matter, dust particles and nitrogen dioxide gas; their presence, lowers the air quality in the area leading to respiratory problems, eyes, ear and skin irritation. (**De**) This can be mitigated by use of electrostatic precipitator - absorption system and also encouraging the workers to always use personal protective equipment (**Dm**)

$$(Di) + (De) + (Dm) = D_3 = 06 \text{ Scores}$$

Benefit identified (Sb) Benefit explained (Be) Benefit impact (Si)

The plant creates job opportunity (**Sb**) especially to the workers such as engineers, technicians and other unskilled workers. This improves their income (**Se**) and hence improving their standard of living (**Si**).

$$(Sb) + (Se) + (Si) = B_3 = 06 \text{ Scores}$$

The plant is a source of government revenue through tax; leading to improved infrastructures such as roads, schools, hospitals; hence improved standard of living.

$$P_3 + D_3 + B_3 = 06 + 06 + 06 = 18 \text{ Scores}$$

SECTION B (PART II) SCENARIO ITEMS [NATURAL RESOURCES]

Types/Category (C)	Reason (R)	Example (E)
Renewable Natural resources	These are materials whose use by man does not deplete the resources and can be replenished/replaced within man's life time.	Air, Water, Forests Charcoals, wood
Non-Renewable Natural resources	These are materials whose use by man deplete the resources and can <u>NOT</u> be replenished/replaced within man's life time.	Crude oils, Rocks, minerals

ITEM 1:

The government of Uganda intends to extract and refine the crude oil deposit that was recently discovered in Kibiro on the shores of Lake Albert in Western Uganda with the aim to meet the Country's Energy demands. However, up to know, the extraction process has delayed to kick start, due to the expected high potential risks of environmental contamination from the mining and refinery activities in the areas. The engineering team is organizing a sensitization forum with the district local government, councilors and the community and you have been invited to be part.

Task: As a Chemistry student. Make a write message containing information you would like to use on that day's meeting upon invitation.

Category; reason and Example(s)

The surrounding people around the production plant and the Country at large, should know that natural resources can be categorized either as:

Non – renewable natural resources; (Ci) because they are finite resources and can not be replenished/replaced within man's lifetime; **(Cr)** examples may include crude oil, natural gas and coal. **OR**
Renewable natural resources; since they are finite resources and can be replenished/replaced within man's lifetime; examples include air, water, and forests. **$C_2 = 02\text{Scores}$**

Compositions of: **$3C_{O_1} = 03\text{Scores}$**

Crude oil is a carbon – based fuel composed of elements such as carbon, **C_{O_1}** hydrogen, nitrogen, sulphur including some heavy metals such as lead, mercury.

Air is composed of a mixture of gases such as (nitrogen, oxygen, water vapour, carbon dioxide gas and noble gases) and some dust particles carbon monoxide, sulphur dioxide and nitric oxide gases) **C_{O_1}** **$3C_{O_1} + C_2$**
 $= N_2$ 05Scores

Water is composed of hydrogen and oxygen; it may also contain some dissolved toxic substances such as heavy metals among others. **C_{O_1}**

Danger identified (Di) Danger explained (De) Danger mitigated (Dm)

Oil spills during its extraction; refining processes and fossil fuel burning for energy, causes soil, water and air pollutions **(Di)**. The effects, causes suffocation and death of aquatic life, poor air quality and respiratory related diseases. **(De)** This effect can be mitigated by use of effective monitoring equipment and carrying out regular routine repair of the oil pipes including using alternative energy fuel cells such as hydroelectric power, solar energy to reduce on total dependence on fossil fuels for energy. **(Dm)** **$D_3 = 06\text{Scores}$**

Benefit identified (Bb) Benefit explained (Be) Impact of Benefit (Bi)

Air contains oxygen **(Sb)** which is used by animals during cellular respiration to generate energy needed to support normal body functioning and carbon dioxide used as raw materials during photosynthesis by green plants to make their own food in the presence of sunlight and chlorophyll. **(Se)** This facilitates the flow of energy in a food chain **(Si)**. **$(Sb) + (Se) + (Si) = B_3 = 04\text{Scores}$**

Crude oils provide energy fuel cells used in transportation, industries, heating and electricity sectors. This improves on the economic growth such as infrastructures like roads, schools, hospitals and industries.

$$N_2 + D_3 + B_3 = 05 + 06 + 04 = 15\text{Scores}$$

HOD AND TEAM OF EHS WISH YOU GOOD LUCK A HEAD