SCORING GUIDE ($\frac{X}{57}$)

MENGO SENIOR SCHOOL

END OF TERM THREE ASSESSMENT 2025

S.2 CHEMISTRY

Time: 2 hours

INSTRUCTIONS

This examination paper consists of **two** *sections;* **A** *and* **B**. *It has* **six** *examination items.*

Section **A** *has* **two compulsory** *items. Response to Section* **A** **must** *be written in the spaces provided*

Section **B** *has* **two Parts**; **I** and **II**. *Respond to* ***only one item from each part***

Response to Section **B** **must** *be written on the answer sheet(s) provided.*

Respond to four items in all

ITEM	*1*	*2*	*3 or 4*	*5 Or 6*	*TOTAL*
SCORE	*12*	*12*	*18*	*15*	*57*

SECTION A

ITEM 1

A new metal fabrication company that deals in construction materials such as gates and windows is to be set-up by Mr. Were, a reknown businessman in Namanve Industrial area, Central Uganda. Mr. Were wants to produce products that shall be of quality and sell fast in the market due their unique properties. He lacks knowledge of the best materials to make outstanding products without affecting the environment. He has been advised to use steel instead of pure **iron but lacks detailed knowledge about steel and needs advice.**

Task

As a chemistry learner;

a) Explain the type of material Mr. Were has been advised to use including its composition **(04 scores)**

Steel is an alloy Ci which is metallic substance made up of a uniform mixture of a metal and a non-metal

Steel is composed of iron (99%) and carbon (1%) Co

b) What are the essential properties acquired by the material in (a) above **(04 scores)**

- ***Stronger due to mixed atomic structure✓ P***
- ***Has improved resistance to corrosion i.e. steel resists rust✓ P***
- ***Less malleable and ductile but more durable✓ P***
- ***Harder due to different atom sizes reducing slip between layers✓ P***
- ***Has lower electrical and thermal conductivity✓ P***

c) Suggest any other daily application of the material Mr. Were is advised to use **(01 scores)**

- **Steel is the primary material for construction of buildings, bridges U**
- **Making railway tracks, locomotives U**
- **Making bicycle frames, chains and gears U**
- **Making steel pipelines for transporting oil and gas over long distances U**
- **Making frames and components of milling machines and drills U**
- **Making hand tools such as hammers, screwdrivers and saws U**

d) Evaluate the choice the material Mr. Were's has been advised to use by giving its similarities and differences with pure iron **(03 scores)**

Pure iron	**Steel**
More prone to corrosions or easily rusts	**Has improved resistance to corrosion**

Strongly magnetic	**Weakly magnetic**
High electrical and thermal conductivity	**Lower conductivity due**
Higher and defined melting point	**Lower melting point**

TOTAL SCORE = 12 SCORES

ITEM 2

Diamond and Graphite are two different forms of carbon that occur naturally. The government of Uganda is carrying out mineral exploration in different parts of the country in order to discover arrears that may be rich in Diamond and Graphite. To create awareness about the importance of the two substances, secondary school students have been asked to write messages to be used to sensitize the communities. Your school is among those selected to carry out this awareness campaign.

As a chemistry learner;

Task

a) Explain the category of the two different forms of carbon **(04 scores)**

Diamond and graphite are (crystalline) allotropes Ci of carbon because they are all made up of only carbon atoms in the same physical state.

b) Suggest at least two properties possessed by each of the two forms of carbon giving one use associated with a particular property **(04 scores)**

Properties of Diamond

- ***Hardest naturally occurring substance*** ✓ P
- ***Has a tetrahedral structure in which each carbon atom is joined to four other carbons*** ✓ P
- ***Has a high refractive index i.e. it reflects light/shiny*** ✓ P
- ***Colourless*** ✓ P

Properties of graphite

- ***Soft and slippery*** ✓ P
- ***Black and opaque*** ✓ P
- ***Two dimensional structure made up of layers arranged in hexagonal rings*** ✓ P
- ***Conducts electricity since it has free mobile electrons*** ✓ P

c) Evaluate the two carbon based substances by giving **ONLY** their differences **(02 scores)**

Graphite	*Diamond*
Soft and slippery	*Hardest natural substance*
Black and opaque	*Transparent and shiny*
Conducts electricity	*Does not conduct electricity*
Layers made of hexagonal rings	*Tetrahedral structure*

d) Suggest the dangers to the environment associated with the overuse of the carbon based substances and their mitigation **(02 scores)**

- ***Mining of Diamond and graphite leads to deforestation and soil erosion✓ Di since large areas are cleared and many trees are cut to clear ground to remove small amounts of the minerals✓ De mitigated by controlled mining and filling large pits excavated✓ Dm***
- ***Water pollution✓ Di from chemical released during processing of the minerals leading to contamination of water lowering its quality and also death of aquatic organisms✓ De mitigated by proper disposal of chemical wastes✓ Dm***
- ***Greenhouse gas emission and air pollution Di since there is high CO_2 emissions, dust and toxic chemicals causing global warming and reducing air quality respectively De mitigated by use of alternative source of energy such as electricity in processing industries Dm***

TOTAL SCORES = 12 SCORES

SECTION B

Part 1

Respond to only one item from this part in the answer booklet provided

ITEM 3

Charcoal is one of the cheapest fuels used by many homes especially in urban communities of Uganda. The government of Uganda is encouraging sustainable production of charcoal yet the practice is dangerous to the environment.

Fig 1 Showing drums for charcoal making

A group of S2 learners intend to carry out a project of producing charcoal using metal drums and later scale it up as a commercial activity but are not sure of how to carry out the process.

You have been chosen to guide the learners to ensure success of the project.

Task

As a chemistry learner with knowledge of charcoal making, write a message you shall use to guide the S2 learners in their project.

(Your message should include; ***the raw materials to be used, process of production, dangers of the process to the environment and mitigation and the benefits of the process of production***)

Raw materials: Hardwoods from acacia, eucalyptus or mango trees

Process of production

The trees are cut down and the wood is chopped into manageable pieces Rm. The wood is left to dry pp for several weeks to reduce the moisture content. The dry wood is then packed in a metal drum V with small ventilation holes. The wood is ignited Cp at the base of the drum. The

small holes on the walls of the drum allow controlled amounts of oxygen and ensure that the wood burns slowly without combusting Cp. Carbonization Cp occurs where the organic substance in wood is converted to carbon/charcoal Cd in the absence or limited supply of oxygen. After carbonization, the kiln or drum is completely sealed to extinguish any fire and allow charcoal to cool down in two to three days.

The drum is opened and the charcoal is removed. Large pieces of charcoal are sorted and packed into bags for transportation and sale

1Rm+1V+3Pp+1cp+1Pr+1Cd+1Ch = P3 = 06 scores

Dangers of charcoal making

- *Deforestation due to excessive tree cutting for charcoal production✓ Di leading to habitat destruction, biodiversity loss and reduced carbon dioxide absorption✓ De mitigated by sustainable forestry, agroforestry and use of alternative sources of energy such as biogas, solar and improved cookstoves✓ Dm*
- *Release of smoke and toxic gases during burning✓ Di leading to air pollution and health issues causing respiratory diseases, eye irritation ✓ De This is mitigated by promoting improved charcoal making techniques with better ventilation and emission controls✓ Dm*
- *Burning wood for charcoal reduces moisture retention in the environment reducing rainfall since the water cycle is affected leading to droughts mitigated by sustainable charcoal production such as carbonization using agricultural waste*

Di + De + Dm = S3 = 06 scores
Di only =02 scores

Benefits of charcoal making process

- ✓ *Source of employment✓ Sb for chain saw operators of people who cut and chop tress, build kilns and pack charcoal which gives them income ✓Se to improve their standard of living✓ Si*

- ✓ ***Ensures energy independence ✓ Sb since communities can produce own cooking and heating fuel from local resource ✓ Se, reducing dependence on imported fuels such as gas ✓ Si***
- ✓ Sb + Se +Si = B3 = 06 scores
- ✓ Sb = B1 = 02 Scores
- ✓ **TOTAL = P3 + S3 + B3 = 06 + 06 + 06 = 18 Scores**

ITEM 4

Oxygen is one of the most important substances with many applications in daily life including as medical oxygen and in welding works in many industries. To ensure a steady supply of stored oxygen, the government of Uganda has cleared a Ugandan based company based in Kawempe, Kampala to produce the much needed product.

Fig. 2 An Oxygen Plant

However, the population in the area requested to be informed about the process leading to the production of oxygen, the economic and social benefits of the manufacturing plant and how any side effects is/are mitigated. A radio talk show has been organized to address the request by the population and your school has chosen you as their representative

Task

Write details of the key issues you will present during the talk show

a) **Raw materials and process of production (06 scores)**

Raw material is atmospheric air Rm later turned into liquid air

Method: fractional distillation of liquid air.

The air is collected and filtered[Pr]. The clean air is cooled[Cp] to allow water vapour condense (a drying agent like silica gel can be used). The water free air is then bubbled through concentrated sodium hydroxide solution[Cp] to remove carbon dioxide gas (the air can be passed over beds of an adsorbent like alumina or zeolite). The resultant gas is compressed[Cp] by passing it through a compressor V, cooled[Cp] using refrigeration cycles and heat exchangers V. This cool air is then allowed to expand[Cp] which makes it much colder. The three processes of compressing, cooling and expanding are repeated until temperatures fall to around -200^{0}C where air has liquefied. The liquid air is then fed into the fractionating column[V] where it is slowly warmed[Cd] until -183^{0}C when oxygen boils off and it is collected and packed.

Alternative description of process of production of oxygen

Air Compression PP

- *Air Intake: Atmospheric air is drawn into the system and filtered to remove dust, moisture, and other impurities.*
- *Compression: The air is compressed to high pressure (around 5-10 bar) using compressors V. This increases the density of the air and prepares it for cooling.*

Air Purification PP

- *Removal of CO_2 and Moisture: The compressed air is passed through molecular sieves V or other adsorbents to remove carbon dioxide (CO_2) and water vapor. These impurities can freeze and block the system during the cryogenic (very low temperature) process.*

Cooling and Liquefaction Cd

- *Heat Exchange: The purified air is cooled in a series of heat exchangers V using countercurrent flow of cold gases (e.g., nitrogen and oxygen) from the distillation process.*
- *Expansion: The cooled air is expanded through a turbo-expander V or expansion valve V, which further reduces its temperature and causes it to liquefy. The air is now in a liquid state at around -185°C.*

Fractional Distillation Cd

- *Distillation Column: The liquefied air is fed into a fractional distillation column V, which consists of multiple trays or packing material to facilitate separation.*
- *Separation by Boiling Points:*
    - *Nitrogen (N_2) has a lower boiling point (-196°C) and evaporates first, rising to the top of the column.*
    - *Oxygen (O_2) has a higher boiling point (-183°C) and remains as a liquid, collecting at the bottom of the column.*
    - *Argon (Ar), with a boiling point between nitrogen and oxygen, is separated in an intermediate column.*

Output:

- *Nitrogen Gas: Collected at the top of the column.*
- *Oxygen-Rich Liquid: Collected at the bottom of the column.*
- *Argon Gas: Separated in a secondary column for further purification.*

Oxygen Purification Pr

- *The oxygen-rich liquid is further distilled in a low-pressure column V to achieve high-purity oxygen (99.5% or higher).*
- *Impurities like argon and trace gases are removed.*

Storage and Distribution

- *Liquid Oxygen: The purified oxygen is stored in cryogenic (very low temperature) tanks at very low temperatures (-183°C) for large-scale industrial use or transportation.*
- *Gaseous Oxygen: Liquid oxygen can be vaporized and compressed into high-pressure cylinders for medical or industrial use.*

1Rm+1V+3Pp+1cp+1Pr+1Cd+1Ch = P3 = 06 scores

b) **Side effects of the process of production, explanation and mitigation**

One danger identified, explained and mitigated (06 scores)

- *Danger and effect: Gas explosion; Di Due to high pressure, the gas cylinders may burst and this can lead to death of the personnel De.*
  Mitigation: Therefore strong materials must be used to make these cylinders and also care must be taken. Dm
  Or installation of

suppression systems Dm

- *Danger and effect: fire out breaks; Di Due to high oxygen concentration, there is a risk of fire outbreak which can lead to loss of lives.*

Mitigation: Firefighting equipment must be installed. Dm

- *Cryogenic (Very low temperature) Burns Di Liquid oxygen cause burns if it comes into contact with the skin De*
  Mitigation: Use of PPE such as gloves and safety glasses to protect workers from burns Dm

Di + De + Dm = S3 = 06 scores
Di only =02 scores

c) **Social benefit of the process of production, impact and result**

One Social Benefit Explained and its Impact (*06 scores*)

- **Source of revenue to the government through taxes**,✓Sb **hence improved infrastructures**,✓ Se e.g. health facilities, roads, hospitals, and schools, improved road networks will facilitate trade **hence improved income and better standards of living**,✓ Si
- **Source of employment/*job* opportunities**,✓Sb; **improved income** ✓Se thus better **standards of living**,✓Si

Sb + Se +Si = B3 = 06 scores
Sb = B1 = 02 Scores

TOTAL = P3 + S3 + B3 = 06 + 06 + 06 = 18 Scores

Part II

Respond to only one item from this part in the answer booklet provided

ITEM 5

Water is an important natural resource that should be conserved. There is improper waste disposal in some homes, industries and garages involving careless disposal of waste into water bodies such as rivers, swamps which waste end up in lakes such as Lake Victoria. These activities introduce contaminants into water hence affecting water quality.

FIG. 3 Showing polluted water bodies

An area Member of Parliament has asked your School Science Club to organize a sensitization campaign aimed at mitigating the challenge. The theme of the campaign is '**Be a water quality Champion**'. You have been chosen to speak to the communities and industrial managers regarding the theme.

Task

Make a write-up of the message you will present

(***Your message should include the category with a reason, composition of the natural resource, man's activities that affect the resource with their mitigation and benefits of the resource***)

RESPONSE

TITLE: BECOMING A WATER QUALITY CHAMPION BY AVOIDING WATER POLLUTION

a) Identity of category of natural resource with a reason and Composition of natural resource

Water is a **renewable natural resource; ✓ Ci** because **it be replenished /replaced ✓; R** by natural processes such as **the water cycle**

Water, composed of two elements; two atoms **hydrogen✓Co** and **oxygen✓Co;** and **dissolved mineral ions ✓Co**

b) Impact of Human activities on the natural resource and on the environment, how it occurs, and mitigation

One human activity (Mi) identified, explained (Me) and mitigated (Mm) (04 scores)

- **Disposal of Industrial waste**✓ **Mi** which release pollutants such as chemicals and heavy metals into water bodies✓ **Me**

This is mitigated by implementing effective waste water treatment systems to reduce pollution✓ **Mm**

- ***Use of agrochemicals*** ✓ **Mi** ***Agricultural runoff*** *Fertilizers, pesticides and manure from agricultural activities can enter water bodies causing algal blooms or eutrophication*✓ **Me** *mitigated by adopting organic farming or use of organic manure and crop rotation*✓ **Mm**
- **Domestic waste**✓ **Mi** Sewage and waste water from homes, restaurants can contaminate water causing algal blooms that compete for oxygen with aquatic animals hence causing the death of such animals e.g. fish✓ **Me** mitigated by treatment of waste water and sewage before disposal in water bodies✓ **Mm**
- **Oil spills**✓ **Mi** Oil spills from vessels (ships) and pipelines can form a layer on water surface hence denying aquatic organisms oxygen hence causing death of such organisms✓ **Me** mitigated by proper inspection of vessels and pipelines transporting oil✓ **Mm**

c) Benefits /Importance of the natural resource

One Benefit /Importance of the natural resource/Water and explained

- **Water for irrigation**✓ **Bi** water is a raw material during the process of photosynthesis where it combines with carbon dioxide to form organic food✓ **Be**
- **Industrial uses** **Bi** Water is used as a solvent in many industrial processes and for cooling of machines **Be**
- **Hydration** **Bi** water helps to regulate body temperature, transport nutrients and remove waste products **Be**
- **Domestic uses**: **Bi** Water is used for washing clothes, drinking, bathing and cooking food **Be**

Bi + Be = B2 = 05

TOTAL = N_2 + M_3 + B_2 = 06 + 04 + 05 = 15scores

ITEM 6

In Karamoja region of Uganda, there are many sedimentary rocks and mineral reserves. Due to the rapid population growth, their exploitation is causing proportional environmental degradation. The government through media houses wants to make public awareness on the matter.

Fig 4 showing a Rock Quarry

Your school has been chosen to lead the environmental conservation campaign in Karamoja region.

You have been chosen to present on one of the radio talk shows trusting your chemistry knowledge on natural resources.

TASK

Write down the information that can be conveyed

(***Your message should include the category with a reason, composition of the natural resource, man's activities that affect the resource with their mitigation and benefits of the resource***)

RESPONSE

a) **<u>Identity of category of natural resource with a reason and Composition of natural resource</u>**

Sedimentary rocks are ***non-renewable natural resources;*** ✓ ***Ci*** *because* ***they cannot be replenished /replaced*** *by natural processes in man's life time. Or they get used up.* ✓; **R**

Sedimentary rocks, composed of minerals like ***Calcite Co, Quartz Co, Clay Co ,sand Co, limestone Co,*** *materials like* ***rock salt Co, Gypsum✓; Co***

b) <u>Impact of Human activities on the natural resource and on the environment, how it occurs, and mitigation)</u>

- ✓ ***Limestone quarrying produces dust particles✓ Mi*** *which erode into water bodies, hence reducing on its quality;* ***✓Me***

  This can be mitigated by extracting carefully and use of personal protective equipment from dust; ***✓ Mm***

  Mi + + Me+ Mm = M_3 =04 scores
- ✓ *Or Limestone quarrying and mineral extraction removes top soil; and causing ditches* ***✓ Mi*** *which degrades the soil environment, affecting growth of plants, hence destruction of vegetation cover* ***Me****; Can be Mitigated, by careful extraction of rocks and minerals;* ***Mm***
- ✓ *Or Mineral extraction results into breaking of rocks into smaller stones* ***✓ Mi*** *and gravels which depreciates the rocks;* ***Me*** *Mitigated by careful extraction of rocks and minerals;* ***Mm***

c) Benefits /Importance of the natural resource

Benefits of sedimentary rocks

They are useful in ***formation of soil*** ***✓Bi*** *by a process of weathering;* ***✓Be***

- limestone dust crushed in industries ✓ Bi *used as raw material for manufacture of cement for construction of roads, bridges, and houses.;* ***✓Be***

- Pebbles or rock plates are a source of building materials. *✓Bi which can be used for construction and decoration of buildings. ✓Be*

Bi + Be = B_2 = 05 scores

TOTAL = N_3 + M_3 + B_2

= 06 + 04 + 05 = 15 scores