CHEMISTRY 545/1

By

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545/1 PAPER STRUCTURE

- It consists of 2 sections A & B, with a total of 6 items.
- **Section A** consists of 2 compulsory items.
- All structured, 10 scores each.
- **Section B** consists of 2 parts; part I and part II; each with 2 items from the same EOC.
- 1 item is responded to from each part.
- All essay items, 20 scores each.

ITEM DEVELOPMENT

- Items are developed from 4 elements of construct(EOCs) viz;

  SECTION A: 3 compulsory items; require **fill in responses**.

- Item 1 from EOC-2= Application of chemistry in daily life
- Item 2 from EOC-3= Diversity & interactions of substances and their importance in everyday life. Can be interchanged.

  SECTION B: 4 Items; require **extended responses**.

- **Part I**: Item 3 +4 both from EOC-1= Contribution of chemistry to our economy [**choose 1**].
- **Part II**: Item 5 +6 (part 2) both from EOC-4=Existence of natural resources in env't & their importance in life. [**choose 1**].

THE 4 EOCs

The 4 broad areas where items are developed from;

1. Contribution of chemistry to our economy[3 & 4].
2. Application of chemistry in daily life[1/2] .
3. Diversity & interactions of substances and their importance in everyday life [2/1].
4. Existence of natural resources in env't & their importance in life[5 & 6].

ITEM 1: Application of chemistry in daily life

- **Topics** involved;

1. Chemistry and society
2. Chemicals for consumers [mainly food additives, medicine & drugs and detergents]
3. Nuclear processes

ITEM 1/EOC_2 BOA

- Identify the category/type of the product(02).
- Mention the function(s) of the product(s) identified(01).
- Explain the dangers/side effects of the identified product and their mitigation(03)
- Evaluate/compare the products/processes[similarities & differences](02)

ASSESSABLE AREAS

1. **Food additives**; flavour enhancers, preservatives, food colours etc: Natural Vs synthetic.
2. **Drugs & medicines**; antibiotics, herbal medicine, analgesics: Modern Vs traditional/herbal
3. **Nuclear processes**; nuclear fission, nuclear fusion, nuclear decay & half-life.
4. **Detergents**; soapy detergents and soapless detergents.

BRAIN TEASER 1

A new food manufacturing company has developed a new beverage that has attracted many customers due to its good flavour and taste. As a result, the director of a similar competing company in the same area, has instructed the production manager to add vanilla extract to their existing beverage so as to keep their customers. However, the manager, Mr. Kercan is worried about the director's decision.

…TEASER 1

Task: As a chemistry student;

(a) Explain to the manager why the director chose the product.

(02 scores)

(b) Guide him to know how the product works. (02 scores)

(c) Sensitize him about the risks associated with the long term use of the product and advise him on what should be done to overcome such.

(04 scores)(

(d) What guidance would you give him to evaluate the product?

(02 scores)

SUGGESTED RESPONSES

a) Is a natural food additive; which is a flavour enhancer;

b) Is a food enhancer that boosts existing food flavour;

c)

- Some people are allergic to some natural food additives that may lead to skin irritation/vomiting on prolonged use;
- natural food additives quicken the rate of food spoilage due to rapid growth of microbes;
- Use the recommended amounts;
- Limit their use;

… RESPONSES

(d)

Similarities

- Both make food delicious;
- Both can preserve food;

Differences

- Natural food additives are less effective in action than synthetic food additives;
- Natural food additives have fewer side effects than synthetic food additives;

ITEM 2:Diversity & interactions of substances and their importance in everyday life

- **Topics** involved;

1. Air
2. Using materials
3. The periodic table
4. Trends in the periodic table
4. Structures and bonds
5. Reactivity series
6. Structure & properties of substances
7. Carbon in life
8. Formulae, stoichiometry & mole concept

ITEM 2/EOC_3 BOA

- Identify the category of the element/compound/substance/material with a reason and example(03).
- State the properties(04) of substance/predict the trends of the substances[03]
- State the use/application of the substance/quantity of matter i.e. moles (01).
- Identify the impact of the substance and how it is mitigated.(02)

ASSESSABLE AREAS

1. **Polymers**; synthetic(Nylon)Vs natural (natural rubber)
2. **Materials**; natural(wood) Vs artificial (glass, ceramics, plastic etc)
3. **Elements**; metals(sodium) Vs non-metal (phosphorus)

BRAIN TEASER 2

- A dairy factory in Kawempe intends to make a long-lasting and environmentally friendly packaging material for its new dairy product. The managing director prefers aluminium bottles to the rest of materials available on market. However, she is unsure of the material's suitability.

…TEASER 2

Task: A strong learner in chemistry, the manager has consulted you for help;

(a) Explain

- The category of the product.
- The suitability of the material for the product.
- (b) Advise her on the choice of the product.

SUGGESTED RESPONSES

(a) (i)

- Is artificial material; since it is man-made;

(ii)

- Is strong; durable; with low density thus, light; for easy carriage/transportation.
- Has a high melting point thus, resists fire;

(b)

- Can be used to make cans and tins for packaging;
- However, it is non-biodegradable; depletes soil fertility if it accumulates; thus, it should be recycled;

ITEM 3 & 4: Contribution of chemistry to our economy

- **Topics** involved;

1. Industrial processes
2. Air [Mainly on manufacture of oxygen]
3. Chemistry and society
4. Carbon in life [mainly crude oil, fermentation & saponification]
5. Chemical reactions [mainly contact, Haber processes]
6. Oxidation & reduction [Fe extraction, electrolysis in Al & Cu extraction, Cl_2 & NaOH manufacture]

ITEM 3 &4/EOC_1 BOA

- Mention all the raw materials required(02)
- Describe the process of production[specify: vessel, chemical process, conversion of desired product & its purification; logically](03)
- Explain the side effects/dangers of the production process and how it can be mitigated. (03)
- Explain the social benefits of the production process(03)

ASSESSABLE AREAS

- Manufacture of oxygen gas
- Manufacture of chlorine gas
- Manufacture of fertilizers
- Manufacture of detergents
- Manufacture of oxygen NaOH
- Manufacture of sulphuric acid
- Manufacture of cement.
- Manufacture of bio gas.
- Manufacture of ammonia.
- Manufacture of ethanol.
- Extraction of metals [Al, Fe, Cu]

BRAIN TEASER 3

- Biogas is one of the modern fuel sources used by many Ugandans nowadays in the name of minimizing environmental pollution. As a result, the government has contracted a foreign investor to set up a biogas production plant in your village to meet the increased demand of the gas. However, the villagers are worried about the effects of plant to their well-being. The LC1 chair person has approached you for guidance before he meets the residents.
- **Task:** As a chemistry student, prepare a leaflet of message to advice the villagers.

SUGGESTED RESPONSES

Raw materials:Organic waste; water;

Process of production

- Bio-degradable organic materials like plant and animal wastes are collected and put into a digester;
- The wastes are anaerobically digested/decomposed/broken down/fermented by bacteria in absence of oxygen to form biogas;
- The biogas is cleaned, compressed and sent to the storage tank;
- The digestate/bio-slurry formed can be used as a bio-fertilizer;

RESPONSES…

Side effects

- Fire outbreaks during pipe leakage;
- Poisonous fumes in cases of any pipe leakages;

Mitigation

- By sealing off all pipes;
- By maintaining the tap closed;
- Proper use of personal protective equipment;

…RESPONSES

Social benefits

- Provide employment to opportunities to villagers, increasing their income and thus, improving their standard of living;
- Source of government revenue hence, improved infrastructures like roads, hospitals; etc
- Training programs for villagers/local people in biogas production thus, enhanced skills and expertise;
- Sources of organic fertilizers and animal feeds from bio-slurry thus, improved agricultural productivity;

BRAIN TEASER 4

- National water and sewerage corporation(NWSC) supplies water for domestic and industrial use after treatment with chlorine. The supply of chlorine for water treatment is not enough for the corporation due to rapidly increased Ugandan population. It is planning to establish a chlorine production plant in Katose village, Mukono district. However, citizens are against this plan, claiming that the plant will cause more harm than good. The chairman of environment protection unit has approached you to sensitize the citizens on how the production will be done.
- **Task:** As a serious learner of chemistry, prepare a write up to use during the presentation.

SUGGESTED RESPONSES

Raw materials:Concentrated sodium chloride solution(brine), water, mercury.

Process of production

- Chlorine is manufactured by electrolysis of concentrated sodium chloride solution using graphite anode and mercury cathode in mercury cathode cell;
- Chloride and hydroxide ions migrate to the anode but chloride ions are preferentially discharged to form chlorine gas; which is collected and stored in tanks;
- Sodium and hydrogen ions migrate to the cathode; but sodium ions are preferentially discharged to form sodium metal;
- Sodium reacts with mercury to form sodium amalgam;
- Sodium amalgam is dissolved in water to form sodium hydroxide solution, hydrogen gas and mercury which is recycled into the cell;

RESPONSES…

Side effects

- Itching of eyes and nose due to toxic fumes of chlorine gas;
- Exposure of excessive noise from mechanical equipment that cause ear defects;
- Exposure to highly toxic mercury that causes damage to nervous system, reproductive system on prolonged exposure;

Mitigation

- Proper use of personal protective equipment/gear;

…RESPONSES

Social benefits

- Source of government revenue hence, improved infrastructures like roads, hospitals and schools etc
- Provision employment to opportunities to villagers, increasing their income and hence, improving their standard of living;
- Training programs for locals in chlorine production thus, enhanced skills and expertise;

ITEM 5 & 6: Existence of natural resources in env't & their importance in life

- **Topics** involved;

1. Air
2. Water
3. Rocks and minerals
4. Carbon in the environment
5. Fossil fuels.

ITEM 5 &6 BOA

- Identify the category of the natural resource with a reason and an example. (03)
- Describe the composition[components] of the natural resource. (02)
- Explain the impact of the natural resource on the env’t, its occurrence and mitigation.(03)
- Describe the benefit/importance of natural resource.(01)

ASSESSABLE AREAS

- Renewable natural resources(air, water) Vs Non-renewable resources(fossil fuels, rocks/minerals).
- Air: N, O, CO_2, rare gases; Water: H and O; Fossil fuels: C, H, O; Rocks: Fe, Cu, $CaCO_3$, Au, Co.
- Air; some components cause air pollution, e.g. CO_2 cause greenhouse effect/global warming.
- Afforestation, trees absorb CO_2 from atmosphere thus, reducing global warming.

…ASSESSABLE AREAS

- Air;
- Oxygen facilitates respiration by combining with carbohydrates to provide energy for proper body functioning.
- Carbon dioxide combines with water in presence of light trapped by chlorophyll to form carbohydrates thus facilitates photosynthesis.

BRAIN TEASER 5

- Following the discovery of oil in Bunyoro region, its extraction process is ongoing in high gear. As a result, many trees have been cut to clear land for the project yet the region, has been known for farming. The residents are unhappy with the activities of the project, complaining that the project interfered with traditional activities and hence their livelihood.
- **Task:** With reference to your chemistry knowledge, guide the project manager on his way to the annual regional meeting as regards the project's operations.

SUGGESTED RESPONSES

GUIDANCE TO THE PROJECT MANAGER

Category of the product

- Crude oil is a non-renewable resource; since it can't be replenished;

Composition: Contains carbon, hydrogen and oxygen;

Impact on environment

- Air pollution due to emission of CO_2, NOx and SOx from extraction and combustion; cause global warming and greenhouse effect, since CO_2 is a greenhouse gas; climate change due to deforestation;
- Health problems like lung cancer, skin cancer, respiratory diseases;
- Habitat destruction and displacement of people;
- Soil pollution and death of wild animals due to oil spoilage and other soil contaminants;

…RESPONSES

Mitigation

- Re-afforestation to absorb carbon dioxide;
- Use alternative sources of fuel like HEP, biogas, and solar;
- Treatment of wastes before disposal/proper disposal of wastes;
- Establishment carbon dioxide sinks;

Importance of crude oil: Is a source of fuel for domestic and industrial use;

BRAIN TEASER 6

- Namanve village is a fast-developing industrial area in Wakiso district, consequently, swamps in the area are now filled with buildings. Wells filled with polluted water are drying up at a worrying rate. The local farmers are complaining of unpredictable seasonal changes that led to famine in the area. National Environment Management Authority (NEMA) has organized a sensitization seminar titled “PURE ENVIRONMENT PURE LIFE” and you have been invited to deliver a massage to the residents.
- **Task:** As a learner of chemistry, make a write up for your presentation.

SUGGESTED RESPONSES

SENSITIZATION MESSAGE TO THE RESIDENTS

Category of the product

- Water is a renewable natural resource; since it can be replenished;

Composition

- Contains hydrogen and oxygen in a ratio of 2:1;

…RESPONSES

Environmental impact

- Water contains dissolved gases like oxygen and carbon dioxide; carbon dioxide dissolves in it to form carbonic acid which makes water acidic;
- Acid rains dissolve rocks, corrodes plant roots leading to death of plants; thus, famine; death of soil living organisms and thus, soil infertility; mitigated by re-afforestation to remove carbon dioxide from atmosphere;
- Hot water discharge from industries causes thermal population of water bodies; kills aquatic organisms due to high temperatures and oxygen deprivation and hence suffocation of organisms; Thus, reduced biodiversity; mitigated by setting up hot water reservoirs to cool the exhaust water before discharging it into waterbodies;
- Industrial effluents rich in nitrates and phosphates cause eutrophication and its effects; mitigated by treatment of industrial wastes before disposal;

THANK YOU!