

SECTION A

Respond to all the items from this section

1. The use of alternative energy sources other than firewood is being largely encouraged by the government as a way of reducing deforestation. A farmer in one of the districts started making bio-gas from waste materials as a source of energy/fuel for cooking.

A few days later, the farmer made the following observations;

- There was a lot of heat produced from the bio-digester pit.
- The amount of gas produced reduced with time taken to add more waste material even when the gas tap would be fully opened.
- Reduction in the amount of gas produced increased the cooking time.

The farmer got concerned about the happenings and asked his son, a senior five student to help him understand. In an attempt to provide an explanation, the son researched about the formation of methane from glucose and rate of combustion of methane gas and collected the data as shown in tables 1 and 2;

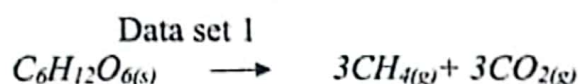


Table 1

Compound	Enthalpy of formation/ $kJmol^{-1}$
Glucose	-1273.3
Methane	-74.9
Carbon dioxide	-394



Table 2

Experiment	Initial concentrations ($mol\,dm^{-3}$)		Initial rate ($mol\,dm^{-3}\,s^{-1}$)
	CH_4	O_2	
A	0.1	0.2	5.0×10^{-4}
B	0.2	0.1	1.0×10^{-3}
C	0.2	0.2	40×10^{-4}

The son also realized that the rate equation for combustion of methane would be of help but failed to obtain it. He has therefore failed to interpret the data and has approached you for help.

Task:

As a chemistry learner;

- analyze the data provided to explain the observations.
- use the data set 2 to assess how the use of methane as a fuel can be maximized.

2. Juice just like other beverages is widely used for refreshment but ensuring proper quantities of the additives is important. A juice processing company in a certain area produces and supplies large quantities of juice to the surrounding communities. The customers have however raised concerns about the quality of the juice supplied sometimes. They say that it sometimes possesses a sour taste and freezes rapidly when placed in refrigerators hence affecting their sales. The company acknowledged that they usually add sodium benzoate, benzoic acid and sugar to the juice in order to maintain its pH and improve sweetness.

The company is investigating whether the quantities of these additives are responsible for the customers' concerns. The factory manager provided data in table 3 for two sets that has always been used to prepare 50 cm³ of juice.

Table 3

Substance	Set A	Set B
Benzoic acid (g)	1.525	1.525
Sodium benzoate(g)	0.1578	0.1578
Sugar (g)	20.0	5.0

The two sets were then placed in the fridge.

The pK_a of benzoic acid is 4.2 and pH range recommended for juice is 3.5 - 4.0.

Your teacher came across the manager's monthly report containing this information and has decided to give you an assignment.

Task:

As a chemistry learner;

- analyse the data provided to assess the customers' concerns.
- evaluate the impacts of additives used to human life.

SECTION B

Part I

Respond to any one item from this part

3. Glass is a widely used material in the construction industry and is usually manufactured from silica (SiO_2) as the main raw material. Recently, a group of senior five learners visited a newly established glass manufacturing factory in a nearby town for a study trip. The learners discovered that, during the production process, solid acidic wastes and fumes containing phosphorous and sulphur are produced, and that the district health officer and environmental officer raised concerns that the solid wastes contaminate soil while the fumes cause water pollution in the surrounding. The health and environmental officers advised that the solid wastes should be treated using calcium oxide and magnesium oxide before disposal while chlorine tablets should be used to disinfect water for use by the surrounding community members. The learners asked the study guide to explain why the company considered silica as the best raw material for glass making, how calcium oxide and magnesium oxide can control soil contamination and why not aluminium oxide, why the fumes are considered to

contaminate water. The learners also asked for an evaluation of chlorine usage as a water disinfectant. Your teacher who also attended the study trip has provided you with this information and has asked you to interpret it.

Task:

As a chemistry student, make a write-up with the information the study guide should have used to help the learners address their concerns.

4. Road construction requires proper selection of the materials to be used so as to ensure durability. Senior five students from a certain school recently visited a bridge construction site on a given river. The learners noticed that the materials available for use were aluminium and iron. One of the engineers on site told the learners that selection of the materials for use depends on factors like their structural properties, how the material interacts with the environment and their health or environmental impact(s). On their return from the trip, learners engaged in a discussion on which of the materials is better for bridge construction. One of the learners said that iron can be used when coated with magnesium while another learner suggested use of beryllium instead of aluminium since both have similar properties. The rest of the class members failed to understand the information from the two learners and hence the class failed to agree. The learners have approached you for help.

Task:

As a S.6 chemistry student;

- a) assess the properties of the materials and with reasons select the best material for carrying heavy load in the bridge.
- b) analyse the interactions of the materials with the environment and help learners understand the suggestions made during the discussion.
- c) assess the impacts of using these materials on the environment.

Part II

Respond to any one item from this part

5. Recently in Kampala, accumulation of plastic waste which causes blockage of drainage channels has led to flooding during heavy rains. Joan an environmental science student doing internship, discovered that much of the waste collected from the drainage channels comprise mainly of the synthetic plastic materials. and that the plastic does not easily decompose but she cannot explain why. To find out more about this plastic, she visited a nearby factory manufacturing the same kind of plastic. While at the factory, she discovered that the main raw material used for the plastic manufacture was vinegar, although she lacks information about how this happens. From her analysis of this plastic material, she became concerned that it may cause other environmental and health dangers. Joan wants to do a detailed study of this plastic and be able to solve the likely dangers but lacks the skills of doing so. She has approached you for help. The structural formula of the plastic is $\{CH_2CH\}_n$ and the active ingredient in vinegar is ethanoic acid.

Task:

As a chemistry student, make a write-up with information to help Joan;

- a) understand why the plastic material does not easily decompose.
 - b) understand how the plastic can be manufactured using vinegar as the raw material and the mechanism of the reaction stage leading to formation of its monomers.
 - c) evaluate the usage of the plastic material and be able to provide appropriate mitigation strategies for the dangers.
6. A pharmaceutical factory in Arua town making herbal products uses organic compounds as solvents to dissolve organic active ingredients from medicinal plants. Recently, your teacher visited the factory to study about these organic solvents. During her study, she also learnt that the factory was facing a challenge with some compounds which were not effective as solvents. In her interview with the managing director, she was informed that, they wanted to start making food flavors and perfumes as well as propanone which is a more effective solvent but they still lacked expertise in doing so. The teacher noted that the long term stay in this factory's store maybe dangerous to humans and compounds in the store may cause bad effects to the environment. The compounds in the store which are being used as solvents were; Compound A, a straight chain hydrocarbon with 6 carbon atoms and molecular mass 86.
Compound B, a hydrocarbon with 7 carbon atoms, an aromatic ring and molecular mass 92.
Compound C, an alcohol with 2 carbon atoms and molecular mass 46.

The teacher has decided to give you an assignment to analyse her experiences and concerns while at the factory, as narrated above and she has informed you that perfumes and food flavors are actually simple esters.

Task:

Make a write-up to present to the teacher with information on how to help the factory to;

- a) select with reasons the most suitable organic solvent from the store.
- b) understand how the reaction of formation of food flavors or perfumes from compound C occurs and how the compound C can be used to make propane.
($C=12, H=1$)
- c) evaluate the effects of the organic compounds in the store and come up with possible mitigation strategies.