

Aga Khan University Examination Board

Notes from E-Marking Centre on SSC-II Chemistry Examination April/ May 2019

Introduction

This document has been produced for the teachers and candidates of Secondary School Certificate (SSC) Part II Chemistry. It contains comments on candidates' responses to the 2019 SSC-II Examination indicating the quality of the responses and highlighting their relative strengths and weaknesses.

E-Marking Notes

This includes overall comments on candidates' performance on every question and *some* specific examples of candidates' responses which support the mentioned comments. Please note that the descriptive comments represent an overall perception of the better and weaker responses as gathered from the e-marking session. However, the candidates' responses shared in this document represent some specific example(s) of the mentioned comments.

Teachers and candidates should be aware that examiners may ask questions that address the Student Learning Outcomes (SLOs) in a manner that requires candidates to respond by integrating knowledge, understanding and application skills they have developed during the course of study. Candidates are advised to read and comprehend each question carefully before writing the response to fulfil the demand of the question.

Candidates need to be aware that the marks allocated to the questions are related to the answer space provided on the examination paper as a guide to the length of the required response. A longer response will not in itself lead to higher marks. Candidates need to be familiar with the command words in the SLOs which contain terms commonly used in examination questions. However, candidates should also be aware that not all questions will start with or contain one of the command words. Words such as 'how', 'why' or 'what' may also be used.

General Observations

In comparison to previous years, overall performance of the candidates has improved. However, there is still room for improvement. Mentioned below are few concepts that teachers need to focus on and give candidates more drill and practice to have a stronger grip.

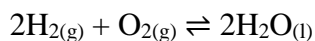
- a. Direction of thermal reactions and application of Le Chatelier's principle on reversible reactions at equilibrium.
- b. Concepts related to acidity of bases and basicity of acids.
- c. Process that occurs during denaturation of protein molecule.
- d. Representation of basic chemical reactions of Solvay process.
- e. Causes and consequences of global warming, acid rain and ozone depletion based on the differences among each phenomenon.

Detailed Comments:

Constructed Response Questions (CRQs)

Question 1:

Consider the following chemical equation.



- Identify the direction in which the given equation shows endothermic reaction.
- Give TWO reasons to justify your answer to part a.

Better responses depicted a good grip over the concept of chemical equilibrium, i.e. thermal reactions. These responses showed the correct identification of the reverse direction in which endothermic reaction takes place. These responses justified their identification by stating that the reaction is endothermic in the reverse direction because water molecule decomposes (breaks down) to give hydrogen and oxygen and the breaking of bonds requires the input of energy. Therefore, energy (heat) is absorbed from the surrounding.

Example:

- a. Identify the direction in which the given equation shows endothermic reaction. (1 Mark)

The given equation shows endothermic reaction in reverse (left) direction.

- b. Give TWO reasons to justify your answer to part a. (2 Marks)

It is because:- 1. Endothermic reaction takes place during bond breakings; energy is required to break the bonds.

2. Heat energy is required for decomposition to take place. so heat energy is absorbed due to which endothermic reaction occurs.

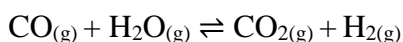
Weaker responses showed lack of knowledge about the concept of chemical equilibrium, i.e. thermal reactions. These responses mostly displayed irrelevant answers. Some candidates were able to answer part 'a' correctly but made mistakes in part 'b'. The incorrect responses to part 'a' included forward direction/ change in composition shows endothermic reaction (gas to liquid)/ pressure will no longer effect as there are equal number of molecules on both sides. The error made in part 'a' was then carried forward in part 'b' with justifications such as endothermic reaction is the reversible reaction in which amount of product is greater than the amount of reactant/ endothermic reactions involve bond making which requires energy/ temperature and pressure of the system in endothermic reactions remain constant/ the reactants get enough heat or energy to fastly convert themselves into product/ when a product breaks it loses heat energy/ when two reactants react they require energy to make a bond.

Example:

a.	Identify the direction in which the given equation shows endothermic reaction.	(1 Mark)
	<u>Backward direction.</u>	
b.	Give TWO reasons to justify your answer to part a.	(2 Marks)
	<u>- The reasons are:</u>	
	<u>1. The temperature of the reaction remain constant.</u>	
	<u>2. The pressure of the reaction changes with the passage of time.</u>	

Question 2a:

Consider the given reaction at equilibrium.



What is meant by dynamic equilibrium in a chemical reaction?

Better responses displayed a thorough understanding about dynamic equilibrium. Majority of these responses showed the correct definition that dynamic equilibrium is the state when the concentration of reactants and products become constant/ it is the point at which the forward reaction proceeds at the same rate as the reverse reaction and the reaction does not stop.

Example:

a. What is meant by dynamic equilibrium in a chemical reaction? (1 Mark)

Dynamic equilibrium is a state in which rate of forward reaction becomes equal to rate of reverse reaction in a closed system.

Weaker responses included incorrect or vague definition of dynamic equilibrium. These responses showed statements such as the reaction when in its static condition, no reaction takes place in both reverse and forward direction is known as dynamic equilibrium/ the equilibrium in which the amount of reactant and product becomes equal/ when a chemical reaction is equal after the reaction/ when product and reactant are same, the reaction is called dynamic equilibrium.

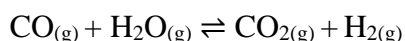
Example:

a. What is meant by dynamic equilibrium in a chemical reaction? (1 Mark)

A dynamic equilibrium is when a chemical reaction is equal after the reaction.

Question 2b:

Consider the given reaction at equilibrium.



What will be the effect on the concentration of H₂O if a small amount of CO gas is added to the reaction mixture? Give a reason to support your answer.

Better responses displayed a thorough understanding and application of the concept of Le Chatelier's principle. These responses in part 'b' included the correct shift of equilibrium towards the right on applying the mentioned stress on the given reversible reaction. Candidates were able to justify their prediction about the effect of increase of small amount of CO gas on the concentration of H₂O.

Example:

b. What will be the effect on the concentration of H₂O if a small amount of CO gas is added to the reaction mixture? Give a reason to support your answer. (2 Marks)

If a small amount of CO gas is added to the reaction mixture the the concentration of H₂O will decrease and the reaction will move in forward direction.

Weaker responses couldn't figure out the counteraction of the reversible reaction when the given stress is applied on it at equilibrium. Some such responses correctly included the shift of equilibrium in the forward direction but could not specify the decrease in concentration of H₂O.

Example:

- b. What will be the effect on the concentration of H₂O if a small amount of CO gas is added to the reaction mixture? Give a reason to support your answer. (2 Marks)

When we add a small amount of CO gas in the reaction, the concentration of H₂O would increase hence in product, there might be an hydrogen molecule.

Question 3:

Sulphuric acid is a strong dibasic acid.

- What is a dibasic acid?
- Write a chemical equation to show the stepwise dissociation of sulphuric acid in an aqueous medium.

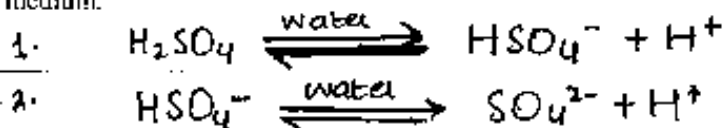
Better responses stated the correct understanding of dibasic acid. In part 'a', these responses included a variety of correct statements such as a dibasic acid has two replaceable/ acidic hydrogen atoms which can be ionised/ which releases double ionisable H⁺ ions in aqueous medium/ which is capable of forming two conjugate bases when is being dissociated. In part 'b', candidates produced stepwise chemical equations showing dissociation of sulphuric acid in an aqueous medium.

Example:

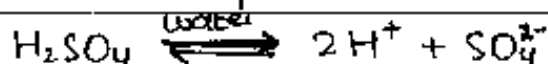
- a. What is a dibasic acid? (1 Mark)

If there are two ionizable or replaceable H⁺ ions in a molecules of an acid, then the acid is called dibasic acid.

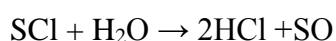
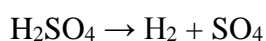
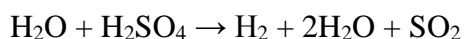
- b. Write a chemical equation to show the stepwise dissociation of sulphuric acid in an aqueous medium. (2 Marks)



Overall dissociation of sulphuric acid in aqueous medium is



Weaker responses showed the incorrect description of dibasic acids. The incorrect responses to part 'a' included statements such as dibasic acid is an acid whose basicity of acid alternates or decreases or increases according to the reaction/ it is an acid whose pH levels are high and which is a strong acid/ it is an acid in nature but shows the properties of a base/ it works as both acidic and basic salt. Furthermore, in part 'b', these responses also presented unbalanced/ incomplete/ wrong chemical equations. These equations mostly showed irreversible arrow with aqueous medium missing/ wrong formulae/ wrong products. For example:



Example:

a.	What is a dibasic acid?	(1 Mark)
<p style="margin: 0;"><u>one those acids, whose one molecule gives 2 H⁺ ion in aqueous solution.</u></p>		
b.	Write a chemical equation to show the stepwise dissociation of sulphuric acid in an aqueous medium.	(2 Marks)
<p style="margin: 0;"><u>H₂SO₄ → H⁺ + SO₄⁻²</u></p> <p style="margin: 0;"><u>H₂SO₄ + H₂O → H₂O + SO₄</u></p>		

Question 4:

- a. State the composition of natural gas.
- b. How does natural gas produce energy? Support your answer with the help of a balanced chemical equation.

Better responses demonstrated a strong understanding of the composition and use of natural gas. In part 'a', candidates identified methane as the major component while ethane, propane and butane as minor components of natural gas. The responses to part 'b' highlighted combustion/ oxidation of natural gas as exothermic reactions that produce energy. A well balanced chemical equation was presented in support of this statement by the candidates.

Example:

a. State the composition of natural gas. (1 Mark)
<u>Natural gas is a mixture of low molecular mass hydrocarbons. Its major component is methane (80%) with some other gases like ethane etc.</u>
b. How does natural gas produce energy? Support your answer with the help of a balanced chemical equation. (2 Marks)
<u>Natural gas is used as a fuel in automobiles and as a domestic fuel. Natural gas which is chiefly methane burns in the excess of air at high temperature to produce heat which is used as energy.</u> <u>$CH_4 + 2O_2 \xrightarrow{\text{heat}} CO_2 + 2H_2O + \text{heat}$</u>

Weaker responses failed to identify the components that make up natural gas. These responses mentioned irrelevant or incorrect statements such as natural gas is a type of gas which occurs in every natural body (living human being)/ it is formed under the surface of earth under extreme pressure and heat due to the reaction of various elements/ it is a mixture of gases in the air/ petroleum + oxygen. Some of these responses presented invalid chemical equations such as $CH_2 + 2[H] \rightarrow CH_4 + \text{energy}$ or highlighted coal, petroleum, argon, carbon dioxide as components of natural gas in part 'a'. Majority of these responses showed the reaction of carbon with oxygen/ carbon monoxide with water/ carbon with hydrogen as a response to part 'b'.

Example:

a. State the composition of natural gas. (1 Mark)
<u>Natural gas is composed of coal, methane, Carbon.</u>
b. How does natural gas produce energy? Support your answer with the help of a balanced chemical equation. (2 Marks)
<u>Natural gas produces energy by decomposing the coal, methane, carbon.</u>

Question 5:

- a. Mention any TWO functions of vitamin A which are essential for human eye.
- b. State any ONE source of vitamin A.

Better responses established clear knowledge regarding the sources and functions of vitamin A. Candidates were able to clearly mention the major functions of vitamin A with reference to the human eye in specific as was asked in the question. The correct responses to part 'a' included statements like vitamin A is responsible for the maintenance of normal vision/ production of a pigment in the retina of the eye/ production of rhodopsin that is needed for coloured vision and to see in dim light/ protection of the surface of the eye/ prevention of eye from drying/ infections/ inflammation. Furthermore, these responses indicated dairy products/ eggs/ oils and fats/ carrots as a source of vitamin A in part 'b'.

Example:

a. Mention any TWO functions of vitamin A which are essential for human eye. (2 Marks)
<u>Vitamin A is essential for the formation of rhodopsin in the retina of eye. Without rhodopsin, person will not be able to see in dark.</u>
<u>Vitamin A is also needed for proper vision by eye. It allows distant and near objects to be seen clearly and maintain the epithelial lining of eye.</u>
b. State any ONE source of vitamin A. (1 Mark)
<u>Vitamin A can be obtained by eating fish and carrots.</u>

Weaker responses illustrated poor grip on the concept of vitamins or limited understanding of the question. They failed to mention the function of vitamin A related to the human eye. These responses included role of vitamin A with reference to the growth of hair, improvement of skin and other parts of the human body. However, a few of these responses identified the correct source of vitamin A, i.e. carrots/ eggs/ dairy products in part 'b'. The irrelevant responses to part 'a' included statements such as it helps in the growth of hair as the intake of vitamin A will mix up with the blood/ it can make you healthy as they contain essential energy/ it gives protein to our body/ it gives mineral to our body/ it contains more carbohydrate through this humans are not blind and clearly see the object.

Example:

a. Mention any TWO functions of vitamin A which are essential for human eye. (2 Marks)

1) Vitamin A intake can make you healthy as they contain essential ~~to~~ energy.

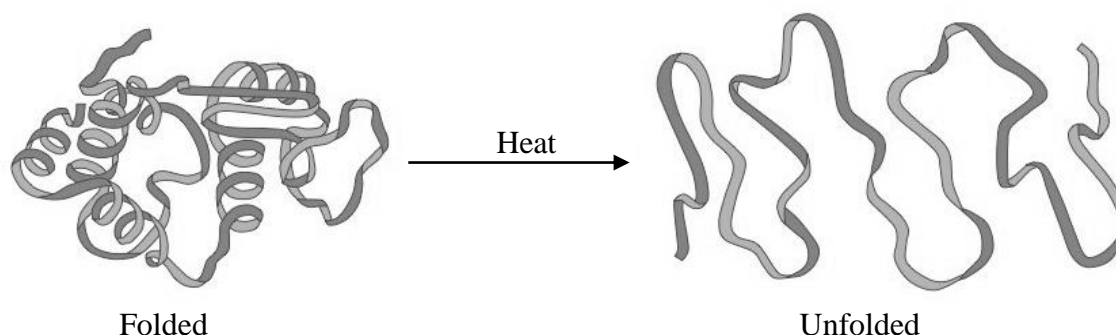
2) Vitamin A also helps in the growth of hair as the intake of it will mixed up the blood with it.

b. State any ONE source of vitamin A. (1 Mark)

Carrots

Question 6:

The given diagram illustrates the change in the structure of a protein molecule due to increase in temperature.



- Name the process of changing a folded protein molecule into an unfolded protein molecule.
- Write ONE chemical change that causes the unfolding of the protein molecule.
- What is the effect of unfolding on the function of the protein molecule?

Better responses correctly named denaturation of proteins in part 'a', mentioned the breaking of hydrogen bonds as a chemical change in part 'b' and loss of biological activity as a consequence of denaturation in part 'c'. These responses showed a strong grip over the concept of denaturation of proteins and the change that occurs in a protein when unfolded.

Example:

a.	Name the process of changing a folded protein molecule into an unfolded protein molecule.	(1 Mark)
	<u>Denaturation of protein.</u>	
b.	Write ONE chemical change that causes the unfolding of the protein molecule.	(1 Mark)
	<u>Breakdown of hydrogen bonds in protein molecule.</u>	
c.	What is the effect of unfolding on the function of the protein molecule?	(1 Mark)
	<u>The protein will lose its efficiency and will not perform its functions.</u>	

Weaker responses indicated lack of clarity about the process of denaturation. These responses mostly identified the name in part 'a' but failed to highlight the changes that occur due to denaturation as responses to part 'b' and 'c'. The responses to part 'b' included increase of temperature and pH causes the unfolding of protein/ amino acids will reduce/ when heat increases it will change the chemical structure of protein/ denaturing of enzyme/ breaking of peptide bonds/ optimum temperature. Moreover, mostly in weaker responses, candidates mentioned that when protein molecule is denatured its primary structure is lost as a response to part 'c'. This indicated that such candidates lack understanding that during denaturation of proteins possible destruction of both the secondary and tertiary structures take place and not the primary structure.

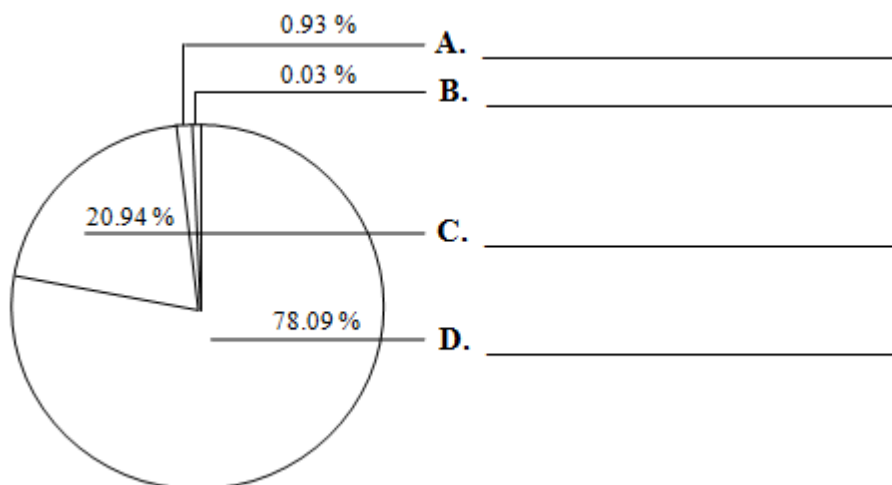
Example:

a.	Name the process of changing a folded protein molecule into an unfolded protein molecule.	(1 Mark)
	<u>Denaturation of Protein.</u>	
b.	Write ONE chemical change that causes the unfolding of the protein molecule.	(1 Mark)
	<u>Increase of temperature and pH cause the unfolding of protein.</u>	
c.	What is the effect of unfolding on the function of the protein molecule?	(1 Mark)
	<u>The protein molecule is denatured. so its primary structure is lost</u>	

Question 7:

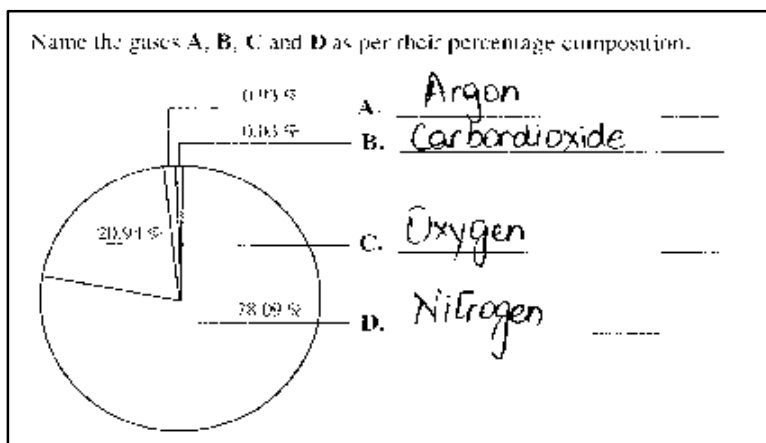
The given pie chart shows the composition of dry air with reference to percentage (%) by volume of gases.

Name the gases **A**, **B**, **C** and **D** as per their percentage composition.



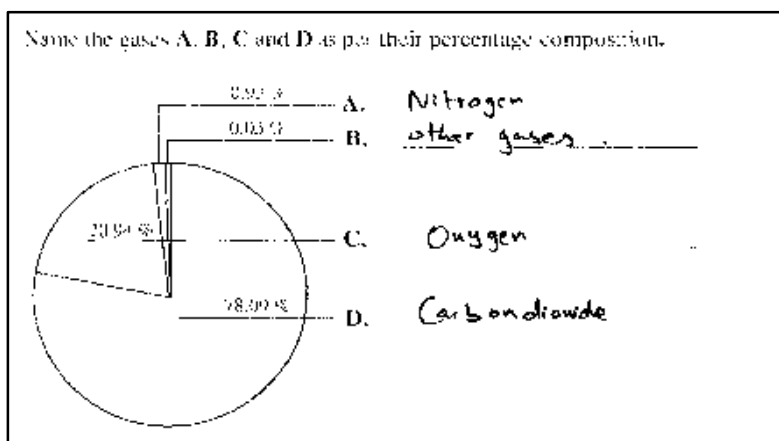
Better responses expressed good understanding about the percentage composition of air. These responses identified the four correct names, i.e. argon, carbon dioxide, oxygen and nitrogen as per the given percentage composition.

Example:

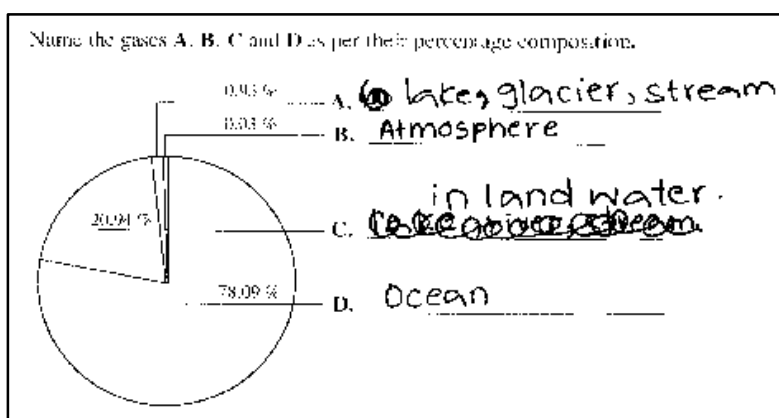


Weaker responses displayed wrong labelling of gases. Many of these responses either got oxygen correct or nitrogen correct. However, the candidates couldn't identify carbon dioxide and argon. Furthermore, there were few candidates who wrote completely irrelevant answers which included forms of water like inland water, ground water, sea water, ocean water, lake, glacier, steam, ice caps or these candidates labelled A as natural gas, B as oil, C as petroleum and D as coal.

Example 1:



Example 2:



Question 8:

Using balanced chemical equations, outline the reactions of Solvay process that take place in the following towers.

- Carbonating tower
- Ammonia recovery tower

Better responses demonstrated in-depth understanding of the basic chemical reactions of Solvay process. In part 'a', they showed either stepwise or one-step balanced chemical equation of the reaction that takes place in carbonating tower. In part 'b', these responses correctly depicted the reaction between ammonium chloride and calcium hydroxide that occurs in the ammonia recovery tower.

Example:

a. Carbonating tower	(2 Marks)
$\text{NH}_3 + \text{CO}_2 + \text{H}_2\text{O} \longrightarrow \text{NH}_4\text{HCO}_3$	
$\text{NH}_4\text{HCO}_3 + \text{NaCl} \longrightarrow \text{NH}_4\text{Cl} + \text{NaHCO}_3$	
b. Ammonia recovery tower	(1 Mark)
$2\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \longrightarrow \text{CaCl}_2 + 2\text{NH}_3 + 2\text{H}_2\text{O}$	

Weaker responses depicted lack of knowledge regarding the reactions that take place in the Solvay process. A few responses succeeded in getting the answer to part 'b' correct by mentioning the correct chemical equation with or without balancing. However, the candidates struggled to produce the reactions that occur in the carbonating tower. Being distracted by the name of the tower, candidates produced equations that mostly comprised of the decomposition of calcium carbonate or reaction of carbon with oxygen.

Example:

a. Carbonating tower	(2 Marks)
$\rightarrow \text{CaCO}_3 + \text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2$	
$\rightarrow \text{C} + \text{O}_2 \rightarrow \text{CO}_2$	
b. Ammonia recovery tower	(1 Mark)
$2\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \longrightarrow \text{CaCl}_2 + 2\text{NH}_3 + 2\text{H}_2\text{O}$	

Extended Response Questions (ERQs)

The following questions (9 and 10) offered a choice between part **a** and **b**.

Approximately, 70% candidates attempted part 'a' while 30% answered part 'b' of question 9 and 10. This shows their inclination towards the concept of Acids, Bases and Salts with an interest in environmental chemistry. However, the few candidates who showed confidence in and preference for the concepts of hydrocarbon and metallurgical operations performed well in part 'b' of question 9 and 10.

Question 9a:

In a titration process, 15 cm³ of 0.5 M dilute sulphuric acid is completely used to neutralise 10 cm³ of sodium hydroxide solution.

- What is meant by molarity (M) and neutralisation?
- Calculate the molarity of sodium hydroxide solution with the help of a balanced chemical equation.

Better responses demonstrated good problem solving skills by determining the correct number of moles using balanced chemical equation. In such responses, candidates manipulated the values given in the stimulus well and calculated the exact molarity of sodium hydroxide solution. These responses were well constructed with the definitions of molarity and neutralization in part 'i' followed by balanced chemical equation for the reaction, data, formula, solution and desired answer in part 'ii'.

Example:

a.

i. **MOLARITY (M)** : It is defined as no. of moles of solute present / dissolved in one litre of the solution.

$$M = \frac{\text{no. of moles}}{\text{litre of solution}}$$

ii. **NEUTRALISATION**: Process in which acid and base react with each other to form salt and water.

Eg $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
(base) (acid) (salt) (water)

ii. **DATA**: $\text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$

DATA:
Molarity of Dilute $\text{H}_2\text{SO}_4 = M_1 = 0.5\text{M}$

Volume of H_2SO_4 used $\rightarrow V_1 = 15\text{cm}^3$	No of moles of $\text{H}_2\text{SO}_4 = n_1 = 1$
Molarity of $\text{NaOH} = M_2 = ?$	Volume of NaOH used $= V_2 =$
No. of moles of $\text{NaOH} = n_2 = 2$	$= 10\text{cm}^3$
<u>FORMULA:</u>	
$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$	
<u>SOLUTION:</u>	
$\frac{0.5 \times 15}{1} = \frac{M_2 \times 10}{2}$	
$\frac{7.5 \times 2}{10} = M_2$	
$1.5\text{ M} = M_2.$	
<u>RESULT:</u>	
The Molarity of NaOH used is 1.5 M .	

Weaker responses mostly showed inaccurate interpretation of the given question. They wrote equation incorrectly (producing from recall as the reactants were different from those in the question) rather than using the given reactants. These responses displayed incorrect formula for sodium salt and the by-product and were unable to balance the chemical equation. Moreover, candidates were unable to write the definition of molarity and calculate the molarity of sodium hydroxide solution. A few of these responses wrote the correct definition of neutralization and the formula for molarity. The mistakes of candidates which led to wrong answer mostly included incomplete neutralization of sulphuric acid with sodium hydroxide solution, neutralization of hydrochloric acid with sodium hydroxide, incorrect identification of number of moles and use of dilution formula in place of molarity.

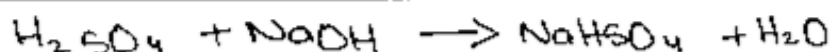
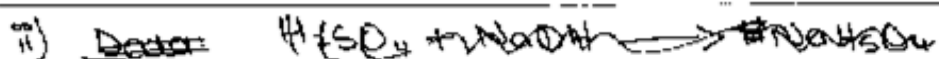
Example:

a.) Molarity:

No. number of moles in a solution is known as its molarity.

ii) Neutralisation:

Neutralisation is a process where amount of concentration of acids and bases is balanced.



Data:

$$\text{Volume of } \text{H}_2\text{SO}_4 = V_1 = 15\text{cm}^3$$

$$\text{Molarity of } \text{H}_2\text{SO}_4 = M_1 = 0.5\text{M}$$

$$\text{Volume of } \text{NaOH} = V_2 = 10\text{cm}^3$$

$$\text{Molarity of } \text{NaOH} = M_2 = ?$$

Solution

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$\frac{M_1 V_1 n_2}{n_1 V_2} = M_2$$

$$M_2 = \frac{0.5 \times 15 \times 1}{1 \times 10}$$

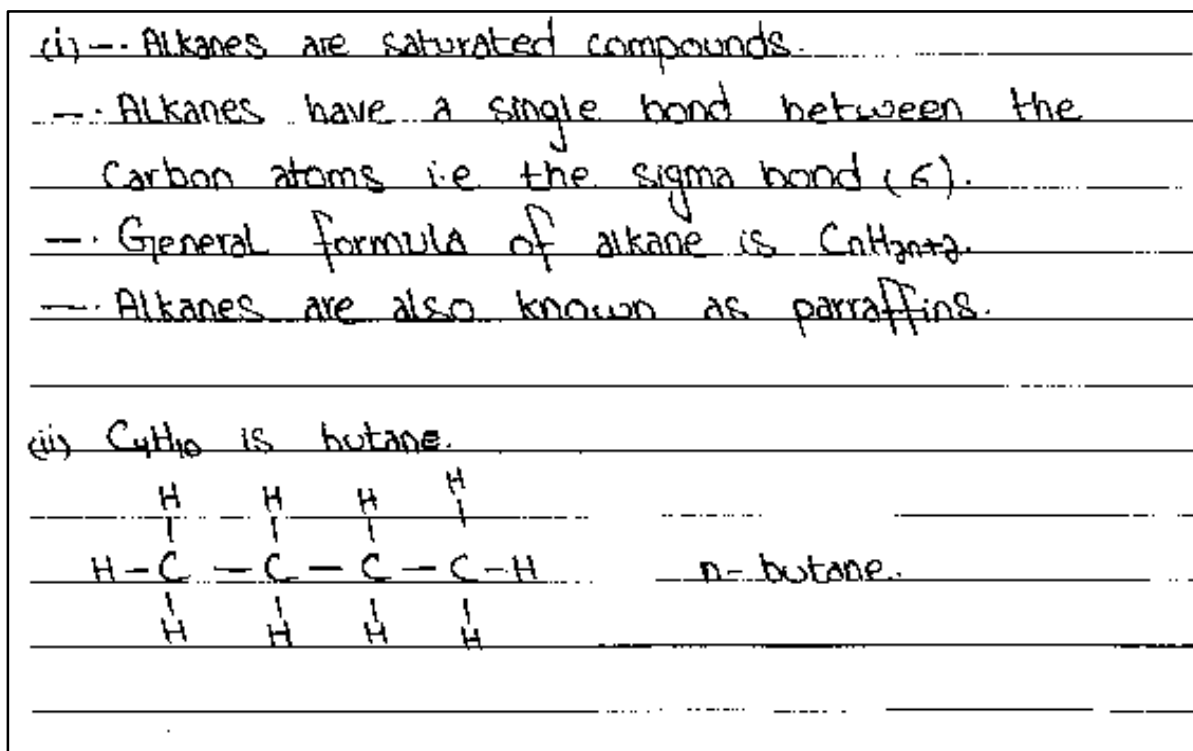
$$M_2 = 0.75\text{M}$$

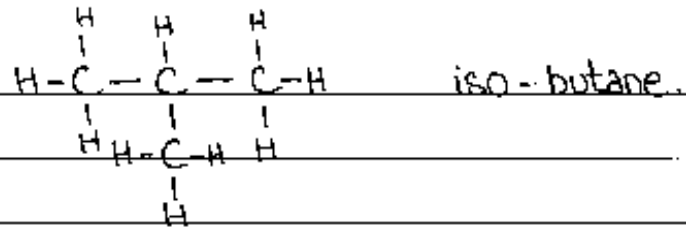
Molarity of NaOH is 0.75M

Question 9b:

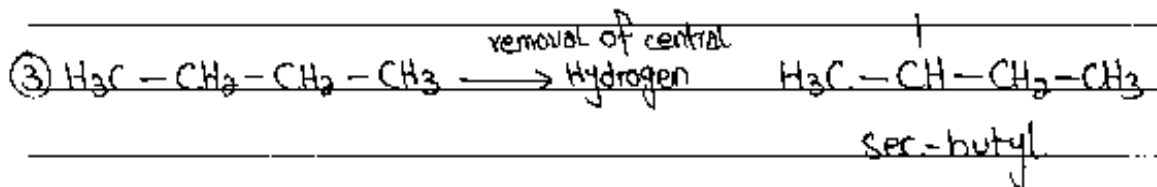
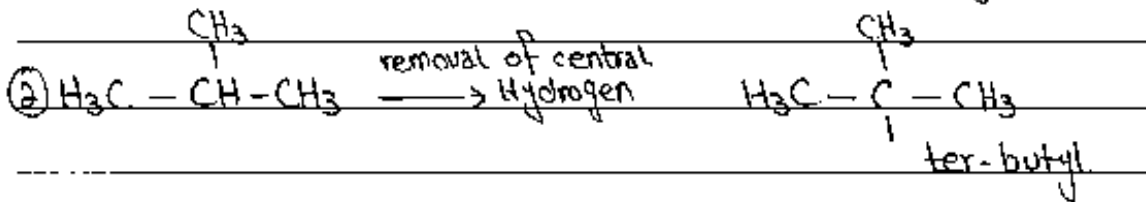
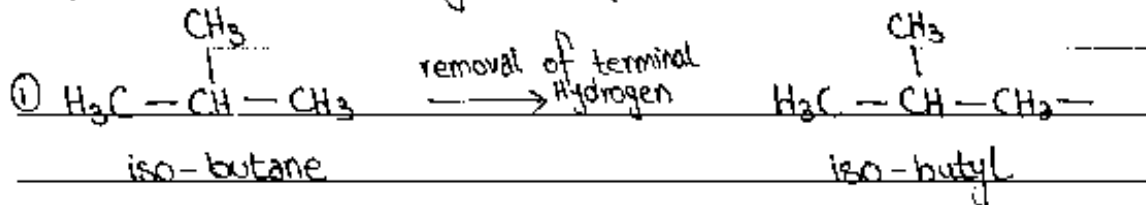
- i. Describe any THREE general characteristics of alkanes.
- ii. Draw the structural formulae of the TWO isomers with a molecular formula C_4H_{10} .
- iii. Show the formation of the following alkyl radicals from the alkane (isomers) mentioned in part ii.
 - I. Isobutyl
 - II. sec-butyl
 - III. tert-butyl

Better responses exhibited good understanding about the general characteristics, isomerism and conversion of alkanes into alkyl radicals. In part 'i', these responses mentioned the specific characteristics of alkane such as alkanes are saturated hydrocarbons/ they have the general formula of C_nH_{2n+2} / they have single bond between carbon atoms/ they give substitution reactions/ they are least reactive therefore called paraffin/ they are non-polar. In part 'ii', candidates clearly represented n-butane and isobutane as the two isomers with the molecular formula C_4H_{10} . Furthermore, candidates expressed their clear understanding of the formation of the given alkyl radicals from n-butane and isobutane in part 'iii'.

Example:

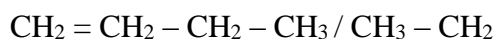


Alkyl radicals are formed by removing a hydrogen from alkane. Their general formula is $\text{C}_n\text{H}_{2n+1}$.

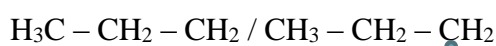


Weaker responses managed to write the characteristics of alkane in part 'i' but struggled to draw the desired structures in part 'ii' and 'iii'. These responses showed incorrect branching, number of carbon atoms and types of covalent bonds between carbon atoms. Some of these responses in part 'i' included incorrect statements such as they are not radical/ they occur naturally/ they are polar solvents/ they are soluble in aqueous solutions/ their melting point is 9.8°C/ they have strong bonds. Furthermore, a few candidates succeeded in presenting the correct structure of n-butane but could not figure out the structures of isobutane, isobutyl, sec-butyl and tert-butyl. Following are few examples of the incorrect structures.

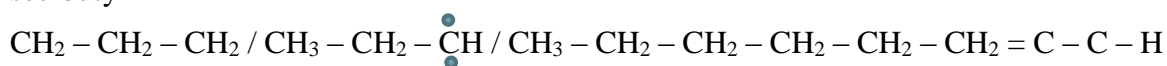
Isobutane



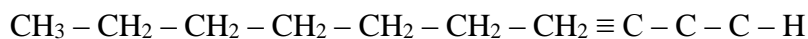
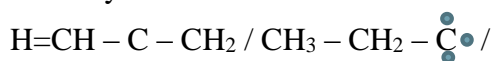
Isobutyl



sec-butyl



tert-butyl



Example:

→ The alkanes generally have many characteristics but some are given below:

- i) Alkanes have low melting points because of their weak ~~and~~ ~~bandings~~ bandings.
- ii) These are colorless & odorless almost.
- iii) Easily reacts with other chemicals because of their instability.
- iv)

→ The molecular formula of C₂H₁₀ is C₂H₅.

* The simplest formula (molecular formula).

Isobutyls → Contain 1 electron.

Sec-butyls → Contain 2 electrons.

Tert-butyls → Contains more than 2 electrons.

Question 10a:

When petrol is burnt in an internal combustion engine of a car, the electrical spark which passes through the air/ petrol mixture produces gases such as ozone and oxides of nitrogen. The release of these gases from car exhaust considerably pollutes the environment.

- i. Identify the main pollution problem caused by each of these gases.
- ii. Describe any TWO harmful impacts of each of the identified problems (in part i) on the environment.
- iii. Suggest any ONE way by which air pollution by cars can be reduced.

Better responses exhibited a well-thought and justified description of the pollution problem caused by ozone and oxides of nitrogen. These responses clearly identified acid rain and smog/ global warming as the problems caused by oxides of nitrogen and ozone respectively in part i. Candidates thoughtfully described the harmful impacts of acid rain and smog/ global warming on the environment inclusive of living and non-living things on earth in part ii. Their descriptions included points like acid rain can damage building material especially of marble and limestone (calcium carbonate)/ it can leach nutrients from the soil thus damaging leaves and plants and growth of forest/ it disrupts the process of photosynthesis resulting in damage to plant life/ it can leach aluminium from the soil into ground water, lakes and rivers that clogs the gills of fish thus causing suffocation. Similarly, in case of global warming, candidates mentioned about melting of glaciers and ice caps/ rise in sea level/ flooding of low lying coastal areas/ changes in weather patterns increasing the frequency, duration, and intensity of floods, droughts, heat waves, and tornadoes/ higher or lower agricultural yields/ extinction of species. A few responses mentioned the impacts of smog that it irritates lungs, causes sore eyes, breathing problems, headaches, and discomfort to nose, throat and chest. In part iii, these responses exhibited considerate suggestions to reduce air pollution by cars such as catalytic converters should be fitted in car exhausts/ a law should be pass to fine cars whose exhaust pollute the air/ car users should be encouraged to use unleaded (lead-free) petrol, fuel with little sulphur content, alternative fuels such methanol, hydrogen, ethanol, and biodiesel/ people should use public transport and avoid using personal cars.

Example 1:

oxides of Nitrogen: These primary air pollutant NO_x formed in internal combustion engines can combine with water vapours in air causing them to be acidic. When rain falls these gases dissolve there to give nitric acid which can reduce the pH of the rain upto 4. ^{causing acid rain.} These oxides also cause irritation when breathed in.

Ozone: It is an allotrope of oxygen i.e. O_3 . It is a poisonous gas when it is present in ~~the~~ troposphere it ~~can~~ causes global warming by absorbing IR (infra red) radiations from earth. It also causes formation of smog.

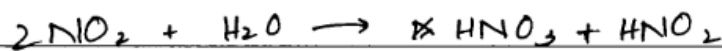
(ii) Acid rain causes decrease in pH of soil and also washes away minerals into lake causing low soil fertility. It also damages leaves and bark of trees which can cause their death. When it take heavy metals e.g. Hg, cadmium etc

into water, they cause health problems in fishes and also humans if it is ^{drank} ~~drinks~~. Global warming causes melting of glaciers which can cause river floods ~~and~~ ^{which} damages residential areas and risk lives. It also causes increase in sea level due to expansion of sea water causing floods in coastal areas and making previously populated areas inhabitable. It also changes weather patterns, and climates which leads to ~~a~~ precipitation/rainfall change ^{which can damage crops} causing low crop yield.

(iii) Air pollution by cars can be reduced by using catalytic converters, using public transport or using alternative sources of energy, e.g. solar energy, to power vehicles.

Example 2:

(i) Release of ozone causes smog which is a mixture of smoke and fog. Ozone is a harmful gas at ground level and forms a yellow coloured mist in the air. Oxides of Nitrogen contribute to acid rains. They dissolve in rain water and then form nitric acid and nitrous acid.



ii) **SMOG** :-¹⁾ It causes respiratory track disorders ~~and~~ by irritating the air passage way. It also causes irritation in the eye and redness. ²⁾ Smog reduces vision and blurs vision. Hence car and truck drivers cannot see properly and it leads to road accidents.

ACID RAIN :-¹⁾ It increases the pH of water bodies and makes rivers and lakes acidic. Fishes cannot survive in acidic water, hence they die. It also makes soil acidic and retards the growth

of plants and crops. ²⁾ Acid rain also causes damage to stone structures and causes ^{washing away} leaching of heavy metals. These metals ^{like Al, Zn, Co, Cu} then drain in the seas and seep into the ground and contaminate water.

When these metals get inside the body of fishes, then they enter the food chain. Human beings who eat contaminated fishes ~~felt~~ fall sick. Al ions clog the gills of fishes.

iii) This pollution can be controlled by the use of catalytic converters that convert harmful oxides of nitrogen into N_2 (diatomic nitrogen). Pollution can also be controlled by ~~the~~ avoiding the use of private cars and encouraging the use of public transport for transportation.

Weaker responses generally tried to explain the harmful effects of air pollution on the environment in part 'i' and 'ii'. Few even mentioned consequences of water pollution without realising that the given stimulus shares information about gases released by a car exhaust and not effluent being discharged from an industry into water bodies. A few of these responses wrote generic definition of global warming with reference to the liberation of carbon dioxide – a gas not stated in the stimulus or lead-in (question). These responses mostly mixed the concepts of global warming, acid rain and ozone depletion and thus mentioned vague harmful effects. However, some of the candidates were able to write the correct suggestion for the reduction of air pollution by a car in part iii. These responses mostly recommended the use of public transport, bicycles and catalytic converters.

Example:

a. (i) POLLUTION: The problem which disturbs the life cycle and events taking place on land. The main problem caused by the release of these gases is called 'AIR POLLUTION'. The type of pollution which pollutes the environment, in many different ways which can be overcome if government take major step to finish this through some safety measures.

(ii) PROBLEMS CAUSED BY AIR POLLUTION: There are many problems which are caused by air pollution.

1. Air Pollution disturbs the habitat of animals living near the residential areas due to less trees in forests the main cause (deforestation). This pollution cause the species to die without producing off-springs due to lack of proper nutrients provided to the animals.

2. This Pollution also cause breathing problems to the human beings who inhale these toxic gases which cause problem to the lungs which cannot do proper exchange of gases.

(iii) The Air Pollution by cars can be reduced by catalytic converters present in only some vehicles. These converters change the toxic gases produced by the car engines into non-harmful gases which donot harm the environment, and are non toxic gases.

Question 10b:

A blast furnace is charged with haematite ore, coke and limestone from the top. It is then heated by blowing hot air in it from the base.

Using the given information, describe the stages that enable the extraction of iron from its ore. Write chemical equations to support your answer.

Better responses exhibited good grip over the concept of chemical industries. Usually candidates find metallurgical operations difficult. But in this case, candidates produced well-constructed, stage wise extraction of iron from the raw materials stated in the stimulus. These responses clearly described the purpose of each raw material and its utilisation in the process of making the product.

Example:

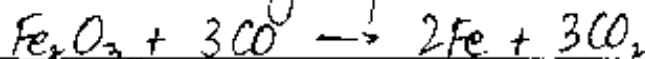
b) * Stage 1: Burning of coke \Rightarrow In the first stage, coke is burnt in air, giving off carbon dioxide. This is an exothermic reaction and here carbon is oxidized to carbon dioxide.



* Stage 2: Carbon monoxide is formed \Rightarrow Carbon dioxide further reacts with more coke to produce carbon monoxide. This is an endothermic reaction and here CO_2 is reduced.



* Stage 3: Extraction of iron \Rightarrow The carbon monoxide reacts with haematite ore to give pure iron.



Here iron is reduced and carbon monoxide is itself oxidized.

* What is the limestone for? Limestone is used to give slaked lime on decomposition.

$\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
This calcium oxide reacts with the impurities to give the slag.

$\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$
Calcium oxide is a basic ~~oxide~~ ^{oxide} while ~~SiO~~ Silica is an acidic oxide. The product, calcium silicate, is a salt.

This slag floats on the iron and is then removed. In this way, iron is extracted from iron ore:

* Waste gases: The waste products of these reactions are carbon dioxide (from stage 3) and nitrogen (from air blast).

Weaker responses mentioned the use of any one of the three raw materials. These responses could not build connections between the stepwise reactions occurring in the blast furnace. These responses failed to highlight the impact of chemical reactions with reference to thermal changes that occur during the extraction of iron. These responses mostly included few correct points that revolved around the reaction between carbon and oxygen or haematite ore and carbon/ carbon monoxide.

Example:

In blast furnace first we add iron ore, coke and lime stone. then will be prepared at different temperature. At the end the slag come out.

Chemical reaction take place ::



Other reaction::

