Aga Khan University Examination Board

Notes from E-Marking Centre on SSC-II Chemistry Examination May 2017

Introduction

This document has been produced for the teachers and candidates of Secondary School Certificate (SSC-II) Chemistry. It contains comments on candidates' responses to the 2017 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, candidates attempted the paper well. However, there is still room for improvement. Mentioned below are few concepts that teachers need to focus and give candidates more drill and practice to have a strong grip.

a. Understanding of the concepts related to chemical equilibrium and application of Le Chatelier's principle.
b. Application of Arrhenius, Brønsted and Lewis concept of acids and bases.
c. Problem solving based on calculation of pH which involves use of correct formula, manipulation of formula as per the data given and substitution of values to obtain the correct answer.

Detailed Comments:

Constructed Response Questions (CRQs)

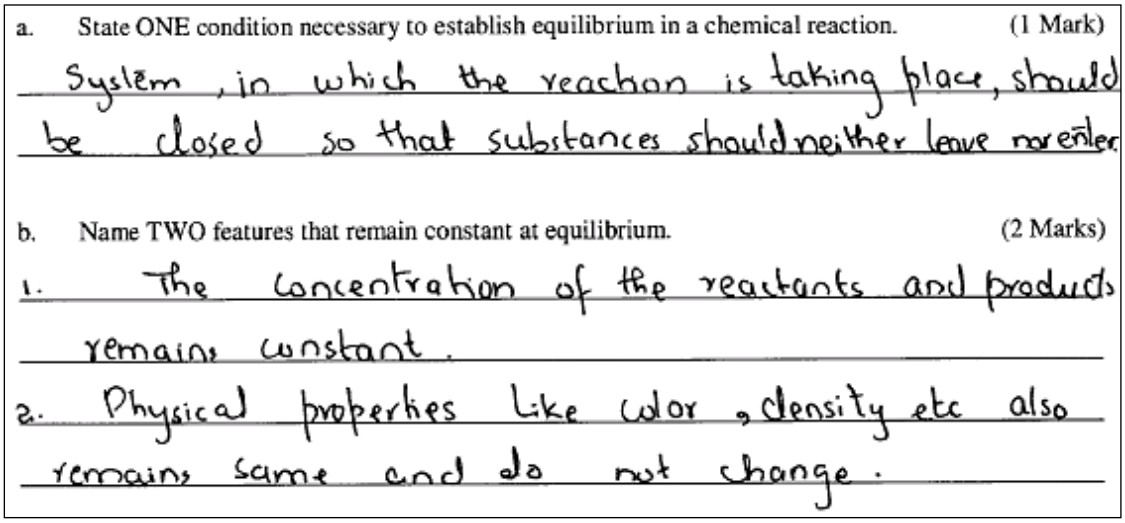
Question 1:

a. State ONE condition necessary to establish equilibrium in a chemical reaction.

b. Name TWO features that remain constant at equilibrium.

Better responses depicted a good grip over the concept of chemical equilibrium. These responses highlighted the conditions necessary to establish equilibrium and identified features that remain constant at equilibrium. Majority of the responses included closed system as an answer to part 'a' while features in part 'b' comprised of macroscopic properties and concentration of reactants and products.

Example:



a. State ONE condition necessary to establish equilibrium in a chemical reaction. (1 Mark)

System, in which the reaction is taking place, should be closed so that substances should neither leave nor enter.

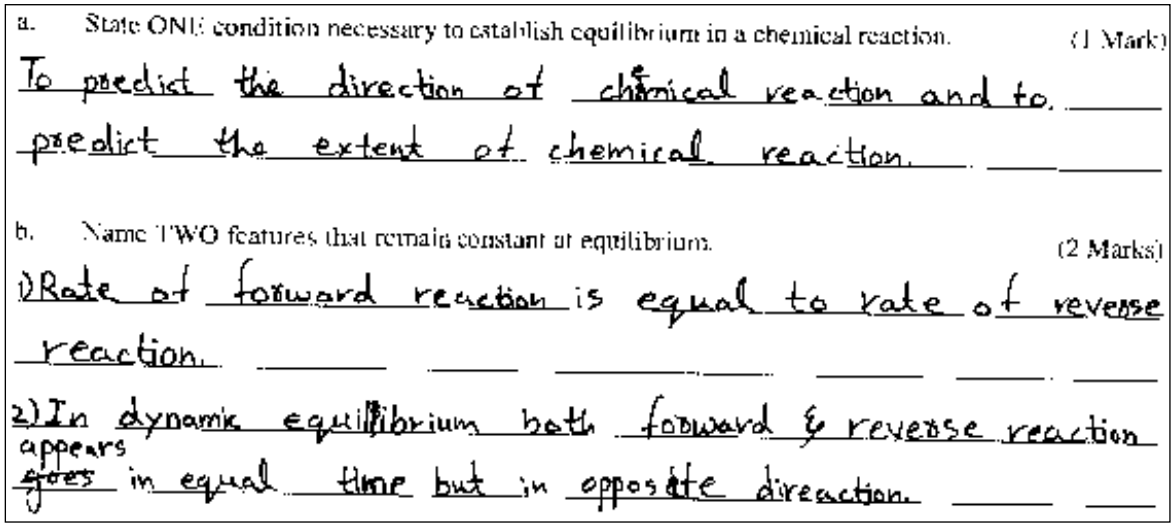
b. Name TWO features that remain constant at equilibrium. (2 Marks)

1. The concentration of the reactants and products remains constant.

2. Physical properties like color, density etc also remains same and do not change.

Weaker responses showed lack of knowledge about the concept of chemical equilibrium. These responses mostly displayed irrelevant answers. A few candidates were able to answer part 'a' correctly but made mistakes in part 'b'. The incorrect responses to part 'b' included molecular mass/ chemicals/ dynamic equilibrium/ chemical equilibrium/ hydrogen chloride acid/ water/ carbon dioxide and oxygen.

Example:



a. State ONE condition necessary to establish equilibrium in a chemical reaction. (1 Mark)

To predict the direction of chemical reaction and to predict the extent of chemical reaction.

b. Name TWO features that remain constant at equilibrium. (2 Marks)

1) Rate of forward reaction is equal to rate of reverse reaction.

2) In dynamic equilibrium both forward & reverse reaction appears goes in equal time but in opposite direction.

Question 2:

Consider the given reaction at equilibrium.

$N_{2(g)} + 3H_{2(g)} \leftrightharpoons 2NH_{3(g)}$ Enthalpy change (ΔH) = – 92 kJ mol^{-1}

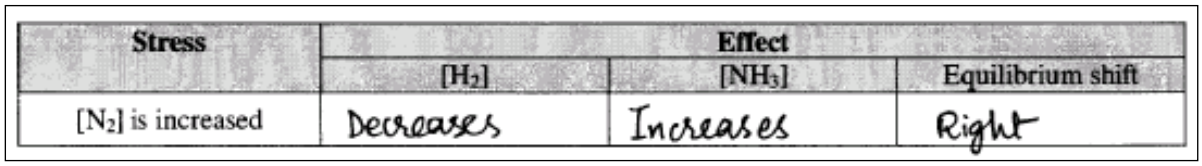
Complete the table by using appropriate words from the given list to show the change in *concentration* of hydrogen and ammonia and the direction of equilibrium.

Increases
Decreases
No change
Left
Right

Stress	Effect		
	$[H_2]$	$[NH_3]$	Equilibrium shift
$[N_2]$ is increased			

Better responses selected the correct words from the given list to represent the change in concentration of hydrogen and ammonia and the direction of equilibrium. These responses displayed a thorough understanding and application of the concept of Le Chatelier's principle.

Example:



Stress	Effect		
	$[H_2]$	$[NH_3]$	Equilibrium shift
$[N_2]$ is increased	Decreases	Increases	Right

Weaker responses couldn't figure out the counteraction of the reversible reaction when the given stress is applied on it at equilibrium. These responses showed lack of grip over Le Chatelier's principle and rarely produced one correct answer.

Example:

Stress	Effect		
	$[H_2]$	$[NH_3]$	Equilibrium shift
$[N_2]$ is increased	No change	Increase	Left

Question 3a:

Write any TWO industrial uses of sulphuric acid.

Better responses mostly highlighted more than two uses of sulphuric acid in industries. These responses included uses such as sulphuric acid is used in the making of fertilisers/ explosives/ dyes/ paints/ detergents/ ammonium sulphate/ calcium superphosphate/ drugs.

Example:

a. Write any TWO industrial uses of sulphuric acid. (2 Marks)

- Sulphuric acid is used to make dyes, paints, explosives and is used in batteries.
- It is used to make fertilizers, and chemicals.

Weaker responses mostly focused on one use and repeated the same in different wordings. For example, sulphuric acid is used for cleaning metals/ washing metals/ removing stains from metals. The incorrect responses included statements such as sulphuric acid is used in ripening of fruits/ making of bleaching powder/ making more efficient products/ to produce things/ to form one thing from another/ to maintain food's freshness.

Example:

a. Write any TWO industrial uses of sulphuric acid. (2 Marks)

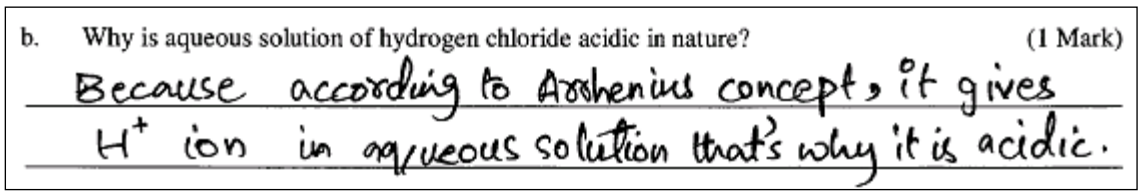
It is use for cleaning, washing, furnishing machinerets machines.
Removing stain of oils, grease etc from parts.

Question 3b:

Why is aqueous solution of hydrogen chloride acidic in nature?

Better responses demonstrated a strong understanding of Arrhenius and Brønsted-Lowry concept of acids and bases. Referring to their theory, candidates constructed their responses which included that the acidic nature of the aqueous solution of hydrogen chloride is because of its tendency to release H^+ ion in aqueous medium or hydrogen chloride has the tendency to donate proton.

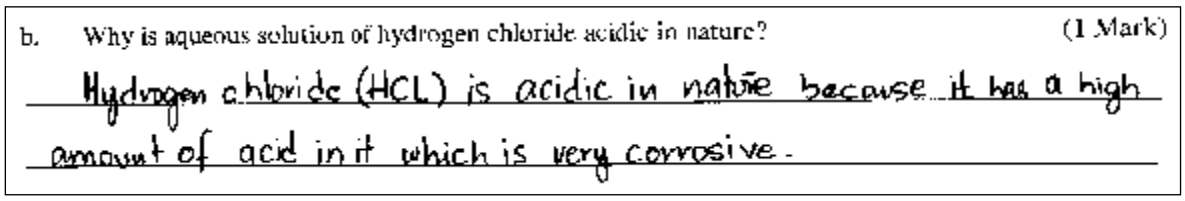
Example:


b. Why is aqueous solution of hydrogen chloride acidic in nature? (1 Mark)

Because according to Arrhenius concept, it gives H^+ ion in aqueous solution that's why it is acidic.

Weaker responses failed to figure out the reason for the acidic nature of the aqueous solution of hydrogen chloride. Majority of these responses showed the properties of acid, i.e. it is corrosive/ turns blue litmus red/ sour in taste/ reacts with metals but couldn't justify the reason behind these properties as to which feature of it makes the solution acidic.

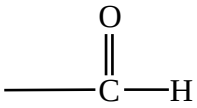
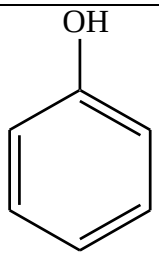
Example:


b. Why is aqueous solution of hydrogen chloride acidic in nature? (1 Mark)

Hydrogen chloride (HCL) is acidic in nature because it has a high amount of acid in it which is very corrosive.

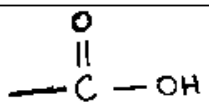
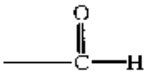
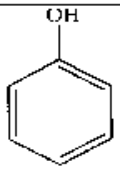
Question 4:

Complete the given table with the missing information regarding detection of functional groups.

Reaction in Test Tube	Result	Functional Group
2.0 cm^3 of 5% $NaHCO_3$ + a pinch of organic compound	Carbon dioxide gas evolves with effervescence	
Equal volumes of Fehling's solution A and B + a pinch of organic compound + boil for five minutes		
	Formation of voilet-purple solution	

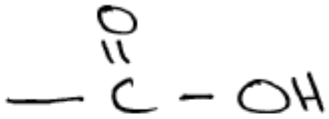
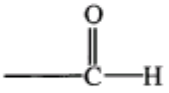
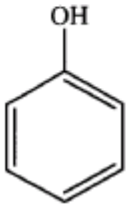
Better responses correctly identified the three blanks, i.e. the functional group, result and the reaction in test tube. These responses showed correct illustration of carboxylic acid functional group in the first blank, mentioned the formation of brick red precipitates of copper(I) oxide (Cu_2O) in the second blank and identified the reaction of freshly prepared ferric chloride solution with the organic compound in the third blank for phenol.

Example:

Reaction in Test Tube	Result	Functional Group
2.0 cm^3 of 5% $NaHCO_3$ + a pinch of organic compound	Carbon dioxide gas evolves with effervescence	
Equal volumes of Fehling's solution A and B + a pinch of organic compound + boil for five minutes	Brick red precipitates are formed.	
Freshly prepared ferric chloride solution ($FeCl_3$) + given organic compound + shake.	Formation of voilet-purple solution	

Weaker responses mostly exhibited the correct structure of carboxylic acid functional group but wrote variety of invalid answers in second and third blank. Candidates came up with different coloured solutions and even the formation of silver mirror for aldehyde. These responses identified phenol in the third blank but candidates couldn't figure out the chemical reaction that leads to the identification of phenols. Hence, a lack of understanding regarding detection of functional group was displayed in this question even though this concept is being studied and assessed in chemistry practical exam as well.

Example:

Reaction in Test Tube	Result	Functional Group
2.0 cm^3 of 5% $NaHCO_3$ + a pinch of organic compound	Carbon dioxide gas evolves with effervescence	
Equal volumes of Fehling's solution A and B + a pinch of organic compound + boil for five minutes	The silver layer will occur at the top of the solution	
Phenol	Formation of voilet-purple solution	

Question 5:

Fill in the blanks.

a. Proteins are made up of amino acids which are joined together through _____.

b. When heated, proteins vibrate violently causing the _____ bonds to break.

c. Denaturation brings about a change in the _____ of proteins.

Better responses established clear knowledge regarding proteins. Candidates were able to fill in the blanks correctly mentioning that the amino acids are joined together through peptide linkages; heating causes hydrogen bonds to break and denaturation changes the structure of proteins. Answers such as biological activity/ function/ shape/ colour/ viscosity were also accepted in part 'c'.

Example:

a. Proteins are made up of amino acids which are joined together through peptide linkage.

b. When heated, proteins vibrate violently causing the hydrogen bonds to break.

c. Denaturation brings about a change in the structure of proteins.

Weaker responses illustrated poor grip on the structure and denaturation of proteins. Candidates mostly made guesses about the missing words. Most of these responses correctly identified peptide bond/ linkage in part 'a'; while made mistakes in 'b' and 'c'. In 'b', their irrelevant answers included all types of bonds such as covalent/ coordinate covalent/ ionic/ peptide/ single/ double; while answer to part 'c' comprised of terms like synthesis/ formation/ nature/ carbon/ reaction.

Example:

a. Proteins are made up of amino acids which are joined together through Peptide Linkage

b. When heated, proteins vibrate violently causing the peptide. bonds to break.

c. Denaturation brings about a change in the nature of proteins.

Question 6:

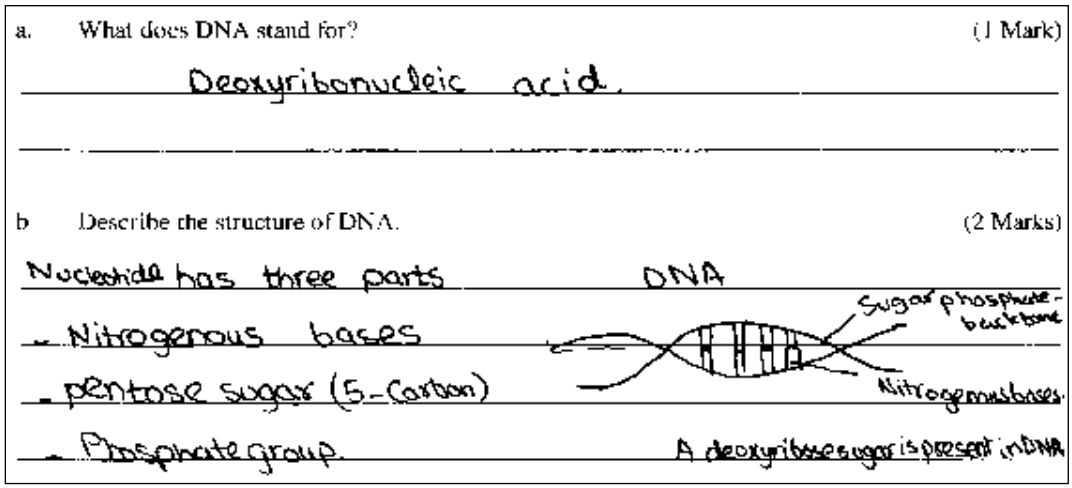
Nucleic acids are of two types: DNA and RNA.

a. What does DNA stand for?

b. Describe the structure of DNA.

Better responses identified the full form of DNA and described its structure by giving points like DNA consists of deoxyribose sugar/ it is long double stranded molecule consisting of two chains/ the chains are wrapped around each other in a double helix form/ each chain is made up of sugar, phosphate and a base/ bases present in DNA are adenine, cytosine, thyamine and guanine.

Example:


a. What does DNA stand for? (1 Mark)

Deoxyribonucleic acid.

b Describe the structure of DNA. (2 Marks)

Nucleotide has three parts
- Nitrogenous bases
- pentose sugar (5-Carbon)
- Phosphate group.

DNA

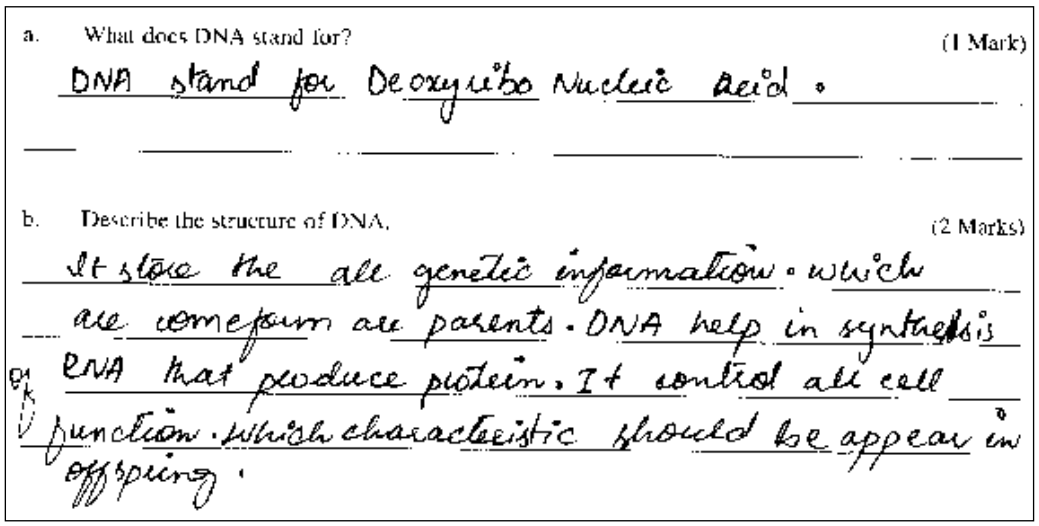
Sugar phosphate-backbone

Nitrogenous bases

A deoxyribose sugar is present in DNA

Weaker responses indicated lack of clarity about DNA and its structure. These responses mostly produced incorrect full form of DNA in part 'a', such as, dehexonoclic acid/ dehydrogination nutrilization alyclic/ deoxynucleotide acid. A few candidates succeeded in figuring out *DNA* as deoxyribonucleic acid but made mistakes in part 'b'. For example, they gave functions of DNA rather than describing its structure.

Example:


a. What does DNA stand for? (1 Mark)

DNA stand for Deoxyribo Nucleic acid.

b. Describe the structure of DNA. (2 Marks)

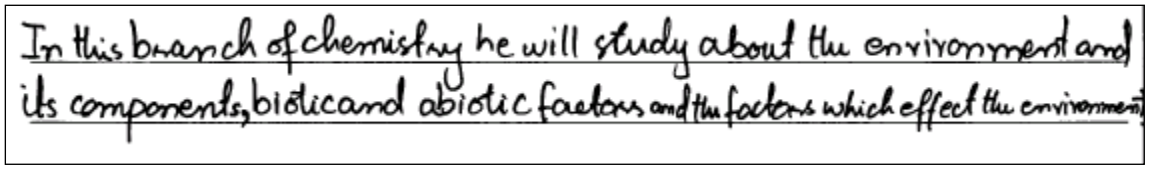
It store the all genetic information. which are come from are parents. DNA help in synthesis of RNA that produce protein. It control all cell function. which characteristic should be appear in offspring.

Question 7a:

A student took environmental chemistry as a subject to study. What do you think he will study in this branch of chemistry?

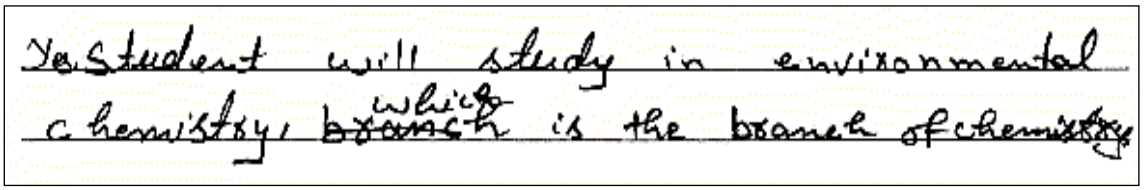
Better responses expressed good understanding about environmental chemistry. These responses presented the correct understanding of the study of environmental chemistry which included components of environment, i.e. biotic and abiotic factors, changes that occur in the environment and the consequences that the earth is facing due to varied human activities.

Example:



Weaker responses displayed irrelevant and meaningless statements. These responses showed candidates' lack of knowledge about the concepts that are studied in the branch of environmental chemistry.

Example:



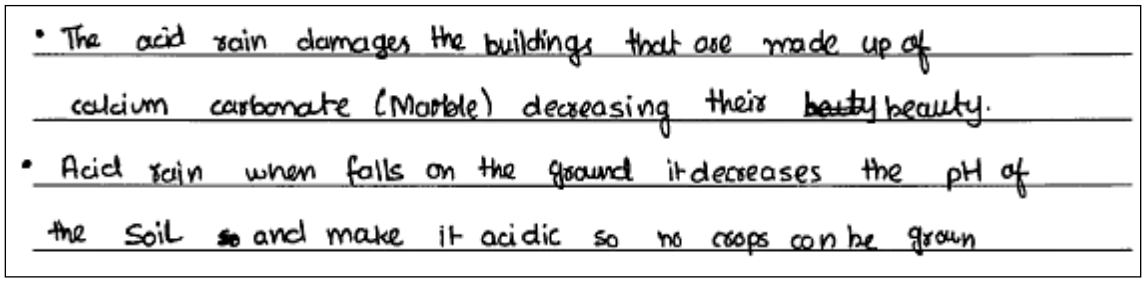
Question 7b:

When fossil fuels burn, oxidation of sulphur takes place and sulphur dioxide is formed. Sulphur dioxide reacts with rain in air and falls to Earth as acid rain.

Describe any TWO damages that acid rain can cause.

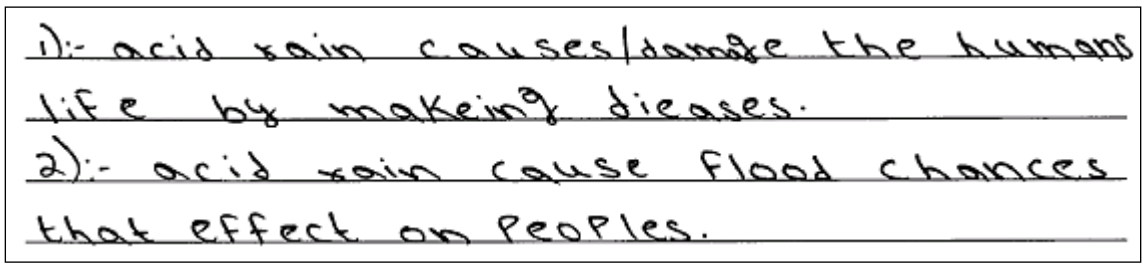
Better responses demonstrated good understanding about acid rain and its effects on the environment. Most of these responses specified damage to marble stone building, aquatic life, soil fertility, plant growth and health hazards for humans that feed on infected fresh water fish etc.

Example:



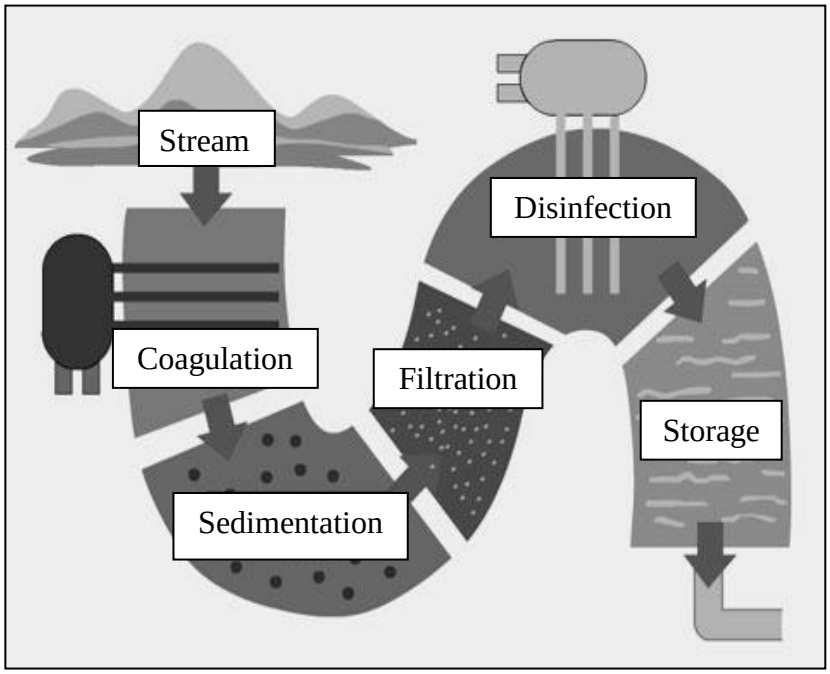
Weaker responses showed little knowledge about the effects of acid rain. They mixed up the concept with global warming. A few of these responses mentioned the eroding of marble stone buildings but failed to give the second point correctly. It contained irrelevant answers such as it causes floods/ increases the pH of soil and water/ it makes the land salty/ it causes oxidation of sulphur/ acid rain are caused by diseases.

Example:



Question 8:

The given diagram shows the stages involved in raw water treatment.



a. Name the chemical which is added in the coagulation stage to stick the smaller solid particles together.

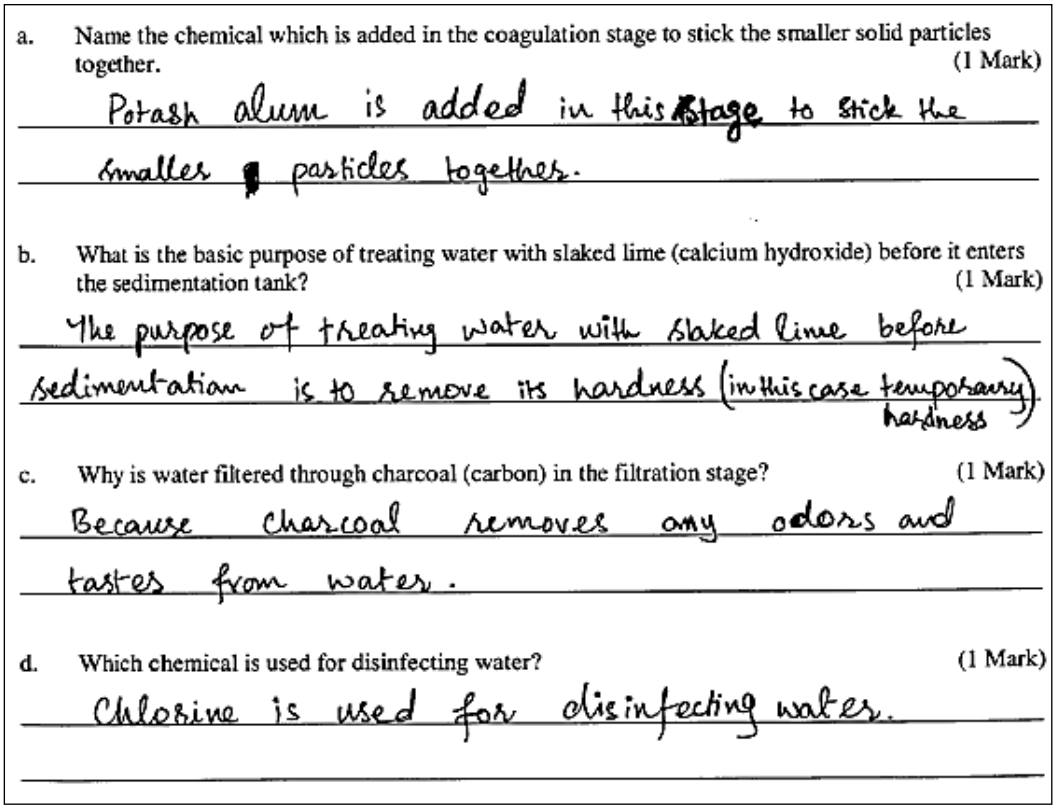
b. What is the basic purpose of treating water with slaked lime (calcium hydroxide) before it enters the sedimentation tank?

c. Why is water filtered through charcoal (carbon) in the filtration stage?

d. Which chemical is used for disinfecting water?

Better responses identified alum as coagulant in part 'a'. In part 'b', these responses gave an appropriate purpose that calcium hydroxide is used to remove temporary hardness/ to neutralise water if it is acidic in nature/ to convert soluble bicarbonates into insoluble carbonates. Furthermore, candidates demonstrated a strong grip over the concept of raw water treatment by giving a logical reason for the use of charcoal in the filtration stage in part 'c'. They clearly stated that charcoal absorbs impurities and removes tastes and smell from water. These responses successfully identified chlorine as a disinfectant in part 'd'.

Example:



a. Name the chemical which is added in the coagulation stage to stick the smaller solid particles together. (1 Mark)

Potash alum is added in this stage to stick the smaller particles together.

b. What is the basic purpose of treating water with slaked lime (calcium hydroxide) before it enters the sedimentation tank? (1 Mark)

The purpose of treating water with slaked lime before sedimentation is to remove its hardness (in this case temporary hardness).

c. Why is water filtered through charcoal (carbon) in the filtration stage? (1 Mark)

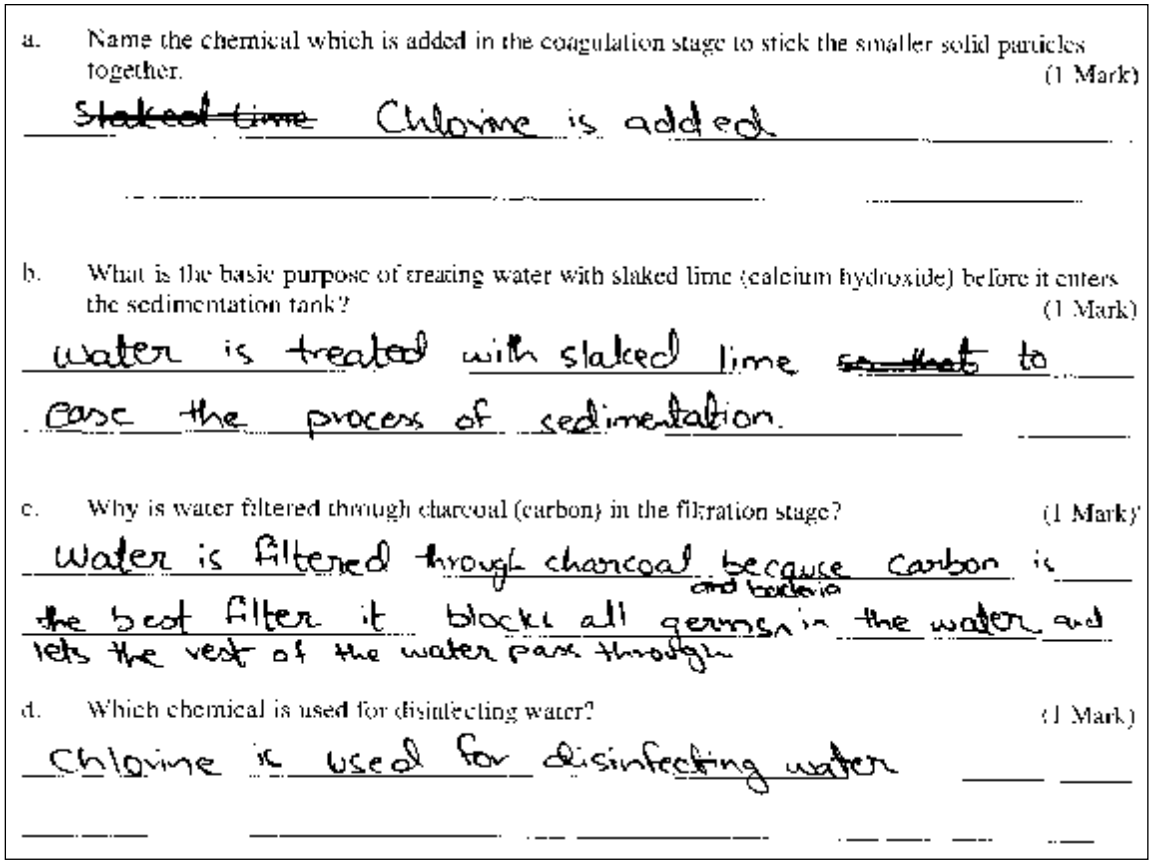
Because charcoal removes any odors and tastes from water.

d. Which chemical is used for disinfecting water? (1 Mark)

Chlorine is used for disinfecting water.

Weaker responses depicted lack of knowledge regarding raw water treatment. A few responses succeeded in getting answers to parts 'c' and 'd' correct but made errors in parts 'a' and 'b'. These responses named the coagulant in part 'a' as aqueous solution/ chlorine/ carbon/ calcium hydroxide/ aluminium hydroxide/ hydrogen chloride/ sodium hydroxide. Moreover, these responses failed to explain the use of calcium hydroxide in part 'b', though candidates study Clark's process which is based upon the use of slaked lime, $Ca(OH)_2$, to remove temporary hardness from water.

Example:



a. Name the chemical which is added in the coagulation stage to stick the smaller solid particles together. (1 Mark)

~~Slaked lime~~ Chlorine is added

b. What is the basic purpose of treating water with slaked lime (calcium hydroxide) before it enters the sedimentation tank? (1 Mark)

water is treated with slaked lime ~~so that~~ to case the process of sedimentation.

c. Why is water filtered through charcoal (carbon) in the filtration stage? (1 Mark)

Water is filtered through charcoal because carbon is the best filter it blocks all germs and bacteria in the water and lets the rest of the water pass through

d. Which chemical is used for disinfecting water? (1 Mark)

Chlorine is used for disinfecting water

Extended Response Questions (ERQs)

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

Approximately, 75% candidates attempted part 'a' while 25% answered part 'b' of question 9. This shows their analytical approach and risk taking in questions based on word problems. However, in question 10, more inclination of candidates was observed in part 'b' than part 'a'. This reflects their confidence and preference over the concept of 'ozone depletion and air pollutant' more than their grip on 'chemical industries'.

Question 9a:

$H_2SO_{4(aq)} + NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + H_2O_{(l)}$

i. Balance the given neutralisation reaction.

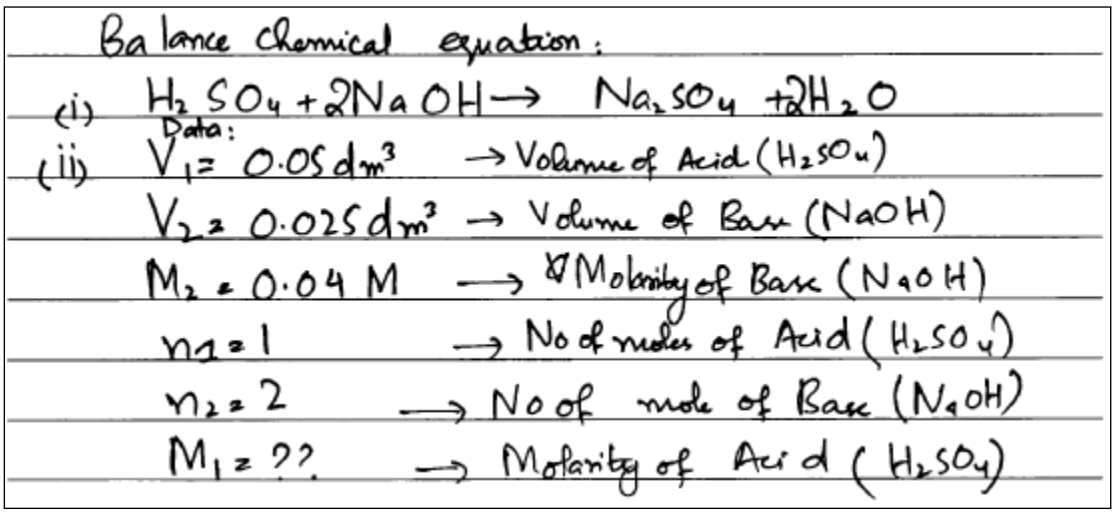
ii. A 0.05 dm^3 sample of H_2SO_4 aqueous solution was titrated against 0.025 dm^3 aqueous solution of 0.04 M NaOH until neutralised. Using balanced chemical equation from part **i**, calculate the concentration of the H_2SO_4 aqueous solution.

iii. Find the pOH of 0.04M NaOH solution. (**Note**: The value of log 4 = 0.6)

(**Note**: Show the steps of working for part **ii** and part **iii**.)

Better responses represented correct balancing of the given equation in part i. These responses demonstrated good analytical skills of extracting data from the given information and applied appropriate formulae to calculate correct answers in part ii and iii. These responses indicated all steps of working for both word problems.

Example:


Balance chemical equation:

(i) $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

(ii) Data:

$V_1 = 0.05\ dm^3$ → Volume of Acid (H_2SO_4)

$V_2 = 0.025\ dm^3$ → Volume of Base ($NaOH$)

$M_2 = 0.04\ M$ → Molarity of Base ($NaOH$)

$n_1 = 1$ → No of moles of Acid (H_2SO_4)

$n_2 = 2$ → No of mole of Base ($NaOH$)

$M_1 = ??$ → Molarity of Acid (H_2SO_4)

$$= \frac{M_1V_1}{n_1} = \frac{M_2V_2}{n_2}$$

$$= \frac{M_1 \times 0.05}{1} = \frac{(0.04)(0.025)}{2}$$

$$= M_1 \times 0.05 = \frac{0.001}{2}$$

$$= M_1 \times 0.05 = 0.0005$$

$$M_1 = \frac{0.0005}{0.05}$$

$$M_1 = 0.01\ M$$

(iii) Data
Molarity (Concentration) of OH^- ion $= 0.04M$
$= 4 \times 10^{-2} M$

$pOH = ??$

$pOH = -\log[OH^-]$

$pOH = -\log[4 \times 10^{-2}]$

$pOH = -[\log 4 + (-2\log 10)]$

Note: $\log 10^x = 1$, $\log 4 = 0.6$

$pOH = -[0.6 + (-2 \times 1)]$

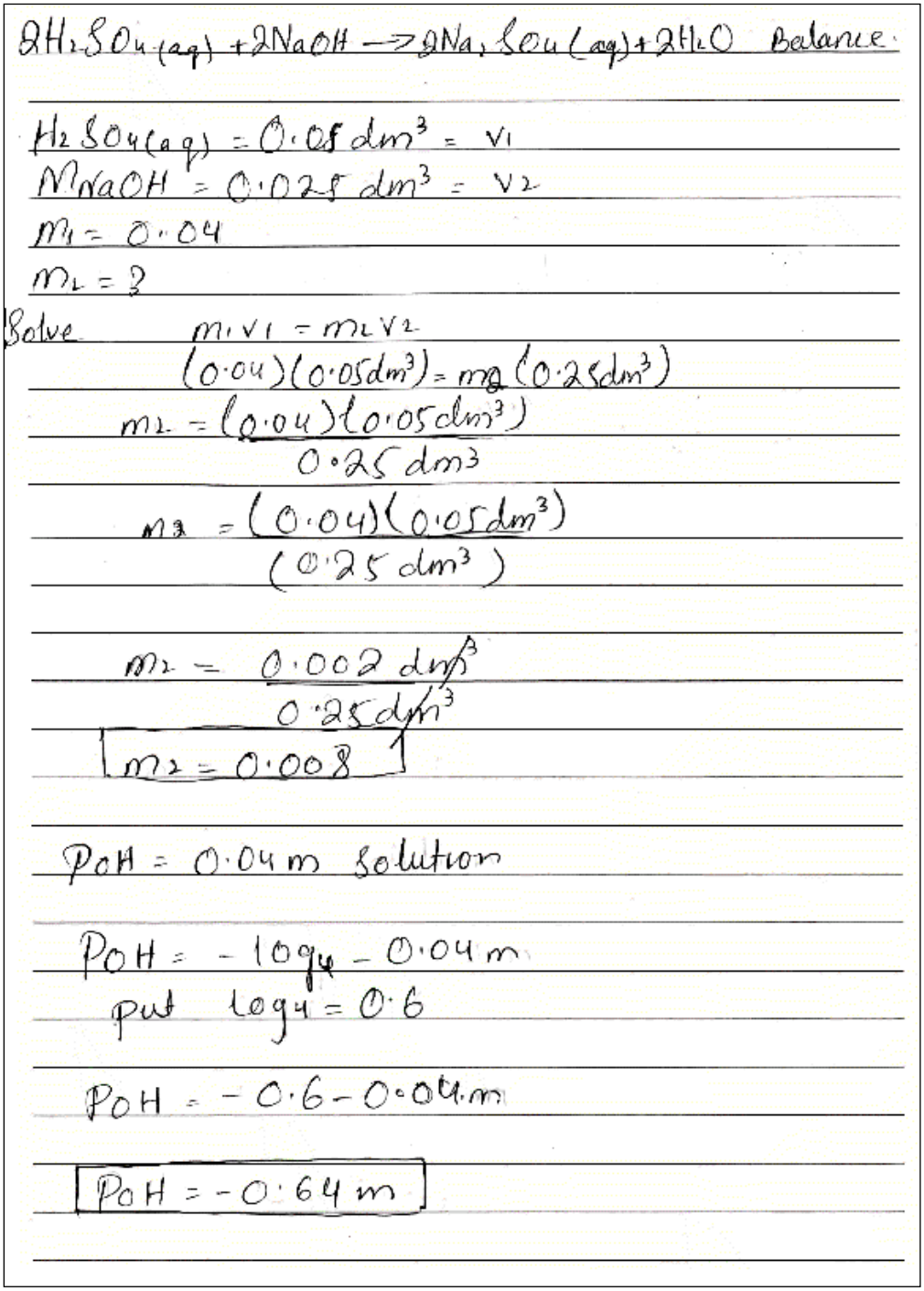
$pOH = -[0.6 - 2]$

$pOH = -0.6 + 2$

$pOH = 1.4$

Weaker responses mostly showed accurate balancing of chemical equation but displayed incorrect formula and wrong calculations. A few responses worked with the dilution formula, ignoring the number of moles of acid and base. Similarly, candidates showed lack of knowledge with reference to numerical based on pOH. They failed to convert the given hydroxide ion concentration into scientific notation and were unable to substitute the values correctly in the formula of pOH = − log [OH^-]. This resulted in wrong calculation of the answer.

Example:



Question 9b:

i. Draw dot and cross structures of ethene ($H_2C = CH_2$) and ethyne ($HC \equiv CH$).

ii. Using balanced chemical equation, show the complete steps of oxidation of the following organic compounds with potassium permanganate ($KMnO_4$) solution.

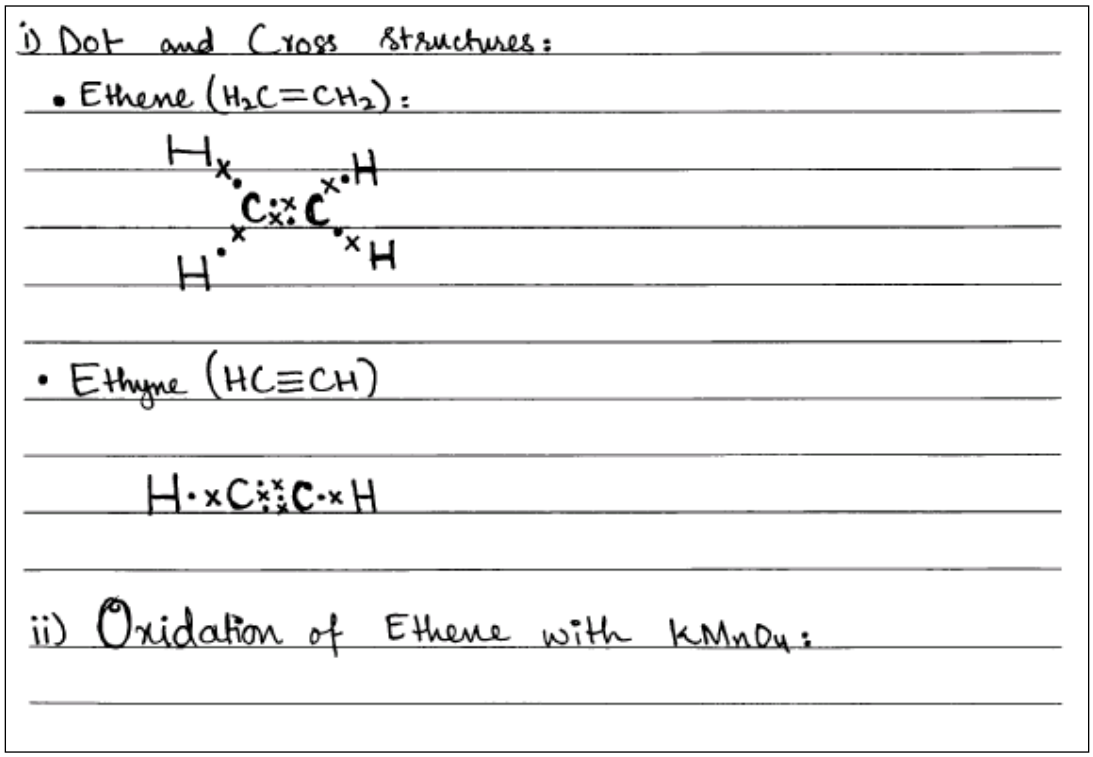
   I. Ethene

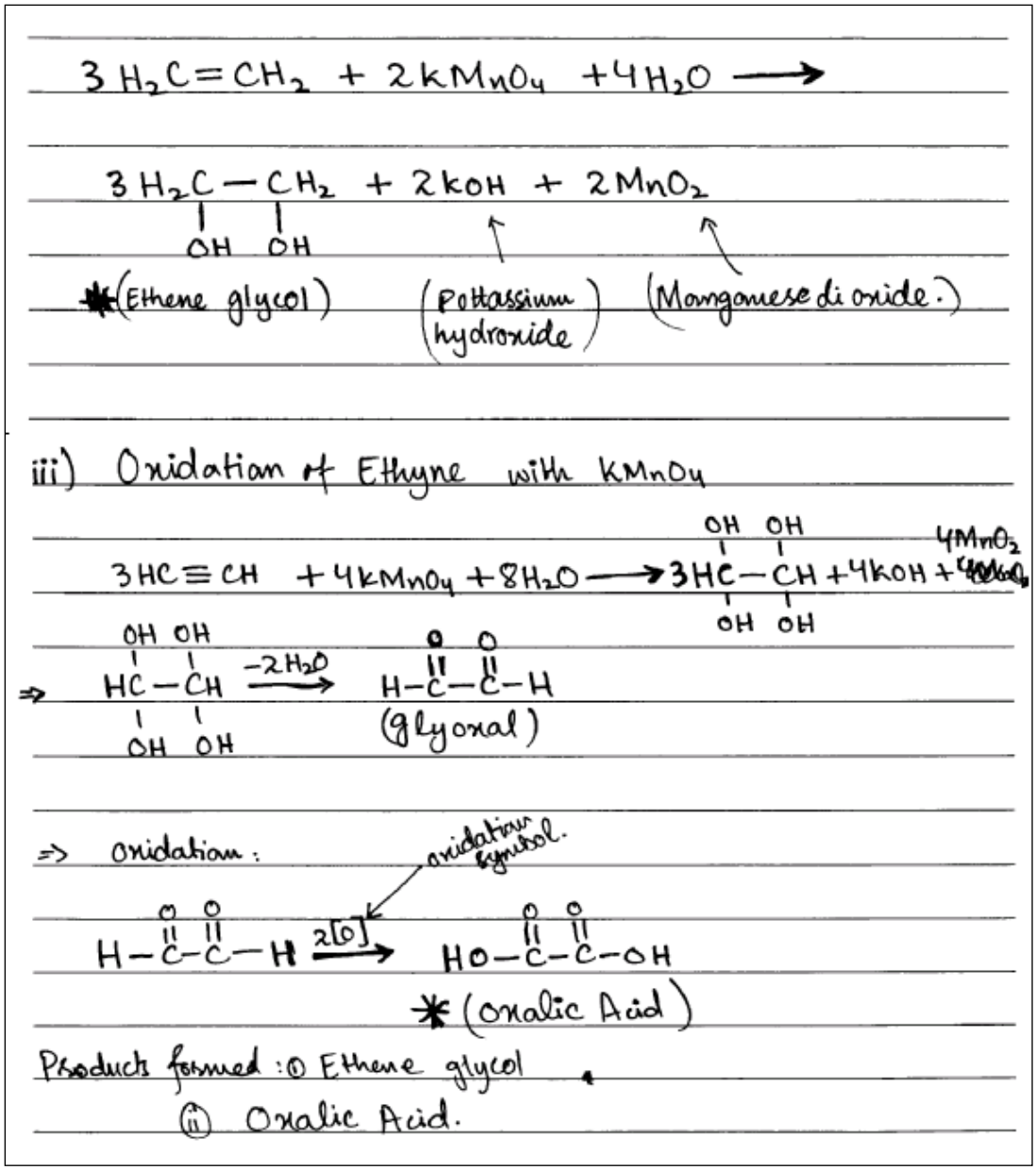
   II. Ethyne

iii. Name the final products obtained on complete oxidation of (I) ethene and (II) ethyne in part **ii**.

Better responses exhibited good understanding about the dot and cross structures of ethene and ethyne in part i. In part ii, these responses showed all the steps for the oxidation of ethene and ethyne by potassium permanganate. Candidates expressed their clear understanding of the concept using balanced chemical equations with correct chemical formulae of reactants and products in each case. Furthermore, they specified the names of the final products as required in part iii.

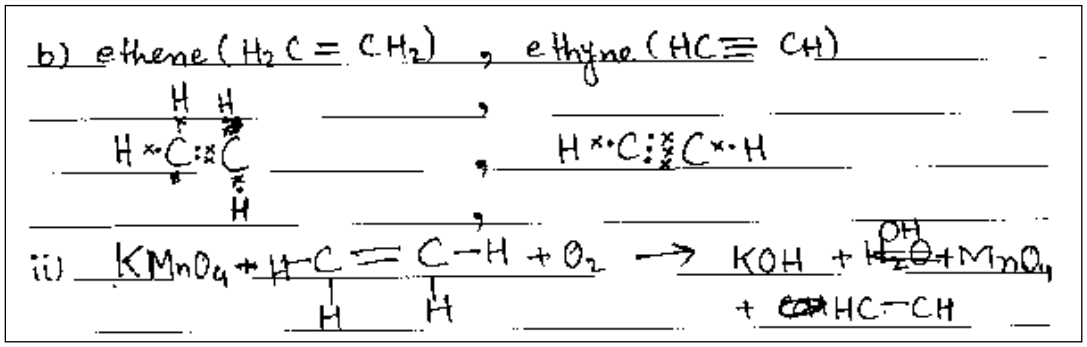
Example:

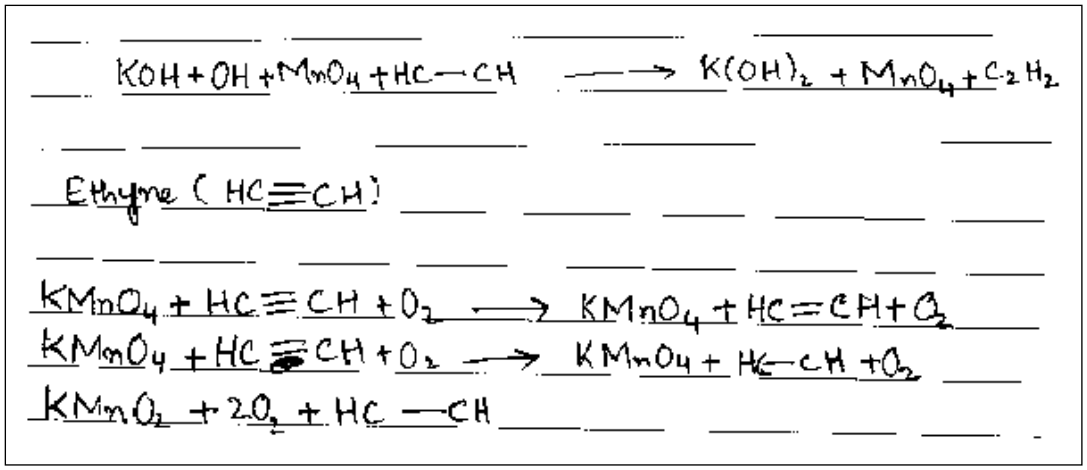




Weaker responses managed to draw the correct dot and cross structures of ethene and ethyne in part i but struggled to figure out the balanced chemical equation with correct chemical formulae for reactants and products in part ii. As candidates were unable to show the complete steps of oxidation of ethene and ethyne, they couldn't answer part iii either.

Example:





Question 10a:

Sana is a farmer. She cares about the environment and the health of her family. She uses some of her produce and sells the rest as 'Sana's Organic Products'.

i. Which type of fertiliser should she use? Justify your answer giving any THREE advantages of using it.

ii. What problems (any THREE) would she face while using this fertiliser?

Better responses exhibited a well-thought and justified description of the use of natural fertiliser by Sana, the farmer. These responses clearly enlisted the advantages and problems associated with the use of natural fertilisers. Benefits included points like natural fertilisers add organic matter to the soil/ they do not contain toxic chemicals/ they improve the structure of the soil allowing more air to get to the plant roots/ they improve the porosity of the soil increasing its ability to hold water and nutrients. Problems comprised of statements such as microorganisms are required to break down and release nutrients into the soil/ distribution of nutrients in natural fertilisers is not equal/ they have slow releasing capability of nutrients/ pests may be attracted to certain natural fertilisers.

Example:

i) Since Sana cares about the environment, she should use organic and natural fertilizers which is made from animals and human wastes and dead plant matter after it is decomposed. There are several advantages of using organic fertilizers:

* These are biodegradeable and hence they don't cause any damage to the environment.
* They increase porosity of soil, helping the soil hold more water and nutrients.

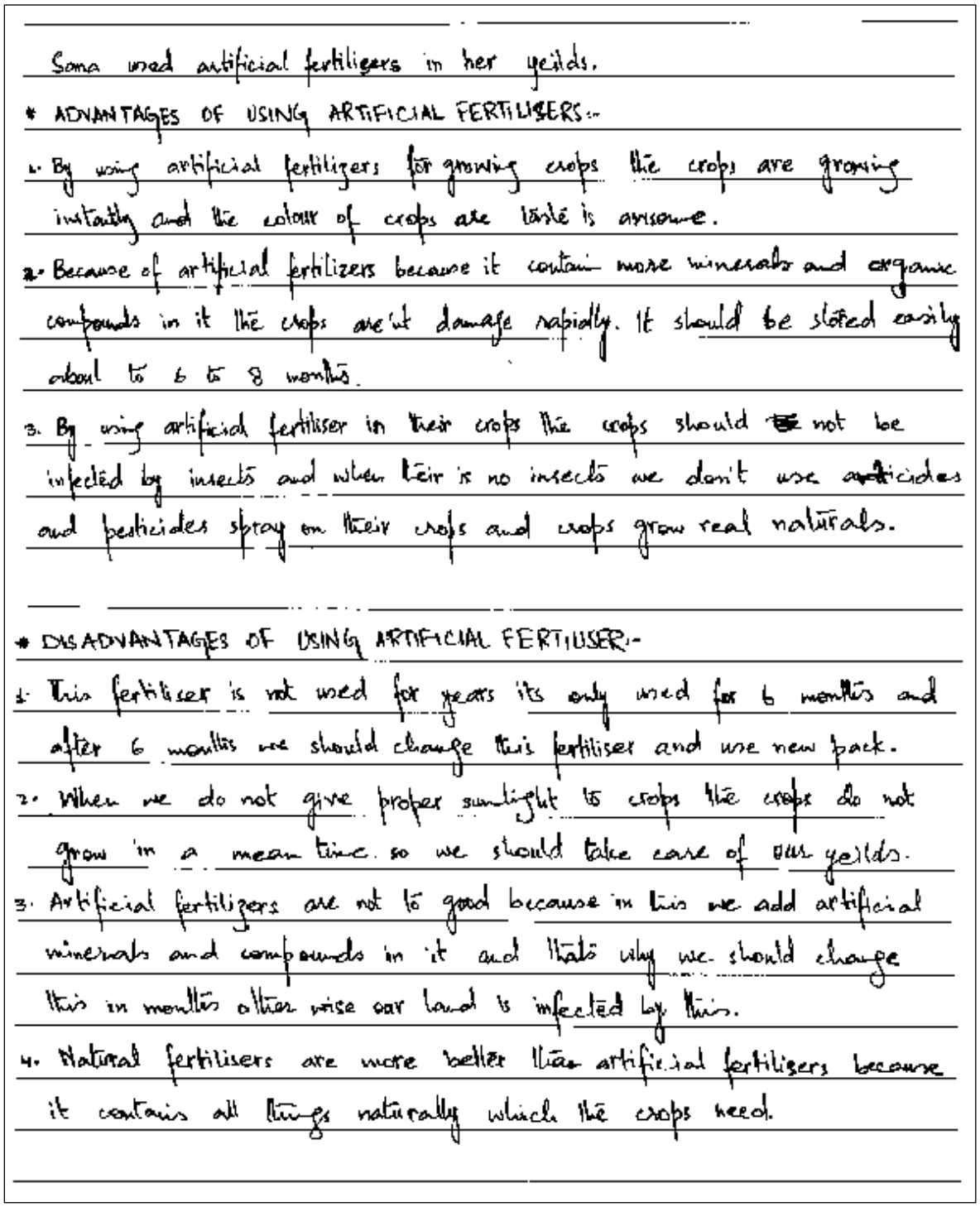
* The fertilizers will not be needed again and again by a plant as it lasts a longer period than synthetic fertilizers.

ii) Despite the advantages, there are also several disadvantages of using organic fertilizers:

* Organic fertilizers release nutrients much more slowly as compared to synthetic fertilizers. So in some cases, there might not be enough nutrients available for uptake by plants.
* Organic fertilizers may not be as rich in having inorganic nutrients as synthetic fertilizers. So the plants may suffer from deficiency of inorganic nutrients like magnesium or phosphorus.
* Organic fertilizers may carry some weeds or eggs of some pests. This means that plants become more prone to attack by pests if we use organic fertilizers.
* The organic and natural fertilizers, if used cause growth of plant at slower rates than if we use synthetic fertilizers.

Weaker responses were unable to identify the correct type of fertiliser and mostly described the advantages and problems of synthetic fertiliser. These responses gave generalised benefits of the use of fertilisers for growing crops but couldn't associate them with natural fertiliser. For example, it produces more crop yield/ it does not harm the environment/ it doesn't cause health problems/ it provides nutrients which are needed for the plant growth.

Example:



Sona used artificial fertilizers in her yeilds.

* ADVANTAGES OF USING ARTIFICIAL FERTILISERS:-

1. By using artificial fertilizers for growing crops the crops are growing instantly and the colour of crops ate taste is awsome.

2. Because of artificial fertilizers because it contain more minerals and organic compounds in it the crops are'nt damage rapidly. It should be stored easily about to 6 to 8 months.

3. By using artificial fertiliser in their crops the crops should ~~be~~ not be infected by insects and when their is no insects we don't use pesticides and pesticides spray on their crops and crops grow real naturals.

* DISADVANTAGES OF USING ARTIFICIAL FERTILISER:-

1. This fertiliser is not used for years its only used for 6 months and after 6 months we should change this fertiliser and use new pack.

2. When we do not give proper sunlight to crops the crops do not grow in a mean time. so we should take care of our yeilds.

3. Artificial fertilizers are not to good because in this we add artificial minerals and compounds in it and thats why we should change this in months other wise our land is infected by this.

4. Natural fertilisers are more better than artificial fertilizers because it contains all things naturally which the crops need.

Question 10b:

i. Name the man-made chemical substance that causes ozone depletion.

ii. Using balanced chemical equations, illustrate the destruction of the ozone layer.

iii. Write any THREE harmful effects of ozone.

Better responses exhibited crisp understanding of the concept of ozone. In these responses, starting from the man-made chemical causing ozone depletion, i.e. chlorofluorocarbon, candidates proceeded by writing the balanced chemical equations for the destruction of ozone layer by chlorine free radical and finished their answer by stating three harmful effects that the increase or decrease of ozone causes in the environment.

Example:

(b) (i) The man made chemical substance that causes ozone depletion is chlorofluorocarbons($CFCl_3$).

(ii) Chlorofluorocarbons which are used in refrigrants and in air conditioners are a source of ozone depletion. They escape by one way or another and move to the stratosphere. The Ultraviolet rays coming from the sun break the C-Cl bond and there is a release of chlorine radical.

$$CFCl_3 \longrightarrow CFCl_2 + Cl^{\cdot}$$

This chlorine free radical is very reactive and reacts with ozone in the stratosphere breaking it down by a series of chemical reactions. These are:

$$O_3 + Cl^{\cdot} \longrightarrow O_2 + OCl^{\cdot}$$

$$OCl^{\cdot} \longrightarrow O^{\cdot} + Cl^{\cdot}$$

$$O^{\cdot} + O^{\cdot} \longrightarrow O_2$$

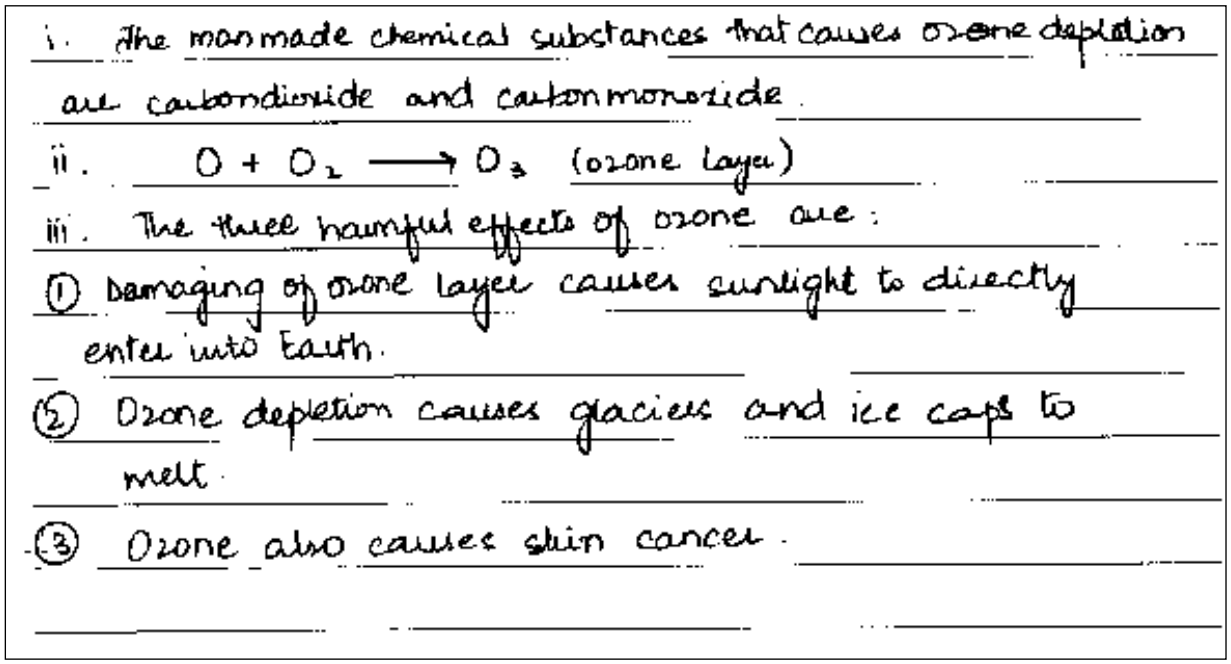
The area from which ozone is depleted is known as ozone hole.

(iii)

* Ozone is an allotropic form of oxygen if it is increased in the atmosphere it may lead to reduction in diatomic oxygen causing breathing problems.
* If ozone is decreased in the stratosphere it causes ozone depletion which leads to the UV radiations coming to the earth which may causes diseases like skin cancer, ozone depletion also leads to the spread in infectious diseases like malaria, it may also cause malfunctions in animals and plants which may disrupt the food chain.
* Ozone is a greenhouse gas if it is present in excess amount in the atmosphere it leads to greater amount of heat being retained in the earths atmosphere increasing global warming.

Weaker responses mentioned the harmful effects of the increase and decrease of ozone in the atmosphere but failed to give the correct balanced chemical equations for the destruction of ozone by chlorine free radical. Some of these responses also showed incorrect identification of the man-made chemical. Candidates stated chlorine and carbon monoxide instead of chlorofluorocarbon.

Example:


i. The man made chemical substances that causes ozone depletion are carbondioxide and carbon monoxide.

ii. $O + O_2 \longrightarrow O_3$ (ozone layer)

iii. The three haunful effects of ozone are:

① Damaging of ozone layer causes sunlight to directly enter into Earth.

② Ozone depletion causes glaciers and ice caps to melt.

③ Ozone also causes skin cancer.