CAMI Education (Pty) Ltd
Reg. No. 1996/017609/07
CAMI House
Fir Drive, Northcliff
P.O. Box 1260
CRESTA, 2118
Tel: +27 (11) 476-2020
Fax : 086 601 4400
web: www.camiweb.com
e-mail: info@camiweb.com

CAMI EDUCATION

PHYSICAL SCIENCES
PAPER 2
CHEMISTRY - GRADE 12
2011

MARKS: 150

TIME: 3 HOURS

INSTRUCTIONS AND INFORMATION

1. Write your name on the answer sheet and on your answer book.
2. Answer all the questions.
3. Answer section A on the attached answer sheet.
4. Answer section B in the answer book.
5. Non-programmable calculators may be used.
6. Applicable mathematical instruments may be used.
7. Number your answers correctly according to the numbering of the questions used in the paper.
8. Information pamphlets are included.
9. Give short motivations, discussions etc. where needed.

SECTION A

Answer this section on the attached ANSWER SHEET.

QUESTION 1: ONE – WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 - 1.5) on the answer sheet.

1.1 The chemical process by which heavy hydrocarbons are broken down into lighter hydrocarbons. (1)

1.2 The minimum amount of energy needed for a chemical reaction to take place. (1)

1.3 A group of atoms within an organic molecule that is responsible for certain properties of the molecule and reactions in which it takes part. (1)

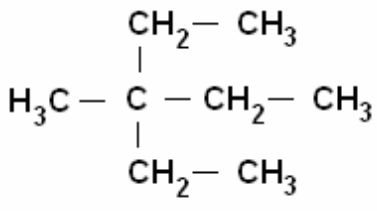
1.4 The chemical reaction that occurs when a vegetable oil or animal fat is mixed with a strong alkali like NaOH. (1)

1.5 A laboratory device that allows the flow of charged ions between two half-cells, but prevents diffusional mixing of the two different metal salt solutions. (1)
[5]

QUESTION 2: MULTIPLE – CHOICE QUESTIONS

Four possible options are provided as answers to the following questions. Each question has only ONE correct answer. Choose the correct answer and mark the appropriate block (A – D) next to the question number (2.1 – 2.10) on the answer sheet with a cross (X).

2.1 What is the correct IUPAC name for the following compound?



A. 3,4-dimethylhexane

B. 3-methyl-4-ethylpentane

C. 3-ethyl-3-methylpentane

D. 2,3-diethylbutane (2)

2.2 In which one of the following alternatives are the three compounds listed in order of increasing boiling point?

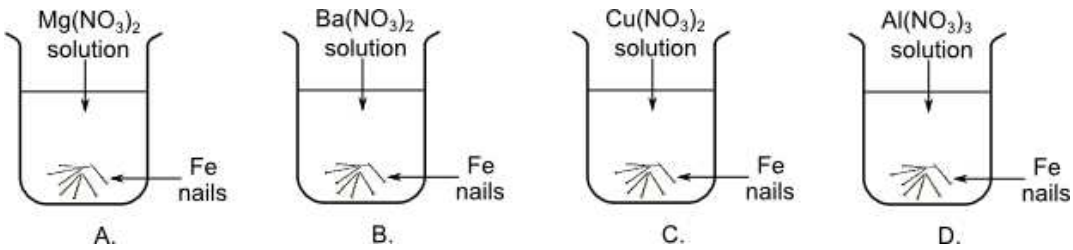
A. Propanoic acid, butan-1-ol, pentane

B. Pentane, butan-1-ol, propanoic acid

C. Propanoic acid, pentane, butan-1-ol

D. Butan-1-ol, propanoic acid, pentane (2)

2.3 A few small iron nails are placed in each of the solutions shown in the diagram below. In which beaker will there be a spontaneous reaction?



(2)

2.4 Identify the strongest oxidising agent and the strongest reducing agent in the following half-reactions.

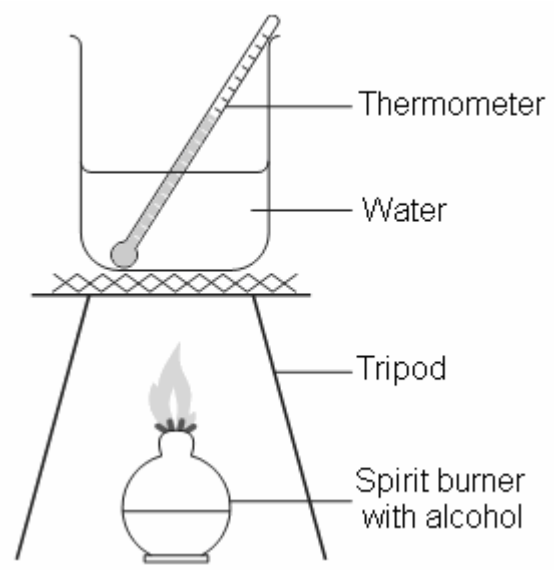
$$Ca^{2+}(aq) + 2\,e^- \rightarrow Ca(s)$$

$$I_2(s) + 2\,e^- \rightarrow 2I^-(aq)$$

	Strongest oxidising agent	Strongest reducing agent
A.	Ca^{2+}	I^-
B.	I_2	Ca
C.	Ca	I_2
D.	I^-	Ca^{2+}

(2)

2.5 The apparatus below is used in an investigation to determine and compare the energy released when three different liquid alcohols burn in air.



Which one of the following is the **dependent** variable?

A. Type of alcohol used

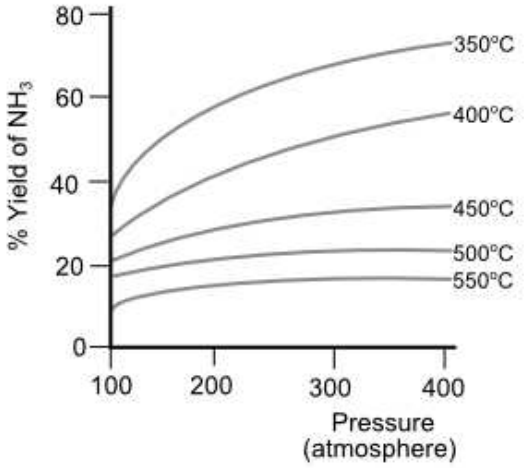
B. Amount of alcohol used

C. Amount of water used

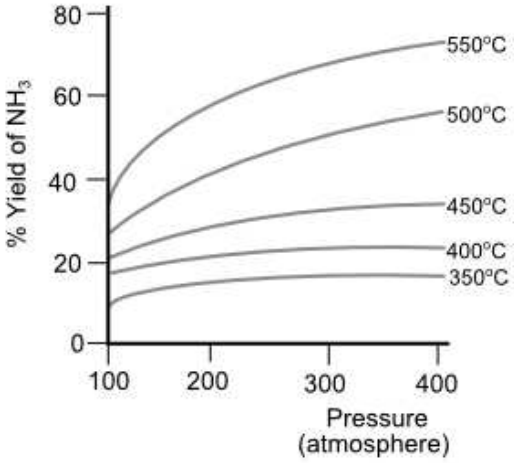
D. Change in temperature of the water (2)

2.6 Which one of the following graphs shows correctly how pressure and temperature affect the yield of ammonia produced by the Haber process?

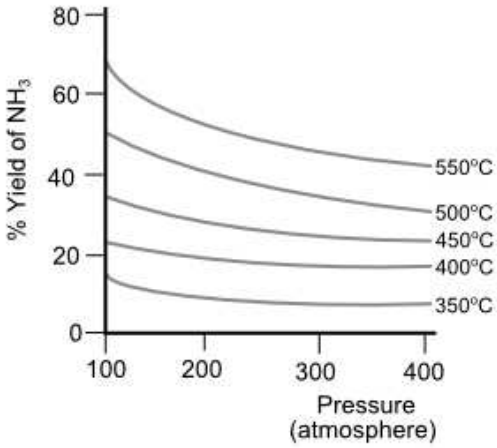
A.



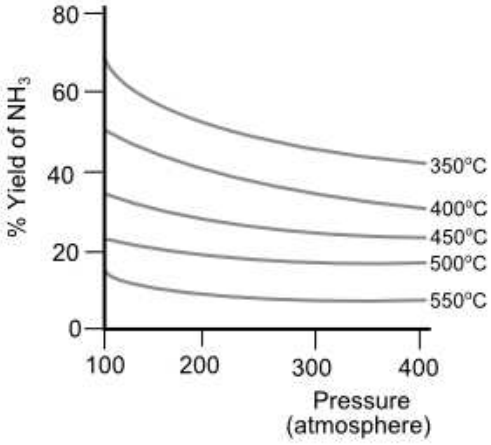
B.



C.



D.



2.7 Consider the following hypothetical reaction that reached equilibrium in a closed container at 450 ℃:

$$XY(s) \rightleftharpoons X(g) + Y(s) \qquad \Delta H > 0$$

Which ONE of the following changes will NOT affect the equilibrium position?

A. Increase in temperature

B. Increase in the amount of Y(s)

C. Decrease in pressure at constant volume

D. Increase in the volume of the container (2)

2.8 Which one of the following is a common use for ethyl pentanoate?

A. Flavouring

B. Fuel

C. Indicator

D. Solvent (2)

2.9 The commonest ore of aluminium is bauxite. Bauxite is treated to produce pure aluminium oxide, which is then electrolysed. Which **one** of the following statements about the electrolysis process is **correct**

A. The electrolyte is molten aluminium oxide.

B. The electrolyte is a molten mixture of aluminium oxide and cryolite.

C. The electrolyte is kept molten using blasts of hot air.

D. Aluminium is a light metal and so floats to the top of the electrolyte, where it can be tapped off. (2)

2.10 A battery consists of which type of cells?

A. electrolytic

B. voltaic

C. electroplating

D. electromagnetic (2)
[20]

TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS

1. Answer this section in the ANSWER BOOK.
2. In all calculations, formulae and substitutions must be shown.
3. Round off your answers to TWO decimal places.

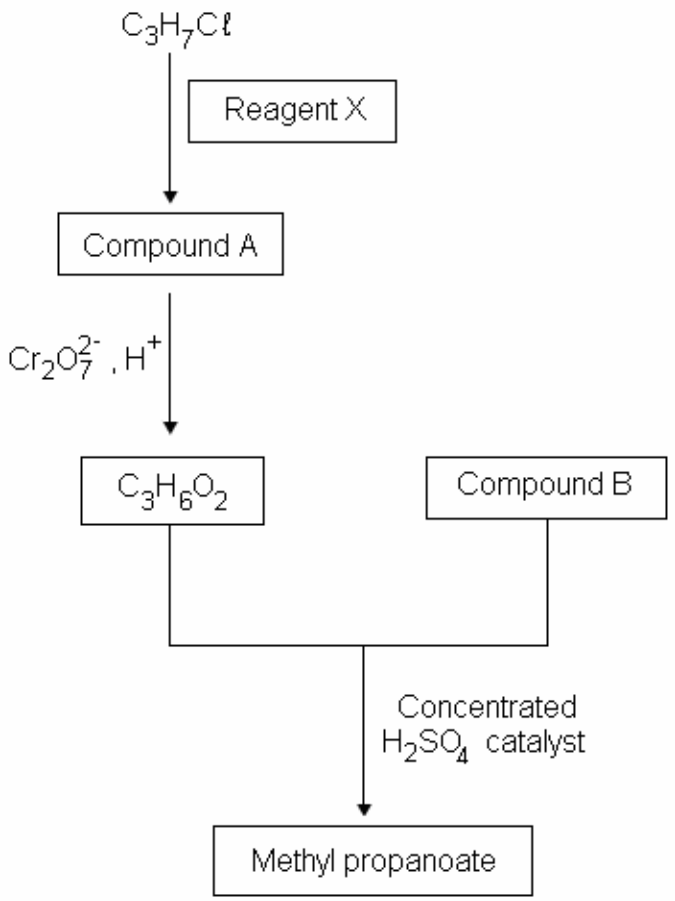
QUESTION 3

2-methylhexane, 2,3-dimethylpentane and 2,2,3-trimethylbutane are three **structural isomers**.

3.1	What is meant by "structural isomers"?	(2)
3.2	Write the structural formula for 2,2,3-trimethylbutane.	(2)
3.3	Predict which of 2-methylhexane, 2,3-dimethylpentane and 2,2,3-trimethylbutane has the lowest boiling point.	(1)
3.4	Explain in terms of intermolecular forces the difference between the boiling points of these three compounds.	(3)
3.5	Define viscosity.	(2)
3.6	Which one of the three compounds would you expect to have the highest viscosity? Explain your answer.	(3)
		[13]

QUESTION 4

The ester, methyl propanoate, has a characteristically fruity odour. It has been isolated from many fruits including pineapple. A sample of this ester is to be prepared in the laboratory.
A partly completed reaction pathway for this preparation is shown below.



4.1 Write a structural formula for methyl propanoate. (2)

4.2 Write the structural formula and name of compound A. (3)

4.3 Write the structural formula and name of compound B. (3)

4.4 Write the formula for reagent X. (2)

4.5 Name the two groups of compounds required to prepare an ester. (2)

4.6 In the final step of the reaction, H_2SO_4 is used as a catalyst. What is the function of the catalyst in the reaction? (1)

4.7 The final reaction is exothermic. Sketch a potential energy diagram for this reaction. (3)

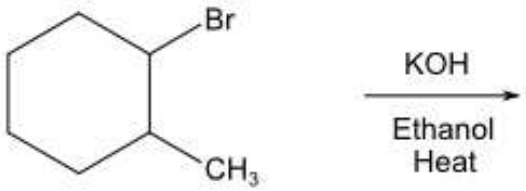
[16]

QUESTION 5

Write balanced chemical equations for the following reactions:

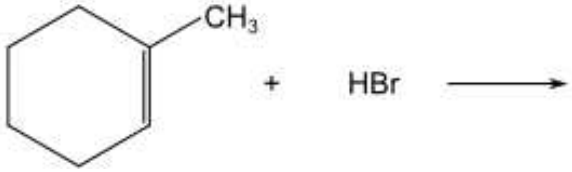
5.1 $C_4H_{10} + O_2 \xrightarrow{\triangle}$ (3)

5.2



(4)

5.3



(2)
[9]

QUESTION 6

In an experiment, learners investigated the effect of concentration on the rate of a chemical reaction.

They placed a conical flask on top of a black cross marked on white paper. The learners measured the time for the cross to become obscured by the precipitate produced in the reaction. One learner started a stopwatch as soon as 50 cm^3 of a 0.20$mol.dm^{-3}$ sodium thiosulfate solution was poured into the conical flask containing 10 cm^3 of a 1.0$mol.dm^{-3}$ HCℓ solution. The inverse of this reaction time (1/t) was taken as a measure of the initial rate of the chemical reaction.

They diluted the 0.20$mol.dm^{-3}$ solution of sodium thiosulfate to produce different concentrations of sodium thiosulfate solutions. 50 cm^3 of each of the following concentrations were prepared and placed in identical conical flasks: 0.16$mol.dm^{-3}$, 0.12$mol.dm^{-3}$, 0.08$mol.dm^{-3}$, 0.04$mol.dm^{-3}$, and 0.02$mol.dm^{-3}$. The times taken for these solutions to react with 10 cm^3 of the 1.0$mol.dm^{-3}$ HCℓ solution were also measured as described above. All six reactions were carried out at 20 ºC and the results are given in the following table.

Concentration $Na_2S_2O_3$ ($mol.dm^{-3}$)	0,20	0,16	0,12	0,08	0,04	0,02
Reaction time (min)	1,14	1,43	1,89	2,94	5,88	11,11
$^1/_t$ (min^{-1})	0,88	0,70	0,53	0,34	0,17	0,09

6.1 Identify the precipitate produced in the conical flasks. (1)

6.2 Why are the concentration and the volume of the HCℓ solution kept constant? (2)

6.3 Plot a graph of reaction rate (1/t) versus concentration of sodium thiosulfate. (3)

6.4 What conclusion can be drawn from the graph about the relationship between the rate of the reaction and the concentration of the sodium thiosulfate? (2)

6.5 Use your graph to predict the time taken for 50 cm^3 of a 0.10$mol.dm^{-3}$ solution of sodium thiosulfate to react with 10 cm^3 of the 1.0$mol.dm^{-3}$ HCℓ solution at 20 ºC. (3)

The procedure described above was repeated using four portions of the 0.20$mol.dm^{-3}$ sodium thiosulfate solution (volume 50 cm^3 each) and 10 cm^3 portions of the 1.0 $mol.dm^{-3}$ HCℓ solution at four different temperatures between 10 ºC and 70 ºC. The reaction times were measured as before.

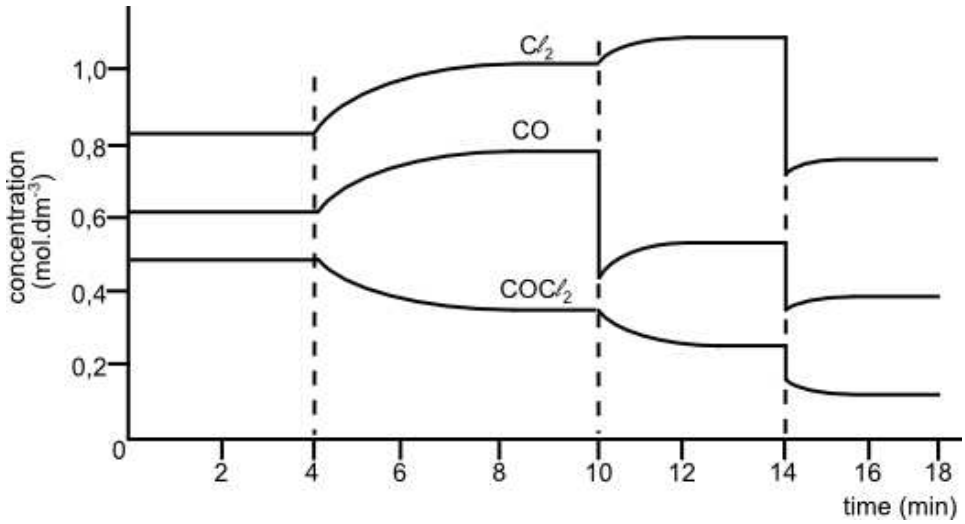
6.6 Would you expect the reaction times to increase, decrease, or stay the same, as the temperature was increased? Explain your answer using Maxwell - Boltzmann distribution curves in your explanation. (6)

[17]

QUESTION 7

The following graph shows the variation in concentration of reactant and products as a function of time for the following equilibrium system:

$$COC\ell_2\,(g) \rightleftharpoons C\ell_2(g) + CO(g) \qquad \Delta H = 108 kJ.mol^{-1}$$



7.1 This is a <u>reversible</u> reaction and a dynamic <u>equilibrium</u> is reached. Explain the underlined terms. (4)

7.2 Why is the equilibrium described as "dynamic"? (2)

7.3 State Le Chatelier's principle. (2)

7.4 Give a possible reason for the change in equilibrium conditions that occurs at t = 4s. (1)

7.5 Explain the changes in concentrations at t = 4s using Le Chatelier's principle. (3)

7.6 At t = 10s the concentration of the CO(g) decreased. Use Le Chatelier's principle to explain the changes in concentration of the $C\ell_2(g)$ and $COC\ell_2(g)$. (3)

7.7 Give a possible reason for the sudden drop in concentration of the reactant and the products at t = 14s. (1)

[16]

QUESTION 8

At a particular temperature, iodine trichloride dissociates into iodine gas and chlorine gas according to the following equation:

$$2IC\ell_3\,(g) \rightleftharpoons 3C\ell_2\,(g) + I_2\,(g)$$

Initially 81,73g of $IC\ell_3(g)$ was introduced into a 2,0dm^3 container and allowed to come to equilibrium. At equilibrium there was 0.45mol $C\ell_2(g)$ present in the container.

8.1 Write the equilibrium constant (Kc) expression for the above reaction. (2)

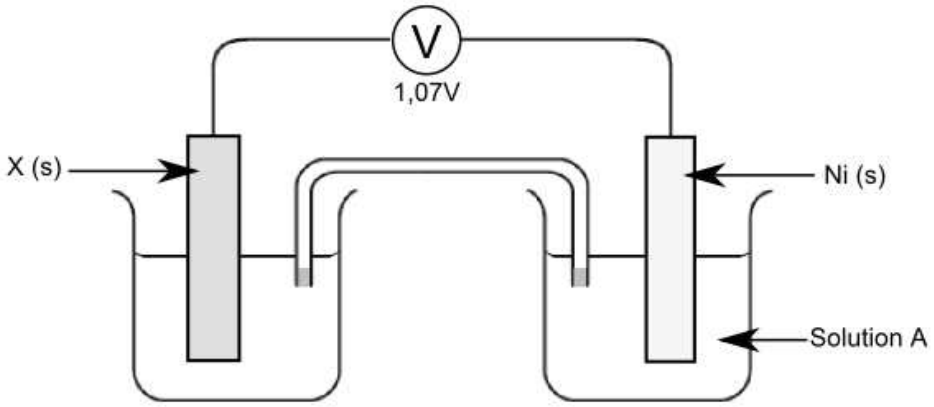
8.2 Calculate the value of the equilibrium constant (Kc) for the reaction at the particular temperature. (8)

8.3 When the temperature of the equilibrium mixture is increased, the value of the equilibrium constant also increases. Is the reaction endothermic or exothermic? Justify your answer. (3)

[13]

QUESTION 9

The diagram shows a galvanic cell, which functions under standard conditions. X represents an unknown metal. The voltmeter reading is 1,07V. The mass of the nickel electrode decreased after a while.



9.1 Give the formula for a possible solution that can be used in the nickel half-cell (solution A). (1)

9.2 Classify the nickel electrode as the cathode or the anode in the cell given above. Explain your reasoning. (4)

9.3 Write down the reaction that takes place at the nickel electrode. (2)

9.4 Give the formula for the solution used in the salt bridge. (1)

9.5 Determine the unknown metal. Show all calculations. (4)

9.6 Write the net ionic reaction that takes place in this cell. (2)

[14]

QUESTION 10

The lithium button cell, used to power watches and calculators, is a **primary cell** containing lithium metal. The lithium ion cell is a **secondary cell** that is used to power laptop computers.

10.1 What is the difference between a **primary** and **secondary** cell? (2)

10.2 By referring to information provided in the table of STANDARD REDUCTION POTENTIALS, give one reason why lithium is used as a reactant in these galvanic cells. (1)

Some early lithium metal batteries exploded when exposed to water.

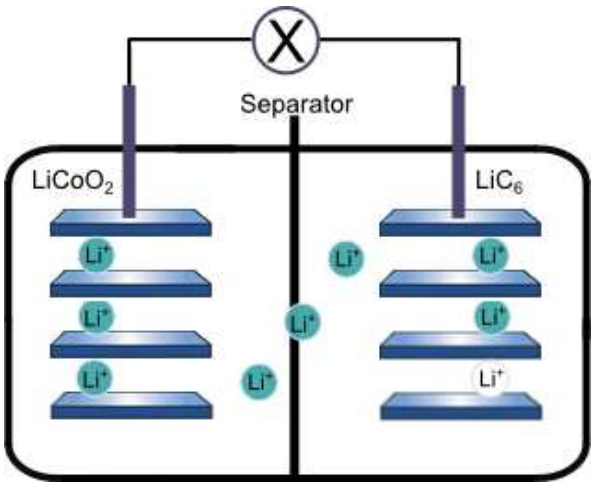
10.3 Write a balanced equation, including states, for the reaction between lithium metal and water to explain why an explosion might occur. (3)

In lithium ion cells, lithium ions move between the electrodes as the cell provides current and when it is recharged. The negative electrode consists of lithiated graphite (LiC_6) and the positive electrode consists of lithium cobalt oxide, ($LiCoO_2$).
The chemical reactions that take place in the lithium ion cell are complex. The following equations present a simplified description of the reactions that occur at the electrodes as the cell is **recharged.**

positive electrode: $LiCoO_2\,(g) \rightarrow LiO_2\,(g) + Li^+\,(g) + e^-$

negative electrode: $6C + Li^+\,(g) + e^- \rightarrow LiC_6$

10.4



Use the diagram above to predict the direction in which electrons (clockwise or anti-clockwise), and Li^+ ions (to the left or to the right) move as the lithium ion cell is **discharged** (2)

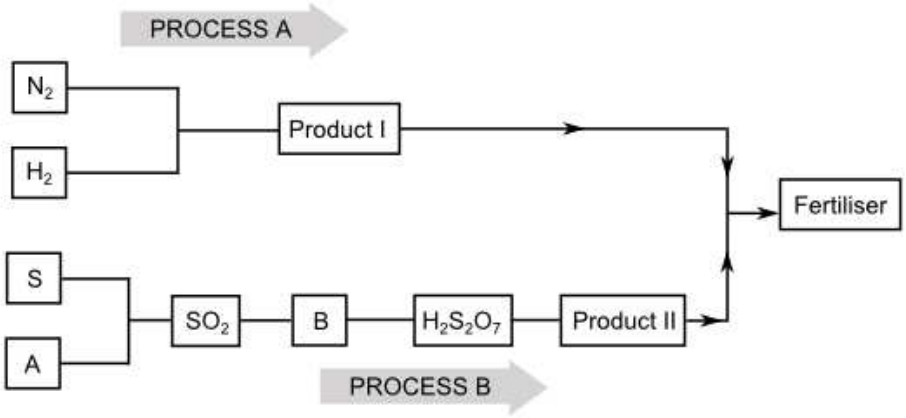
[8]

QUESTION 11

Plants need sun, water and nutrients to grow. The nutrients can be taken from air or soil. If there is a sufficient supply of nutrients in the soil, crops are likely to grow well and produce high yields. If even one of the nutrients needed is in short supply, plant growth is limited and crop yields are reduced.

Fertilisers are needed to obtain high yields because they supply crops with the nutrients the soil lacks. By adding fertilisers, crop yields can often be doubled or even tripled.

The following flow diagram shows two industrial processes needed for the manufacturing of fertilisers.



11.1 Give the name of process A. (1)

11.2 Write the balanced equation for the reaction taking place in process A. (3)

11.3 Give the name of product I. (1)

11.4 Give the name of process B. (1)

11.5 Write down the chemical formulae for reagents A and B. (2)

11.6 Write down the chemical formula for the substance added to reagent B to produce $H_2S_2O_7$ (1)

11.7 Give the name for $H_2S_2O_7$ (1)

11.8 Give the name of the fertiliser formed in the reaction between product I and product II. (1)

11.9 The label on a fertiliser bag has the following numbers on it: **7:2:3** Explain the meaning of these numbers. (3)

Soil and water pollution is a serious concern for soil scientists. Normal societal activities like farming and even lawn care, continually add fertilisers to the soil. If fertilisers are added in excessive quantities, fertiliser runoff from farms and lawns can create a huge problem in rivers and dams. The extra nutrients in the water cause eutrophication. Eutrophication has created enormous “dead zones” in several parts of the world.

11.10 What is meant by the term “eutrophication”? (2)

11.11 What is the effect of eutrophication on the natural water ecosystem in a dam? (3)
[19]

TOTAL SECTION B: 125

GRAND TOTAL: 150