



2016

**HIGHER SCHOOL CERTIFICATE  
TRIAL EXAMINATION**

**CHEMISTRY**

**General Instructions**

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
  
- Draw diagrams using pencil
- Board-approved calculators may be used
- A data sheet and periodic table are provided
- *Write your name and teacher at the top of the Part A Answer Sheet, the Part B Written Answer Booklet and the Section II Answer Booklet*

**Total marks - 100**

**Section I**

**75 marks**

This section has two parts, Part A and Part B

**Part A – 20 marks**

- Attempt Questions 1- 20
- Allow about 35 minutes for this part

**Part B – 61 marks**

- Attempt Questions 21 - 37
- Allow about 1 hour and 45 minutes for this part

**Section II**

**19 marks**

- Attempt Questions 38 - 42
- Allow about 40 minutes for this section

## Section I

81 marks

Part A – 20 marks

Attempt Questions 1 – 20

Allow about 35 minutes for this part

Use the multiple choice answer sheet

Select the alternative A, B, C or D that best answers the question. Fill in the response circle completely.

**Sample**  $5 + 4 =$  (A) 2 (B) 6 (C) 8 (D) 9

A  B  C  D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A  B  C  D

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

A  B  C  D   
*correct*

- Which of the following would be the most appropriate chemical to neutralise a large amount of concentrated acid spilt on a warehouse floor?
  - Add a large volume of water and clean with a mop.
  - Add powder sodium hydrogen carbonate until no more bubbling occurs.
  - Pour on sodium hydroxide until there is no more reaction.
  - Wipe the acid with paper towelling or a dry sponge.

- What are the products for the reactions between the Group 1 or 2 oxides of periods 1-2 with water and an acid?

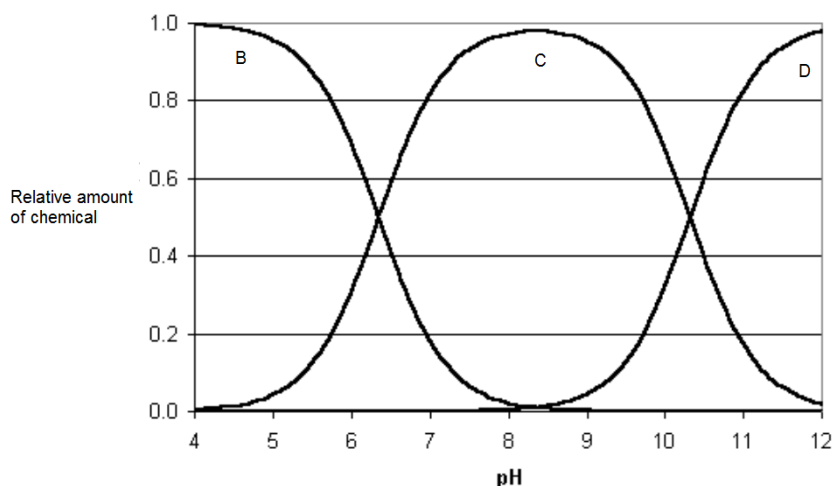
	Reaction with acid	Reaction with water
(A)	Salt and water	Base
(B)	Salt and water	No reaction
(C)	No reaction	Salt and water
(D)	Base	acid

- Which option represents the pH sequence from lowest to highest for 0.20 M solutions of citric, acetic and nitric acids?

	Lowest pH → highest pH		
(A)	acetic	citric	nitric
(B)	citric	nitric	acetic
(C)	nitric	acetic	citric
(D)	nitric	citric	acetic

- Which organic compound would have the highest boiling point?
  - hexan-1-ol
  - hexane
  - hex-1-ene
  - pentanoic acid

5. The figure below represents the effect of pH on the ionisation of an acid represented by B. C and D are formed during the ionisation process.



Which option represents the events that are occurring as the pH is altered?

- (A)  $\text{HX}(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{X}^-(\text{aq})$                       (B)  $\text{H}_2\text{X}(\text{aq}) \rightleftharpoons 2\text{H}^+(\text{aq}) + \text{X}^{2-}(\text{aq})$
- (C)  $\text{H}_2\text{X}(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{HX}^-(\text{aq})$                        $\text{H}_3\text{X}(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{H}_2\text{X}^{1-}(\text{aq})$   
 $\text{HX}^-(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{X}^{2-}(\text{aq})$                       (D)  $\text{H}_2\text{X}^{1-}(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{HX}^{2-}(\text{aq})$   
 $\text{HX}^{2-}(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{X}^{3-}(\text{aq})$

6. If energy is released in an acid-base neutralisation reaction at the rate of  $57 \text{ kJ mol}^{-1}$  of base at  $25^\circ\text{C}$ , how much energy is released by the complete neutralisation of  $25 \text{ mL}$  of  $1.0 \text{ mol L}^{-1}$   $\text{HCl}(\text{aq})$  and  $25 \text{ mL}$  of  $1.0 \text{ mol L}^{-1}$   $\text{NaOH}(\text{aq})$ ?

- (A) 1.43 J  
 (B) 1425 J  
 (C) 713 J  
 (D) 7.13 kJ

7. The condensed structural formula of an ester that gives a strawberry-smell is given below.



What two compounds would be used to form the strawberry-smelling ester?

- (A) propan-1-ol and hexanoic acid  
 (B) butan-1-ol and pentanoic acid  
 (C) pentan-1-ol and butanoic acid  
 (D) hexan-1-ol and propanoic acid

8. Which of the following is formed from the industrial use of ammonia?
- (A) addition polymers  
 (B) explosives  
 (C) sulfuric acid  
 (D) CFCs
9. CFC molecules can be identified by a numbered code. To assign the numbered code for each molecule, the following rules are followed.

1. Count the numbers of each C, H and F atom present in the molecule.
2. Write this number as a three digit number. For example, in the molecule  $\text{CCl}_2\text{F}_2$ , there is 1 carbon atom, 0 hydrogen atoms and 2 fluorine atoms, so the number becomes 102.
3. Subtract 90 from this number to determine the code for the molecule.

Using this information, what would be the name of one isomer for a CFC that has a code of 114?

- (A) 1,1-dichloro-1,2,2,2-tetrafluoroethane  
 (B) 2,2-dichloro-1,1,1,2-tetrafluoroethane  
 (C) 1,1,2,2-tetrachloro-1,2,-difluoroethane  
 (D) 1-chloro-1,1,2,2-tetrafluoroethane

10. Solutions of aqueous salts where used as a cation source in determining the identity of an anion in an unknown aqueous salt solution. The results of mixing these chemicals are shown in the table.

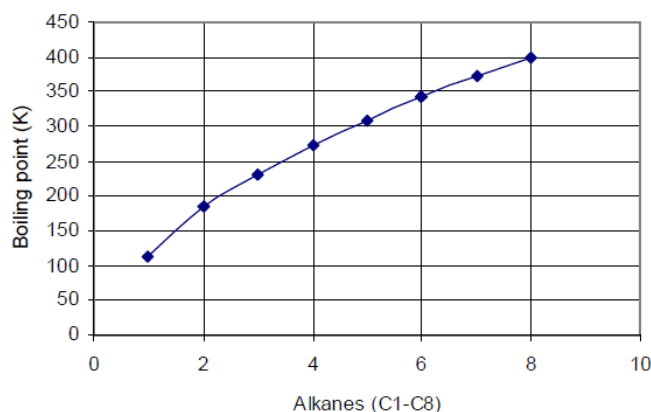
Cation of aqueous salt solution	Result of mixing with unknown salt solution (pH > 7)
$\text{Ag}^+$	precipitate
$\text{Fe}^{3+}$	precipitate
$\text{Na}^+$	No precipitate

What is the identity of the anion in the unknown salt solution?

- (A) chloride  
 (B) nitrate  
 (C) phosphate  
 (D) sulfate

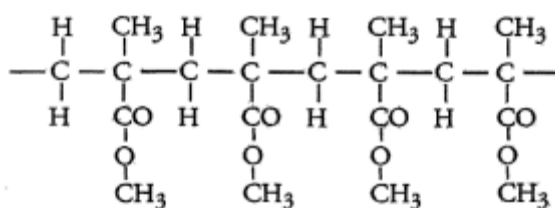
11. Which of the following test results could be used to determine that the  $\text{CO}_3^{2-}$  ion is present in a sample?
- (A) addition of  $\text{HCl}$  (aq) causes a yellow precipitate to form  
 (B) addition of  $\text{H}_2\text{SO}_4$  (aq) causes a white precipitate to form  
 (C) addition of  $\text{HNO}_3$  (aq) causes gas bubbles to form  
 (D) addition of  $\text{H}_3\text{PO}_4$  (aq) causes a blue precipitate to form
12. Which statement outlines a reason why combustion reactions need to be monitored?
- (A) When there is inadequate oxygen present, combustion reactions can also produce sulfur dioxide.  
 (B) When there is excess oxygen present, combustion reactions can also produce oxides of nitrogen.  
 (C) When there is excess oxygen present, combustion reactions can also produce sulfur dioxide.  
 (D) When there is inadequate oxygen present, combustion reactions can also produce carbon monoxide
13. If equal volumes of the following aqueous solutions were mixed, which one would have the highest pH?
- (A)  $1 \text{ mol L}^{-1} \text{NaOH} + 1 \text{ mol L}^{-1} \text{HCl}$   
 (B)  $1 \text{ mol L}^{-1} \text{NH}_3 + 1 \text{ mol L}^{-1} \text{H}_2\text{SO}_4$   
 (C)  $1 \text{ mol L}^{-1} \text{H}_2\text{SO}_4 + 1 \text{ mol L}^{-1} \text{Ba}(\text{OH})_2$   
 (D)  $1 \text{ mol L}^{-1} \text{KOH} + 1 \text{ mol L}^{-1} \text{CH}_3\text{COOH}$

14. The graph shows the boiling points for a homologous series of organic compounds. Which gaseous compound would liquefy first if the temperature is lowered commencing at  $25^\circ\text{C}$ ?



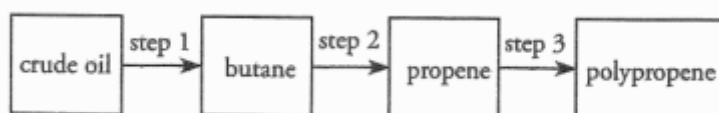
- (A) butane  
 (B) methane  
 (C) pentane  
 (D) propane

15. A group of students performed two tests on an organic compound. In the first test they found that 3 moles of the compound burns completely in oxygen to produce 6 moles of carbon dioxide. In the second test they found that the compound did not decolourise bromine water in the absence of UV light. The molecular formula of this compound could be:
- (A)  $C_2H_4$   
 (B)  $C_2H_6$   
 (C)  $C_3H_8$   
 (D)  $C_6H_{14}$
16. Perspex is a hard transparent plastic polymer made by the polymerisation of methyl methacrylates. A section of the polymer is shown below.



The monomer from which this polymer is made has the molecular formula

- (A)  $C_4H_6O_2$   
 (B)  $C_5H_8O_2$   
 (C)  $C_2H_4O$   
 (D)  $C_4H_8O_2$
17. The flow chart given below summarises the industrial preparation of propylene.



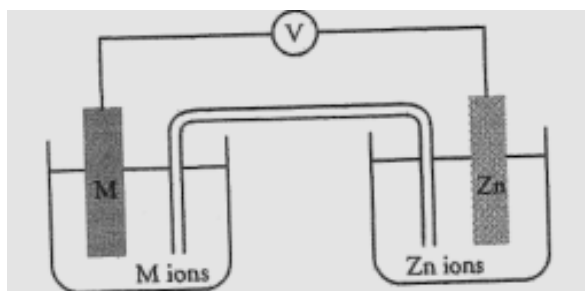
Which one of the following correctly identifies steps 1-3?

	Step 1	Step 2	Step 3
(A)	Fractional distillation	Addition polymerisation	Steam cracking
(B)	Catalytic cracking	Distillation	Addition polymerisation
(C)	Catalytic cracking	Fractional distillation	Addition polymerisation
(D)	Fractional distillation	Steam cracking	Addition polymerisation

18. Which of the following is a transuranic element?

- (A) Caesium
- (B) Cerium
- (C) Chromium
- (D) Curium

19. The diagram given below shows a galvanic cell.



Which one of the following metals (M) acting as an anode gives the highest theoretical potential of the cell?

- (A) Calcium
  - (B) Copper
  - (C) Iron
  - (D) Manganese
20. Cellulose is a biopolymer that exists abundantly as plant material waste. Hydrolysis means reacting with water. Which one of the following steps correctly converts cellulose to ethylene?

	Step 1	Step 2	Step 3
(A)	Hydrolysis of cellulose to glucose	Fermentation of glucose to propanol	Dehydration of propanol to ethene
(B)	Dehydration of cellulose to glucose	Fermentation of glucose to ethanol	Dehydration of ethanol to ethylene
(C)	Hydrolysis of cellulose to glucose	Fermentation of glucose to ethanol	Dehydration of ethanol to ethylene
(D)	Hydrolysis of cellulose to galactose	Fermentation of glucose to ethanol	Hydrolysis of ethanol to ethylene



**Girraween High School  
Higher School Certificate Chemistry  
2016 Trial Examination**

Student Name	
Class	
Mark /	

**Section I (continued)**

**Write your Name and Class at the top of this Part A Answer Sheet.**

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Select the alternative A, B, C or D that best answers the question and fill in the response circle completely using ink.

1.     A ○         B ○         C ○         D ○
2.     A ○         B ○         C ○         D ○
3.     A ○         B ○         C ○         D ○
4.     A ○         B ○         C ○         D ○
5.     A ○         B ○         C ○         D ○
6.     A ○         B ○         C ○         D ○
7.     A ○         B ○         C ○         D ○
8.     A ○         B ○         C ○         D ○
9.     A ○         B ○         C ○         D ○
10.    A ○         B ○         C ○         D ○
11.    A ○         B ○         C ○         D ○
12.    A ○         B ○         C ○         D ○
13.    A ○         B ○         C ○         D ○
14.    A ○         B ○         C ○         D ○
15.    A ○         B ○         C ○         D ○
16.    A ○         B ○         C ○         D ○
17.    A ○         B ○         C ○         D ○
18.    A ○         B ○         C ○         D ○
19.    A ○         B ○         C ○         D ○
20.    A ○         B ○         C ○         D ○

Student Name	
Class	

**Write your Name and Class at the top of this Part B Answer Booklet.**

**Section I (continued)**

**Part B – 61 marks**

**Attempt Questions 21 - 37**

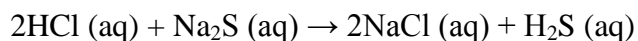
**Allow about 1 hour and 45 minutes for this part**

**Answer the questions in the spaces provided**

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**Question 21 (2 marks)**

Justify why the reaction of sodium sulfide with hydrochloric acid is classified as an acid/base reaction according to Brønsted/Lowry theory, but not according to Arrhenius' theory of acids and bases.



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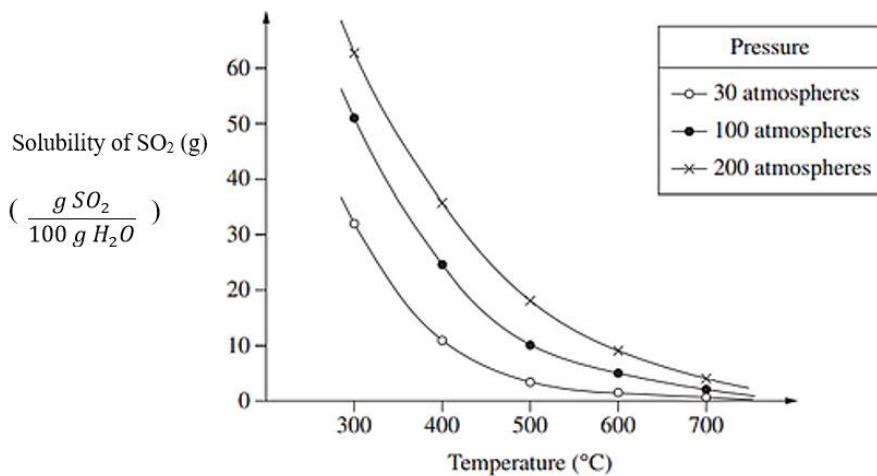
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**Question 22** (4 marks)

The graph below shows the solubility of sulfur dioxide in water under various conditions.



Identify the trends in the solubility of sulfur dioxide and explain them in terms of Le Chatelier's principle.

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**Question 23** (2 marks)

Nitric acid reacts with copper to form nitrogen dioxide, water and copper (II) nitrate. What volume of gas is formed when 0.500 g copper is added to 50.0 mL 1.00 M nitric acid at 25°C and 100 kPa?

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**Question 24** (2 marks)

25.0 mL of 0.500 M HCl (aq) is placed in a flask. Calculate the total volume this aliquot of the HCl (aq) must be diluted to in order to form HCl (aq) that has a pH of 4.5.

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**Question 25** (6 marks)

An aqueous solution of ammonia is often used as a window cleaning agent. Quality control checks on the concentration of the ammonia are conducted that involve titrating the cleaning agent with sulfuric acid. Ammonia is a much stronger base than sulfate ion.

- (a) Identify a chemical suitable for standardising the sulfuric acid. (1 mark)

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- (b) 10.0 mL of cleaning agent is diluted to 50.0 mL and the diluted form is used in a quality control titration. The results of this titration are provided in the table below.

	Titres			
	Trial 1	Trial 2	Trial 3	Trial 4
Volume of H <sub>2</sub> SO <sub>4</sub> (aq) required to reach end point (mL)	38.50	37.30	37.40	37.50
Volume of diluted cleaning agent used (mL)	25.00	25.00	25.00	25.00
Concentration of standardised H <sub>2</sub> SO <sub>4</sub> (aq)	0.170 M			

Calculate the concentration of ammonia in the original cleaning agent. (2 marks)

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**Question 25** *Continued*

(c) Justify the use of an identified indicator for this analysis. (2 marks)

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(d) What should the flask containing the diluted cleaning agent be rinsed with? (1 mark)

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**Question 26** (1 mark)

The National Australian Standard for sulfur in petrol is 50.0 ppm maximum. The mass of one litre of petrol in Australia having 50 ppm sulfur is 772 grams.

Calculate the mass of sulfur in one litre of Australian petrol.

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**Question 27** (5 marks)

(a) Draw a fully labelled diagram of the apparatus and reagents needed for the esterification reaction between 1-hexanol and methanoic acid. (3 marks)

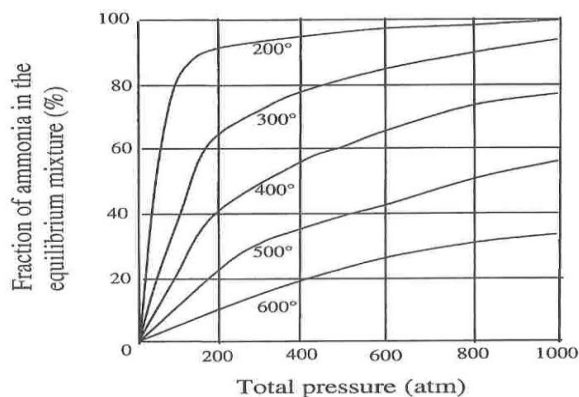
(b) Identify and draw the structural formula of the products formed in the above reaction. (2 marks).

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**Question 28** (5 marks)

The graphs below show the fraction of ammonia present at equilibrium when nitrogen and hydrogen react under varying conditions of temperature and pressure.



- (a) Use the information from the graphs above to identify the conditions of temperature and pressure which would give the highest yield of ammonia. (1 mark)

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- (b) Explain why the Haber process is carried out industrially under compromise conditions. (2 marks)

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- (c) Explain the effect of the catalyst used in the Haber process on the rate and yield of this industrial process. (2 marks)

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**Question 29** (6 marks)

Chlorofluorocarbons have important effects on the ozone layer.

(a) Explain why small amounts of CFC's have large effects on the ozone layer. (2 marks)

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(b) What will be the consequences of ozone depletion? (2 marks)

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**Question 29** *Continued*

(c) Draw a Lewis electron-dot structure to represent an ozone molecule. (1 mark)

(e) Use the structure you have drawn above to explain what is meant by a coordinate covalent bond. (1 mark)

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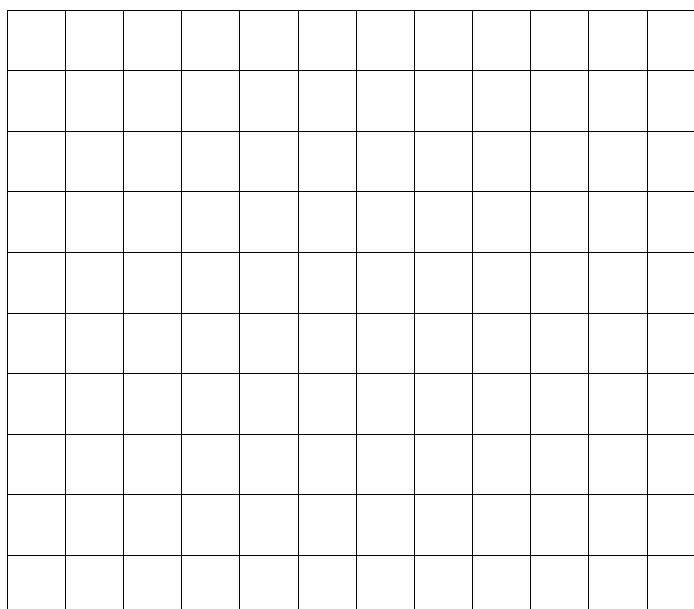
**Question 30** (3 marks)

A group of scientists used AAS to investigate the trace elements in three commercially available vitamin tablets. In one investigation, they used AAS to determine the concentration of zinc ions ( $\text{Zn}^{2+}$ ) in solutions they made by dissolving each of the three tablets in the same volume of deionised water. They used samples of known concentration of zinc ions to calibrate their instrument and then tested the three different brands of vitamin tablets.

The absorbance of the standards are given below:

<i>Standards [<math>\text{Zn}^{2+}</math>] (ppm)</i>	1	2	4	6	10	12
<i>Absorbance</i>	0.09	0.16	0.33	0.48	0.83	0.98

- (a) Construct a graph of the absorbance versus concentration (ppm) for the standards on the grid below. (2 marks)



- (b) The absorbance of solutions made from the three different brands of vitamin tablets are given below.

<b><i>Brand</i></b>	<b>A</b>	<b>B</b>	<b>C</b>
<b><i>Absorbance</i></b>	0.26	0.86	0.48

Use your graph to determine the concentration of zinc ions in the vitamin tablet with the highest concentration of zinc ions. (1 mark)

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**Question 31** (3 marks)

Scientists use AAS to monitor and manage the environment. Assess the use of AAS in pollution control.

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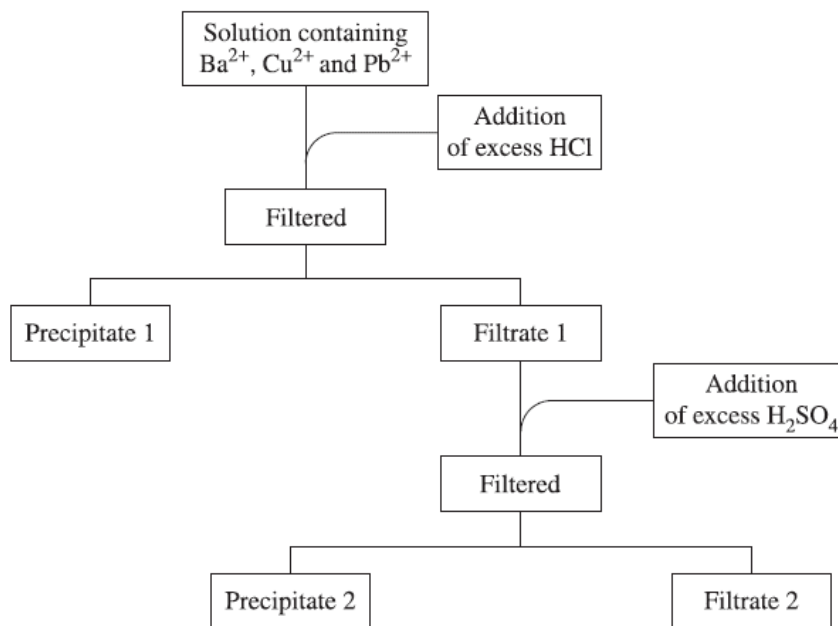
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**Question 32** (5 marks)

A solution contains three cations,  $\text{Ba}^{2+}$ ,  $\text{Cu}^{2+}$  and  $\text{Pb}^{2+}$ . The flow chart indicates the plan used to confirm the identity of these cations.



(a) Name Precipitate 2. (1 mark)

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(b) Write a balanced net ionic equation for the formation of Precipitate 1. (2 marks)

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(c) Suggest a test and the expected result that would confirm the identity of the metal cation remaining in Filtrate 2. (2 marks)

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**Question 33** (2 marks)

The procedure of a first-hand investigation conducted in a school laboratory to determine the percentage of sulfate in a lawn fertiliser is given below.

1. 2.00 g of a sample of fertiliser was ground up and placed in a beaker.
2. The fertiliser was dissolved in about 200 mL of 0.1 mol L<sup>-1</sup> hydrochloric acid, stirred and filtered.
3. Excess barium chloride solution was quickly added to this beaker and a precipitate formed.
4. The precipitate was then allowed to settle, filtered using filter paper and the residue collected.
5. The residue was dried and weighed and had a mass of 2.23 g.

Calculate the percentage of sulfate in the original fertiliser sample. Show all working.

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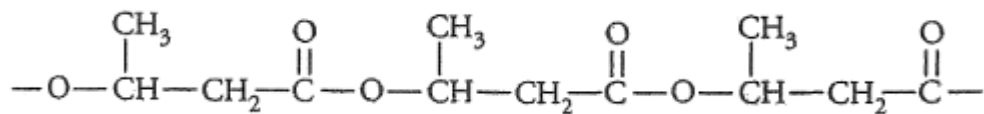
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**Question 34** (5 marks)

A number of bacteria can produce the biopolymer PHB (polyhydroxybutanoate). Part of the structure of PHB is shown below.



- (a) PHB can be used to make surgical stitches to close cuts and wounds. Give two properties that PHB should possess if it is to be used this way. (2 marks)

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- (b) Describe the type of reaction that forms PHB by including a chemical equation. (2 marks)

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- (c) Identify one advantage and one disadvantage of the use of PHB. (1 mark)

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**Question 35** (4 marks)

Campers use methylated spirits (ethanol) in stoves to boil water and cook food.

- (a) 1364 kJ of energy is released when one mole of ethanol is burnt completely. Calculate the amount of energy produced when 1 g of ethanol burns. (2 marks)

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- (b) Calculate the mass of ethanol that needs to burn to heat 950 mL of water in a kettle at 10°C to 100°C. In your calculations consider the loss of 60% of energy to the equipment and to the atmosphere. (2 marks)

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**Question 36** (1 mark)

The rarest naturally occurring element is astatine (At) with very small amounts of  $^{219}\text{At}$  being found in uranium ores.

Why are atoms of At-219 expected to be unstable?

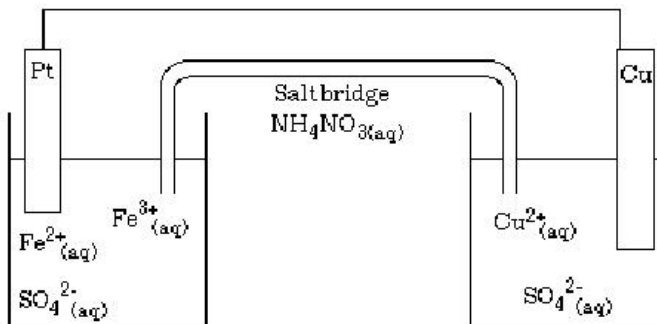
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**Question 37** (5 marks)

A group of students set up the galvanic cell shown in the diagram.



- (a) Identify the anode and cathode in this cell. (1 mark)

Anode: ..... Cathode: .....

- (b) Using half-equations, explain how this cell works in terms of oxidation and reduction reactions. (2 marks)

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- (c) Calculate the standard emf (voltage) of the cell at 25°C and 100 kPa. Show your working. (2 marks)

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**End of Section I**

Student Name	
Class	
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**Girraween High School      Higher School Certificate Chemistry 2016 Trial Examination**

**Write your Name and Class at the top of this Section II Answer Booklet**

**SECTION II**

**Allow about 40 minutes for this part**

**Show all relevant working in questions involving calculations**

**Questions 38 - 42 - Industrial Chemistry (19 marks)**

**Question 38 (4 marks)**

During your practical work you performed a first-hand investigation to observe the reaction of sulfuric acid acting as a dehydrating agent.

(a) Justify TWO precautions that must be taken when carrying out this investigation. (2 marks)

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(b) Outline the observations of the above investigation. (2 marks)

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**Question 40** (3 marks)

An important role of chemistry is to provide for our material needs, in an environmentally and socially viable way.

- (a) Identify a shrinking natural resource that is not a fossil fuel. (1 mark)

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- (b) Outline issues associated with the reduction in the availability of this resource, and identify a current or potential solution. (2 marks)

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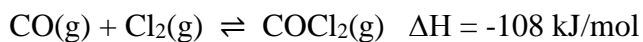
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**Question 41** (4 marks)

Phosgene,  $\text{COCl}_2$ , is considered a chemical weapon, and its manufacture is monitored. It is also an industrially important compound, being useful in the synthesis of many carbon compounds.

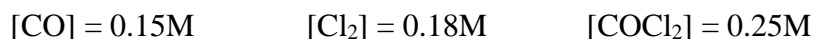
The equilibrium constant for the formation of phosgene is  $1.2 \times 10^3$  at  $670^\circ\text{C}$ .



(a) Identify the reaction condition which can change the value of  $K$  for this reaction. (1 mark)

.....

(b) The concentrations of each species in a mixture at  $670^\circ\text{C}$  were as follows:



Deduce whether the system was shifting to the left or the right to reach equilibrium at the time these measurements were taken. (3 marks)

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**Question 42** (2 marks)

Outline two environmental impacts of Frasch's process for extracting sulfur from mineral deposits.

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**End of Section II**



2016

**HIGHER SCHOOL CERTIFICATE  
TRIAL EXAMINATION**

**CHEMISTRY**

**General Instructions**

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
  
- Draw diagrams using pencil
- Board-approved calculators may be used
- A data sheet and periodic table are provided
- *Write your name and teacher at the top of the Part A Answer Sheet, the Part B Written Answer Booklet and the Section II Answer Booklet*

**Total marks - 100**

**Section I**

**75 marks**

This section has two parts, Part A and Part B

**Part A – 20 marks**

- Attempt Questions 1- 20
- Allow about 35 minutes for this part

**Part B – 61 marks**

- Attempt Questions 21 - 37
- Allow about 1 hour and 45 minutes for this part

**Section II**

**19 marks**

- Attempt Questions 38 - 46
- Allow about 40 minutes for this section

## Section I

81 marks

Part A – 20 marks

Attempt Questions 1 – 20

Allow about 35 minutes for this part

Use the multiple choice answer sheet

Select the alternative A, B, C or D that best answers the question. Fill in the response circle completely.

**Sample**  $5 + 4 =$  (A) 2 (B) 6 (C) 8 (D) 9

A  B  C  D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A  B  C  D

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

A  B  C  D   
*correct*



1. Which of the following would be the most appropriate chemical to neutralise a large amount of concentrated acid spilt on a warehouse floor?
- (A) Add a large volume of water and clean with a mop.
- (B) Add powder sodium hydrogen carbonate until no more bubbling occurs.**
- (C) Pour on sodium hydroxide until there is no more reaction.
- (D) Wipe the acid with paper towelling or a dry sponge.
2. What are the products for the reactions between the Group 1 or 2 oxides of periods 1-2 with water and an acid?

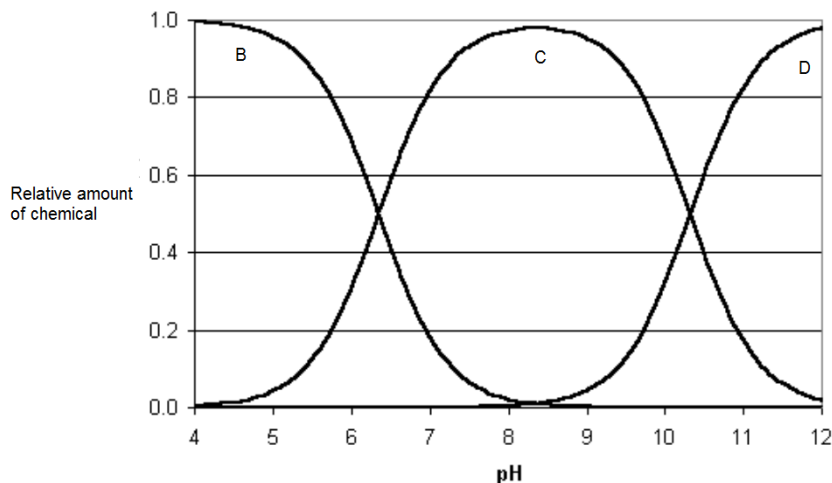
	Reaction with acid	Reaction with water
(A)	<b>Salt and water</b>	<b>Base</b>
(B)	Salt and water	No reaction
(C)	No reaction	Salt and water
(D)	Base	acid

3. Which option represents the pH sequence from lowest to highest for 0.20 M solutions of citric, acetic and nitric acids?

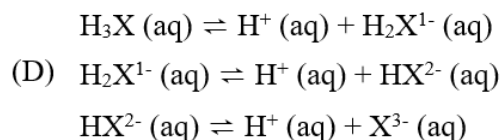
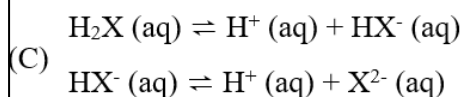
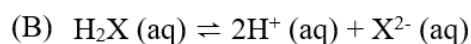
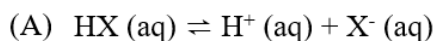
	Lowest pH → highest pH		
(A)	acetic	citric	nitric
(B)	citric	nitric	acetic
(C)	nitric	acetic	citric
<b>(D)</b>	<b>nitric</b>	<b>citric</b>	<b>acetic</b>

4. Which organic compound would have the highest boiling point?
- (A) hexan-1-ol
- (B) hexane
- (C) hex-1-ene
- (D) pentanoic acid**

5. The figure below represents the effect of pH on the ionisation of an acid represented by B.



Which option represents the events that are occurring as the pH is altered?



6. If energy is released in an acid-base neutralisation reaction at the rate of  $57 \text{ kJ mol}^{-1}$  of base at  $25^\circ\text{C}$ , how much energy is released by the complete neutralisation of  $25 \text{ mL}$  of  $1.0 \text{ molL}^{-1}$   $\text{HCl}(\text{aq})$  and  $25 \text{ mL}$  of  $1.0 \text{ molL}^{-1}$   $\text{NaOH}(\text{aq})$ ?

- (A) 1.43 J  
 (B) **1425 J**  
 (C) 713 J  
 (D) 7.13 kJ

7. The condensed structural formula of an ester that gives a strawberry-smell is given below.



What two compounds would be used to form the strawberry-smelling ester?

- (A) propan-1-ol and hexanoic acid  
 (B) butan-1-ol and pentanoic acid  
 (C) **pentan-1-ol and butanoic acid**  
 (D) hexan-1-ol and propanoic acid

8. Which of the following is formed from the industrial use of ammonia?
- (A) addition polymers  
**(B) explosives**  
 (C) sulfuric acid  
 (D) CFCs
9. CFC molecules can be identified by a numbered code. To assign the numbered code for each molecule, the following rules are followed.

1. Count the numbers of each C, H and F atom present in the molecule.
2. Write this number as a three digit number. For example, in the molecule  $\text{CCl}_2\text{F}_2$ , there is 1 carbon atom, 0 hydrogen atoms and 2 fluorine atoms, so the number becomes 102.
3. Subtract 90 from this number to determine the code for the molecule.

Using this information, what would be the name of one isomer for a CFC that has a code of 114?

- (A) **1,1-dichloro-1,2,2,2-tetrafluoroethane**  
 (B) 2,2-dichloro-1,1,1,2-tetrafluoroethane  
 (C) 1,1,2,2-tetrachloro-1,2,-difluoroethane  
 (D) 1-chloro-1,1,2,2-tetrafluoroethane

10. Solutions of aqueous salts where used as a cation source in determining the identity of an anion in an unknown aqueous salt solution. The results of mixing these chemicals are shown in the table.

Cation of aqueous salt solution	Result of mixing with unknown salt solution (pH > 7)
$\text{Ag}^+$	precipitate
$\text{Fe}^{3+}$	precipitate
$\text{Na}^+$	No precipitate

What is the identity of the anion in the unknown salt solution?

- (A) chloride  
 (B) nitrate  
**(C) phosphate**  
 (D) sulfate

11. Which of the following test results could be used to determine that the  $\text{CO}_3^{2-}$  ion is present in a sample?

- (A) addition of  $\text{HCl}$  (aq) causes a yellow precipitate to form
- (B) addition of  $\text{H}_2\text{SO}_4$  (aq) causes a white precipitate to form
- (C) **addition of  $\text{HNO}_3$  (aq) causes gas bubbles to form**
- (D) addition of  $\text{H}_3\text{PO}_4$  (aq) causes a blue precipitate to form

12. Which statement outlines a reason why combustion reactions need to be monitored?

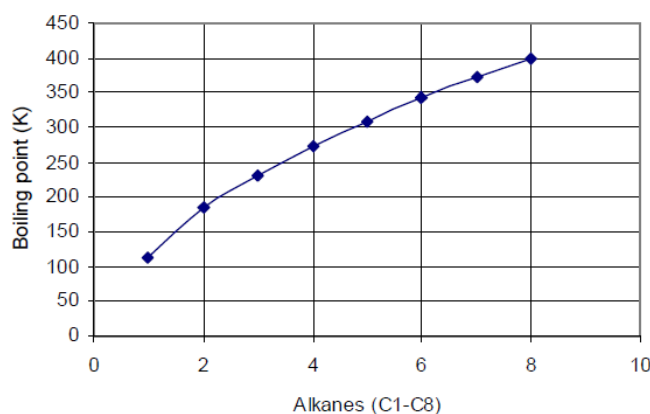
- (A) When there is inadequate oxygen present, combustion reactions can also produce sulfur dioxide.
- (B) When there is excess oxygen present, combustion reactions can also produce oxides of nitrogen.
- (C) When there is excess oxygen present, combustion reactions can also produce sulfur dioxide.
- (D) **When there is inadequate oxygen present, combustion reactions can also produce carbon monoxide**

13. If equal volumes of the following aqueous solutions were mixed, which one would have the highest pH?

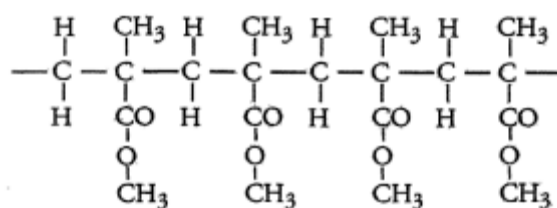
- (A)  $1 \text{ mol L}^{-1} \text{NaOH} + 1 \text{ mol L}^{-1} \text{HCl}$
- (B)  $1 \text{ mol L}^{-1} \text{NH}_3 + 1 \text{ mol L}^{-1} \text{H}_2\text{SO}_4$
- (C)  $1 \text{ mol L}^{-1} \text{H}_2\text{SO}_4 + 1 \text{ mol L}^{-1} \text{Ba}(\text{OH})_2$
- (D)  **$1 \text{ mol L}^{-1} \text{KOH} + 1 \text{ mol L}^{-1} \text{CH}_3\text{COOH}$**

14. The graph shows the boiling points for a homologous series of organic compounds. Which gaseous compound would liquefy first if the temperature is lowered commencing at  $25^\circ\text{C}$ ?

- (A) **butane**
- (B) methane
- (C) pentane
- (D) propane



15. A group of year 12 chemistry students performed two tests on an organic compound. In the first test they found that 3 moles of organic compound burns completely in oxygen gas to produce 6 moles of carbon dioxide. In second test they found that the compound did not decolourise bromine water. The molecular formula of this compound could be:
- (A)  $C_2H_4$   
 (B)  $C_2H_6$   
 (C)  $C_3H_8$   
 (D)  $C_6H_{14}$
16. Perspex is a hard transparent plastic polymer made by the polymerisation of methyl methacrylates. A section of the polymer is shown below.



The monomer from which this polymer is made has the molecular formula:

- (A)  $C_4H_6O_2$   
 (B)  $C_5H_8O_2$   
 (C)  $C_2H_4O$   
 (D)  $C_4H_8O_3$
17. The flow chart given below summarises the industrial preparation of propylene.



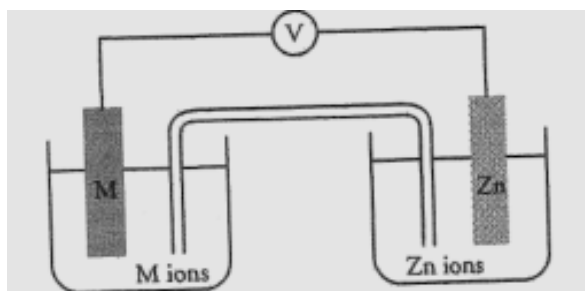
Which one of the following correctly identifies steps 1-3?

	Step 1	Step 2	Step 3
(A)	Fractional distillation	Addition polymerisation	Steam cracking
(B)	Catalytic cracking	Distillation	Addition polymerisation
(C)	Catalytic cracking	Fractional distillation	Addition polymerisation
(D)	<b>Fractional distillation</b>	<b>Steam cracking</b>	<b>Addition polymerisation</b>

18. Which of the following is a transuranic element?

- (A) Caesium
- (B) Cerium
- (C) Chromium
- (D) Curium**

19. The diagram given below shows a galvanic cell.



Which one of the following metals (M) acting as an anode gives the highest theoretical potential of the cell?

- (A) Calcium**
- (B) Copper
- (C) Iron
- (D) Manganese

20. Cellulose is a biopolymer that exists abundantly as plant material waste. Which one of the following steps correctly converts cellulose to ethylene?

	Step 1	Step 2	Step 3
(A)	Hydrolysis of cellulose to glucose	Fermentation of glucose to propanol	Dehydration of propanol to ethene
(B)	Dehydration of cellulose to glucose	Fermentation of glucose to ethanol	Dehydration of ethanol to ethylene
<b>(C)</b>	<b>Hydrolysis of cellulose to glucose</b>	<b>Fermentation of glucose to ethanol</b>	<b>Dehydration of ethanol to ethylene</b>
(D)	Hydrolysis of cellulose to galactose	Fermentation of glucose to ethanol	Hydrolysis of ethanol to ethylene

**Girraween High School  
Higher School Certificate Chemistry  
2016 Trial Examination**

Student Name	
Class	
Mark /	

**Section I (continued)**

**Write your Name and Class at the top of this Part A Answer Sheet.**

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Select the alternative A, B, C or D that best answers the question and fill in the response circle completely using ink.

1.     A ○        B ■        C ○        D ○
2.     A ■        B ○        C ○        D ○
3.     A ○        B ○        C ○        D ■
4.     A ○        B ○        C ○        D ■
5.     A ○        B ○        C ■        D ○
6.     A ○        B ■        C ○        D ○
7.     A ○        B ○        C ■        D ○
8.     A ○        B ■        C ○        D ○
9.     A ■        B ○        C ○        D ○
10.    A ○        B ○        C ■        D ○
11.    A ○        B ○        C ■        D ○
12.    A ○        B ○        C ○        D ■
13.    A ○        B ○        C ○        D ■
14.    A ■        B ○        C ○        D ○
15.    A ○        B ■        C ○        D ○
16.    A ○        B ■        C ○        D ○
17.    A ○        B ○        C ○        D ■
18.    A ○        B ○        C ○        D ■
19.    A ■        B ○        C ○        D ○
20.    A ○        B ○        C ■        D ○

Student Name	
Class	

**Write your Name and Class at the top of this Part B Answer Booklet.**

## **Section I (continued)**

**Part B – 61 marks**

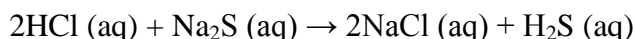
**Attempt Questions 21 - 37**

**Allow about 1 hour and 45 minutes for this part**

**Answer the questions in the spaces provided**

### **Question 21 (2 marks)**

Justify why the reaction of sodium sulfide with hydrochloric acid is classified as an acid/base reaction according to Brønsted/Lowry theory, but not according to Arrhenius' theory of acids and bases.



Arrhenius proposed that acids are substances that produce hydrogen ions in water and bases were substances that dissociated in water to produce hydroxide ions. This would not be an Arrhenius acid/base reaction because no hydroxide ions are produced. Brønsted/Lowry defined acids as proton donors and bases as proton acceptors. In this case, HCl donates a proton and  $\text{S}^{2-}$  (aq) accepts a proton so is an acid/base reaction.

Outcome criteria	Marks
Gives one reason for why the reaction represents Brønsted/Lowry theory and gives one reason why the reaction does not support Arrhenius' theory of acids and bases	2
One of the above	1

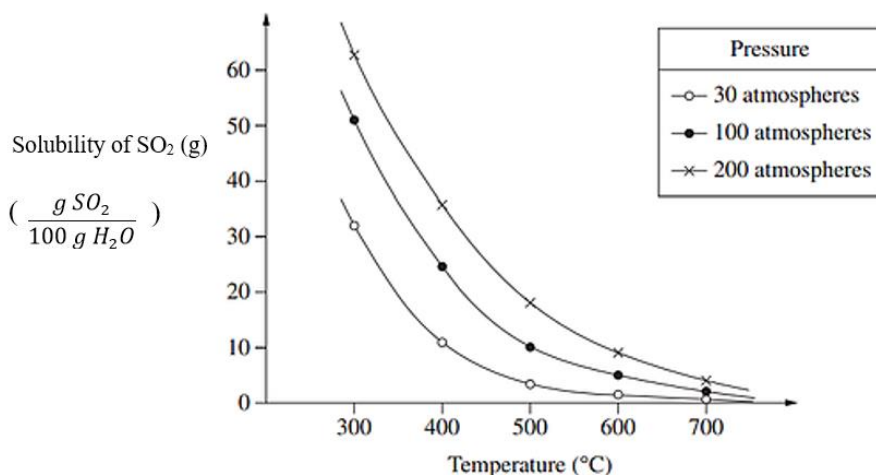
Note: B = Brønsted/Lowry; A = Arrhenius

Must identify the acid and the base when presenting the case for Brønsted/Lowry.



**Question 22** (4 marks)

The graph below shows the solubility of sulfur dioxide in water under various conditions.



Identify the trends in the solubility of sulfur dioxide and explain them in terms of Le Chatelier's principle.

The solubility of sulfur dioxide is dependent upon temperature and pressure.

The solubility of sulfur dioxide decreases with increasing temperature since the solvation process is exothermic. Le Chatelier's principle states that an increase in temperature would shift the equilibrium to favour the backward reaction and thus favour formation of SO<sub>2</sub> (g) instead of SO<sub>2</sub> (aq). Hence sulfur dioxide becomes less soluble with increasing temperatures.

The graph shows the solubility of sulfur dioxide in water increases with increasing pressure. The solvation reaction causes a reduction in gas volume from 1 unit to 0. Le Chatelier's principle states that an increase in gas pressure would shift the equilibrium to the side with the least gas volume which is the forward reaction and thus favour the formation of SO<sub>2</sub> (aq) instead of SO<sub>2</sub> (g).

Outcome criteria	Marks
Describes the two trends and explains each trend in terms of Le Chatelier's principle	4
Describes the two trends and explains one trend in terms of Le Chatelier's principle	3
Describes the two trends and describes one trend in terms of Le Chatelier's principle	2
Describes the two trends	1

Notes: the context is dissolving:  $\text{SO}_2(\text{g}) \rightleftharpoons \text{SO}_2(\text{aq})$   $\Delta H < 0$  and not the reaction of SO<sub>2</sub> with water to form sulfurous acid.

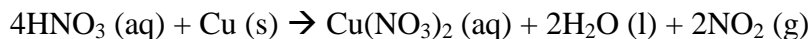
Many students did not state the side that has the least number of *gaseous molecules* is favoured when the pressure increases for a reaction at equilibrium.

Tt = temperature trend; Te = temperature explanation

Pt = pressure trend; Pe = pressure explanation

**Question 23** (2 marks)

Nitric acid reacts with copper to form nitrogen dioxide, water and copper (II) nitrate. What volume of gas is formed when 0.500 g copper is added to 50.0 mL 1.00 M nitric acid at 25°C and 100 kPa?

**Step 1: write a balance equation for this reaction****Step 2: calculate the amount of the limiting reagent**

$$0.500 \text{ g Cu} \times ? \text{ mole Cu}/63.55 \text{ g Cu} = 7.86782 \times 10^{-3} \text{ moles Cu}$$

$$50 \times 10^{-3} \text{ L HNO}_3 \times 1.0 \text{ moles HNO}_3 / 1 \text{ L HNO}_3 = 0.050 \text{ moles HNO}_3$$

Thus,  $7.86782 \times 10^{-3}$  mole Cu requires 0.03147 moles HNO<sub>3</sub> Hence Cu is limiting reagent.

**Step 3: calculate the volume of NO<sub>2</sub>**

$$7.86782 \times 10^{-3} \text{ mole Cu} \times 2 \text{ mole NO}_2 / 1 \text{ mole Cu} \times 24.79 \text{ LNO}_2 / 1 \text{ mole NO}_2 = 0.390 \text{ L NO}_2$$

Outcome criteria	Marks
Calculates the limiting reagent and calculates the volume of NO <sub>2</sub> (g)	2
One of the above or writes a balanced equation for this reaction	1

Notes: many students cannot balance the equation and got 0.195 L as an answer.

Must state the units.

**Question 24** (2 marks)

25.0 mL of 0.500 M HCl (aq) is placed in a flask. Calculate the total volume this aliquot of the HCl (aq) must be diluted to in order to form HCl (aq) that has a pH of 4.5.

$$25.0 \times 10^{-3} \text{ L HCl} \times 0.500 \text{ moles HCl} / 1 \text{ L HCl} = 0.0125 \text{ moles HCl} = 0.0125 \text{ moles H}^+$$

$$\text{pH } 4.5 = 3.16227 \times 10^{-5} \text{ M H}^+$$

$$3.16227 \times 10^{-5} \text{ moles H}^+ / 1 \text{ L} = 0.0125 \text{ moles H}^+ / ? \text{ L}$$

$$? = 395.28 \text{ L}$$

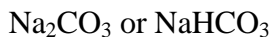
Calculate the volume that 25.0 mL of 0.500 M HCl (aq) must be made to in order form a solution that has a pH 4.5.

Note: the answer is 395.3 L (not mL)

**Question 25** (6 marks)

An aqueous solution of ammonia is often used as a window cleaning agent. Quality control checks on the concentration of the ammonia are conducted that involve titrating the cleaning agent with sulfuric acid. Ammonia is a much stronger base than sulfate ion.

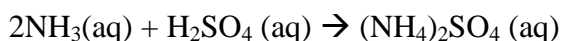
- (a) Identify a chemical suitable for standardising the sulfuric acid. (1 mark)



- (b) 10 mL of cleaning agent is diluted to 50 mL and the diluted form is used in a quality control titration. The results of this titration are provided in the table below.

	Titres			
	Trial 1	Trial 2	Trial 3	Trial 4
Volume of H <sub>2</sub> SO <sub>4</sub> (aq) required to reach end point (mL)	38.5	37.3	37.4	37.5
Volume of diluted cleaning agent used (mL)	25.0	25.0	25.0	25.0
Concentration of standardised H <sub>2</sub> SO <sub>4</sub> (aq)	0.170 M			

Calculate the concentration of ammonia in the original cleaning agent. (2 marks)



$$37.4 \times 10^{-3} \text{ L H}_2\text{SO}_4 \times 0.170 \text{ mole H}_2\text{SO}_4 / 1 \text{ L H}_2\text{SO}_4 \times 2 \text{ mole NH}_3 / 1 \text{ mole H}_2\text{SO}_4 = 0.012716 \text{ mole NH}_3$$

Thus there is 0.012716 moles NH<sub>3</sub> in 25 × 10<sup>-3</sup> L diluted solution:

$$0.012716 \text{ moles NH}_3 / 25 \times 10^{-3} \text{ L} = ? \text{ moles NH}_3 / 50 \times 10^{-3} \text{ L} \quad ? = 0.025432 \text{ moles NH}_3$$

Hence, there is 0.025432 moles NH<sub>3</sub> / 10 × 10<sup>-3</sup> L = 2.54 M NH<sub>3</sub> in undiluted cleaning agent

Outcome criteria	Marks
Calculates the number of moles of NH <sub>3</sub> in 25.0 mL (diluted) using stoichiometric relationship and correctly averages titres (discards Trial 1); converts results into undiluted cleaning agent	2
One of the above	1

Notes: many students did not provide a suitable base for standardising the acid (i.e. primary standard).

Average titre is 37.4 mL (discard the first titre as it is >0.2 mL difference compared to the others).

Many students did not write the correct balanced equation for this reaction and got a 1:1 ratio instead of 2: 1 ratio.

F = flow on error

(c) Justify the use of an identified indicator for this analysis. (2 marks)

Methyl orange (3.1 – 4.4), methyl red (4.4 – 6.2), bromophenol blue (3 – 4.6) would be suitable indicators since the pH at the equivalence point is acidic, a result of the acidic nature of the salt formed,  $(\text{NH}_4)_2\text{SO}_4$  (aq)

Bromothymol blue (6 – 7.6) not acceptable due to a large end point error.

Outcome criteria	Marks
Identifies a suitable indicator giving a reason related to the acidic nature of the salt formed at the reaction's equivalence point	2
One of the above	1

Note: must stipulate the pH range for the indicator in order to justify its use for the reaction.

Flow on error applies e.g., basic salt forms hence phenolphthalein is used...

(d) What should the flask containing the diluted cleaning agent be rinsed with? (1 mark)

Distilled water

**Question 26** (1 mark)

The National Australian Standard for sulfur in petrol is 50.0 ppm maximum. The mass of one litre of petrol in Australia having 50 ppm sulfur is 772 grams. Calculate the mass of sulfur in one litre of Australian petrol. (1 mark)

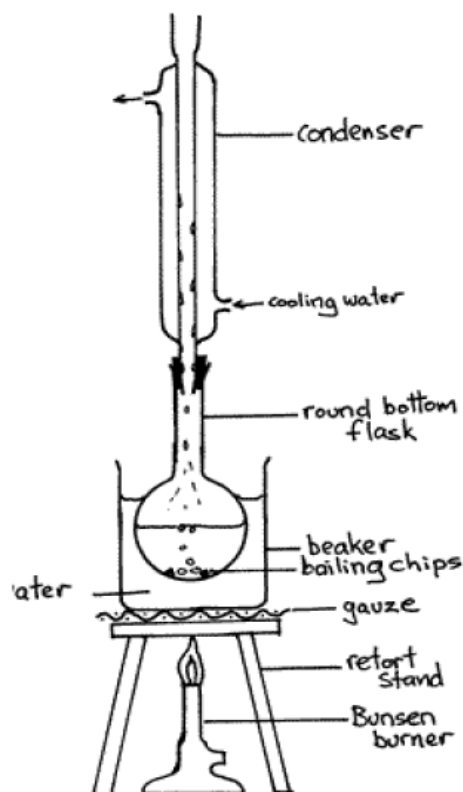
Criteria	Marks
Correctly calculates the mass of sulphur in petrol	1

$$50(\text{sulphur})/1000000(\text{petrol}) = x(\text{sulphur}) / 772$$
$$= 0.0386 \text{ g of S}$$

**Question 27** (5 marks)

- (a) Draw a fully labelled diagram of the apparatus and reagents needed for the esterification reaction between 1-hexanol and methanoic acid. (3 marks)

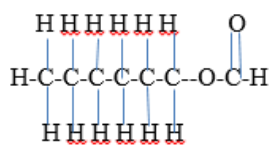
Criteria	Mark
Correctly drawn and labelled <ul style="list-style-type: none"> <li>condenser with water in and out</li> <li>Flask containing reactants and catalyst</li> <li>Heating mantle or Bunsen Burner and water bath</li> </ul>	3
<ul style="list-style-type: none"> <li>Any two of the above</li> </ul>	2
<ul style="list-style-type: none"> <li>Any one of the above</li> </ul>	1



- (b) Identify and draw the structural formula of the products formed in the above reaction. (2 marks).

Criteria	Mark
<ul style="list-style-type: none"> <li>Correctly identifies the products of the reaction</li> <li>Correctly draws the structural formula of the products</li> </ul>	2
<ul style="list-style-type: none"> <li>One of the above</li> </ul>	1

*Sample Answer*



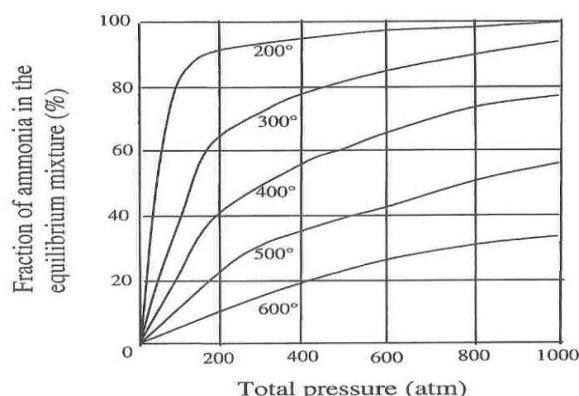
hexylmethanoate



water

**Question 28** (5 marks)

The graphs below show the fraction of ammonia present at equilibrium when nitrogen and hydrogen react under varying conditions of temperature and pressure.



- (a) Use the information from the graphs above to identify the conditions of temperature and pressure which would give the highest yield of ammonia. (1 mark)

The highest yield of ammonia is produced at the lowest temperature (200°C) and the highest pressure (1000 atm).

Criteria	Mark
• Correct answer	1

- (b) Explain why the Haber process is carried out industrially under compromise conditions. (2 marks)

The compromise conditions are a moderate temperature (700K, 400°C), so that the reaction rate is fast enough to be economically viable but the yield is not as great as it would be at lower temperatures. Pressure is kept high (250 atm) to give both a high rate and the high yield – but is not at 1000 atm (because of costs and safety). A catalyst is used to increase the rate and the product is removed as it is formed to give the maximum yield of product from a given amount of reactants.

Criteria	Marks
• Recognition of a compromise between rate of reaction and yield of product AND an indication of the temperature and pressure conditions used	2
• Recognition of a compromise between rate of reaction and yield of product OR • An indication of the temperature and pressure conditions used	1

- (c) Iron on the surface of magnetite is the catalyst used for this process. Explain how the catalyst affects the rate and/or yield of this industrial process. (2 marks)

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The catalyst (iron on the surface of magnetite) increases the rate of both the forward and reverse reactions and hence allows the system to reach equilibrium faster. As with all catalysts, it provides a lower energy pathway for the reaction by lowering the activation energy for the reaction, so allowing a greater proportion of molecules to react successfully.

The yield is NOT changed as the rates of both the forward and reverse reactions are increased by the catalyst; the position of the equilibrium is not altered.

<b>Criteria</b>	<b>Marks</b>
<ul style="list-style-type: none"><li>• Explanation of the effect of the catalyst on the rate of both the forward and reverse reactions AND explanation of why the catalyst does not affect the yield</li></ul>	2
<ul style="list-style-type: none"><li>• Explanation of the effect of the catalyst on the rate of both the forward and reverse reactions</li></ul> OR <ul style="list-style-type: none"><li>• Explanation of why the catalyst does not affect the yield</li></ul>	1

**Question 29** (6 marks)

Chlorofluorocarbons have important effects on the ozone layer.

(a) Explain why small amounts of CFC's have large effects on the ozone layer. (2 marks)

The net result of the destruction of ozone by CFC's is that an ozone molecule and an oxygen atom are converted into two oxygen molecules and the reactive chlorine atom (originally produced from reaction of CFC with uv light) is preserved. The reactive chlorine is able to attack another ozone molecule and repeat the process again – a chain reaction.

Criteria	Marks
• regeneration of reactive chlorine atom.	1
• repeated chain reaction.	1

(b) What will be the consequences of ozone depletion? (2 marks)

Ozone depletion leads to more uv radiation reaching the earth's surface. This radiation is destructive to cells of living organisms.

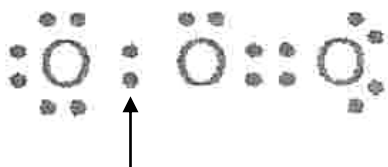
Criteria	Marks
• increase in uv radiation reaching earth's surface.	1
• uv radiation destructive to living cells.	1

(c) Draw an electron-dot formula to represent an ozone molecule. (1 mark)



Criteria	Mark
• Correct answer	1

(e) Use the formula you have drawn above to explain what is meant by a coordinate covalent bond. (1 mark)



The bond indicated above contains 2 electrons shared by the 2 oxygen atoms – hence the bond is covalent. However, the bond is also described as coordinate as both electrons came from the same atom, the central oxygen atom (rather than one electron from each bonding atom, as in a normal covalent bond).

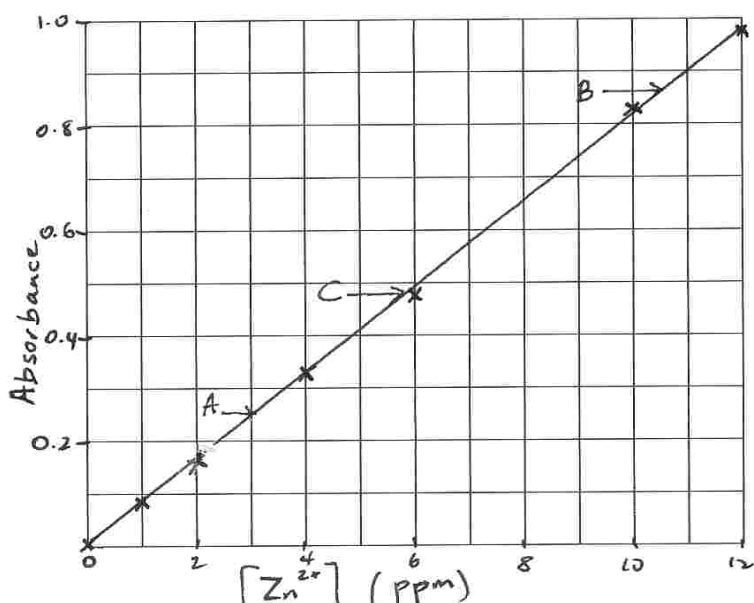
**Question 30** (3 marks)

A group of scientists used AAS to investigate the trace elements in three commercially available vitamin tablets. In one investigation, they used AAS to determine the concentration of zinc ions ( $\text{Zn}^{2+}$ ) in solutions they made by dissolving each of the three tablets in the same volume of deionised water. They used samples of known concentration of zinc ions to calibrate their instrument and then tested the three different brands of vitamin tablets.

The absorbance of the standards are given below:

<i>Standards [<math>\text{Zn}^{2+}</math>] (ppm)</i>	1	2	4	6	10	12
<i>Absorbance</i>	0.09	0.16	0.33	0.48	0.83	0.98

- (a) Draw a calibration curve of the absorbance versus concentration (ppm) for the standards on the grid below. (2 marks)



<b>Criteria</b>		<b>Marks</b>
• Draws calibration curve, using suitable labelled axes and plots all points correctly		2
• Draws calibration curve, using suitable labelled axes and plots some points correctly		1

- (b) The absorbance of solutions made from the three different brands of vitamin tablets are given below.

<i>Brand</i>	<b>A</b>	<b>B</b>	<b>C</b>
<i>Absorbance</i>	0.26	0.86	0.48

Use your calibration curve to determine the concentration of zinc ions in the vitamin tablet with the highest concentration of zinc ions. (1 mark)

B = 10.6 ppm. This vitamin tablet brand has the highest concentration of zinc ions.

<b>Criteria</b>	<b>Mark</b>
<ul style="list-style-type: none"><li>• Uses the calibration curve drawn in part (a) (i) to determine the concentration of brand B</li></ul>	1

**Question 31** (3 marks)

Scientists use AAS to monitor and manage the environment. Assess the use of AAS in pollution control.

Atomic absorption spectroscopy (AAS) is a technique which is very sensitive and can measure concentrations of <1 ppm of metal ions in a sample.

AAS can be used, not only to detect the presence of heavy metals in the environment, but to determine their concentrations. Heavy metals include the transition metals, plus lead and the semi-metal arsenic. The heavy metals that are of concern because of their detrimental health effects are mercury, lead, cadmium, chromium and arsenic. Analytical chemists from government organisations such as the Environmental Protection Authority (EPA) carry out programs involving investigation, compliance assessment, environmental monitoring and evaluation and enforcement, in order to protect the environment by controlling and minimising pollution and waste.

Measurement of the concentrations of those pollutants and wastes is vital in this process. AAS provides a quantitative technique for determining the levels of metal ions in the environment.

Pollutants would go undetected, and hence legislation could not enforce standards by industry and the population in general, without a sensitive and accurate method of measurement.

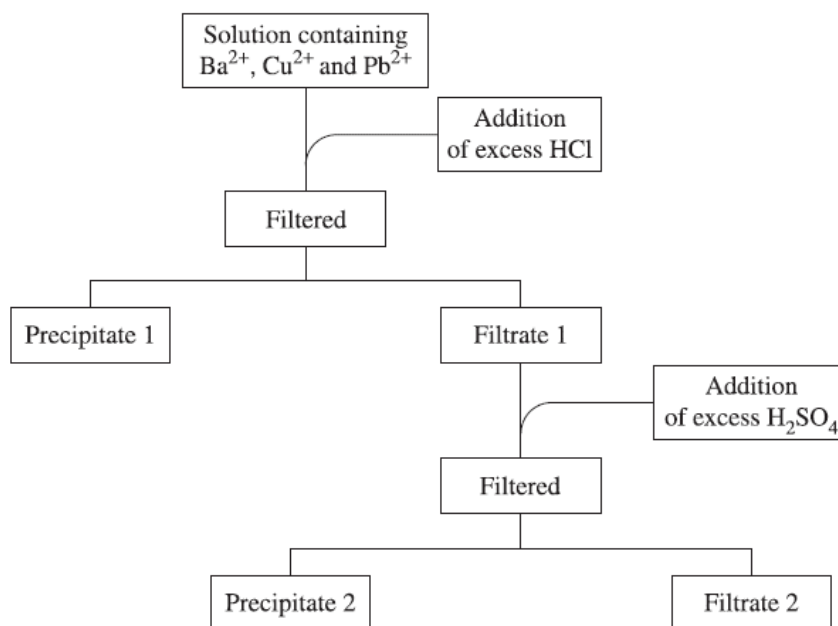
AAS is used routinely in chemical industries to check the wastes released into the environment, to ensure that the concentrations of the metals in wastes do not exceed the levels known to be detrimental to the environment.

While AAS is an important tool for all chemists, it has limitations, in that tests for a range of metals must be done separately and AAS is only suitable for detecting metal ions. Other pollutants, such as hydrocarbons, cannot be detected by AAS. The use of emission spectroscopy is less limiting, in that an emission spectrum will show lines for all metals in a sample at the same time.

<b>Criteria</b>	<b>Marks</b>
• Describes some positive effects and some limitations of AAS in controlling pollution	3
• Describes some positive effects of AAS and links these with pollution control	2
• Describes some correct information relating to the use of AAS	1

**Question 32** (5 marks)

A solution contains three cations,  $\text{Ba}^{2+}$ ,  $\text{Cu}^{2+}$  and  $\text{Pb}^{2+}$ . The flow chart indicates the plan used to confirm the identity of these cations.

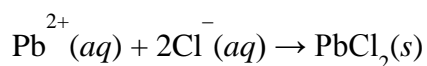


(a) Name Precipitate 2. (1 mark)

Criteria	Marks
• Correctly identifies the name of Precipitate 2 Barium Sulfate	1

(b) Write a balanced net ionic equation for the formation of Precipitate 1. (2 marks)

Criteria	Marks
• Provides a correct, balanced net ionic equation	2
• Provides a partially correct net ionic equation	1



(c) Suggest a test and the expected result that would confirm the identity of the metal cation remaining in Filtrate 2. (2 marks)

Criteria	Marks
• Suggests a suitable test AND • Provides the observation expected	2
• Suggests a suitable test OR • Provides the observation expected	1

The remaining metal ion is  $\text{Cu}^{2+}$  which can be tested by a flame test. When present  $\text{Cu}^{2+}$  copper will turn the flame blue-green.

- Tests for  $\text{Pb}^{2+}$  or  $\text{Ba}^{2+}$  if answers to (a) and (b) have been incorrect
- Other possible tests for  $\text{Cu}^{2+}$ , with their positive results

**Question 33** (2 marks)

The procedure of a first-hand investigation conducted in a school laboratory to determine the percentage of sulfate in a lawn fertiliser is given below.

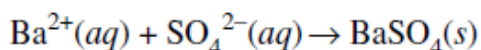
1. 2.00 g of a sample of fertiliser was ground up and placed in a beaker.
2. The fertiliser was dissolved in about 200 mL of 0.1 mol L<sup>-1</sup> hydrochloric acid, stirred and filtered.
3. Excess barium chloride solution was quickly added to this beaker and a precipitate formed.
4. The precipitate was then allowed to settle, filtered using filter paper and the residue collected.
5. The residue was dried and weighed and had a mass of 2.23 g.

Calculate the percentage of sulfate in the original fertiliser sample. Show all working.

Criteria	Marks
• Correctly calculates the percentage of sulfate in the original sample	3
• Provides a substantially correct response	2
• Applies a relevant step OR • Provides a relevant equation	1

*Sample answer:*

Calculations:



mass of fertiliser used: 2.00 g

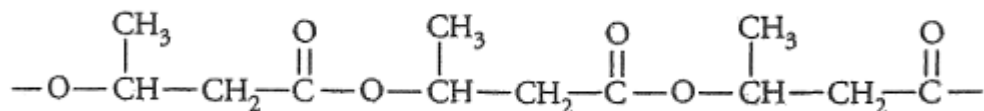
mass of precipitate formed: 2.23 g

$$\text{mass of SO}_4^{2-} = \frac{\text{Molar mass of SO}_4^{2-}}{\text{Molar mass of BaSO}_4} \times 2.23 = \frac{96.07}{233.37} \times 2.23 = 0.918$$

$$\therefore \% \text{ of SO}_4^{2-} \text{ in the fertiliser} = \frac{0.918}{2.00} \times 100 = 45.9\%$$

**Question 34** (5 marks)

A number of bacteria can produce the biopolymer PHB (polyhydroxybutanoate). Part of the structure of PHB is shown below.



- (a) PHB can be used to make surgical stitches to close cuts and wounds. Give two properties that PHB should possess if it is to be used this way. (2 marks)

It must be flexible so that it can fold to form a stitch.

It is biodegradable so that it can dissolve and merge with tissues. There is no need to remove stitches.

It is biocompatible so that it does not sensitize immune system.

It must be tough and strong so that stitches do not break and open the wound.

It is impermeable to oxygen and water such that it forms a complete barrier.

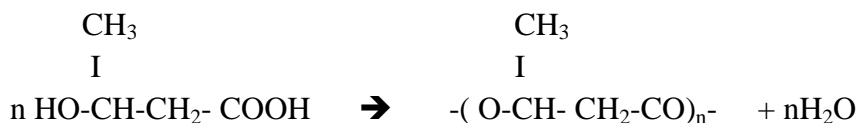
It does not cause any toxicity to tissues/compatibility

Any two = 2 marks

- (b) Describe the type of reaction that forms PHB by including a chemical equation. (2 marks)

PHB is made by the condensation polymerization of monomer 3-hydroxybutanoic acid.

Bacteria like *Alcaligene eutrophus* convert glucose into 2 carbon compound which are then converted into 4 carbon monomer.



Criteria	marks
<ul style="list-style-type: none"> <li>States that monomer 3-hydroxybutanoic acid undergoes condensation polymerization</li> <li>Gives a chemical equation to support the process</li> </ul>	2
<ul style="list-style-type: none"> <li>States that monomer 3-hydroxybutanoic acid undergoes condensation polymerization OR</li> <li>Gives a chemical equation to support the process</li> </ul>	1

- (c) Identify one advantage and one disadvantage of the use of PHB. (1 mark)

Advantage: PHB is made from renewable resource such molasses from sugar cane as such it can be produced again/ It lowers our reliance on non renewable resources.

Advantage: It is biodegradable as such it saves huge pile up in rubbish pits.

Disadvantage: It is costly as compared to plastics made from petroleum

Disadvantage: The process is lengthy and yield is low.

Disadvantage: It starts to get brittle with time.

(ANY ONE ADVANTAGE AND ONE DISADVANTAGE 1 MARK)



**Question 35** (4 marks)

Campers use methylated spirits (ethanol) in stoves to boil water and cook food.

- (a) 1364 kJ of energy is released when one mole of ethanol is burnt completely. Calculate the amount of energy produced when 1 g of ethanol burns. (2 marks)

$$1364/46.068=29.60840\text{kJ}=30\text{kJ}$$

Working shown 1 mark

Correct answer (2-3sf) 1 mark

- (b) Calculate the mass of ethanol that needs to burn to heat 950 mL of water in a kettle at 10°C to 100°C. In your calculations consider the loss of 60% of energy to the equipment and to the atmosphere. (2 marks)

$$\text{Heat produced} = -mc\Delta T$$

$$-950 \times 4.18 \times 90 = -357390\text{J}$$

If 60% of heat is lost then need to work out total heat produced.

If available heat is 40 then total heat produced is 100

If available heat is 357390J the total heat produced = 893475J (1 mark)

46.068g of ethanol when burns produce 1364000J of heat

To produce 893475J of heat mass of ethanol burnt will be  $46.068/1364000 \times 893475 =$

$$30.17639\text{g} =$$

30.2g or 30g (1 mark)

**Question 36** (1 mark)

The rarest naturally occurring element is astatine (At) with very small amounts of  $^{219}\text{At}$  being found in uranium ores.

Why are atoms of At-219 expected to be unstable?

.Astatine has atomic number 85 which is greater than 83. All elements above atomic number 83 have unstable nucleus due to many nucleons.

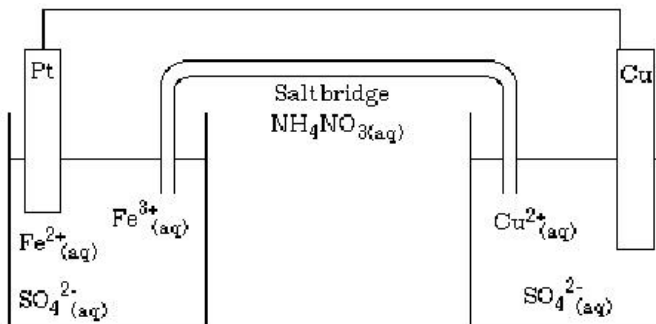
OR n to p ratio is greater than 1.5:1

$$134:85 = 1.576:1$$

(1 mark)

**Question 37** (5 marks)

A group of students set up the galvanic cell shown in the diagram.



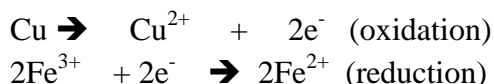
(a) Identify the anode and cathode in this cell. (1 mark)

Anode: ..... Cathode: .....

- Anode is COPPER and cathode is PLATINUM (1 mark)

(b) Using half-equations, explain how this cell works in terms of oxidation and reduction reactions. (2 marks)

Copper is a stronger reductant as such copper atom is oxidized by losing electrons  
 These electrons travel through external wire to cathode where electrons are gained by Fe<sup>3+</sup> ions.  
 Fe<sup>3+</sup> ions are stronger oxidant as such are reduced by gaining electrons to become Fe<sup>2+</sup> ions.



Criteria	marks
<ul style="list-style-type: none"> <li>• States that copper atoms are stronger reductant and are oxidized by losing electrons</li> <li>• States that iron(III) ions are stronger oxidant and are reduced by gaining electrons.</li> <li>• States that electrons travel through external wire from anode to cathode</li> <li>• Gives two half equations</li> </ul>	2
States only oxidation and reduction OR Only give half equations with no explanation	1

(c) Calculate the standard emf (voltage) of the cell at 25°C and 100 kPa. Show your working. (2 marks)

EMF = 0.77 - 0.34 = 0.43V  
 Values are shown ( 1 mark)  
 Correct emf calculated with units ( 1 mark)

**End of Section I**

Student Name	
Class	
Mark /	

**Girraween High School Higher School Certificate Chemistry 2016 Trial Examination**

**Write your Name and Class at the top of this Section II Answer Booklet**

**SECTION II**

**Allow about 40 minutes for this part**

**Show all relevant working in questions involving calculations**

**Question 33 - Industrial Chemistry (19 marks)**

- (a) During your practical work you performed a first-hand investigation to observe the reaction of sulfuric acid acting as a dehydrating agent.
- (i) Justify TWO precautions that must be taken when carrying out this investigation. (2 marks)

Criteria	Marks
<ul style="list-style-type: none"> <li>Correctly identifies two risks AND</li> <li>States the relevant precautions</li> </ul>	2
<ul style="list-style-type: none"> <li>One of the above</li> </ul>	1

**Sample Answer**

- Sulfuric acid is very corrosive and protective gloves and safety goggles should be worn as it can damage skin and eyes*
- Concentrated sulphuric acid gives out toxic fumes of acidic gas SO<sub>2</sub> so the experiment must be conducted in a fume hood*

- (ii) Outline the observations of the above investigation. (2 marks)

**Sample Answer**

- When concentrated sulphuric acid was added to sugar*
- Sugar(white) changes to a black spongy mass*
  - The beaker in which the reaction was carried out became very hot and steam was released (highly exothermic reaction)*

Criteria	Marks
<ul style="list-style-type: none"> <li>Correctly states two observations</li> </ul>	2
<ul style="list-style-type: none"> <li>Correctly states one observation</li> </ul>	1

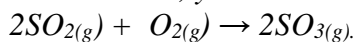
- (c) Evaluate the importance of monitoring and managing the conditions in the Contact Process with reference to yield and environmental impact. (6 marks)

**Sample Answer**

*Maximising yield in the production of sulfuric acid occurs mainly in the second step of the contact process where sulfur dioxide is converted to sulfur trioxide.*

*The nature of this exothermic step requires a careful manipulation of the reaction conditions of concentration, pressure and temperature so that yield is maximised without comprising reaction rate. In addition, this manipulation also reduces the amount of SO<sub>2</sub> released into the atmosphere (a major environmental concern leading to formation of acid rain) and helps to dispose of waste heat produced in all steps in the process.*

*In the second, yield-determining step, the following reaction occurs:*



*To maximise yield, the initial air used contains about 30%–50% more oxygen than is required to fully convert sulfur to SO<sub>3</sub>. This increased concentration of O<sub>2(g)</sub> forces reaction to right, maximising yield. In addition, the reaction is carried out at about 1.5 atm. Since there is a 1.5 : 1 ratio of gas particles reactants : products the reaction is also forced to the right to reduce pressure, maximising yield.*

*The initial gas stream at the beginning of this step is at 1000°C after combustion of sulfur. This is too high to produce effective yield in the exothermic reaction above. The gas stream is cooled (heat exchanged, with heat used to liquefy sulfur in first step, which reduces heat released from process) to about 550°C. At this lower temperature, the gas stream passes over a bed of V<sub>2</sub>O<sub>5</sub> catalyst, which produces a relatively rapid 70% conversion of SO<sub>2</sub> to SO<sub>3</sub>. The gas stream is then further cooled to 400°C and passed over a second catalytic bed, producing overall 97% conversion at the lower temperature. In the past, 3% SO<sub>2</sub> released was considered acceptable. However, now it is not permitted to release SO<sub>2</sub> at this concentration into the atmosphere.*

*So, after conversion of SO<sub>3</sub> to H<sub>2</sub>SO<sub>4</sub> (via oleum), the remaining gas stream is passed over a final bed of V<sub>2</sub>O<sub>5</sub> to produce a 99.7% conversion. 0.3% SO<sub>2</sub> released is considered acceptable.*

*In order to ensure that the process is economical, efficient and doesn't have negative impact on the environment due to release of significant amount of pollutant SO<sub>2</sub>, continuous monitoring and management of this industrial process is essential.*

Criteria	Marks
<ul style="list-style-type: none"> <li>• Judgement is provided</li> <li>• Coherent, concise response with no irrelevant extraneous information</li> <li>• Includes relevant equation</li> <li>• Thorough description of process relating several factors to maximisation of yield</li> <li>• Clearly relates manipulation of reaction to reduction of environmental impact</li> </ul>	6
<ul style="list-style-type: none"> <li>• Coherent, concise response with no irrelevant extraneous information</li> <li>• Includes relevant equation</li> <li>• Thorough description of process relating several factors to maximisation of yield</li> <li>• Clearly relates manipulation of reaction to reduction of environmental impact</li> </ul>	5
<ul style="list-style-type: none"> <li>• Includes relevant equation</li> <li>• Sound description of process relating several factors to maximise yield</li> <li>• Identifies that the process reduces environmental impact</li> </ul>	4
<ul style="list-style-type: none"> <li>• Includes relevant equation</li> <li>• Process is described including some reaction conditions</li> <li>• An environmental issue identified</li> </ul>	3
<ul style="list-style-type: none"> <li>• Process is described including some reaction conditions</li> <li>• An environmental issue identified</li> </ul>	2
<ul style="list-style-type: none"> <li>• One aspect of the production of sulfuric acid is identified OR</li> <li>• Environmental issue identified</li> </ul>	1

- (d) An important role of chemistry is to provide for our material needs, in an environmentally and socially viable way.
- (i) Identify a shrinking natural resource that is not a fossil fuel. (1 mark)

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Marking guidelines	Marks
Identifies a shrinking natural resource. Eg. Fresh water	1

- (ii) Outline issues associated with the reduction in the availability of this resource, and identify a current or potential solution. (2 marks)

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Marking guidelines	Marks
Outlines two associated issues and identifies a current or potential solution	2
Identifies two associated issues.	1

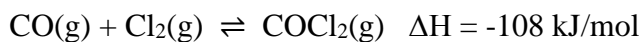
Issues associated with shrinking reserves of fresh water include:

- drought: this can result in reduced crop production, reduced dietary health, and reductions in hygiene
- conflict: fresh water could become a cause of conflict wars, increasing suffering, death and injustice in the world

One possible solution to water shortages in Australia is the construction in NSW for example, of a desalination plant.

- (e) Phosgene,  $\text{COCl}_2$ , is considered a chemical weapon, and its manufacture is monitored. It is also an industrially important compound, being useful in the synthesis of many carbon compounds.

The equilibrium constant for the formation of phosgene is  $1.2 \times 10^3$  at  $670^\circ\text{C}$ .



- (i) Identify the reaction condition which can change the value of  $K$  for this reaction. (1 mark)

Marking guidelines	Marks
Identifies temperature	1

- (ii) The concentrations of each species in a mixture at  $670^\circ\text{C}$  were as follows:

$$[\text{CO}] = 0.15\text{M} \quad [\text{Cl}_2] = 0.18\text{M} \quad [\text{COCl}_2] = 0.25\text{M}$$

Deduce whether the system was shifting to the left or the right to reach equilibrium at the time these measurements were taken. (3 marks)

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The equilibrium constant expression is  $K = [\text{COCl}_2]/[\text{CO}][\text{Cl}_2]$ .

The concentration values give a value of the reaction quotient,  $Q = 0.25/(0.15 \times 0.18) = 9.3$ .

Because this is less than the value of  $K$ , the proportion of  $\text{COCl}_2$  in the mixture is lower than the equilibrium value at this temperature. Thus, the system is shifting to the right to produce more  $\text{COCl}_2$ .

Marking guidelines	Marks
Identifies that the system is shifting to the right by calculating a value for the reaction quotient and correctly comparing this to the value of $K$ given, showing working.	3
Correctly calculates the value of the reaction quotient.	2
Identifies the correct equilibrium constant expression for the reaction.	1

**Question 42** (2 marks)

Outline two environmental impacts of Frasch's process for extracting sulfur from mineral deposits.

- While sulfur itself is non-toxic and odourless, it **oxidises easily to sulfur dioxide** and is **reduced easily to hydrogen sulfide**, both of which are serious **air pollutants**; care must be taken to avoid these reactions.
- The water used to make superheated steam cannot be **discharged into the environment**, as it contains contaminants, and will cause *thermal pollution* due to its intense heat; it must be reused.
- **Extraction of large amounts of sulfur** creates large underground caverns which can possibly collapse upon themselves. These are called earth *subsidences*.

<b>Marking guidelines</b>	<b>Marks</b>
<ul style="list-style-type: none"><li>• Correctly outline TWO impacts on the environment</li><li>• Link it to sulfur deposits</li></ul>	2
<ul style="list-style-type: none"><li>• Only ONE of the above</li></ul>	1



**End of Section II**