

Student Number _____



*Caringbah High School
Chemistry: HSC Course
Trial Exam 2017*

***Write all your answers in this answer booklet.
Use pen for written responses and pencil for diagrams and graphs.***

Total Marks: 100

Exam Length: 3 hours + 5 minutes reading time

PART A: Multiple Choice Questions (20 marks)

PART B: Longer Response Questions (80 marks)

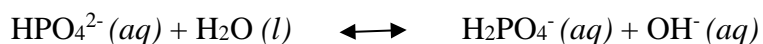
Exam Prepared by: C. Williams

<i>OUTCOME</i>	<i>MARK</i>
<i>Knowledge and Understanding</i>	
<i>Q</i>	<i>/68</i>
<i>Practical investigations</i>	
<i>Q 22, 29, 30</i>	<i>/16</i>
<i>Problem solving</i>	
<i>Q, 27, 28a, 34c, 34ai</i>	<i>/16</i>

PART A: Circle the letter of the BEST answer on the grid (20 marks)

<p>1.</p>	<p><i>What is the molecular formula of the monomer used in the production of polystyrene?</i></p> <p>A. C_2H_4 B. C_2H_3Cl C. $C_6H_{12}O_6$ D. C_8H_8</p>	
<p>2.</p>	<p><i>Four chemical reactions are shown below:</i></p> <p>I $MgO + 2HCl \rightarrow MgCl_2 + H_2O$</p> <p>II $Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$</p> <p>III $CuCO_3 \rightarrow CuO + CO_2$</p> <p>IV $4Fe + 3O_2 \rightarrow 2Fe_2O_3$</p> <p><i>Which of the reactions are redox reactions?</i></p> <p>A. II only B. II and IV C. I and II D. III and IV</p>	
<p>3.</p>	<p><i>A student was asked to compare the reactions with bromine water of alkanes and alkenes. She decided to use the compound below as one of the two hydrocarbons being investigated.</i></p> $\begin{array}{ccccccc} & H & H & H & & H & \\ & & & & & & \\ H & -C & -C & -C & =C & -C & -H \\ & & & & & & \\ & H & H & & H & H & \end{array}$ <p><i>The other hydrocarbon investigated should be</i></p> <p>A. pent-1-ene. B. pentane. C. hexane. D. cyclohexane.</p>	
<p>4.</p>	<p><i>The molar heat of combustion of pentan-1-ol is 2800 kJ mol⁻¹. A quantity of pentan-1-ol was combusted, generating 79.5 kJ of heat energy.</i></p> <p><i>What mass of pentan-1-ol was combusted?</i></p> <p>A. 17.2 g B. 2.15 g C. 2.50 g D. 2.55 g</p>	

5. In the following equation



A.	HPO_4^{2-} is acting as an acid	OH^{-} is acting as its conjugate base
B.	HPO_4^{2-} is acting as an acid	$\text{H}_2\text{PO}_4^{-}$ is acting as its conjugate base
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6. Select the correct value for the oxidation number of sulfur in $\text{S}_2\text{O}_3^{2-}$

- A. -2
- B. +2
- C. +4
- D. +6

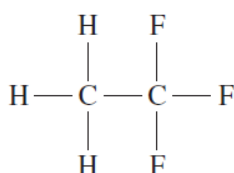
7. Which of the following would be the most appropriate risk management strategy for the testing of bond saturation in hydrocarbons?

- A. Ensure you do not touch the equipment in the experiment.
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- C. Use chemicals in a fume cupboard if practicable.
- D. Heat all substances on an electric stove and not with a naked flame.

8. What is the name of the process by which ethanol is purified from aqueous solution?

- A. distillation
- B. fermentation
- C. filtration
- D. polymerisation

9. The diagram shows the structural formula of a gas.

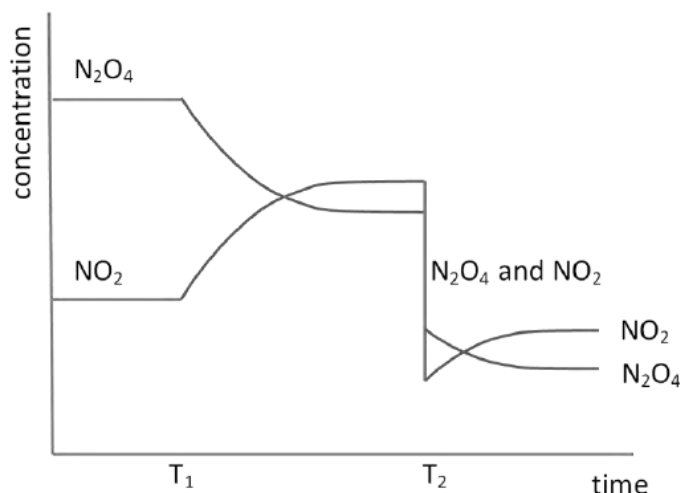
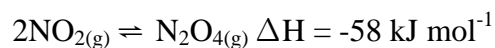


How many isomers does this compound have?

- A. 1
- B. 2
- C. 3
- D. 4

<p>10.</p>	<p><i>Which of the following statements best describes condensation polymerisation?</i></p> <p>A. <i>The reaction between many units, whereby the units link to each other across their double bonds to form a chain.</i></p> <p>B. <i>The reaction between many units, whereby the functional groups of the units react in such a way as to form a chain and expel water molecules.</i></p> <p>C. <i>The reaction between many units, whereby the amine group of one molecule reacts with the carboxyl group of the next to form a chain and expel water.</i></p> <p>D. <i>The reaction between many units, whereby the units link to each other to form a chain and expel many small molecules.</i></p>	
<p>11.</p>	<p><i>Which of the following is important in the nuclear stability of an atom?</i></p> <p>A. <i>the ratio of protons to electrons.</i></p> <p>B. <i>the ratio of protons to neutrons.</i></p> <p>C. <i>the atomic radius.</i></p> <p>D. <i>the atomic mass.</i></p>	
<p>12.</p>	<p><i>Select the most accurate value for the pH of a 0.04 M solution of H₂SO₄.</i></p> <p>A. <i>1.1</i></p> <p>B. <i>1.4</i></p> <p>C. <i>2.5</i></p> <p>D. <i>3.2</i></p>	
<p>13.</p>	<p><i>Which one of the following species could be analysed using AAS?</i></p> <p>A. <i>Sr²⁺</i></p> <p>B. <i>S²⁻</i></p> <p>C. <i>SO₂</i></p> <p>D. <i>SO₄²⁻</i></p>	
<p>14.</p>	<p><i>Expanded polystyrene can be produced by blowing gases through molten polystyrene and then allowing it to cool. A common use of this polystyrene is in the manufacture of protective foam packaging.</i></p> <p><i>Which property of polystyrene makes it suitable for this use?</i></p> <p>A. <i>Stiffness</i></p> <p>B. <i>Transparency</i></p> <p>C. <i>Flexibility</i></p> <p>D. <i>Brittleness</i></p>	

15. The graph shows the concentrations over time for the equilibrium system:



What has happened to the temperature at T_1 and to the volume at T_2 ?

	Temperature change at T_1	Volume change at T_2
A.	Decrease	Increase
B.	Increase	Decrease
C.	Decrease	Decrease
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16. Which of the following conditions would be best used to increase the reaction rate in the Haber Process?

- A. High pressure, high temperature
- B. Low pressure, high temperature
- C. High pressure low temperature
- D. Low pressure low temperature

17. How is a Bronsted-Lowry acid best described?

- A. A substance which forms H^+ ions in water.
- B. A substance which contains oxygen.
- C. A substance which is a proton donor.
- D. A substance which contains hydrogen.

18. Which of the following solutions contains the greatest number of moles of solute?

- A. 10.0mL of 0.50M $\text{HCl}_{(\text{aq})}$
- B. 20.0mL of 0.40M $\text{HCl}_{(\text{aq})}$
- C. 30.0mL of 0.30M $\text{HCl}_{(\text{aq})}$
- D. 40.0mL of 0.20M $\text{HCl}_{(\text{aq})}$

<p>19.</p>	<p><i>Which of the following statements best describes how a catalyst operates in a reversible reaction?</i></p> <p>A. <i>The catalyst increases the enthalpy change of the reverse reaction.</i></p> <p>B. <i>The catalyst decrease the enthalpy change of the forward reaction.</i></p> <p>C. <i>The catalyst decreases the activation energy of both the forward and reverse reactions.</i></p> <p>D. <i>The catalyst increase the activation energy of the reverse reaction.</i></p>	
<p>20.</p>	<p><i>A simple way of detecting ozone in polluted air is to bubble the air through potassium iodide solution.</i></p> $O_{3(g)} + 2H^+_{(aq)} + 2I^-_{(aq)} \rightleftharpoons I_{2(aq)} + H_2O_{(l)} + O_{2(g)}$ <p><i>What mass of iodine (in g) would be produced from 0.2g of ozone?</i></p> <p>A. <i>0.79</i></p> <p>B. <i>1.06</i></p> <p>C. <i>1.59</i></p> <p>D. <i>3.17</i></p>	

PART A: Answer the multiple choice questions HERE. Circle the letter of the BEST answer.

Do NOT detach this page from the rest of the exam.

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

PART B: Longer Answers

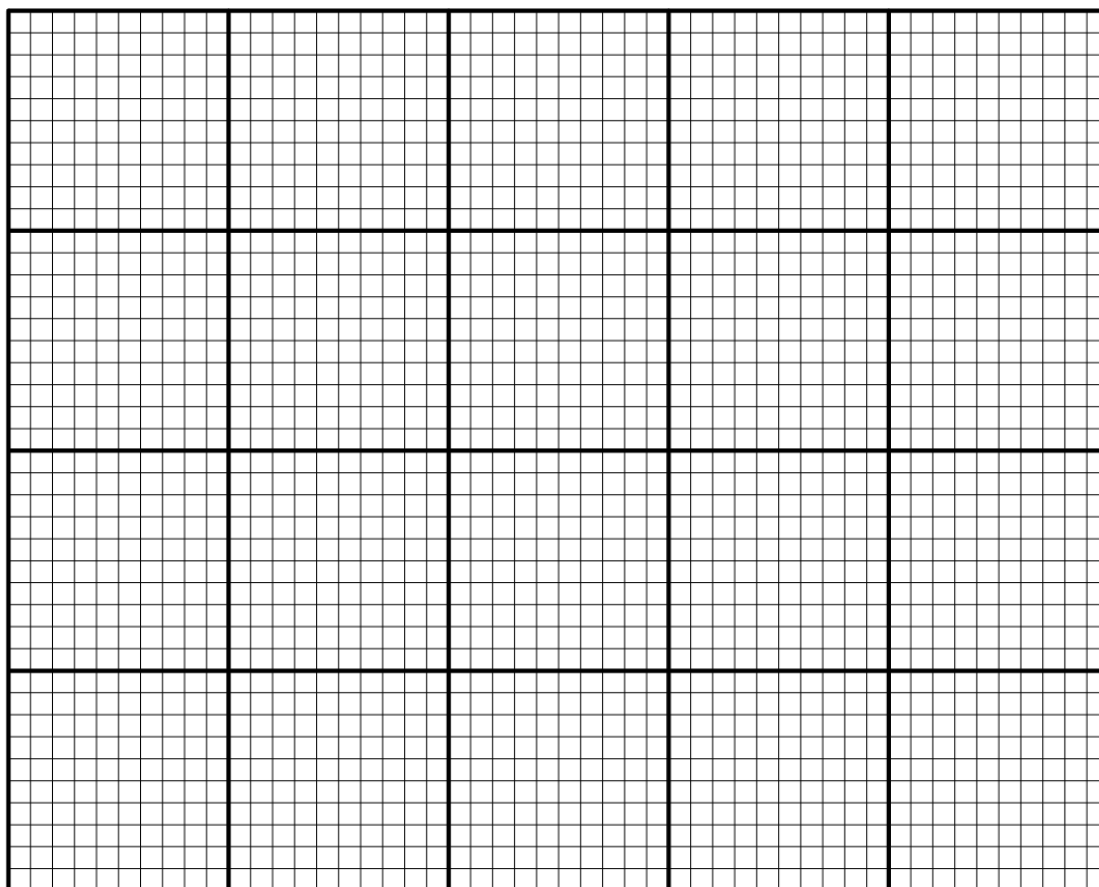
<p>21.</p>	<p>The following model was used by a chemistry student to demonstrate their understanding of the reaction to form a short segment of polyethene, and the composition of polyethene.</p> <div style="text-align: center;"> </div> <p>With reference to the model only, assess the student's understanding of polyethene and the reaction that forms it.</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	<p>2</p>
<p>22.</p>	<p>When a zinc strip is placed in a solution of silver nitrate a chemical reaction takes place.</p> <p>a. Write half-equations for the oxidation and reductions taking place, and write a balanced chemical equation for the overall reaction.</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>b. Calculate the E_{CELL} if these two half reactions comprised an electrochemical cell under standard conditions.</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>c. Predict and explain any observations that would be made if a silver strip was placed in a solution of zinc nitrate.</p> <p>.....</p> <p>.....</p>	<p>3</p> <p>1</p> <p>1</p>

25. A scientist monitoring the impact of effluent on a river system used AAS to compare the lead ion concentration above and below the effluent discharge point in the river.

The table below shows the absorbance values for the water samples and also those for a range of standard solutions.

<i>Solution</i>	<i>[Pb²⁺] (mg/L)</i>	<i>Absorbance %</i>
Standard	0.1	15
Standard	0.2	32
Standard	0.4	63
Standard	0.6	97
River sample 1		1
River sample 2		2
River sample 3		53
River sample 4		48

a. Use the grid below to plot the absorbance for the standards.



b. Complete the data in the table for the [Pb²⁺].

Question 25 continues on the next page

Question 25 (continued)

c. Assess the quality of the river water for freshwater organisms, above and below the entry point of the effluent, given that the maximum acceptable level for $[Pb^{2+}]$ is 0.05 ppm.

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d. Outline a chemical procedure for determining the lead ion concentration in a river. Include an equation for the reaction(s) you describe.

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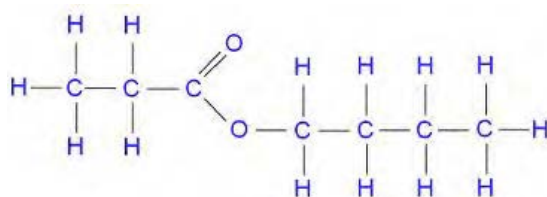
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26. The compound shown below was prepared in a school laboratory by refluxing TWO carbon compounds with concentrated sulfuric acid.



a. Draw the expanded structural formulae for the TWO carbon compounds and name these compounds.

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b. Explain the role of sulfuric acid in the formation of this compound.

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29. *In the course of his studies a pupil measured the pH of identical concentrations of hydrochloric acid and acetic acid.*

a. Explain the difference in pH of the two solutions.

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He then diluted 10 mL of each solution by a factor of 10.

b. Describe the procedure he should use to perform this task.

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When he re-measured the pH of each solution, the pH of the hydrochloric acid had increased by one pH unit, but that of the acetic acid had increased by only 0.5 pH units.

c. Explain why the pH increases as the solutions are diluted.

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d. Explain why the two solutions change pH by different amounts.

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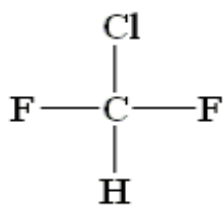
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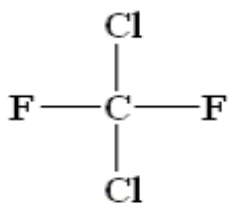
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<p>30.</p>	<p><i>During the HSC Chemistry course you performed a first-hand investigation in which you identified the pH of a variety of salt solutions. If solutions of NH_4Cl and Na_2CO_3 were used in this task, predict the acidic basic or neutral nature that you would identify for these two compounds. Justify your prediction, including relevant equations in your answer.</i></p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	<p>4</p>
<p>31.</p>	<p><i>Many products found in the supermarket contain acids or esters. Some of these are extracted from natural resources but an increasing number are being synthetically prepared. Providing specific examples, outline the use of acids and esters in food products.</i></p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	<p>2</p>
<p>32.</p>	<p><i>Identify a buffer in a natural system and explain how the buffer works with reference to your example.</i></p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	<p>4</p>

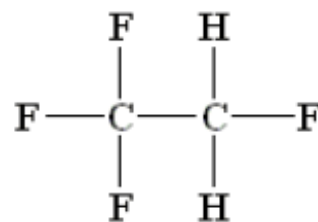
33. The structural formulae of three haloalkanes are shown below.



Compound 1



Compound 2



Compound 3

a. Give the correct systematic (IUPAC) name for Compound 3.

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b. Evaluate the impacts of these haloalkanes on depletion of ozone in the stratosphere. Include relevant equation(s) in your response.

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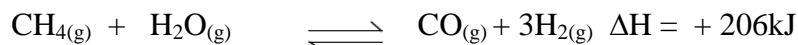
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PART B: ELECTIVE Longer response questions (marks)

34. a. Consider the following mixture of gases in a closed 5.0L vessel at 730 °C.

Gas	Quantity (mol)
CH ₄	2.00
H ₂ O	1.25
CO	0.75
H ₂	0.75

The following reaction occurs:



The equilibrium constant, *K*, is 0.26 at 730 °C.

i. Deduce whether the system is shifting to the left or right to reach equilibrium.

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ii. Explain how conditions in this reaction could be adjusted to increase the quantity of products

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b. Describe the process of extraction of sulfur from mineral deposits of sulfur.

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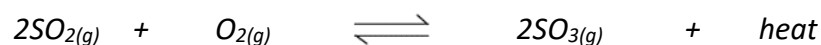
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Question 34 continues on the next page

Question 34(continued)

c. Sulfuric acid is a chemical of major importance to industrialised nations.

The production of sulfuric acid is a step-wise procedure. One of these steps is described by the equation



i. Write the expression for the equilibrium constant for the reaction as written above.

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ii. In one preparation the following concentrations of gases were recorded at equilibrium

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$$\begin{aligned} [\text{SO}_2] &= 0.04 \text{ mol L}^{-1} \\ [\text{O}_2] &= 1.0 \text{ mol L}^{-1} \\ [\text{SO}_3] &= 5.0 \text{ mol L}^{-1} \end{aligned}$$

Calculate the value of the equilibrium constant, K.

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iii. Explain what would happen to the value of K and the position of equilibrium if the temperature at which the reaction was conducted was increased while keeping other conditions constant.

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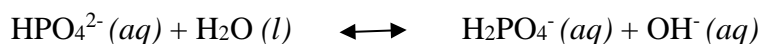
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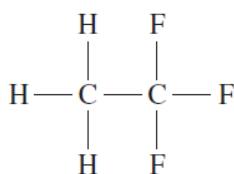
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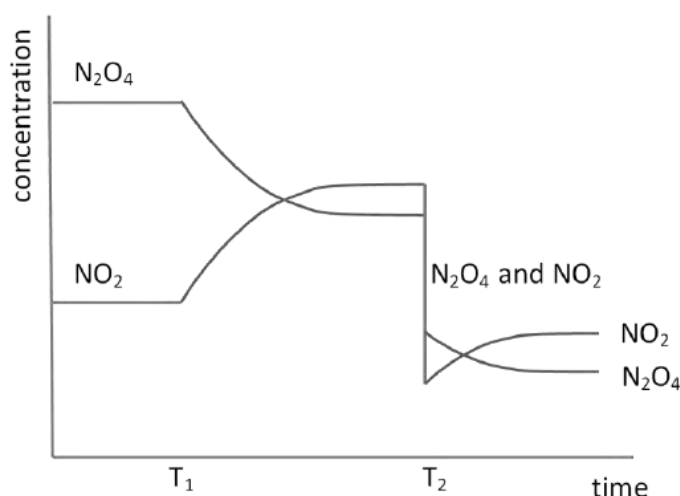
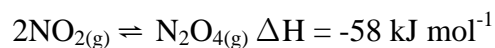


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- D. 40.0mL of 0.20M $\text{HCl}_{(\text{aq})}$

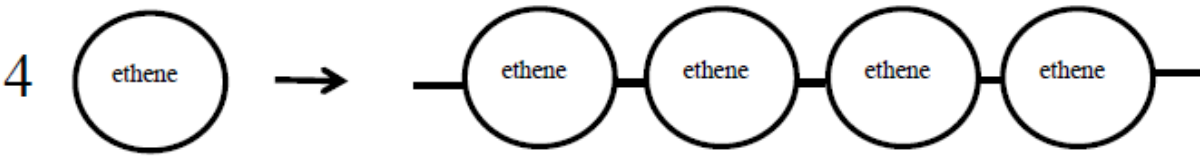
<p>19.</p>	<p><i>Which of the following statements best describes how a catalyst operates in a reversible reaction?</i></p> <p>A. <i>The catalyst increases the enthalpy change of the reverse reaction.</i></p> <p>B. <i>The catalyst decrease the enthalpy change of the forward reaction.</i></p> <p>C. <i>The catalyst decreases the activation energy of both the forward and reverse reactions.</i></p> <p>D. <i>The catalyst increase the activation energy of the reverse reaction.</i></p>	
<p>20.</p>	<p><i>A simple way of detecting ozone in polluted air is to bubble the air through potassium iodide solution.</i></p> $O_{3(g)} + 2H^+_{(aq)} + 2I^-_{(aq)} \rightleftharpoons I_{2(aq)} + H_2O_{(l)} + O_{2(g)}$ <p><i>What mass of iodine (in g) would be produced from 0.2g of ozone?</i></p> <p>A. <i>0.79</i></p> <p>B. <i>1.06</i></p> <p>C. <i>1.59</i></p> <p>D. <i>3.17</i></p>	

PART A: Answer the multiple choice questions HERE. Circle the letter of the BEST answer.

Do NOT detach this page from the rest of the exam.

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

PART B: Longer Answers

<p>21.</p>	<p>The following model was used by a chemistry student to demonstrate their understanding of the reaction to form a short segment of polyethene, and the composition of polyethene.</p>  <p>With reference to the model only, assess the student's understanding of polyethene and the reaction that forms it.</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p>.. The double bond of the ethene molecule will open up to form the polymer but the diagram indicates the double bond still present when it is not.</p> <p>.. There is no catalyst or initiator shown which is needed for the reaction to proceed.</p> <p>.. The student lacks a correct understanding of the structure of polyethene and the reaction that forms it.</p> </div> <div style="border: 1px solid red; padding: 5px; margin-bottom: 5px;"> <p>1 mk = indicates the product still has double bonds</p> </div> <div style="border: 1px solid red; padding: 5px;"> <p>1 mk = judgement</p> </div>	<p>2</p>
<p>22.</p>	<p>When a zinc strip is placed in a solution of silver nitrate a chemical reaction takes place.</p> <p>a. Write half-equations for the oxidation and reductions taking place, and write a balanced chemical equation for the overall reaction.</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p>.. $Zn_{(s)} \longrightarrow Zn^{2+}_{(aq)} + 2e^{-1}$ ox</p> <p>.. $Ag^{+}_{(aq)} + e^{-1} \longrightarrow Ag_{(s)}$ red</p> <p>.. $2Ag^{+}_{(aq)} + Zn_{(s)} \longrightarrow 2Ag_{(s)} + Zn^{2+}_{(aq)}$</p> </div> <div style="border: 1px solid red; padding: 5px; margin-bottom: 5px;"> <p>1 mk = correct oxidation equation</p> </div> <div style="border: 1px solid red; padding: 5px; margin-bottom: 5px;"> <p>1 mk = correct reduction equation</p> </div> <div style="border: 1px solid red; padding: 5px;"> <p>1 mk = correct balanced equation including states</p> </div> <p>b. Calculate the E_{CELL} if these two half reactions comprised an electrochemical cell under standard conditions</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p>.. $E_{CELL} = E_{red} + E_{ox}$</p> <p>.. $E_{CELL} = 0.80 + 0.76 = 1.56V$</p> </div> <div style="border: 1px solid red; padding: 5px;"> <p>1 mk = correct answer</p> </div> <p>c. Predict and explain any observations that would be made if a silver strip was placed in a solution of zinc nitrate</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p>.. No observable differences indicating no reaction as silver has a lower reactivity than zinc</p> </div> <div style="border: 1px solid red; padding: 5px;"> <p>1 mk = correct answer</p> </div>	<p>3</p> <p>1</p> <p>1</p>

23.	<p>“The development of the Haber process to synthesise ammonia was an important scientific contribution during the early 1900’s not only to Germany’s war efforts but also to our understanding of equilibrium processes”</p> <p>Assess the accuracy of the statement above.</p>	6	
	<p>During WWI there was an Allied naval blockade of Germany's shipping routes, which prevented supplies of nitrogen-rich compounds traveling from Chile to Germany (required for munitions and fertilizer production). Fritz Haber began work on developing a process for converting gaseous nitrogen and hydrogen into ammonia:</p> $3\text{H}_2(\text{g}) + \text{N}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g}) \quad -92 \text{ kJ/mol.}$ <p>This allowed munition production to prolong the war. This is an equilibrium reaction that lies very much to the left. According to Le Chatelier’s Principle a system will adjust to counteract the effect of the change. To drive it to the right increasing yield Haber employed LCP 15-35 MPa forces it to the right to restore the pressure as there are less moles of gas on the right. Too high a pressure is unsafe structurally High conc of reactants at a ratio of 3:1 to drive reaction to right Magnetite used as a catalyst High temperature 400-550 C is contrary to LCP as this is an exothermic reaction (shifts to left with heat) but is needed to overcome activation energy Development of this process to an industrial scale had a huge impact on world history, since it undoubtedly enabled Germany to maintain its war effort for longer than it otherwise would have. It also contributed to understanding of equilibrium reactions and the industrial monitoring needed to produce the greatest amount of yield.</p>	<p>5-6 mks = states conditions and explains LCP Explains importance of Haber process to WW1 Germany. Includes a judgement. Correct chemical equation included Coherence and logical progression</p> <p>3-4 mks = Correct chemical equation AND Either States conditions and explanation of LCP. OR Explains importance of Haber process to WW1 Germany</p> <p>2 mks = Outlines the historical context of the Haber process, and identifies the synthesis of ammonia from its elements AND Correct equation OR Outlines the reaction is equill</p> <p>1 mk = 1 correct statement OR equation</p>	
	<p>$^{125}_{53}\text{I}$ emits Beta particles when it decays and has a half life of 59.49 days.</p>	<p>ning and imaging the thyroid gland. It is amounts of hormones in blood samples.</p>	
	<p>a. Write a nuclear equation for the radioactive decay of $^{125}_{53}\text{I}$.</p>		1
	$^{125}_{53}\text{I} \rightarrow ^{125}_{54}\text{Xe} + ^0_{-1}\text{e}$	<p>1 mk = correct equation</p>	
	<p>b. Although still commonly used in radioimmuno-assays of blood samples, Iodine-125 has mostly been replaced by Iodine-123 in thyroid gland scanning and imaging. Iodine-123 has a half-life of 13 hours and is a beta emitter. Account for the usage of Iodine-125 currently and previously.</p>	<p>1 mk = harm of beta radiation to body 1 mk = lower exposure time of I-123 compared to I-125 1 mk = longer testing use of I-125 without replacement for radioimmunoassay.</p>	3
	<p>c. Identify an instrument used to detect radiation.</p>	<p>1 mk = Identifies an instrument used to detect radiation</p>	1
	<p>Photographic film, Thermoluminescent dosimeters (TLDs), Geiger-Muller (GM) probe and counter and Cloud Chamber are all accepted.</p>		

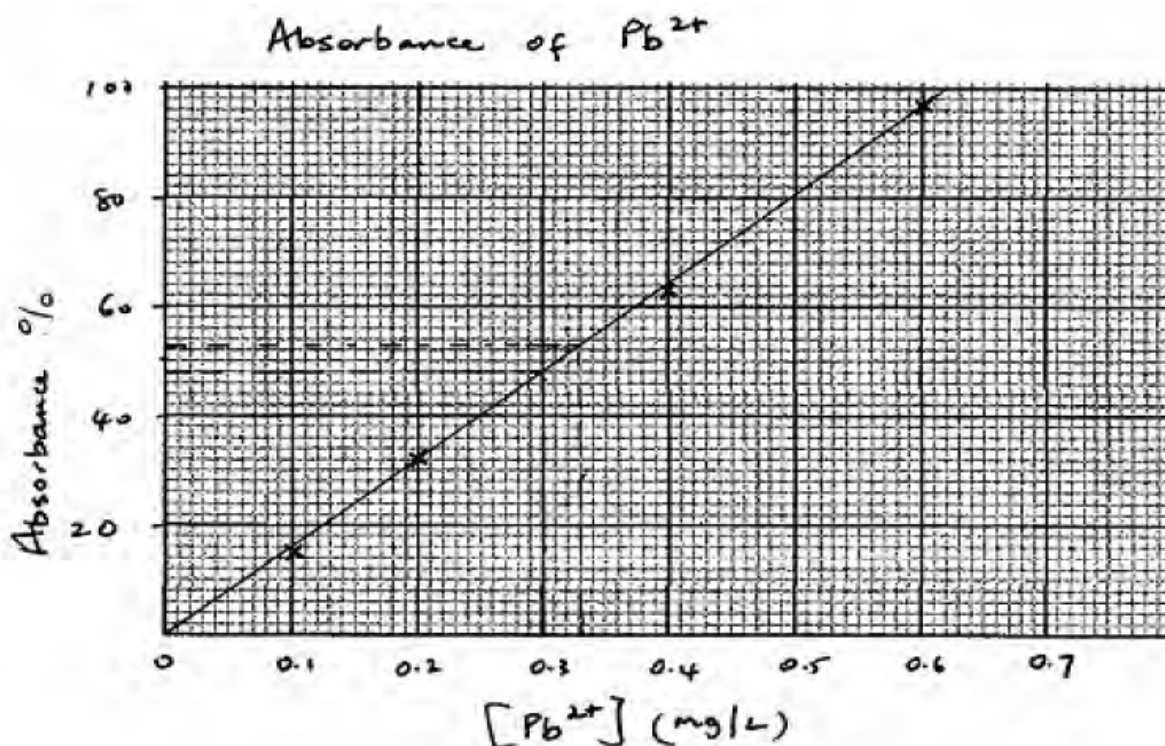
25. A scientist monitoring the impact of effluent on a river system used AAS to compare the lead ion concentration above and below the effluent discharge point in the river.

The table below shows the absorbance values for the water samples and also those for a range of standard solutions.

<i>Solution</i>	<i>[Pb²⁺] (mg/L)</i>	<i>Absorbance %</i>
Standard	0.1	15
Standard	0.2	
Standard	0.4	
Standard	0.6	
River sample 1	0.01 or less	
River sample 2	0.01-0.02	2
River sample 3	0.33 approx	53
River sample 4	0.30	48

2 mks = 4 correct sample values
1 mk = 2 correct sample values

a. Use the grid below to plot the absorbance for the standards.



1 mk = correct axes and scale
1 mk = labels and units
1 mk = plot and LOBF

b. Complete the data in the table for the [Pb²⁺].

Question 25 continues on the next page

Question 25 (continued)

c. Assess the quality of the river water for freshwater organisms, above and below the entry point of the effluent, given that the maximum acceptable level for $[Pb^{2+}]$ is 0.05 ppm.

The point of effluent entry must be between sampling points 2 and 3. Before the entry of effluent the $[Pb^{2+}]$ is $< 0.05\text{ppm (mg/L)}$, so the water is suitable for freshwater organisms. After the entry point, the water is not suitable as the $[Pb^{2+}]$ is $> 0.05\text{ppm (mg/L)}$.

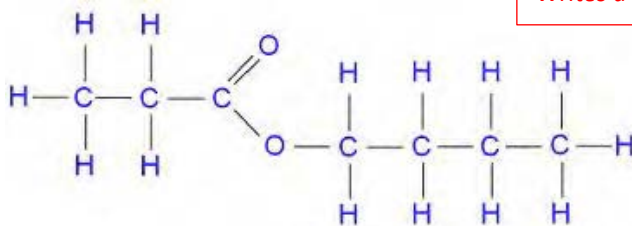
1 mk = correct answer above entry
1 mk = correct answer below entry

d. Outline a chemical procedure for determining the lead ion concentration in a river. Include an equation for the reaction(s) you describe.

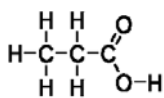
Three 100 mL samples of river water were collected and sealed into previously cleaned and labelled bottles and were taken to the laboratory for testing
Excess hydrochloric acid was added to the sample and the precipitate was filtered through a previously weighed filter paper and left to dry. The mass of the residue, lead chloride, was calculated and hence the concentration of lead ions determined
The procedure was repeated 3 times and the result averaged to determine the $[Pb^{2+}]$.
 $Pb^{2+} (aq) + 2Cl^{-} (aq) \rightarrow PbCl_2 (s)$

3 mks = Outlines, in a logical sequence, a suitable procedure for determining the lead ion concentration AND
Writes a correct equation
2 mks = Outlines a partially correct procedure AND
Writes a correct equation OR
Outlines, in a logical sequence, a suitable procedure for determining the lead ion concentration
1 mk = Outlines a partially correct procedure OR
Writes a correct equation

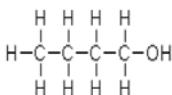
26.



a. Draw the expanded structural formulae for the TWO carbon compounds and name these compounds.



propanoic acid



butan-1-ol

2 mks = both structural formulae and names correct
OR
1 mk = only 1 structural formulae and name

b. Explain the role of sulfuric acid in the formation of this compound.

Sulfuric acid acts as a catalyst, to increase the rate of reaction, by providing a reaction pathway of lower activation energy. It also acts as a dehydrating agent, removing water from the equilibrium mixture and hence driving the equilibrium reaction towards the right and increasing the yield of the ester.

2 mks = Explains the roles of sulfuric acid as a catalyst AND dehydrating agent OR
1 mk = Explains the role of sulfuric acid as a catalyst OR as a dehydrating agent

<p>27.</p>	<p>A sample of lemon juice is to be analysed in the laboratory. A student took 25.00 mL of the juice and diluted it to 250.00 mL. Exactly 25.00 mL of the diluted lemon juice is titrated with standard 0.1045 mol L⁻¹ sodium hydroxide solution using phenolphthalein as the indicator. An average titre of 24.05 mL of sodium hydroxide was required.</p> <p>Assuming that the lemon juice contained only citric acid (molar mass = 192.1 g mol⁻¹), calculate the concentration in mol L⁻¹ of citric acid in the undiluted lemon juice.</p> <div style="border: 1px solid black; padding: 5px;"> $H_3A + 3NaOH \longrightarrow Na_3A + 3 H_2O \quad (1 \text{ mark})$ <p>moles H₃A = 1/3 moles NaOH</p> $= 1/3(C \times V) = 1/3 (0.1045) (0.02405) \quad (1 \text{ mark})$ $= 8.3774 \times 10^{-4}$ <p>conc of H₃A (diluted) = (8.3774 x 10⁻⁴)/0.0250 = 0.0335096 (1 mark)</p> <p>conc of H₃A (undiluted) = 0.0335096 (250/25) = 0.3350 mol L⁻¹ (1 mark)</p> <p>significant figure (four) (1 mark)</p> </div>	<p>5</p>
<p>28.</p>	<p>As the demand for drinking water increases, it has become necessary to monitor levels of contaminants and to develop new technologies for treating impure water sources.</p> <p>a. To measure the concentration of chloride ions in a sample of water, 20.0 mL of this water was titrated with 0.0050 mol L⁻¹ silver nitrate using a suitable indicator such as potassium chromate. The volume of the titre was 8.0 mL.</p> <p>i. Write an ionic equation for the precipitation reaction.</p> <div style="border: 1px solid black; padding: 5px;"> $Ag^+_{(aq)} + Cl^-_{(aq)} \longrightarrow AgCl_{(s)}$ </div> <p>1 mk = correct equation with states</p> <p>ii. Calculate the concentration of the chloride ions in ppm (mg L⁻¹).</p> <div style="border: 1px solid black; padding: 5px;"> $0.005 \times 0.008 = C \times 0.02$ $C = 0.002 \text{ mol L}^{-1}$ $C = 0.002 \times 34.45 \times 10^3 = 70.9 \text{ ppm}$ </div> <p>1 mk = conc in M 1 mk = conc ppm</p> <p>b. Describe the design and composition of microscopic membrane filters and explain how they purify contaminated water.</p> <div style="border: 1px solid black; padding: 5px;"> <ul style="list-style-type: none"> • Thin film of material eg polymer with uniform holes To make it semi-permeable • Contaminated water at high pressure passes over surface of filter and reverse osmosis leads to clean water. </div> <p>1 mk = design 1 mk = composition (polymers) 1 mk = explanation of work</p>	<p>1</p> <p>2</p> <p>3</p>

29. In the course of his studies a pupil measured the pH of identical concentrations of hydrochloric acid and acetic acid.

a. Explain the difference in pH of the two solutions.

HCl acid is a strong acid that will dissociate completely to H^+ ions while acetic acid only partially dissociates producing fewer H^+ ions. This will result in the pH of HCl being lower than acetic acid

1 mk = distinguishes strong and weak acids in terms of complete and incomplete dissociation.

1 mk = effect on pH : acetic > hydrochloric

2

He then diluted 10 mL of each solution by a factor of 10.

b. Describe the procedure he should use to perform this task.

10 mL of each solution was pipetted into separate 100mL volumetric flasks. The volume was made up to 100mL with distilled water

1 mk = correct volume ratio indicated

1 mk = use of pipette and volumetric flask

2

When he re-measured the pH of each solution, the pH of the hydrochloric acid had increased by one pH unit, but that of the acetic acid had increased by only 0.5 pH units.

c. Explain why the pH increases as the solutions are diluted.

The hydrogen ion concentration decreases with dilution. pH is calculated $= -\log_{10}[H^+]$ therefore the value will increase

1 mk = correct explanation

1

d. Explain why the two solutions change pH by different amounts.

HCl dissociates completely in solution and therefore a greater change to H conc. when diluted.
Acetic acid only dissociates partially and therefore a lower change to H conc. When diluted. pH is related to the H conc i.e. A tenth of a larger H conc will be greater than a tenth of a lower H conc

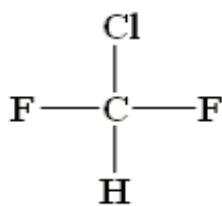
2 mks = explains both HCL and acetic in terms of dissociation and effect on H conc and pH
OR

1 mk= only explains one acid in terms of dissociation and effect on H conc and pH

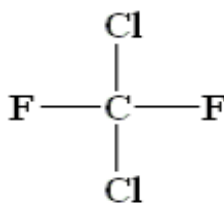
2

<p>30.</p>	<p>During the HSC Chemistry course you performed a first-hand investigation in which you identified the pH of a variety of salt solutions. If solutions of NH_4Cl and Na_2CO_3 were used in this task, predict the acidic basic or neutral nature that you would identify for these two compounds. Justify your prediction, including relevant equations in your answer.</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>Ammonium chloride has a pH <7 NH_4^+ ions react with water to form excess H_3O^+ ions thus lowering pH</p> <p>$\text{NH}_4^+ + \text{H}_2\text{O} \longrightarrow \text{H}_3\text{O}^+ + \text{NH}_3$</p> <p>Sodium carbonate has a pH >7 CO_3^{2-} ions react with water to form excess OH^- ion thus increasing the pH</p> <p>$\text{CO}_3^{2-} + \text{H}_2\text{O} \longrightarrow \text{HCO}_3^- + \text{OH}^-$</p> </div>	<p>4</p>
<p>31.</p>	<p>Many products found in the supermarket contain acids or esters. Some of these are extracted from natural resources but an increasing number are being synthetically prepared. Providing specific examples, outline the use of acids and esters in food products.</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>Phosphoric acid in cola drinks is used as a preservative Isoamyl acetate is used as an artificial banana flavouring</p> </div>	<p>2</p>
<p>32.</p>	<p>Identify a buffer in a natural system and explain how the buffer works with reference to your example.</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>$\text{HCO}_3^- / \text{H}_2\text{CO}_3$ are a buffer pair that occurs naturally in some rivers and lakes. H_2CO_3 is produced from the natural reaction of carbon dioxide and water. HCO_3^- comes from dissolving salts out of rocks around the lakes and rivers.</p> <p>$\text{H}_2\text{CO}_3 + \text{H}_2\text{O} \rightleftharpoons \text{HCO}_3^- + \text{H}_3\text{O}^+$</p> <p>If an acid ($\text{H}^+$) is added to the system, the equilibrium will move to the left to use up added hydronium ions due to Le Chateliers principle. This has the effect of minimising changes to the pH of the added acid.</p> <p>If a base is added to the system, the equilibrium will move to the right to produce more hydronium ions due to the loss of hydronium ion through neutralisation. This has the effect of minimising changes to the pH of the added base.</p> </div>	<p>4</p>

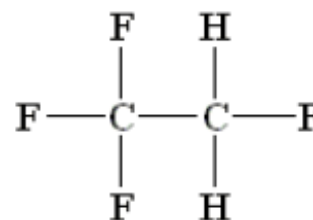
33. The structural formulae of three haloalkanes are shown below.



Compound 1



Compound 2



Compound 3

a. Give the correct systematic (IUPAC) name for Compound 3.

1,1,1,2-tetrafluoroethane

1 mk = correct answer

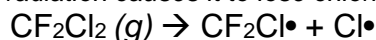
1

b. Evaluate the impacts of these haloalkanes on depletion of ozone in the stratosphere. Include relevant equation(s) in your response.

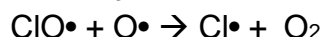
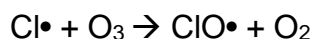
5

The haloalkanes which have greatest impact on the ozone levels are those containing chlorine atoms.

compound 2 (the only CFC) will cause the greatest depletion of ozone, as it has the highest number of chlorine atoms and no hydrogen atoms. The compound is extremely stable in the troposphere and slowly diffuses over many years into the stratosphere. Here the high energy UV radiation causes it to lose chlorine atoms (free radicals).



The free radical $\text{Cl}\cdot$ reacts with ozone, removing it from the stratosphere. The chlorine free radical is then regenerated, by reaction with available oxygen free radicals (from ozone or oxygen in UV light) as shown below.



Compound 1, HCFC – containing hydrogen, chlorine, fluorine and carbon atoms, also does this, but due to less Cl atoms, and reduced stability in the troposphere, it's a good replacement for CFCs.

compound 3, a HFC – containing hydrogen, fluorine and carbon atoms, is the best choice and has zero impact on ozone destruction as it contains no Cl.

Ultimately the impact of these haloalkanes on the destruction of ozone is CFC > HCFC > HFC

1 mark – 3 correct equations depicting the formation of $\text{Cl}\cdot$, the destruction of O_3 , and the recycling of $\text{Cl}\cdot$

1 mark – identifying the three different haloalkanes

2marks – describing impacts of all three aspects (1 mark if only some described)

1 mark evaluation of the three haloalkanes (can only be achieved if all three haloalkanes are described).

NOTE: Many students misinterpreted this question – it was about the impact ON ozone depletion, not the impact OF ozone depletion.

Most students got the equations wrong. Free radicals are represented with a \cdot not $^-$

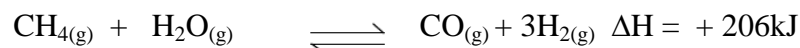
PART B: ELECTIVE Longer response questions (14 marks)

34.

a. Consider the following mixture of gases in a closed 5.0L vessel at 730 °C.

Gas	Quantity (mol)
CH ₄	2.00
H ₂ O	1.25
CO	0.75
H ₂	0.75

The following reaction occurs:



The equilibrium constant, *K*, is 0.26 at 730 °C.

i. Deduce whether the system is shifting to the left or right to reach equilibrium.

Volume of system is 5L but concentration is L therefore:

$$[\text{H}_2] = 0.75/5 = 0.15 \quad [\text{CH}_4] = 2.00/5 = 0.4$$

$$[\text{CO}] = 0.75/5 = 0.15 \quad [\text{H}_2\text{O}] = 1.25/5 = 0.25$$

$$Q = \frac{[\text{CO}][\text{H}_2]^3}{[\text{CH}_4][\text{H}_2\text{O}]}$$

$$= 5.06 \times 10^{-3}$$

$Q < K$ therefore the system is shifting to the right

3 mks = Writes the correct expression for *K*, correctly calculates its value and correctly deduces direction of shift.

2 mks = Writes the correct expression for *K* and correctly calculates its value

OR

Writes the incorrect expression for *K* but calculates the value and deduces direction of shift

1 mk = The response contains one correct step or substitution.

3

ii. Explain how conditions in this reaction could be adjusted to increase the quantity of products

Conditions in the reaction can be adjusted using Le Chatelier's Principle, as the system adjusts to minimise changes of conc, pressure and temp. The forward reaction is endothermic so increasing the temperature will increase the products as it will shift to the right to decrease temperature. Reducing pressure will also increase products. There are less moles of reactants than products so it will shift to increase pressure by creating more moles ie products. Removing either the products (CO or H₂) will cause a shift to replace products or increasing concentration of reactants (CH₄ or H₂O) will also

3 mks = Explains thoroughly all 3 conditions (temp, pressure and conc)

2 mks = Explains 2 or only describes the 3 conditions

1 mk = Explains 1 condition or identifies 2

NOTE: Marked hard. Any explanation of an equilibrium should reference LCP.

3

from mineral deposits of sulfur.

3

Sulfur is extracted from mineral deposits using the Frasch process.

A hole is drilled through the overlying rock and 3 pipes are inserted into the drill hole. The outer pipes contain superheated steam which is pumped down to the deposit where it melts the sulfur, as the melting point of sulfur is quite low. Compressed air is pumped down the second pipe to force the sulfur in water emulsion back out to the surface through the third pipe. As the water cools the insoluble sulfur solidifies and is filtered out.

3 mks = Describes the process fully (superheated water, compressed air, molten/low density S) and identifies it as the Frasch process

2 mks = Outlines the process and identifies it as the Frasch process

OR

Describes the process but fails to identify it as the Frasch process

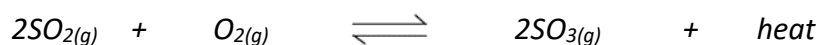
1 mk = Outlines the process OR Identifies the Frasch Process

tir

Question 34(continued)

c. Sulfuric acid is a chemical of major importance to industrialised nations.

The production of sulfuric acid is a step-wise procedure. One of these steps is described by the equation



i. Write the expression for the equilibrium constant for the reaction as written above.

... $K = [\text{SO}_3]^2 / [\text{SO}_2]^2 \times [\text{O}_2]$
 ...
 ...

1 mk = correct expression

1

ii. In one preparation the following concentrations of gases were recorded at equilibrium

$$\begin{aligned} [\text{SO}_2] &= 0.04 \text{ mol L}^{-1} \\ [\text{O}_2] &= 1.0 \text{ mol L}^{-1} \\ [\text{SO}_3] &= 5.0 \text{ mol L}^{-1} \end{aligned}$$

Calculate the value of the equilibrium constant, K.

... $K = 5^2 / (0.04)^2 \times 1 = 15625$
 ...
 ...

1 mk = correct substitution
 1 mk = correct calculation

2

iii. Explain what would happen to the value of K and the position of equilibrium if the temperature at which the reaction was conducted was increased while keeping other conditions constant.

... Temperature is the condition that will affect the value of K. As it is an exothermic reaction, increasing the temperature will result in movement to the left due to Le Chateliers. This decreases the products and increases reactants and therefore a smaller value for K
 ...
 ...

1 mk = position of equilibrium explained.
 1 mk = K value decrease identified.
 NOTE: Marked generously here

2