Girraween High School

Student Number

2020 **HIGHER SCHOOL CERTIFICATE TRIAL EXAMINATION**

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- Calculators approved by NESA may be used

Total Marks: 100

Section I – 20 marks (pages 1 – 8)

- Attempt questions 1–20
- Allow about 35 minutes for this part

Section II – 80 marks (pages 9 – 22)

- Attempt questions 21–33
- Allow about 2 hours and 25 minutes for this part

Section I
20 marks

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

Use the multiple-choice answer sheet for Question 1–20.

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1. Rainwater has a pH of about 5, while seawater has a pH of about 8.
   Which statement is correct concerning the *hydrogen ion concentrations* of rainwater and seawater?

   A. The hydrogen ion concentration in rainwater is greater by a factor of 1000.
   B. The hydrogen ion concentration in rainwater is greater by a factor of 3.
   C. The hydrogen ion concentration in rainwater is less by a factor of 1000.
   D. The hydrogen ion concentration in rainwater is less by a factor of 5/8.

2. How is solubility used by Aboriginal and Torres Strait Islander peoples in the preparation of food sources, such as the fruits of cycads?

   A. Because the starch in the fruits of cycads is more soluble than the toxins found in these fruits.
   B. The toxins in the ground-up fruits are more soluble in running water.
   C. Placing the cycad fruits in water removes hard-to-digest components
   D. The skins of the cycad fruits easily dissolve in water leaving essential nutrients

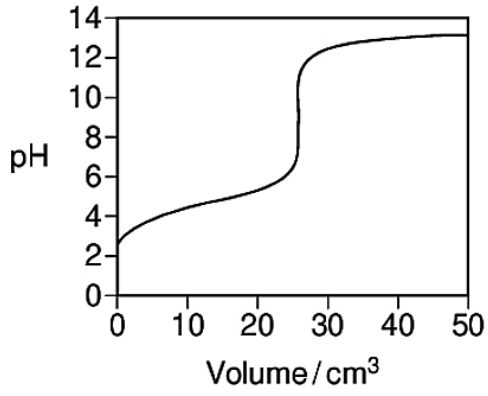
3. Which one of the following statements is correct about addition polymers?

   A. All addition polymers contain double bonds
   B. All addition polymers are recyclable
   C. The crystalline form of an addition polymer is harder than the amorphous form
   D. The length of polymer chains in all addition polymers are the same.

4. Which one of the following reagents is used to convert chloroethane into ethanol?

   A. Dilute sulfuric acid
   B. Sodium hydroxide
   C. Bromine water
   D. Acidified potassium dichromate

5. The following titration curve was obtained from the titration between a base with a sample of an unknown acid.



What acid-base combination does this graph represent?

A. Strong base/strong acid
B. Strong acid/weak base
C. Strong base/weak acid
D. Weak acid/weak base

6. What volume of 0.080 mol L^{-1} potassium hydroxide solution is required to completely neutralise a 20.0 mL volume of 0.050 mol L^{-1} sulfuric acid?

A. 6.3 mL
B. 12.5 mL
C. 20.0 mL
D. 25.0 mL

7. The following table shows the colour changes and pH ranges of three indicators:

Indicator	*Colour change (low pH to high pH)*	*pH range*
Bromophenol blue	Yellow to blue	3.0 – 4.5
Methyl red	Red to yellow	4.5 – 6.3
Alizarin	Yellow to red	10.2 – 12.0

The indicators were used to test a liquid. The following table shows the final colours after adding the indicators to the liquid:

Indicator	*Final colour*
Bromophenol blue	Blue
Methyl red	Yellow
Alizarin	yellow

Which one of the following substances was tested?

A. Vinegar (pH 2.1)
B. Rain water (pH 5.2)
C. Distilled water (pH 7.0)
D. Bleach (pH 12.1)

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

$$CH_3CH_2CH_2COOCH_2CH_2\ CH_2\ CH_2CH_3$$

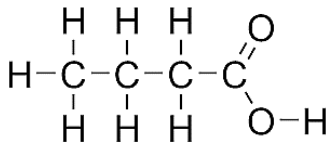
What two compounds would be used to form this ester?

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

9. Which one of the following statements does NOT apply to a system at static equilibrium?

A. The rates of the forward and reverse reactions are zero.
B. There is no exchange between reactants and products.
C. The rate of exchange between reactants and products is steady.
D. The concentration of reactants and products does not change.

10. Examine the structural formula below.



Which of the following compounds is an isomer of this compound?

A. Butanone
B. Butanal
C. Propanoic acid
D. Methyl propanoate

11. A 20 mL volume of 0.010 mol L^{-1} nitric acid solution is diluted to 100 mL.

Which of the following is the change in pH for the nitric acid solution after this dilution?

A. From 2.0 to 2.7
B. From 4.0 to 9.0
C. From 1.7 to 1.0
D. From 2.0 to 2.5

12. In a titration of a strong base with a strong acid, the following procedure was used:

1. A burette was rinsed with water and then filled with the standard acid.
2. A pipette was rinsed with some base solution.
3. A conical flask was rinsed with some base solution.
4. A pipette was used to transfer a measured volume of base solution into the conical flask.
5. Indicator was added to the base sample and it was titrated to the endpoint with the acid.

Which statement is correct?

A. The calculated base concentration will be correct
B. The calculated base concentration will be too low
C. The calculated base concentration will be too high
D. No definite conclusion can be reached about the base concentration

13. Nitric oxide (NO) is a colourless gas. It reacts with oxygen in an equilibrium in which dark brown nitrogen dioxide is formed.

$$NO(g) + \tfrac{1}{2}O_2(g) \longleftrightarrow NO_2(g) \quad \triangle H = -56 \text{ kJ mol}^{-1}$$

colourless dark brown

Which of the following combination of conditions results in the deepest brown colour for the equilibrium system?

	Temperature	*Pressure*	*$[O_2]$*
A.	Low	Low	Low
B.	Low	High	Low
C.	High	Low	High
D.	Low	High	High

14. Which of the following solutions has the greatest buffering capacity?

Solution W: A 1.0 M solution of sulfuric acid and sulfate ions
Solution X: A 0.10 M solution of ammonia and ammonium chloride
Solution Y: A 0.10 M solution of acetic acid and sodium acetate
Solution Z: A 1.0 M solution of ammonia and ammonium chloride

A. Solution W
B. Solution X
C. Solution Y
D. Solution Z

15. Calcium hydroxide dissolves in water and has a $K_{sp}=5.5 \times 10^{-6}$. Calculate the solubility in $molL^{-1}$.

A. 1.1×10^{-2} $molL^{-1}$
B. 1.8×10^{-2} $molL^{-1}$
C. 2.8×10^{-6} $molL^{-1}$
D. 2.3×10^{-3} $molL^{-1}$

16. 4.37g of 2,2,4-trimethylpentane was burnt in a burner to heat 1L of water by 50ºC. The molar heat of combustion (kJ mol^{-1}) of 2,2,4-trimethylpentane is:

A. 5700 kJ mol^{-1}
B. 5460 kJ mol^{-1}
C. 5580 kJ mol^{-1}
D. 550 kJ mol^{-1}

17. A group of students carried out the following tests to find the type of ionic solution they found in an unlabelled bottle.

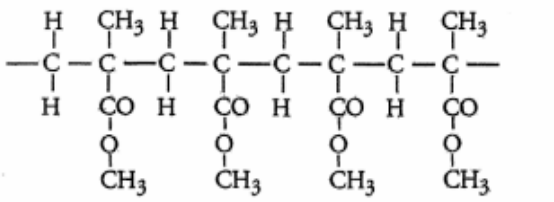
They added 2 mL of unknown solution to three test tubes and then added the following reagents and recorded their results as shown in the table below.

Test tube	*Reagent added*	*Result*
1	Silver nitrate solution	White precipitate
2	Sodium hydroxide solution	No precipitate
3	Sodium sulphate solution	White precipitate

The ionic solution in the bottle is:

A. Calcium nitrate
B. Copper (II) bromide
C. Barium chloride
D. Magnesium chloride

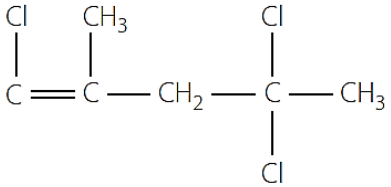
18. Perspex is a hard-transparent plastic polymer made by the addition polymerisation of methyl methacrylates. A section of the polymer is shown below.



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

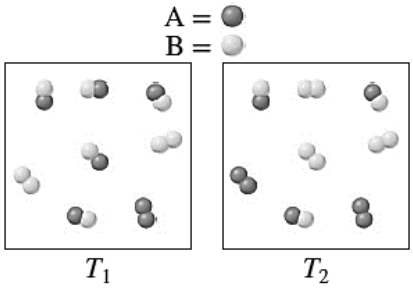
A. $C_4H_9O_2$
B. $C_5H_8O_2$
C. $C_5H_9O_2$
D. $C_4H_8O_2$

19. What is the correct IUPAC name for this haloalkane?



A. 1-chloro-2-methyl-4,4-dicloropentene
B. 1,4,4-trichloro-2-methylpent-1-ene
C. 1-chloro-4-dichloro-2-methylpent-1-ene
D. 1,4,4-trichloro-2-methylpent-2-ene

20. The diagram below shows equilibrium mixtures of A_2, B_2 and AB at two different temperatures, where $T_2 > T_1$.



Which of the following is true for the reaction $A_2 + B_2 \rightleftharpoons 2AB$?

A. It is endothermic
B. It is exothermic.
C. It is neither endothermic or exothermic
D. There is not enough information to determine whether it is endothermic or exothermic.

End of Section I

2020 HIGHER SCHOOL CERTIFICATE TRIAL EXAMINATION

Student Number								

Chemistry Section I – Multiple Choice Answer Sheet

Instructions for answering questions in Section I

- Complete your answers in either blue or black pen
- Multiple choice

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

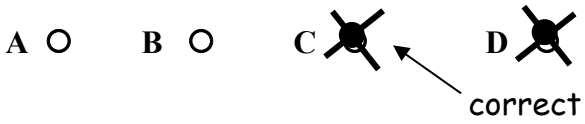
Sample 1: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

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 the correct answer by writing the word ***correct*** and drawing an arrow as follows.



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 Number								
Section I / 20								
Section II / 80								
Total /100								

Chemistry
Section II

80 marks
Attempt Questions 21 – 32
Allow about 2 hours 25 minutes for this section

Instructions

- Write your student number at the top of this page.
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of the response.
- Show all relevant working in questions involving calculations
- Extra writing paper is available, please raise your hand to request more paper. If you use extra paper, clearly indicate your student number and which question you are answering.

Please turn over

Question 21 (6 marks)

A student makes up a 200.0 mL solution of barium hydroxide. The solution is found to have a pH of 12. The student then adds 0.20 mol L^{-1} hydrochloric acid solution to neutralise the barium hydroxide solution.

a) Write a balance chemical equation for the neutralisation reaction. **1**

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b) Calculate the concentration (in mol L^{-1}) of hydroxide ions in the original solution. **2**

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c) Calculate the volume of hydrochloric acid required to complete the neutralisation reaction. **3**

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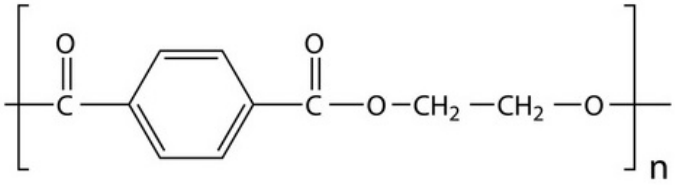
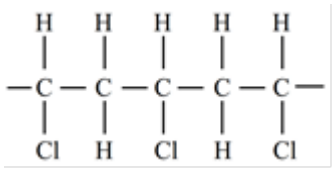
Question 22 (6 marks)

The structures of two polymers polyethylene terephthalate labelled as A and polyvinylchloride labelled as B are shown below.



Polymer A



Polymer B

a) In the table below, draw the condensed structural formulae of the monomers used to make polymers A and B. **2**

Polymer A	Polymer B

Question 22 continues on page 11

b) Identify and compare the types of polymerisation reactions that occur to produce polymers A and B. **4**

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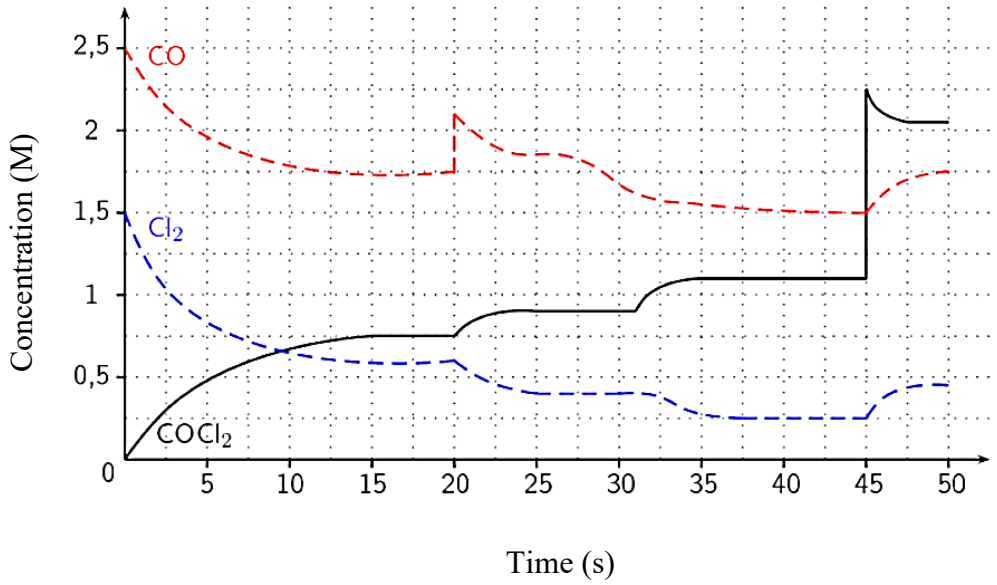
Question 23 (8 marks)

Consider the following chemical equilibrium and graph and answer the questions that follow:

$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$$



a) Write the expression for the equilibrium constant K_{eq} for this reaction. **1**

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b) How much time was necessary for the system to reach equilibrium for the first time? **1**

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Question 23 continues on page 12

Question 23 (continued)

c) Compare the rates of the forward and reverse reactions at t = 5s and t = 17s **2**

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d) Determine K_{eq} for the system at t = 17 s. **1**

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e) Identify the change made to the equilibrium system at t = 20 s, and what happens between 20 s and 25 s. Explain your answer by referring to Le Chatelier's principle and collision theory. **3**

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Question 24 (6 marks)

Dinitrogen tetroxide (N_2O_4) is an almost colourless liquid which boils at 21°C. In the gaseous state it exists in equilibrium with nitrogen dioxide (NO_2) which is an intensely brown coloured gas.

$$\underset{\text{colourless}}{N_2O_4(g)} \rightleftharpoons \underset{\text{brown}}{2NO_2(g)} \qquad \Delta H = 58 \text{ kJ mol}^{-1}$$

To study this equilibrium a chemist injects 0.024 mol of liquid N_2O_4 into a 1.0 L evacuated flask. Using a colorimeter, it is observed that when the flask is heated to 50°C, 50% of the N_2O_4 has decomposed to NO_2.

a) Determine the equilibrium concentration of each gas at 50°C, and hence calculate the equilibrium constant K_c. under these conditions. **2**

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Question 24 continues on page 13

b) The experiment, at 50°C, is repeated starting with 0.040 mol of liquid N_2O_4. Predict and explain any difference in the extent (%) of dissociation to NO_2. **2**

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c) The temperature is raised to 60°C.

Predict and explain the effect on the equilibrium constant (K_c). **2**

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Question 25 (5 marks)

A solution is prepared by mixing 50.0 mL of 0.0100 mol L^{-1} lead(II) nitrate with 50.0 mL of 0.0200 mol L^{-1} of sodium bromide.

a) Write an equation for this reaction. **1**

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b) Write the expression for the solubility product of the precipitate formed. **1**

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c) Predict whether a precipitate will form. Show your working. **3**

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End of Question 25

Please turn over

Question 26 (5 marks)

Ammonia (found as ammonium hydroxide in solution) is often used as a window cleaning agent. Quality control checks on the concentration of ammonia are conducted that involve titrating the cleaning agent with standardised sulfuric acid.

The equation for the reaction is:

$$2NH_4OH(aq) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq) + 2H_2O(l)$$

a) Explain the importance of standardising the sulfuric acid before completing this titration. **2**

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50.0 mL of the cleaning agent is diluted to 250.0 mL and 25.0 mL aliquots of this solution were titrated against standardised sulfuric acid. The results of this titration are provided in the table below.

	Titres			
	Trial 1	Trial 2	Trial 3	Trial 4
Volume of H_2SO_4 (aq) required to reach end point (mL)	38.50	37.35	37.40	37.45
Concentration of standardised H_2SO_4 (aq)	0.170 M			

b) Calculate the concentration of ammonia in the original cleaning agent. **3**

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End of Question 26

Please turn over

Question 27 (7 marks)

Hypoiodous acid (HOI) and hypobromous acid (HOBr) are two weak acids. A solution of hypoiodous acid has a concentration of 0.100 mol L^{-1} and a pH of 5.80. A solution of hypobromous acid with the same concentration has a pH of 4.77.

a) A student wrote the K_a values for these acids as 2.5×10^{-11} and 2.9×10^{-9}, but forgot which was which. Identify which acid each K_a belongs to and explain why. **3**

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b) Calculate the pK_a for each acid and identify the relationship between pK_a and acid strength. **2**

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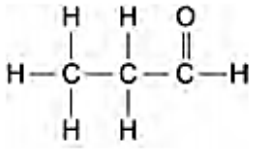
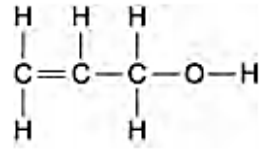
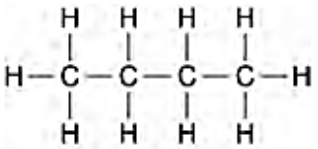
c) In the space below, draw a diagram to compare the difference in strength of hypoiodous acid and hydrochloric acid (a strong acid). **2**

End of Question 27
Please turn over

Question 28 (4 marks)

The table below shows the name and structure of 3 organic molecules.

Name	Propanal	Prop-2-en-1-ol	Butane
Structure			

Sequence the three molecules from highest to lowest boiling point, and justify your choice. **4**

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End of Question 28
Please turn over

Question 29 (4 marks)

Explain how the surfactant properties of the sodium salts of long chain fatty acids help to clean grease from dirty dishes. Include a diagram to support your answer. **4**

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End of Question 29

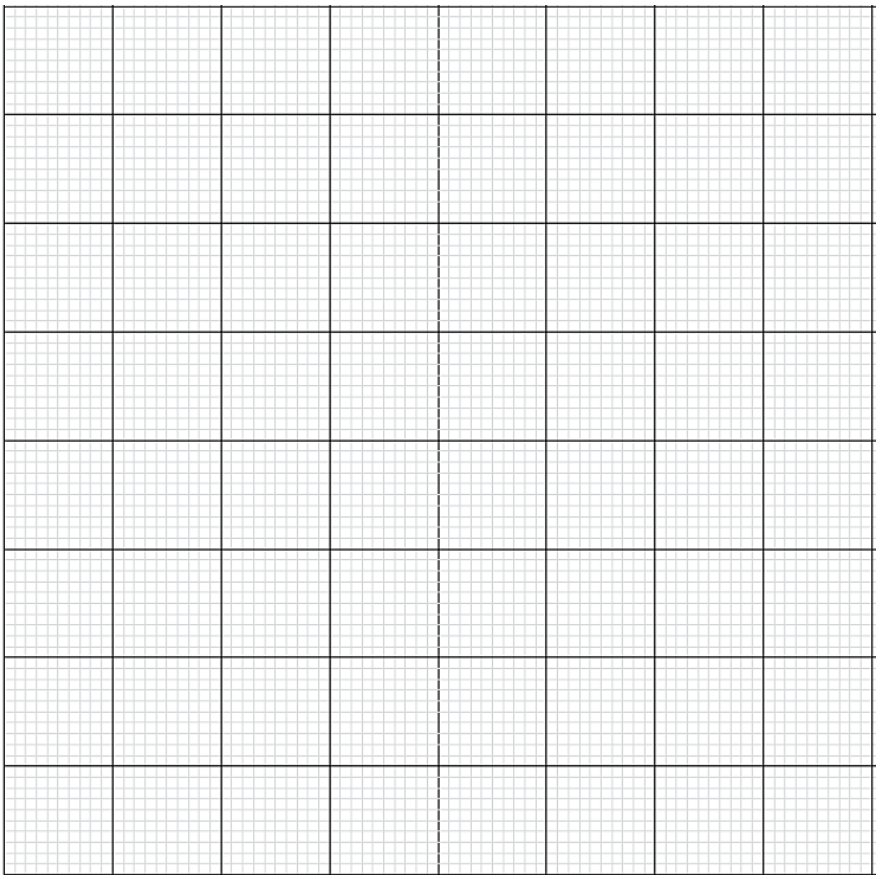
Please turn over

Question 30 (7 marks)

A conductometric titration was carried out to determine the concentration of a potassium sulfate solution. Barium chloride (0.500 M) was titrated into a beaker containing 50.00 mL potassium sulfate solution, and the conductivity of the solution measured and hence calculate the concentration of the unknown solution.

$BaCl_2$ volume (mL)	*Conductivity ($\mu S\ cm^{-1}$)*
2.6	1795
2.8	1757
3.0	1722
3.2	1680
3.4	1700
3.6	1742
3.8	1783

a) Use the data in the table to construct a conductometric titration curve below. **3**



Question 30 continues on page 19

b) Write an equation for the reaction between barium chloride and potassium sulfate. **1**

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c) Use the graph to determine the volume of the barium chloride solution required to completely react with the potassium sulfate. **1**

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d) Calculate the concentration of the potassium sulfate solution. **2**

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Question 31 (3 marks)

A student reacted 250.0 mL of a 0.500 mol L^{-1} solution of sulfuric acid with 500.0 mL of a 0.500 mol L^{-1} solution of potassium hydroxide. The temperature rose by 4.20°C. Calculate the enthalpy of neutralisation. **3**

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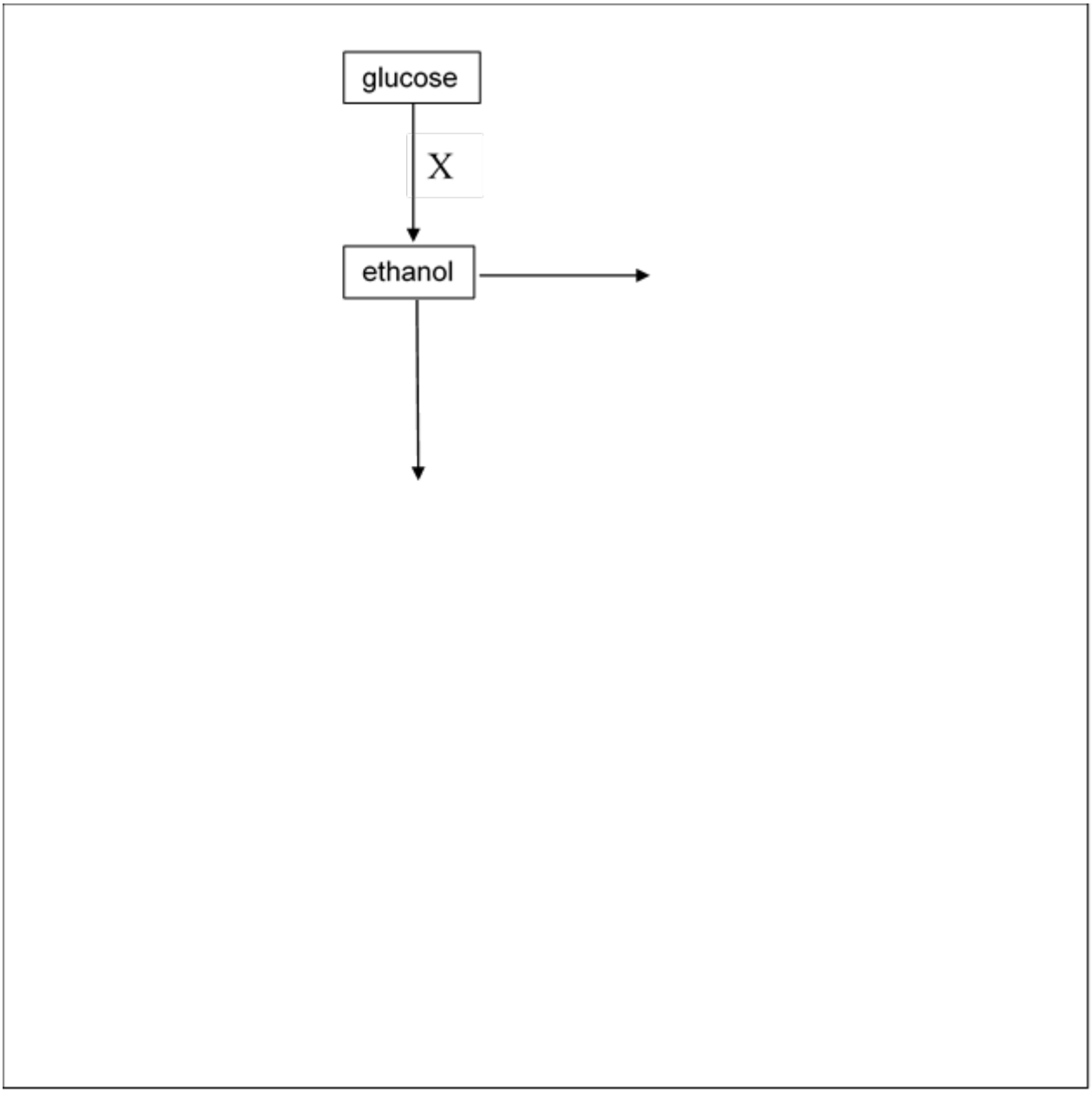
End of Question 31
Please turn over

Question 32 (12 marks)

You are provided with glucose ($C_6H_{12}O_6$), yeast and water.

a) Complete the flow diagram below for the production of chloroethane, ethanal, and ethanoic acid from these starting materials. Include structural formulas for each product, and the reagents and conditions required. **4**



b) Identify process X and state the conditions required. **2**

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Question 32 continues on page 21

c) Two of the above products can be used to produce an ester. Write the equation for the esterification reaction and name the product. **2**

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d) Explain why the process of reflux is used in esterification reactions in a laboratory. **2**

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e) Describe and justify the procedures required to safely handle and dispose of organic substances such as those used in esterification. **2**

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End of Question 32
Please turn over

Question 33 (7 marks)

Evaluate the use of biofuels, such as ethanol, in comparison to hydrocarbons extracted from the earth, such as octane, in regards to their chemistry and impact on the environment. Include relevant chemical equations in your response. **7**

End of Examination

Girraween High School

Student Number

2020 **HIGHER SCHOOL CERTIFICATE TRIAL EXAMINATION**

Chemistry

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- Working time – 3 hours
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Total Marks: 100

Section I – 20 marks (pages 1 – 6)

- Attempt questions 1–20
- Allow about 35 minutes for this part

Section II – 80 marks (pages 7 – 20)

- Attempt questions 21–34
- Allow about 2 hours and 25 minutes for this part

Section I

20 marks

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

Use the multiple-choice answer sheet for Question 1–20.

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

Sample 2 + 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:

correct ↘

A ⊗ B ⊗ C ○ D ○

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1. Rainwater has a pH of about 5, while seawater has a pH of about 8.
   Which statement is correct concerning the *hydrogen ion concentrations* of rainwater and seawater which one of the following statements is correct about addition polymers?

   A. The hydrogen ion concentration in rainwater is greater by a factor of 1000.
   B. The hydrogen ion concentration in rainwater is greater by a factor of 3.
   C. The hydrogen ion concentration in rainwater is less by a factor of 1000.
   D. The hydrogen ion concentration in rainwater is less by a factor of 5/8.

2. How is solubility used by Aboriginal and Torres Strait Islander peoples in the preparation of food sources, such as the fruits of cycads?

   A. Because the starch in the fruits of cycads is more soluble than the toxins found in these fruits.
   B. The toxins in the ground-up fruits are more soluble in running water.
   C. Placing the cycad fruits in water removes hard-to-digest components
   D. The skins of the cycad fruits easily dissolve in water leaving essential nutrients

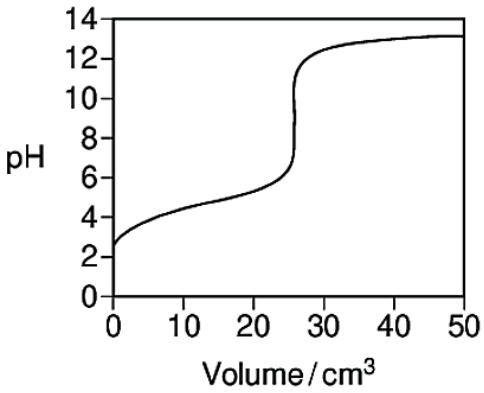
3. Which one of the following statements is correct about addition polymers?

   A. All addition polymers contain double bonds
   B. All addition polymers are recyclable
   C. The crystalline form of an addition polymer is harder than the amorphous form
   D. The length of polymer chains in all addition polymers are the same.

4. Which one of the following reagents is used to convert chloroethane into ethanol?

   A. Dilute sulfuric acid
   B. Sodium hydroxide
   C. Bromine water
   D. Acidified potassium dichromate

5. The following titration curve was obtained from the titration between a base with a sample of an unknown acid.



   What acid-base combination does this graph represent?

   A. Strong base/strong acid
   B. Strong acid/weak base
   C. Strong base/weak acid
   D. Weak acid/weak base

6. What volume of 0.080 mol L^{-1} potassium hydroxide solution is required to completely neutralise a 20.0 mL volume of 0.050 mol L^{-1} sulfuric acid?

   A. 6.3 mL
   B. 12.5 mL
   C. 20.0 mL
   D. 25.0 mL

7. The following table shows the colour changes and pH ranges of three indicators:

Indicator	*Colour change (low pH to high pH)*	*pH range*
Bromophenol blue	Yellow to blue	3.0 – 4.5
Methyl red	Red to yellow	4.5 – 6.3
Alizarin	Yellow to red	10.2 – 12.0

The indicators were used to test a liquid. The following table shows the final colours after adding the indicators to the liquid:

Indicator	*Final colour*
Bromophenol blue	Blue
Methyl red	Yellow
Alizarin	yellow

Which one of the following substances was tested?

A. Vinegar (pH 2.1)
B. Rain water (pH 5.2)
C. Distilled water (pH 7.0)
D. Bleach (pH 12.1)

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

$$CH_3CH_2CH_2COOCH_2CH_2\ CH_2\ CH_2CH_3$$

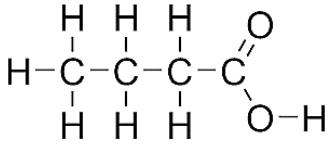
What two compounds would be used to form this ester?

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

9. Which one of the following statements does NOT apply to a system of chemicals at static equilibrium?

A. The rates of the forward and reverse reactions are zero.
B. There is no exchange between reactants and products.
C. The rate of exchange between reactants and products is steady.
D. The concentration of reactants and products does not change.

10. Examine the structural formula below.



Which of the following compounds is an isomer of this compound?

A. Butanone
B. Butanal
C. Propanoic acid
D. Methyl propanoate

11. A 20 mL volume of 0.010 mol L^{-1} nitric acid solution is diluted to 100 mL.

Which of the following is the change in pH for the nitric acid solution after this dilution?

A. From 2.0 to 2.7
B. From 4.0 to 9.0
C. From 1.7 to 1.0
D. From 2.0 to 2.5

12. In a titration of a strong base with a strong acid, the following procedure was used:

1. A burette was rinsed with water and then filled with the standard acid.
2. A pipette was rinsed with some base solution.
3. A conical flask was rinsed with some base solution.
4. A pipette was used to transfer a measured volume of base solution into the conical flask.
5. Indicator was added to the base sample and it was titrated to the endpoint with the acid.

Which statement is correct?

A. The calculated base concentration will be correct
B. The calculated base concentration will be too low
C. The calculated base concentration will be too high
D. No definite conclusion can be reached about the base concentration

13. Nitric oxide is a colourless gas. It reacts with oxygen in an equilibrium in which dark brown nitrogen dioxide is formed.

$$\underset{\text{colourless}}{NO(g) + \tfrac{1}{2}O_2(g)} \longleftrightarrow \underset{\text{dark brown}}{NO_2(g)} \qquad \triangle H = -56 \text{ kJ mol}^{-1}$$

Which of the following combination of conditions results in the deepest brown colour for the equilibrium system?

	Temperature	*Pressure*	*$[O_2]$*
A.	Low	Low	Low
B.	Low	High	Low
C.	High	Low	High
D.	Low	High	High

14. Which of the following solutions has the greatest buffering capacity?

Solution W: A 1.0 M solution of sulfuric acid and sulfate ions
Solution X: A 0.10 M solution of ammonia and ammonium chloride
Solution Y: A 0.10 M solution of acetic acid and sodium acetate
Solution Z: A 1.0 M solution of ammonia and ammonium chloride

A. Solution W
B. Solution X
C. Solution Y
D. Solution Z

15. Calcium hydroxide dissolves in water and has a $K_{sp}=5.5 \times 10^{-6}$. Calculate the solubility in $molL^{-1}$.

A. 1.1×10^{-2} $molL^{-1}$
B. 1.8×10^{-2} $molL^{-1}$
C. 2.8×10^{-6} $molL^{-1}$
D. 2.3×10^{-3} $molL^{-1}$

16. 4.37g of 2,2,4-trimethylpentane was burnt in a burner to heat 1L of water by 50°C. The molar heat of combustion ($kJ\ mol^{-1}$) of 2,2,4-trimethylpentane is:

A. 5700 $kJ\ mol^{-1}$
B. 5460 $kJ\ mol^{-1}$
C. 5580 $kJ\ mol^{-1}$
D. 550 $kJ\ mol^{-1}$

17. A group of students carried out the following tests to find the type of ionic solution they found in an unlabelled bottle.

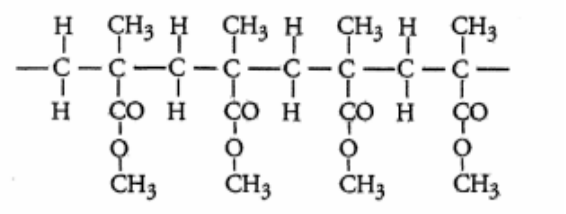
They added 2 mL of unknown solution to three test tubes and then added the following reagents and recorded their results as shown in the table below.

Test tube	*Reagent added*	*Result*
1	Silver nitrate solution	White precipitate
2	Sodium hydroxide solution	No precipitate
3	Sodium sulphate solution	White precipitate

The ionic solution in the bottle is:

A. Calcium nitrate
B. Copper (II) bromide
C. Barium chloride
D. Magnesium chloride

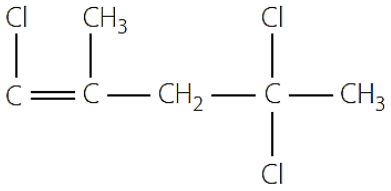
18. Perspex is a hard-transparent plastic polymer made by the addition polymerisation of methyl methacrylates. A section of the polymer is shown below.



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

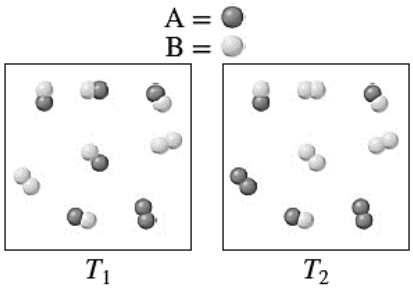
A. $C_4H_9O_2$
B. $C_5H_8O_2$
C. $C_5H_9O_2$
D. $C_4H_8O_2$

19. What is the correct IUPAC name for this haloalkane?



A. 1-chloro-2-methyl-4,4-dicloropentene
B. 1,4,4-trichloro-2-methylpent-1-ene
C. 1-chloro-4-dichloro-2-methylpent-1-ene
D. 1,4,4-trichloro-2-methylpent-2-ene

20. The diagram below shows equilibrium mixtures of A_2, B_2 and AB at two different temperatures, where $T_2 > T_1$.



Which of the following is true for the reaction $A_2 + B_2 \rightleftharpoons 2AB$?

A. It is endothermic
B. It is exothermic.
C. It is neither endothermic or exothermic
D. There is not enough information to determine whether it is endothermic or exothermic.

End of Section I

Examiner's Use Only		

Student Number	
Mark / 80	

Chemistry
Section II

80 marks
Attempt Questions 21 – 32
Allow about 2 hours 25 minutes for this section

Instructions

- Write your student number at the top of this page.
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of the response.
- Show all relevant working in questions involving calculations
- Extra writing paper is available, please raise your hand to request more paper. If you use extra paper, clearly indicate your student number and which question you are answering.

Please turn over

Question 21 (6 marks)

A student makes up a 200.0 mL solution of barium hydroxide. The solution is found to have a pH of 12. The student then adds 0.20 mol L^{-1} hydrochloric acid solution to neutralise the barium hydroxide solution.

a) Write a balanced equation for the neutralisation reaction. **1**

$$Ba(OH)_2\ (aq) + 2HCl\ (aq)\ ) \rightarrow BaCl_2 + 2H_2O(l)$$

Criteria	Marks
• Writes a correct balanced chemical equation	1

b) Calculate the concentration (in mol L^{-1}) of hydroxide ions in the original solution. **2**

pH + pOH = 14
pOH = 14-12 = 2
$[OH^-] = 10^{-2} = 0.01$ mol L^{-1}

Criteria	Marks
• Correctly calculates pOH of solution • Correctly calculates hydroxide ion concentration	2
• Correctly calculates pOH of solution	1

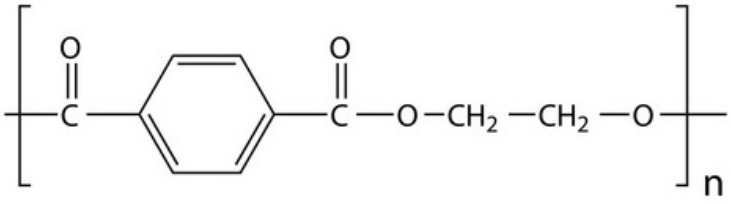
c) Calculate the volume of hydrochloric acid required to complete the neutralisation reaction. **2**

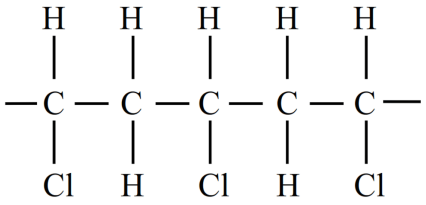
Conc of $Ba(OH)_2 = 0.01/2 = 0.005$ mol L^{-1}
mol of $Ba(OH)_2 = C \times V = 0.005 \times 0.2 = 0.001$ mol
from equation, 0.001 mol $Ba(OH)_2$ requires 0.002 mol HCl
Volume of HCl = n/C = 0.002/ 0.2 = 0.01L (10.0 mL of acid)

Criteria	Mark
• Correctly calculates volume of acid required by any method	3
• Calculates a volume of acid required but with a calculation error	2
• Calculates concentration of Barium hydroxide • OR moles of Barium hydroxide • OR correctly uses the moles ratio in a calculation	1

Question 22 (6 marks)

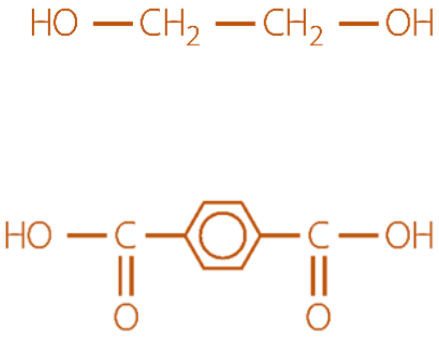
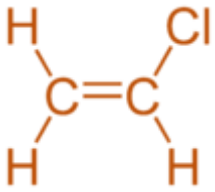
The structures of two polymers polyethylene terephthalate labelled as A and polyvinylchloride labelled as B are shown below.





A B

a) In the table below, draw condensed structural formulae of the monomers used to make polymers A and B. **2**

Polymer A	Polymer B
	

Criteria	**Mark**
• All 3 monomers drawn correctly	**2**
• 2 monomers drawn correctly	**1**

b) Identify and compare the types of polymerisation reactions that occur to produce polymers A and B. **4**

Polymer A: The type of reaction that occurs is condensation polymerisation.
Condensation polymer is not accepted
Polymer B: type of reaction: addition polymerisation. Addition polymer not accepted
Similarities

- Both reactions involve the chemical combination of a large number of small simple molecules called monomers.
- Both reactions require a catalyst (organic or inorganic) to occur.
- Both reactions produce products which are long chained molecules called polymers with large molecular mass.
- Both reactions produce products/polymers which may vary in length.

Differences

- Addition polymerisation involves monomers which have at least one double or a triple bond while condensation polymerisation involves monomers that has two different functional groups to combine.
- Addition polymerisation involves only one type of monomer while condensation polymerisation involves one or more monomers.
- Only polymer is formed as a product by addition polymerisation while condensation polymerisation results in producing an additional by product such as water.
- Addition polymerisation produces polymer which have carbon-carbon backbone structure while condensation polymerisation produces polymer having functional groups such as ester or amide.

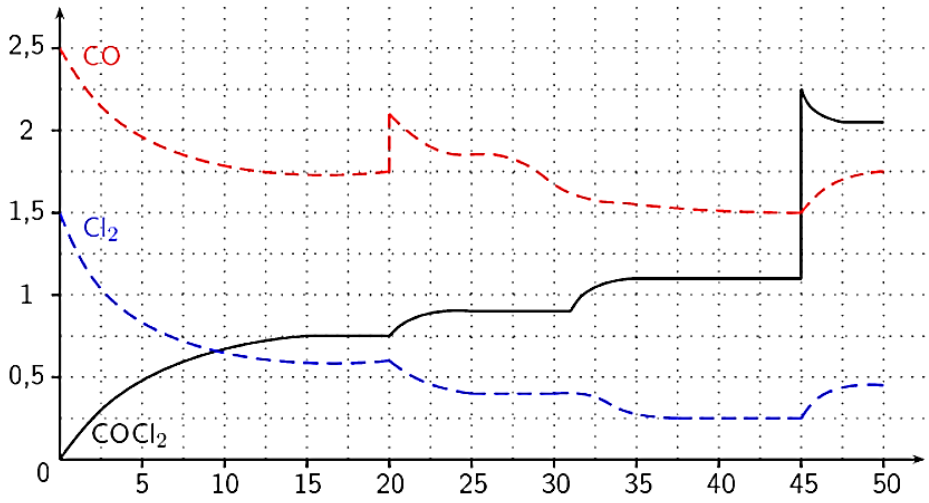
- In addition polymerisation the molar mass of the polymer is same as reactants total mass while in condensation polymerisation polymer has lower mass.

Criteria	Mark
• Correctly identifies A as condensation polymerisation and B as addition polymerisation reactions • Provides at least one similarity and two differences OR • Two similarities and one difference	4
• Any response in above is missing (less 1 mark)	0-3

Question 23 (9 marks)

Consider the following chemical equilibrium and graph and answer the questions that follow:

$$CO\ (g) + Cl_2\ (g) \rightleftharpoons COCl_2\ (g)$$



a) Write the expression for the equilibrium constant K_{eq} for this reaction. **1**

$$K = \frac{[COCl_2]}{[CO][Cl_2]}$$

Criteria	Mark
• Equilibrium expression written correctly	1

b) How much time was necessary for the system to reach equilibrium for the first time? **1**

15 seconds (12.5 s is acceptable)

Criteria	Mark
• Correctly indicates time	1

c) Compare the rates of the forward and reverse reactions at t = 5s and t = 17 s **2**

At t = 5s, the rate of the forward reaction is greater than the rate of the reverse reaction (concentrations of reactants are decreasing, and conc of product is increasing)

At t = 17s the rates of the forward and reverse reactions are equal and the system has reached equilibrium

Criteria	Mark
• Forward and reverse reaction rates are correctly stated for both times	2
• Forward and reverse reaction rates are correctly stated for only one time	1

d) Determine K_{eq} for the system at t = 17 s **1**

Accepted concentration of chlorine between range 0.57-0.64 (given allowance to margin of error)
The value of K accepted range 0.7518 – 0.6696
The exact value is 0.6

$K = \frac{0.75}{1.75 \times 0.6}$
$= 0.714$

Criteria	Mark
• Substitutes correct values into expression to calculate K	1

Question 23 (continued)

e) What happens at t = 20 s? Explain your answer by referring to Le Chatelier's principle and collision theory. **3**

At t=20 s, CO gas has been injected into the equilibrium system. According to Le Chatelier's principle, the equilibrium shifts so as to counteract the change. i.e. equilibrium has shifted to the right, increasing the concentration of product.
When CO was introduced to the system, its concentration increased rapidly, resulting in more frequent successful collisions between CO and Cl_2 molecules. This increased the rate of the forward reaction, leading to a decrease in the concentration of reactants, and an increase in the concentration of products. (As more product molecules were formed, the rate of the reverse reaction increased until the rates of the forward and reverse reactions became equal and a new equilibrium was established)

Criteria	Mark
• States that CO gas has been introduced at t = 20 s • Relates shift in equilibrium to Le Chatelier's principle • Uses collision theory correctly to explain shift in equilibrium due to increased concentration of CO	3
• States that CO gas has been introduced at t = 20 s • Relates shift in equilibrium to Le Chatelier's principle	2
• States that CO gas has been introduced at t = 20 s	1

Question 24 (6 marks)

Dinitrogen tetroxide (N_2O_4) is an almost colourless liquid which boils at 21°C. In the gaseous state it exists in equilibrium with nitrogen dioxide (NO_2) which is an intensely brown coloured gas.

$$\underset{\text{Colourless}}{N_2O_{4(g)}} \leftrightarrows \underset{\text{Brown}}{2NO_{2(g)}} \quad \Delta H = 58 \text{ kJ mol}^{-1}$$

To study this equilibrium a chemist injects 0.024 mmol of liquid N_2O_4 into a 1.0 L evacuated flask. Using a colorimeter, it is observed that when the flask is heated to 50°C, 50% of the N_2O_4 has decomposed to NO_2.

a) Determine the equilibrium concentration of each gas at 50°C, and hence calculate the equilibrium constant K_c. under these conditions.

2

As each molecule of N_2O_4 produces two molecules of NO_2, the equilibrium concentrations are:

$[N_2O_4] = 0.012$ mol L^{-1} $[NO_2] = 0.024$ mol L^{-1}

and $K_c = [NO_2]^2 / [N_2O_4] = 0.024 \times 0.024/0.012 = 0.048$

Criteria	Mark
Calculates the equilibrium concentration of each gas. Calculates the equilibrium constant	**1** **1**

b) The experiment, at 50°C, is repeated starting with 0.040 mol of liquid N_2O_4. Predict and explain any difference in the extent (%) of dissociation to NO_2.

2

The dissociation of dinitrogen tetroxide will be less than 50% (about 42% as calculated using values). Reason: Initially more collisions between dinitrogen tetraoxide molecules will favour the forward reaction. However, as the number of moles/ volumes of nitrogen dioxide produced is double than N_2O_4. This will increase pressure and shift equilibrium to the left to decrease dissociation of N_2O_4.

Criteria	Mark
• Identifies that the change increases the pressure in the system which shifts the equilibrium to the left according to LCP • Correctly relates shift in equilibrium to reduced dissociation of reactant molecules	**2**
• Identifies that the change increases the pressure in the system which shifts the equilibrium to the left according to LCP	**1**

c) The temperature is raised to 60°C. **2**

Predict and explain the effect on the equilibrium constant (K_c).

At 60ºC the value of K_c would be higher than that at 50ºC. The forward reaction is endothermic. According to Le Chatelier's Principle, the equilibrium will shift to the products side to absorb heat when the temperature is increased. A higher concentration of products will increase the value of K_c

Criteria	Mark
• States that the equilibrium constant increases • Explains the effect of temperature on the equilibrium constant by referring to endothermic forward reaction.	**2**
• States that the equilibrium constant increases	**1**

Question 25 (4 marks)

A solution is prepared by mixing 50.0 mL of 0.0100 mol L^{-1} lead(II) nitrate with 50.0 mL of 0.0200 mol L^{-1} of sodium bromide.

a) Write an equation for this reaction.

$Pb(NO_3)_2(aq) + 2NaBr(aq) \rightarrow PbBr_2(s) + 2NaNO_3(aq)$

Criteria	Mark
• Balanced equation written correctly	1

b) Write the expression for the solubility product of the precipitate formed

$K_{sp} = [Pb^{2+}][Br^-]^2$

Criteria	Mark
• Ksp expression written correctly showing correct symbol and charges	1

c) Predict whether a precipitate will form. Show your working

Since volume is doubled when two solutions are mixed, concentrations of solutions will be halved, i.e $[Pb^{2+}] = 0.005$ mol/L and $[Br^-] = 0.005$ mol/L

Ionic product, $Q = 0.005 \times 0.01^2 = 5.0 \times 10^{-7}$

Since K_{sp} for $PbBr_2 = 6.6 \times 10^{-6}$ and $Q < K_{sp}$, then no precipitate will form

Criteria	Mark
• Value of Q is determined • Q compared to K • Correct prediction of precipitate	3
• Value of Q is determined • Correct prediction of precipitate	2
• Q is determined OR values are wrong however make correct relation between the wrong value and K_{sp} and predict precipitation.	1

Question 26 (5 marks)

Ammonia (found as ammonium hydroxide in solution) is often used as a window cleaning agent. Quality control checks on the concentration of ammonia are conducted that involve titrating the cleaning agent with standardised sulfuric acid.

The equation for the reaction is:

$$2NH_4OH_{(aq)} + H_2SO_{4\ (aq)} \rightarrow (NH_4)_2SO_{4\ (aq)} + 2H_2O_{(l)}$$

a) Explain the importance of standardising the sulfuric acid before completing this titration **2**

Standardising the sulfuric acid solution means that its concentration is accurately known. This is important because the calculation for the concentration of the ammonium hydroxide relies on accurately knowing the concentration of the sulfuric acid. Sulphuric acid is hygroscopic substance and absorbs moisture hence its concentration need to be exactly worked out.

Criteria	Marks
• Demonstrates understanding of concept of standardisation. • States that sulphuric acid concentration can vary due to hygroscopic nature as such its exact concentration need to be known. • States that to determine concentration of unknown(ammonia) one reactant concentration need to be known for validity.	2

• One of the above	**1**

50.0 mL of cleaning agent is diluted to 250.0 mL and 25.0 mL aliquots this solution were titrated against standardised sulfuric acid. The results of this titration are provided in the table below.

	Titres			
	Trial 1	Trial 2	Trial 3	Trial 4
Volume of H_2SO_4 (aq) required to reach end point (mL)	38.50	37.35	37.40	37.45
Concentration of standardised H_2SO_4 (aq)	0.170 M			

b) Calculate the concentration of ammonia in the original cleaning agent. **3**

$V(H_2SO_4)$ = (37.35 + 37.4 + 37.45 /3)
= 37.4 mL (average volume is determined)
$n(H_2SO_4)$ = cV = 0.17 * 0.0374
= $6.358 * 10^{-3}$
$n(NH_4OH)$ = 2*$n(H_2SO_4)$ = 0.012716 mol
$C(NH_4OH)$ = 0.012716 / 0.025
= 0.50864 $molL^{-1}$
$C_1V_1 = C_2V_2$
C_1 * 0.05 * 0.25 * 0.50864
C_1 = 2.50 mol L-1

Criteria	Marks
• Average volume calculated based on concordant data • Correct diluted concentration of solution found • Correct original concentration of solution found	**3**
• Two of the above	**2**
• One of the above	**1**

Question 27 (7 marks)

Hypoiodous acid (HOI) and hypobromous acid (HOBr) are two weak acids. A solution of hypoiodous acid has a concentration of 0.100 mol L^{-1} and a pH of 5.80. A solution of hypobromous acid with the same concentration has a pH of 4.77.

a) A student wrote the Ka values for these acids as 2.5×10^{-11} and $2.5 \times 10^{-9,}$ but forgot which was which. Identify which acid each Ka belongs to and explain why.
The smaller Ka (2.5 * 10-11) belongs to the weaker acid, as a smaller value for Ka means less dissociation. HOI is weaker, because the solutions are equal concentration but the pH is higher, meaning less dissociation and therefore a lower [H+]. Therefore, Ka(HOI) = 2.5 * 10^11, and Ka(HOBr) = 2.5 * 10^-9

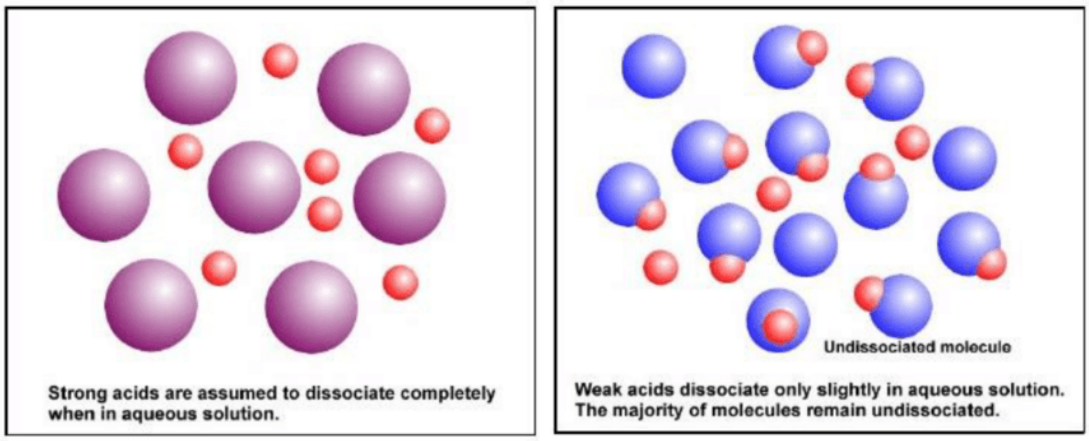
Criteria	Marks
• Identifies that a weaker acid of the same concentration will have a higher pH due to lower H+ concentration OR vice versa • States that low pH of HOBr means higher dissociation of acid into Hydrogen positive ions and hence stronger acid and higher value of K_a • Correctly identifies which Ka belongs to which acid based upon above.	**3**
• State two of above	**2**

• Links smaller Ka to weaker acid ONLY OR • States one of above	**1**

b) Calculate the pK_a for each acid and identify the relationship between pK_a and acid strength.
HOI pKa = -log10(2.5*10^-11) = 10.6
HOBr pKa = - log10(2.5*10^-9) = 8.6
Because HOBr is a stronger acid (part a), it can be seen that the lower the pKa, the stronger the acid.

Criteria	Marks
• Correct calculation of pKa • Links higher pKa to weaker acid / lower pKa to stronger acid	**2**
• Correct calculation of pKa OR Links higher pKa to weaker acid or lower pKa to stronger acid	**1**

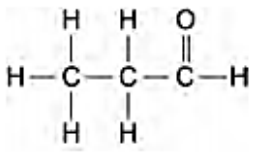
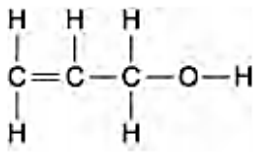
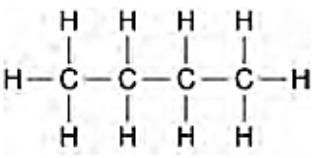
c) In the space below, draw model diagrams to show the difference in the strength of hypoiodous acid and hydrochloric acid (a strong acid).



Criteria	Marks
• Strong acid (HCl) has complete dissociation shown • Weak acid (HOI) has some dissociation but some molecular acid remaining	**2**
• One of the above only	**1**

Question 28

The table below shows the name and structure of 3 organic molecules

Name	Propanal	Prop-2-en-1-ol	Butane
Structure			

Sequence the three molecules from highest to lowest boiling point, and justify your choice.

Molecular mass is the same for all molecules so this will not factor in to the BP, as a higher mw = higher bp. The different functional groups account for the different BPs. Lowest = butane; no polar bonds, so only dispersion forces between the molecules = weakest imf. Second = propanal: C=O is

polar and can form dipole-dipole bonds between moelcules, which is a reasonable strength imf. Highest = prop-2-en-1-ol, due to the presence of the highly polar -OH bond which can form hydrogen bonds between molecules, the strongest imf.

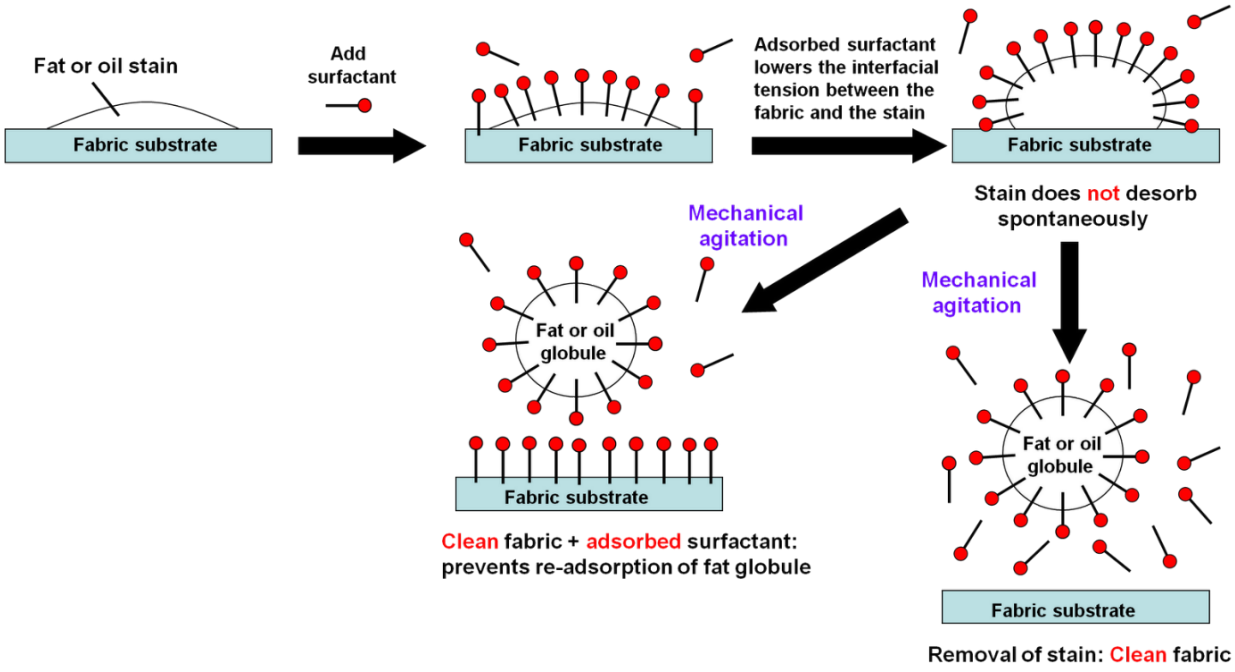
Criteria	Marks
• Correct sequence of boiling points • Justifies that all molecules have same mw so this won't factor in • Identifies different types of imf in each molecule • Relates the relative strengths of the imf's to the bp of the molecules	**4**
• Correct sequence of boiling points • Identifies different types of imf in each molecule • Relates the relative strengths of the imf's to the bp of the molecules	**3**
• Correct sequence of boiling points • Identifies different types of imf in each molecule	**2**
• Some relevant information relating boiling point to intermolecular forces	**1**

Question 29 (4 marks)

Explain how the surfactant properties of the sodium salts of long chain fatty acids help to clean grease from dirty dishes. Include a diagram to support your answer.

Soap has a long hydrocarbon tail that readily dissolves in oily and waxy substances (hydrophobic) and an ionic head that easily dissolves in water (hydrophilic).

When soap is added to water in which dirty clothes are soaked, the two parts of the soap molecule dissolves in two different mediums. The organic tail attaches onto the oily dirt, grime or grease and the ionic head dissolves in water. When the clothes are rinsed or agitated, the dirt gets pulled out of the surface in the water by the soap molecules forming a closed structure called a micelle, with the polar head structure on the outside and the tail structure on the inside. The micelle traps the dirt and grease inside and allowing the heads of the soap molecules to interact with and be dispersed in the water which can be rinse away to remove the grease and oil.



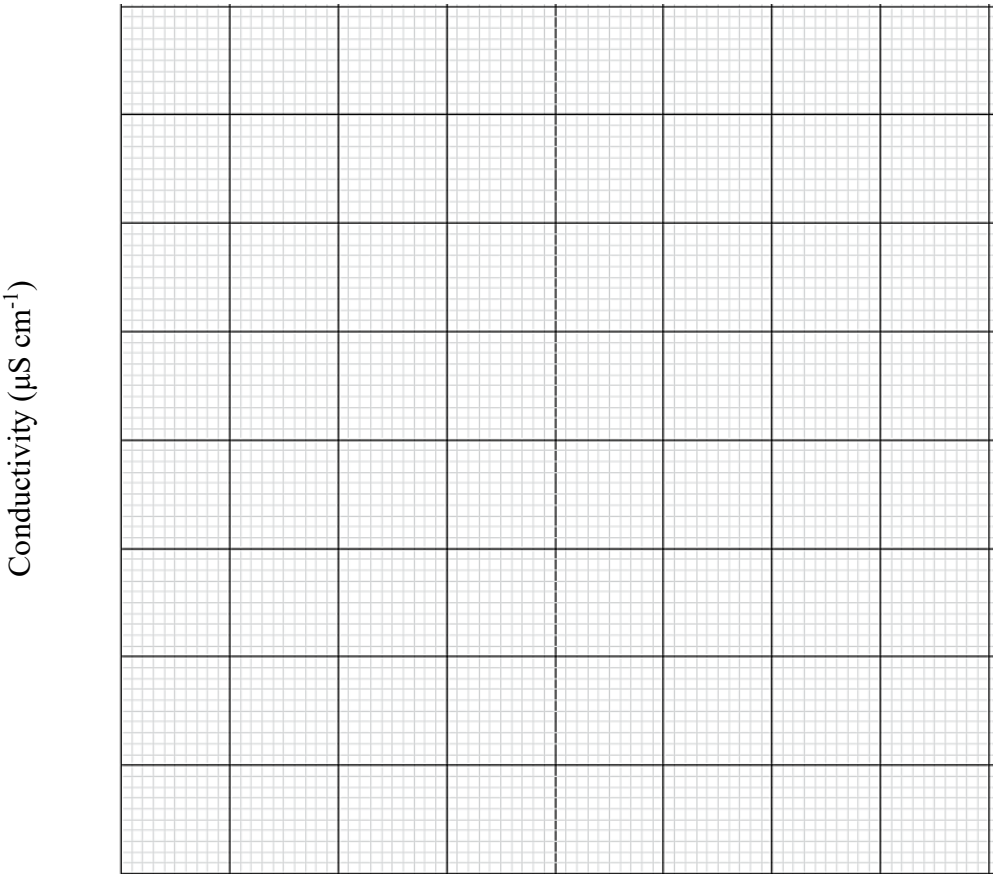
Criteria	Marks
• Structure of a soap molecule is described with the hydrophobic and hydrophilic portions • The structure of the soap molecule is related to its ability to dissolve in both grease/fat and water • The cleaning action of soap to blend the two together and remove from surfaces • Relevant diagram showing the cleaning action	**4**
• Three of the above	**3**
• Two of the above	**2**
• Any relevant information	**1**

Question 30 (7 marks)

A conductometric titration was carried out to determine the concentration of a potassium sulfate solution. Barium chloride (0.500 M) was titrated into a beaker containing 50.00 mL potassium sulfate solution, and the conductivity of the solution measured. and hence calculate the concentration of the unknown solution.

$BaCl_2$ volume (mL)	*Conductivity ($\mu S\ cm^{-1}$)*
2.6	1795
2.8	1757
3.0	1722
3.2	1680
3.4	1700
3.6	1742
3.8	1783

a) Use the data in the table to construct a conductometric titration curve below. **3**



b) Write an equation for the reaction between barium chloride and potassium sulfate. **1**

$BaCl_2(aq) + K_2SO_4(aq) \rightarrow BaSO_4(s) + 2KCl(aq)$

Criteria	Marks
• Writes a correct balanced chemical equation	**1**

c) Use the graph to determine the amount of barium chloride required to completely react with the potassium sulfate.

3.22 mL

Criteria	Marks
• Volume between 3.21 and 3.23 mL	**1**

d) Calculate the concentration of the potassium sulfate solution. **2**

$N(BaCl_2) = 0.5 * 0.00322$
$= 1.611 * 10^{-3}$ mol
$= n(K_2SO_4)$
$C(K_2SO_4) = 1.611*10^{-3} / 0.05$
$= 0.0322$ mol L-1 (0.0321 – 0.0323 M acceptable)

Criteria	Marks

• Correct moles of barium chloride & potassium sulfate found • Correct concentration of potassium sulfate	**2**
• Incorrect mole calculation but correct concentration calculation OR • Correct mole calculation but incorrect concentration calculation	**1**

Question 31 (3 marks)

A student reacted 250.0 mL of a 0.500 mol L^{-1} solution of sulfuric acid with 500.0 mL of a 0.500 mol L^{-1} solution of potassium hydroxide. The temperature rose by 4.20°C. Calculate the enthalpy of neutralisation.

$H_2SO_4 + 2KOH \rightarrow 2H_2O + K_2SO_4$

$N(H_2SO_4)$ = 0.25 * 0.5
= 0.125 mol

n(KOH) = 0.5 * 0.5
= 0. 25 mol

q = mcΔT
= 750 * 4.18 * 4.2
= 13167 J per 0.25 mol KOH = 0.25 mol water

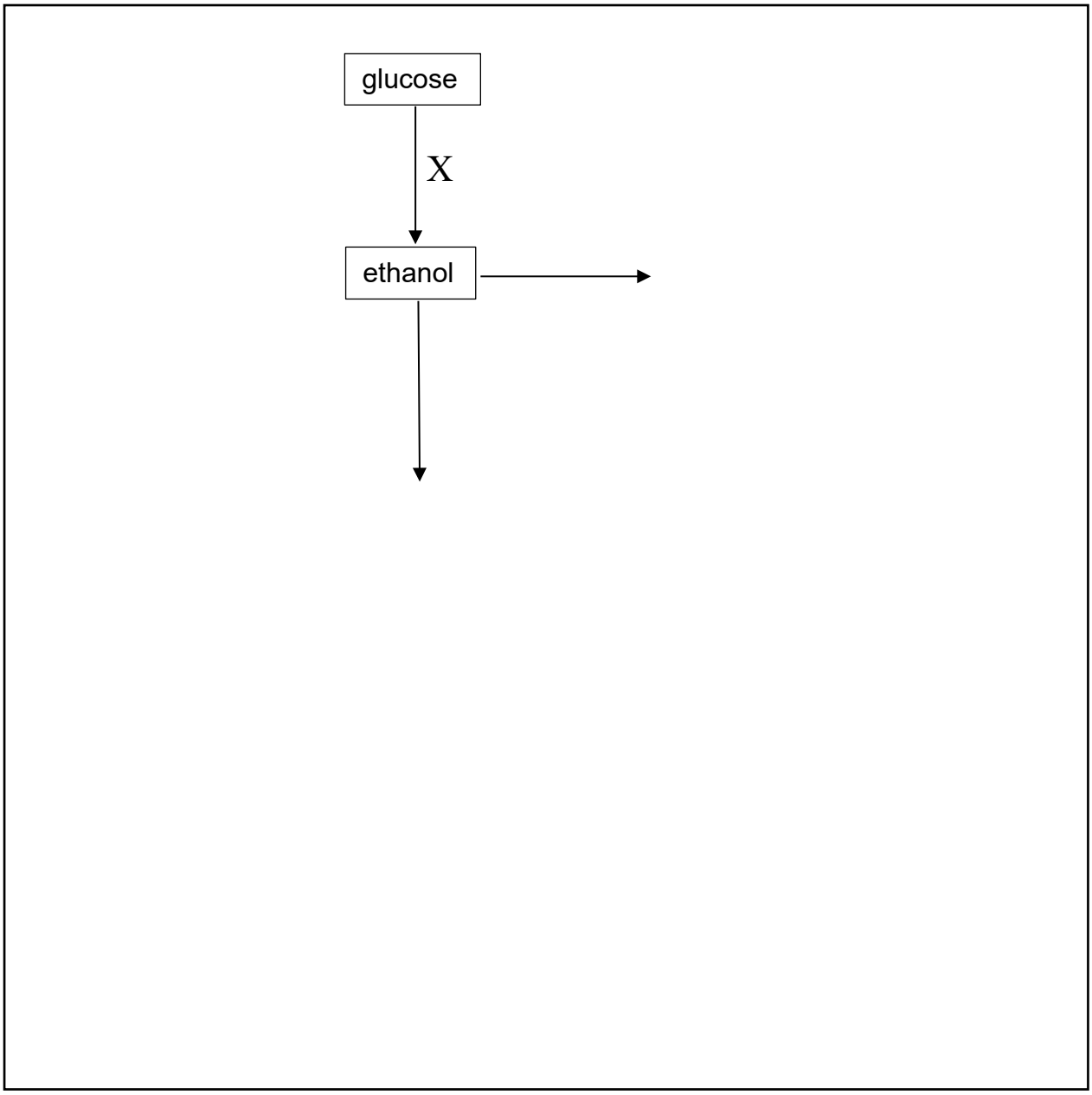
ΔHn = -q/n
= -13167 / 0.25
=-52 668 kJ mol-1
= -52. 7 kJ mol-1

Criteria	Marks
• Calculates correct amount of heat released • Calculates correct moles of water formed • Calculates correct enthalpy of neutralisation	**3**
• One error in the above	**2**
• Two errors in the above	**1**

Question 32 (12 marks)

You are provided with glucose ($C_6H_{12}O_6$), yeast and water.

a) Complete the flow diagram below for the production of chloroethane, ethanal, and ethanoic acid from these starting materials. Include structural formulas for each product, and the reagents and conditions required.



a) Identify process X and state the conditions required. **2**

Process X is fermentation -requires warm, moist, anaerobic environment. It is carried out by an enzyme found in the yeast organism.

$C_6H_{12}O_6(aq) \rightarrow C_2H_5OH(l) + CO_2(g)$

Criteria	Marks
• Correctly identifies the process and identifies the conditions required	**2**
• Identifies the process only	**1**

b) Two of the above products can be used to produce an ester. Write the equation for the

esterification reaction and name the product. **2**

$C_2H_5OH(l) + CH_3COOH(l) \rightarrow C_2H_3OOC_2H_5(l) + H_2O(l)$

Product: ethyl ethanoate

Criteria	Marks
• Correct equation • Ester properly named	**2**
• Correct equation but ester not properly named OR • Incorrect equation and ester properly named	**1**

a) Explain why the process of reflux is used in esterification reactions in a laboratory. **2**

The high temperature used would cause some of the volatile compounds (e.g. ethanol) to vaporise, and therefore escape the reaction vessel. Reflux using the water-cooled condenser prevents this less by condensing the vapour which returns it to the reaction vessel.

Criteria	Marks
• Relates high temperature to loss of volatile compounds • Links reflux to condensation of volatile compounds and return to reaction chamber to maximise yield	**2**
• Partial explanation only	**1**

b) Describe and justify the procedures required to safely handle and dispose of organic substances such as those used in esterification. **2**

Flammable organic solvents such as ethanol should be handled in a well-ventilated area and away from naked flames to avoid inhalation of vapours and/or potential fires and explosions. Waste organic compounds should not be disposed down the sink, but collected for specialist treatment, as many organic compounds can be toxic to organisms.

Criteria	Marks
• Safe handling and disposal procedures for organic substances are described and justified	**2**
• Safe handling and disposal procedures for organic substances are described.	**1**

Question 32 (7 marks) **7**

Evaluate the use of biofuels, such as ethanol, in comparison to hydrocarbons extracted from the earth, such as octane, in regards to their chemistry and impact on the environment. Include relevant chemical equations in your response.

Criteria	Marks
• Clearly defines difference between biofuel and hydrocarbon extracted from the Earth • Thoroughly assesses ethanol as a biofuel in terms of chemistry and impact on the environment	**7**

• Thoroughly assesses octane as a hydrocarbon from the Earth in terms of chemistry and impact on the environment • Provides a judgement based on the assessments • Includes at least two correct, relevant chemical equations	
• Defines difference between biofuel and hydrocarbon extracted from the Earth • Assesses ethanol as a biofuel in terms of chemistry and impact on the environment • Assesses octane as a hydrocarbon from the Earth in terms of chemistry and/or impact on the environment • Provides a judgement based on the assessments • Includes correct, relevant chemical equations	**6-5**
• Assesses ethanol as a biofuel in terms of chemistry or impact on the environment AND • Assesses octane as a hydrocarbon from the Earth in terms of chemistry or impact on the environment • Includes at least one relevant chemical equation	**4-3**
• Identifies environmental impacts of biofuels and/or fossil fuels • Outlines chemical properties of biofuels and/or fossil fuels	**2-1**

Q33 Detailed Marking Guidelines

Very clear definitions of and distinction between biofuels and fossil fuels

Biofuel: fuel derived from biomass eg ethanol produced from fermentation of glucose derived from crops such as corn or sugar cane (include fermentation equation) BD

Hydrocarbons extracted from the Earth: e.g octane obtained by fractional distillation of petroleum, a fossil fuel produced from decomposition of ancient organisms. FD

Assessment of biofuels and fossil in terms of chemistry and impact on the environment

A clear and thorough assessment of each type of fuel referring to both positive and negative impacts on the environment and aspects of chemistry.

Biofuels:

Environment Positive impacts (examples) (BFE+)

- Renewable resource
- Carbon neutral (depending on energy source for distillation)
- Reduced CO_2 emissions from combustion (CO_2 emissions must be linked to greenhouse effect/climate change etc)
- No requirement for drilling/mining/fracking

Environment Negative Impacts (examples) (BFE-)

- Land clearing required for growing crops, deforestation, erosion etc
- CO_2 emissions from distillation if non-renewable energy used

Fossil Fuels:

Environment Positive impacts (example) (FFE+)

- Drilling can reduce pressure in underground reserves, reducing seepage into environment

Environment Negative Impacts (examples) (FFE-)

- Non-renewable resource
- Environmental damage from drilling/mining/fracking
- CO_2 emissions from combustion/extraction must be linked to greenhouse effect/climate change etc
- Impacts of products of incomplete combustion

Biofuels:

Chemistry Positive impacts (examples) (BCE+)

- Burns cleanly (must include explanation)
- Reduced CO_2 emissions
- Include relevant equations

Chemistry Negative impacts (examples) (BCE-)

- Lower energy density

Fossil Fuels:

Chemistry Positive impacts (examples) (FCE+)

- Higher energy density

Chemistry Negative impacts (examples) (FCE-)

- Incomplete combustion

End of Exam