

Hornsby Girls' High School

2023

Year 12 - Assessment Task 1 Processing and Analysing Data



Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 60 minutes
- Write using blue or black pen.
- Attempt all questions.
- Draw diagrams using a pencil.
- NESA-approved calculators must be used.
- A data sheet, formulae sheets and Periodic Table are provided.
- Write your student number at the top of this page and multiple-choice answer sheet.
- The multiple-choice answer sheet may be detached for convenience.
- Marks are as indicated in brackets.

Total marks – 50 marks

- **Section 1 – Knowledge and understanding**
Multiple Choice 15 marks
- **Section 2 – Working scientifically**
Written Responses 35 marks

Section 1 – Multiple Choice [15 marks]

Attempt Questions 1–15

Allow about 15 minutes for this section.

Use the multiple-choice Answer sheet for Questions 1 – 15. This sheet can be *detached* from the back and placed *inside* the front cover at the end of the exam.

Question 1

Which of the following may occur in a closed chemical system?

- a) Energy and matter are exchanged with the surroundings.
- b) Energy, but not matter, is exchanged with the surroundings.
- c) Matter, but not energy, is exchanged with the surroundings.
- d) Neither energy nor matter are exchanged with the surroundings.

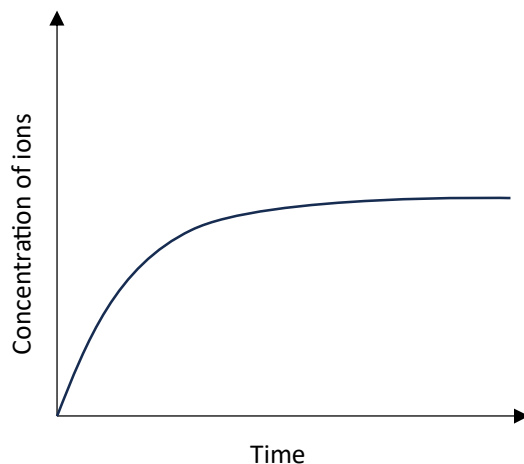
Question 2

What are the conditions required for an effective collision between reactants?

- a) Low temperature and correct orientation
- b) Low temperature and energy less than the activation energy
- c) High temperature and energy less than the activation energy
- d) Correct orientation and energy greater than the activation energy

Question 3

A method used by indigenous Australians to detoxify certain seeds is to crush and soak the seeds in water removing the water-soluble toxins from the seed. A graph of this process is shown below.



Which statement correctly accounts for the shape of this graph?

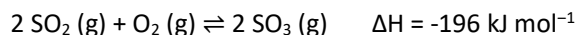
- a) The concentration of ions increases as the seeds are crushed.
- b) The concentration of ions increases the longer the seeds soak in the water.
- c) The concentration of ions increases until the toxin has been completely removed.
- d) The concentration of ions increases until the equilibrium is established with the water.

Question 4

Increasing the temperature of an endothermic reaction results in

- a) More products and fewer reactants.
- b) More reactants and products.
- c) More reactants and fewer products.
- d) Decrease in concentration of reactants and products.

Questions 5 and 6 refer to the following reaction at equilibrium in a closed reaction vessel.



Question 5

Which of the following changes will initially decrease the rate at which $\text{SO}_2 (\text{g})$ is consumed?

- a) decrease the volume of the reaction vessel.
- b) decrease the partial pressure of $\text{O}_2 (\text{g})$.
- c) increase the temperature of the reaction vessel.
- d) add an appropriate catalyst.

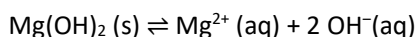
Question 6

Which of the following changes will increase the yield of $\text{SO}_3 (\text{g})$ in the reaction?

- a) remove $\text{O}_2 (\text{g})$ from the reaction vessel
- b) add an inert gas to the reaction vessel
- c) increase the volume of the reaction vessel
- d) decrease the temperature of the reaction vessel

Question 7

Which of the following is the correct equilibrium constant expression for the dissolution of calcium hydroxide, represented by the following equation?



- a) $K = [\text{Mg}^{2+}] [\text{OH}^{-}]^2 / [\text{Mg}(\text{OH})_2]$
- b) $K = [\text{Mg}^{2+}] [2\text{OH}^{-}]^2$
- c) $K = [\text{Mg}^{2+}] [\text{OH}^{-}]^2$
- d) $K = 1 / [\text{Mg}^{2+}] [\text{OH}^{-}]^2$

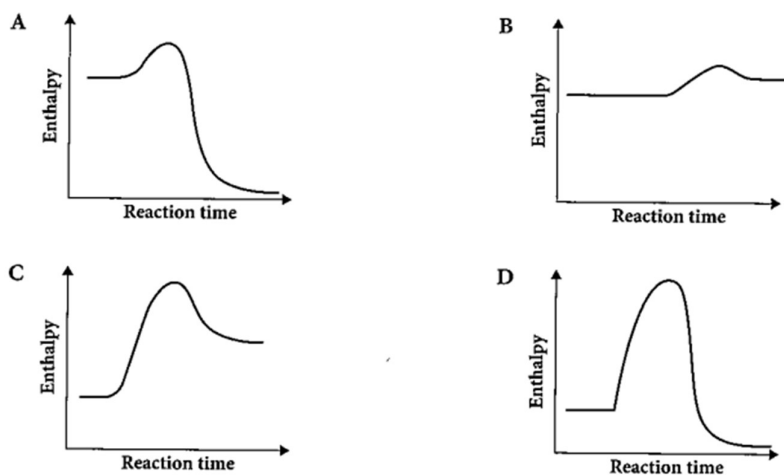
Question 8

Which of the following compounds has the greatest solubility in mol L^{-1} ?

- a) Barium hydroxide
- b) Lead(II) chloride
- c) Magnesium hydroxide
- d) Calcium sulfate

Question 9

Which one of the following energy profile diagrams at constant temperature would best represent a spontaneous endothermic reaction?



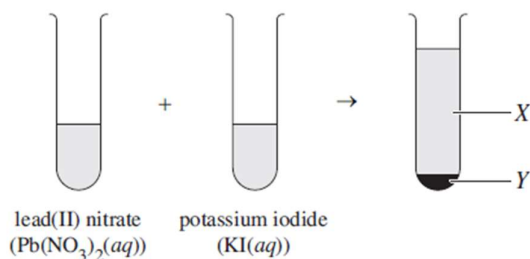
Question 10

The enthalpy change, ΔH , of a reaction is -30 kJ mol^{-1} , and the entropy change, ΔS , is $-90 \text{ J K}^{-1} \text{ mol}^{-1}$. At what temperature will this reaction change from spontaneous to non-spontaneous?

- a) 30°C
- b) 333°C
- c) 670 K
- d) 333 K

Question 11

The diagram shows two solutions being mixed.



Which row of the table identifies X and Y?

	X	Y
a)	$\text{PbI}_2(\text{aq})$	$\text{KNO}_3(\text{s})$
b)	$\text{KNO}_3(\text{aq})$	$\text{PbI}_2(\text{s})$
c)	$\text{PbI}_2(\text{s})$	$\text{KNO}_3(\text{aq})$
d)	$\text{KNO}_3(\text{s})$	$\text{PbI}_2(\text{aq})$

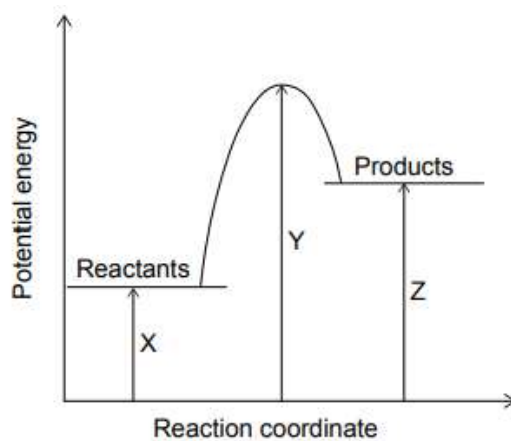
Question 12

What is the molar solubility of silver carbonate in a solution of 0.153molL^{-1} calcium carbonate?

- a) $5.53 \times 10^{-11}\text{ M}$
- b) $1.69 \times 10^{-11}\text{ M}$
- c) $7.44 \times 10^{-6}\text{ M}$
- d) $6.26 \times 10^{-6}\text{ M}$

Question 13

The graph shows an energy profile of a reaction.

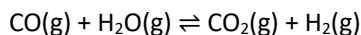


What combination is correct?

	Activation energy of forward reaction	Activation energy of reverse reaction
a)	X	Z
b)	$Y - X$	$Y - Z$
c)	Y	Y
d)	$Y - X$	$Z - X$

Question 14

Carbon monoxide reacts with water according to the following equilibrium system:



1.00 mol of CO reacts with 2.00 mol of H₂O in a fixed volume of 2.00 L and temperature controlled environment. When the reaction reaches equilibrium, the concentration of CO₂ is 0.250 mol L⁻¹.

What is the equilibrium constant, K_{eq}, of this reaction?

- a) 0.0313
- b) 0.125
- c) 0.333
- d) 1.33

Question 15

A student combusted 10.0g of butan-1-ol (C₄H₁₀O) to heat 150.0mL of water. The table shows the initial and final temperatures of the water.

T _{Initial} (°C)	24.0
T _{Final} (°C)	45.5

What is the value of the **molar enthalpy of combustion** of butan-1-ol, assuming there is no heat lost to the environment.

- a) -1.3480 x 10⁴ J/mol
- b) 9.99 kJ/mol
- c) 13480.5 J/mol
- d) -9.99 x 10⁴ J/mol

End of Section 1- Multiple Choice

Section 2 – Written responses [35 marks]

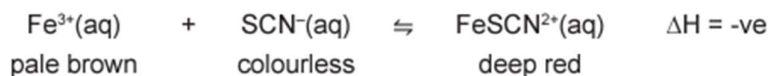
Attempt Questions 16 – 23

Allow about **50 minutes** for this section.

Answer questions in the space provided. These spaces provide guidance for the expected length of response. Show all relevant working in questions involving calculations. An extra writing sheet is on page 16, if needed.

Question 16 [6 marks]

Consider the following system at equilibrium:

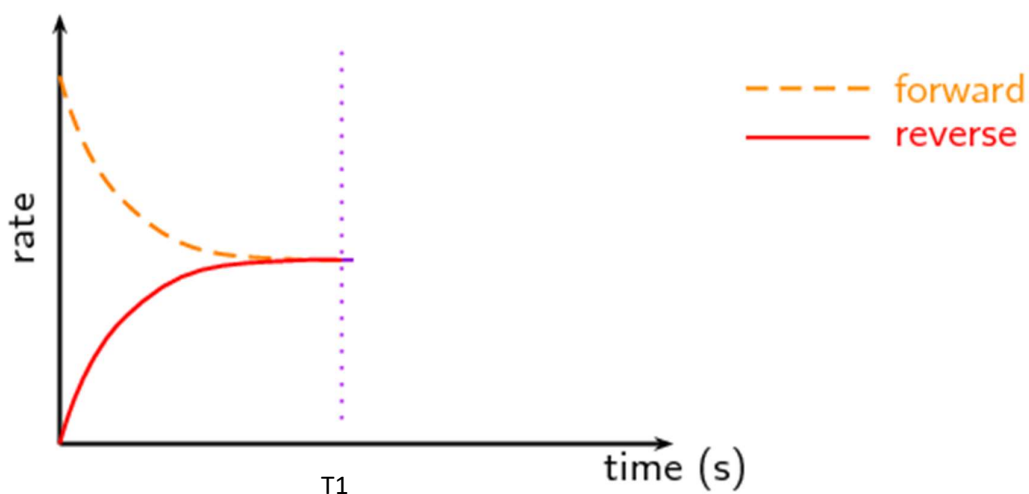


For each of the applied changes after equilibrium is re-established, complete the table below and predict the: (4 marks)

- shift in equilibrium position (left, right or no change)
- rate of the forward reaction compared to the original rate (increase, decrease or no change)
- colour of the reaction mixture (pale brown, colourless, deep red).

Change	Shift in equilibrium position (left, right or no change)	Rate of the forward reaction compared to original rate (increase, decrease or no change)	Colour of reaction mixture
The reaction mixture is heated			
A few crystals of FeCl_3 are added			
Water is added to the reaction mixture			
A few drops of concentrated Na_3PO_4 are added			

b) Complete the graph below for when water is added, at T1, to the reaction mixture (2 marks)

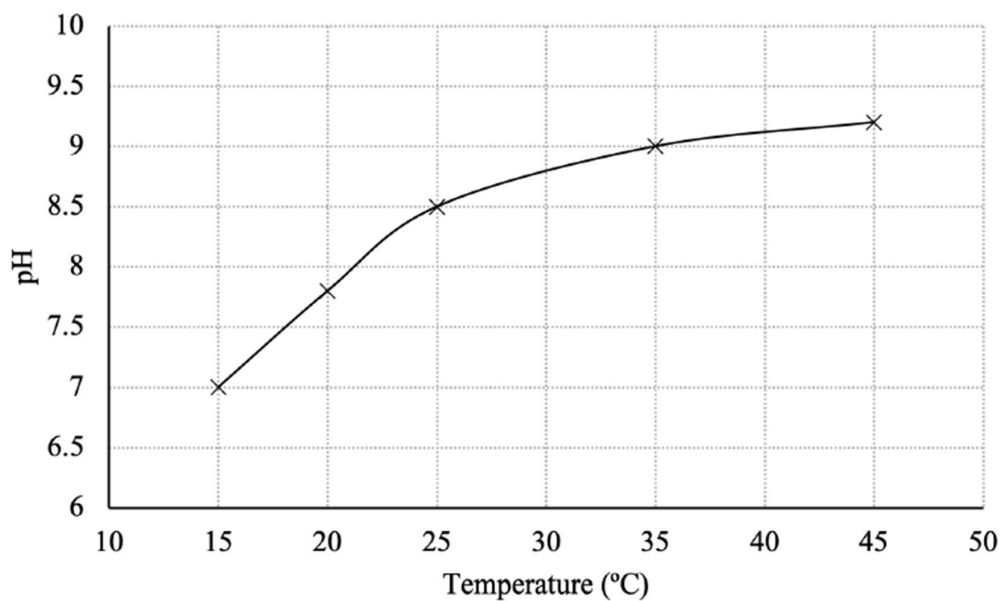


Question 17 [3 marks]

3.50 g of calcium chloride is added to 100.0 mL of 0.100 mol L^{-1} sodium sulfate at 25°C . **Show** that a precipitate is formed and **calculate** the concentration of calcium ions when the solution comes to an equilibrium.

Question 18 [3 marks]

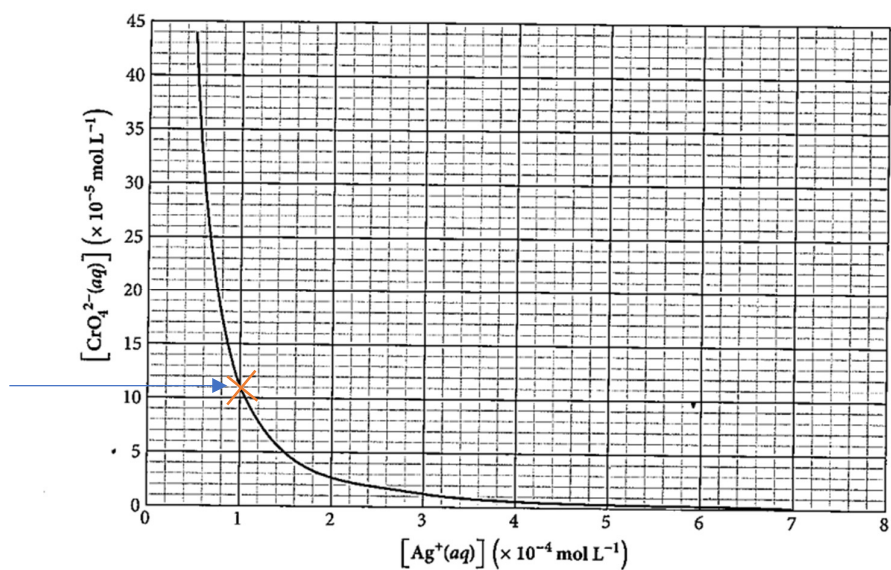
Excess solid iron(III) hydroxide is added to water to produce a saturated solution. The graph below shows the pH of this solution at various temperatures. {Note: The higher the pH the higher the $[\text{OH}^-]$.}



ΔH is the change in enthalpy of iron(III) hydroxide's dissolution in water. Justify what happens to the mass of the precipitate as the temperature increases and the ΔH of the reaction.

Question 19 [2 marks]

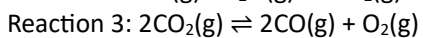
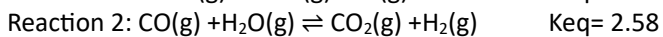
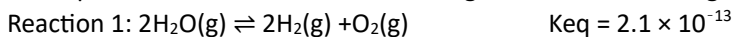
The graph shows the concentration of silver and chromate ions which can exist in a saturate solution of silver chromate.



Using the information provided, calculate the K_{sp} silver chromate at the point marked (x) on the graph.

Question 20 [3 marks]

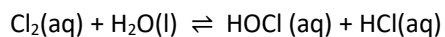
The equilibrium constant for the following reaction at 100°C is given.



What is the value of K_{eq} of reaction 3?

Question 21 [7 marks]

Hypochlorous acid, HOCl, is a sterilizing agent used in swimming pools and is produced when chlorine reacts with water.



- a) Referring to Le Chatelier's Principle, explain why more chlorine reacts with water when NaOH(aq) is added. (2 marks)

- b) Researchers studying the solubility of chlorine in *pure water* at different temperatures compiled the following data from different empirical sources.

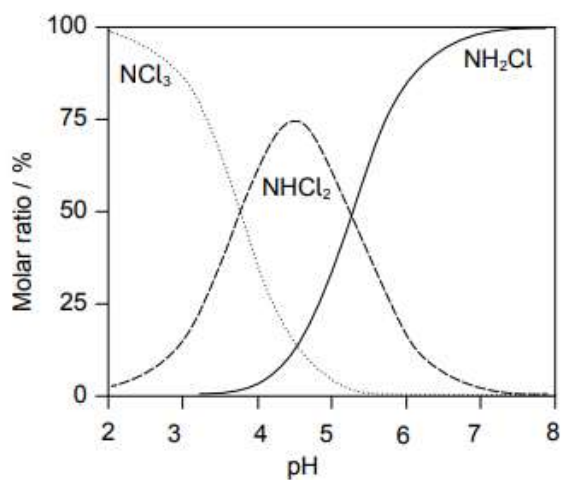
Source	Temperature (°C)	Solubility of chlorine (per 100mL)
A	0	1.46g
B	10	310cm ³
C	20	0.70g
D	25	630mg
E	30	177 g
F	30	0.57cm ³

Identify a problem a researcher would have from comparing the data in this table. (1 mark)

- c) Assume the density of chlorine is 2.86gL⁻¹ at 30°C. Calculate the molarity of the chlorine solution of *Source E*. (2 marks)

- d) Ammonia released from sweat and urine reacts with HOCl to form a range of compounds including chloroamines. Deduce an equation for the formation of dichloroamine, NHCl₂(aq) and liquid water, from ammonia and HOCl(aq). (1 mark)

- e) The graph shows the molar ratio of chloroamines (NCl_3 , NHCl_2 , NH_2Cl) formed at different pH values at 25°C . Trichloroamine, NCl_3 , causes pool water to smell bad.



State ONE condition needed to prevent the bad smell. (1 mark)

Question 22 [6 marks]

A student recorded the following data in a recent experiment on photosynthesis.

Species	CH ₄ (g)	O ₂ (g)	CO ₂ (g)	H ₂ O(g)	C ₁₈ H ₁₈ (l)	C ₆ H ₁₂ O ₆ (s)
Enthalpy of formation (kJ/mol)	+75	0	-381	-287	-250	-1289
Entropy (J/mol)	+186	+187	+236	+54	+361	+234

- a) Write a balanced equation for photosynthesis (1 mark)

- b) Use the data above to calculate the ΔG of photosynthesis, assuming standard conditions. (2 marks)

- c) Using the values you calculated in part b), analyse the effects of entropy and enthalpy on photosynthesis. (3 marks)

Question 23 [2 marks]

The following data apply to magnesium fluoride and magnesium chloride dissolving in water at 298K.

	<i>Magnesium fluoride</i>	<i>Magnesium chloride</i>
$\Delta_{\text{sol}}H^{\ominus} \text{ (kJ mol}^{-1}\text{)}$	-7.81	-160
$\Delta_{\text{sol}}S^{\ominus} \text{ (J K}^{-1} \text{ mol}^{-1}\text{)}$	-223	-115

Use this data to determine the relative solubility of the two magnesium salts

Question 24 [3 marks]

Professor Saachi has prepared a perfectly saturated solution of CaF_2 . To sabotage their work rival chemist, Professor Ashmeet, adds 10 M NaF to their solution. How many grams of CaF_2 fall out of solution if they had prepared 500 mL.

CaF_2 : $K_{\text{sp}} = 4.0 \times 10^{-11}$

Extra writing page.

[Please indicate in the question above, if you need to use this area to write your answer.]

[illegible]

Year 12 Chemistry Assessment Task 1 – Multiple Choice Answer Sheet

Please circle the correct answer. If you would like to change your answer, place a clear cross through your previous answer.

Question	Answer			
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

Working sheet.

[Please use this page for any additional working or calculations, as needed.]

[illegible]