

Hornsby Girls' High School

2021

Year 12 Task 1

Processing and Analysing Data

Chemistry



General Instructions

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

Total marks – 50 marks

- Section I – Multiple Choice
10 marks
- Section II – Written Responses
40 marks

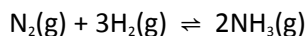
Section I (10 marks)

Attempt Questions 1–10

Allow about 10 minutes for this part

Use the **multiple-choice answer sheet** on page 12 for Questions 1 – 10

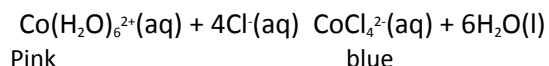
1. Ammonia is produced from atmospheric $\text{N}_2(\text{g})$ according to the equation



Which of the following best describes the effect of adding an iron catalyst to the mixture?

	Equilibrium yield	Rate of reaction
A	increase	no change
B	increase	increase
C	no change	no change
D	no change	increase

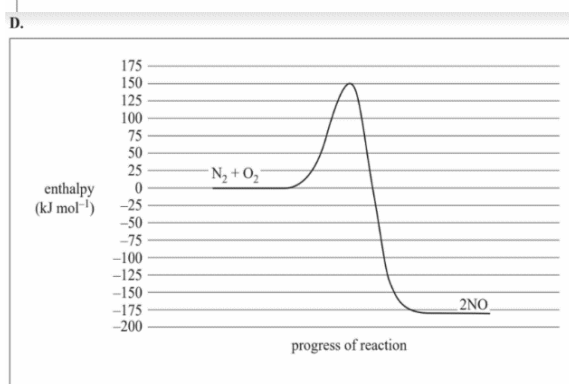
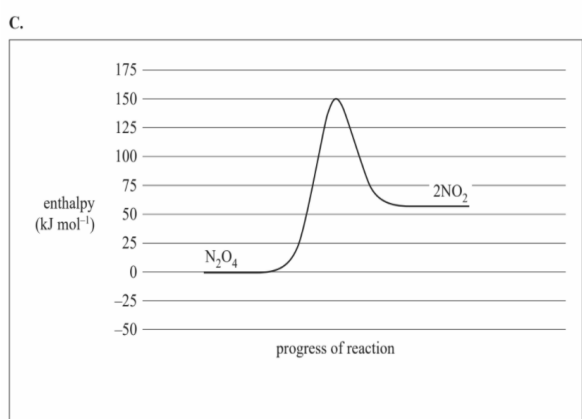
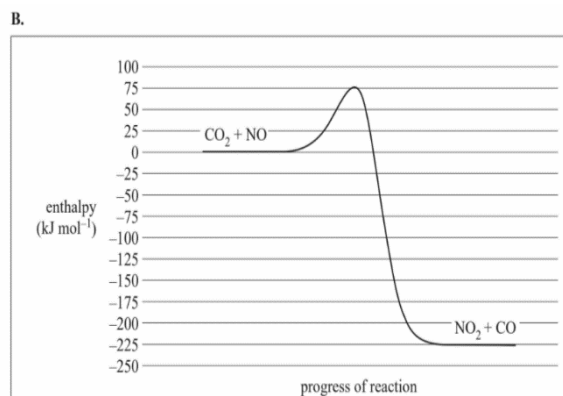
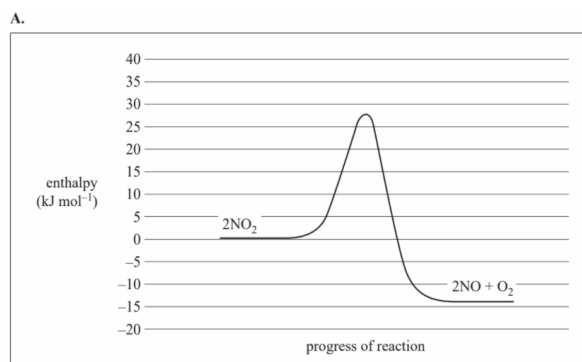
2. The reaction below demonstrates the equilibrium between hydrated cobalt (pink) and the cobalt (II) chloride ion (blue)



What would occur if water was added to the reaction mixture?

- A The CoCl_4^{2-} concentration increases.
B The reaction shifts towards the products.
C The resulting colour changes from blue to pink.
D The temperature increases.
3. When the reaction
 $\text{CO}(\text{g}) + 2\text{H}_2(\text{g}) \rightleftharpoons \text{CH}_3\text{OH}(\text{g})$
Reached equilibrium at 400K and at a total pressure of 202 kPa, the value of $K_c = 0.60$. At a total pressure of 101 kPa, still at 400K, the value of K_c would be
- A Greater than 0.60
B approximately 0.30
C between 0.60 and 0.30
D Still 0.60

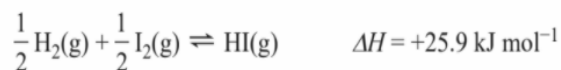
4. Which one of the following graphs is consistent with the chemical equation?



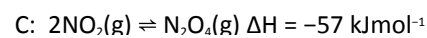
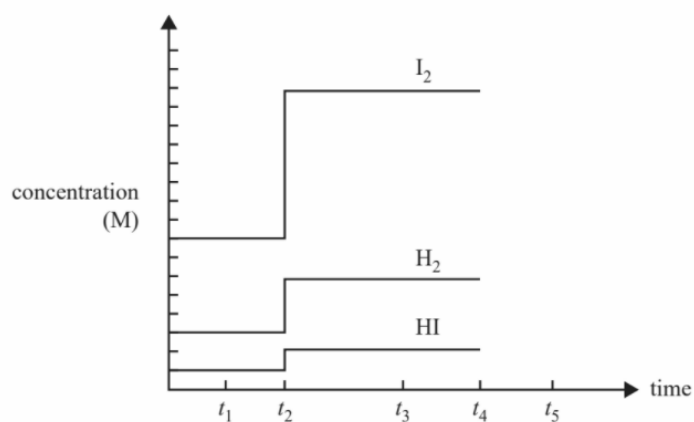
5.

+14 kJmol⁻¹

Hydrogen, H₂, and iodine, I₂, react to form hydrogen iodide, HI.



The graph below shows the concentrations of H₂, I₂ and HI in a sealed container. One change was made to the equilibrium system at time t₂.



Which one of the following statements is correct?

A A catalyst was added.

- B Increase in volume.
- C Decrease in volume.
- D Increase in temperature.

6. As the temperature increases, the value of K_{eq} (i) _____ for endothermic reactions and (ii) _____ for exothermic reactions.

	(i)	(ii)
A	Increases	Increases
B	Decreases	Increases
C	Decreases	Decreases
D	Increases	Decreases

7. There are two unlabelled solutions. One is barium nitrate and the other lead nitrate. Which of the following could be added to the two unlabelled solutions to distinguish between them?

- A Potassium carbonate.
- B Potassium chloride.
- C Potassium nitrate.
- D Potassium sulfate.

8. Arrange the following reactions in order of their increasing ability to reach completion.

- | | | |
|-----|--|-------------------------------|
| I | $\text{Ag}^+(\text{aq}) + 2\text{NH}_3(\text{aq}) \rightleftharpoons \text{Ag}(\text{NH}_3)_2^+$ | $K_{eq} = 1.6 \times 10^7$ |
| II | $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ | $K_{eq} = 1.6 \times 10^{-3}$ |
| III | $\text{Br}_2(\text{aq}) + \text{Br}^-(\text{aq}) \rightleftharpoons \text{Br}_3^-(\text{aq})$ | $K_{eq} = 18$ |
| IV | $\text{I}_2(\text{g}) \rightleftharpoons 2\text{I}(\text{g})$ | $K_{eq} = 4 \times 10^{-5}$ |

(Note: Assume that each equilibrium constant was determined under their optimum conditions)

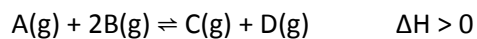
- A IV, II, III, I
- B I, III, II, IV
- C III, II, IV, I
- D I, IV, II, III

9. The reaction $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$ has a $K_{eq} = 1.70$ at 250°C . For the reaction

$2\text{PCl}_5(\text{g}) \rightleftharpoons 2\text{PCl}_3(\text{g}) + 2\text{Cl}_2(\text{g})$, the K_{eq} at the same temperature would be:

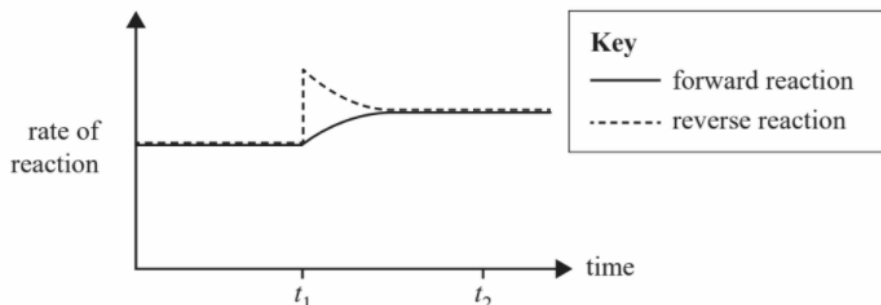
- A 0.85
- B 1.70
- C 2.89
- D 3.40

10. An equilibrium mixture of four gases is represented by the following equation.



The graph below shows the rate of the forward and reverse reactions versus time.

A single change is made to the equilibrium mixture at time t_1 and equilibrium is re-established at time t_2 .



Which one of the following is consistent with the information given above?

- A Argon is added to the equilibrium mixture at time t_1 .
- B At time t_1 reactants are removed from the equilibrium mixture.
- C The amount of products is higher at time t_2 compared to just before time t_1 .
- D The change made at time t_1 results in an increase in the equilibrium constant at time t_2 .

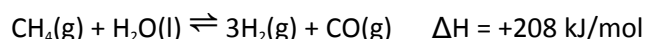
Section II (40 marks)

Attempt Questions 11-18

Allow about 50 minutes for this part

Answer questions in the space provided. These spaces provide guidance for the expected length of response. Show all relevant working in questions involving calculations.

11. [4 marks] Hydrogen can be made by reacting methane with steam. The equation for the reaction is shown below.



Complete the table below by circling the correct temperature and pressure to optimise the yield and rate of hydrogen production. Explain your selections.

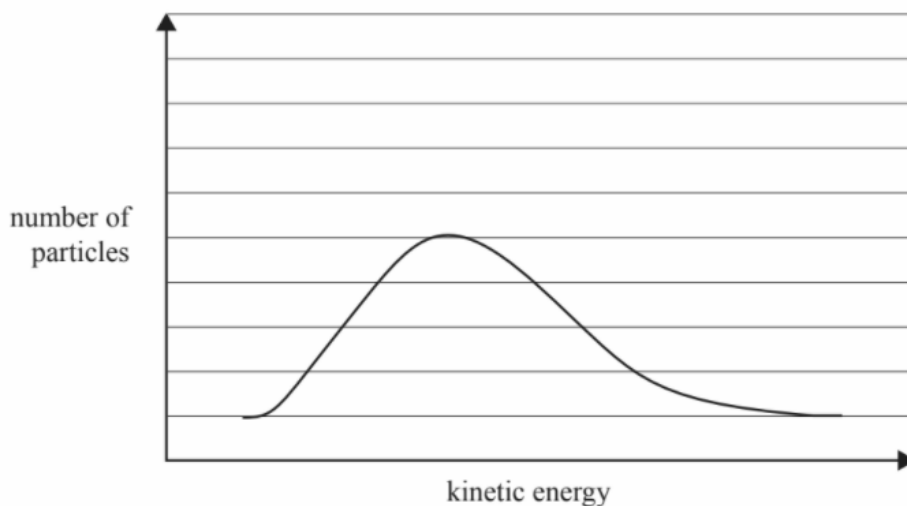
Variable	Optimal condition (Circle one)	Explanation
Temperature	High	
	Low	
Volume	Increase	
	Decrease	

12. [6 marks] The reaction for the oxidation of sulfur dioxide, SO_2 , is shown below.

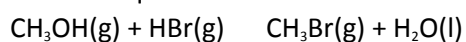


- a. 1.00 mol of SO_2 and 1.00 mol of oxygen, O_2 , are placed into an evacuated, sealed 3.00 L container at 100°C . After the reaction reaches equilibrium, the container contains 20.0 g of sulfur trioxide, SO_3 . Calculate the equilibrium constant, K_c , for this reaction at 100°C . (4 marks)

- b. The graph below shows the distribution curve for the SO_3 molecules in the container at a particular temperature. On the graph, draw the distribution curve of SO_3 at a significantly lower temperature. (2 marks)

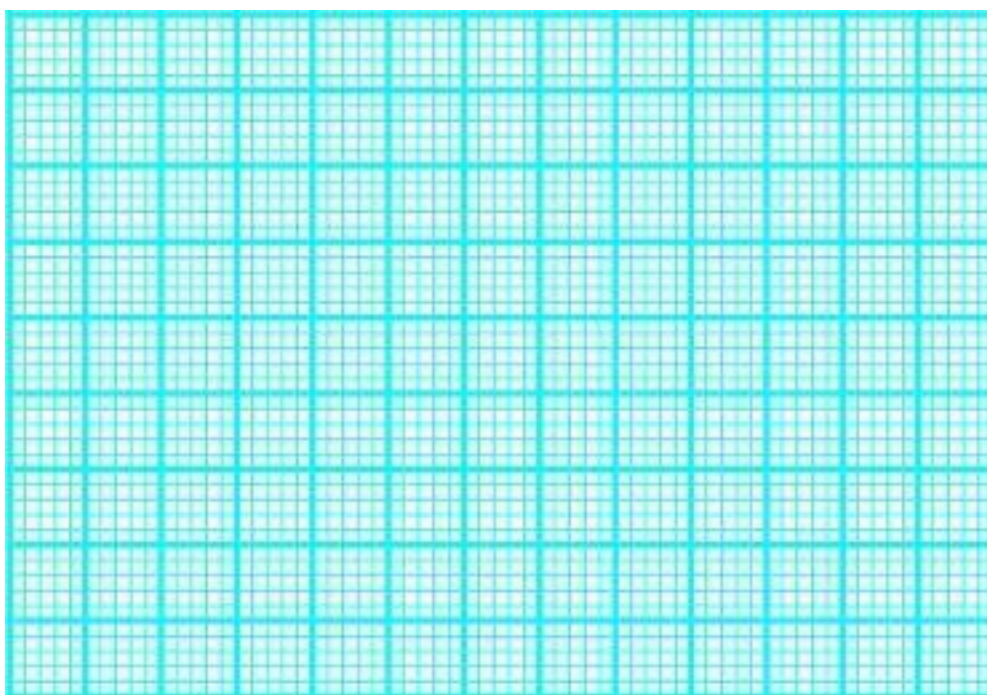


13. [3 marks] Bromomethane, CH_3Br , is manufactured by reacting methanol with hydrogen bromide according to the following equilibrium equation.



It is a toxic, odourless and colourless gas used as an insecticide.

The following graph shows the equilibrium concentrations of three of the compounds involved in the reaction at 298 K. A small amount of methanol was added at time t_x . Sketch the concentrations of the three compounds after time t_x .



concentration (mol L^{-1})

14. [8 marks] In the experiment that you conducted in class pale yellow iron(III) ions reacted with colourless thiocyanate ions to form a deep red-coloured iron(III) thiocyanate complex ion.

a. Write the equilibrium reaction (1 mark)

b. Describe the method that you used to determine the concentration of iron thiocyanate ion in a sample of unknown concentration. Assume the prepared standard solutions have been used to create a calibration curve. (4 marks)

c. Trials were run with samples of three unknown concentrations and the results were recorded in a table.

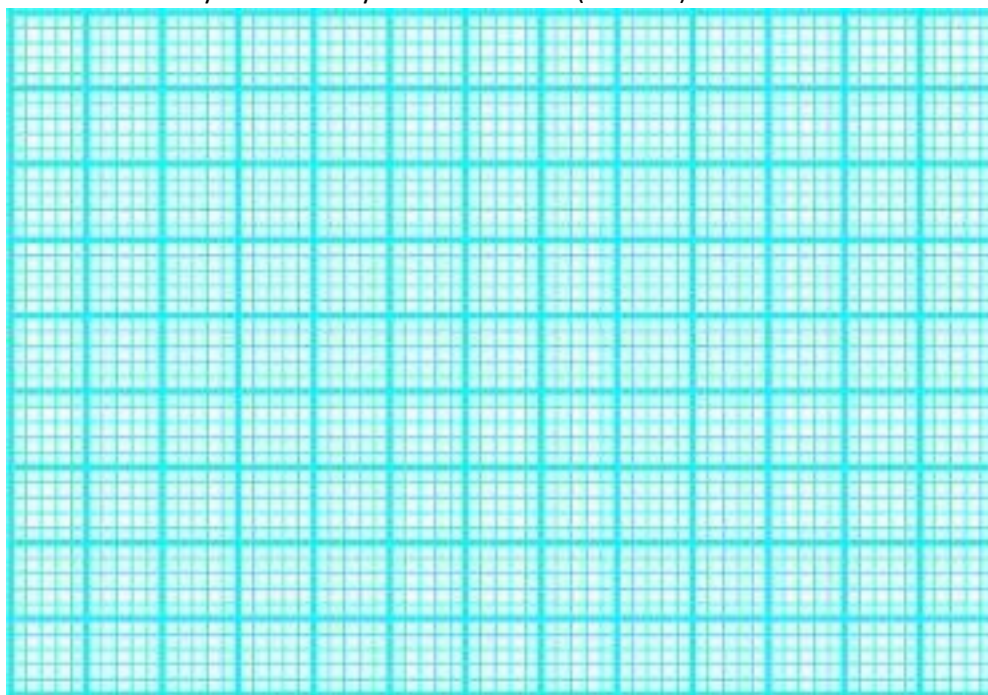
Concentration (molL ⁻¹)	Trial 1	Trial 2	Trial 3
[Fe ³⁺]	0.200	0.273	0.159
[Fe(SCN) ²⁺]	0.0094	0.0190	0.0068
[SCN ⁻]	0.00060	0.0010	0.00086

Calculate the Equilibrium constant for this reaction. (3 marks)

15. [8 marks] The information in the table shows how the solubility of barium hydroxide is affected by temperature. The amount of solvent (water) was kept constant at 100 g.

Temperature of water (°C)	0	20	40	60	80	100
Mass of solute (g)	1.25	1.35	1.55	1.90	2.75	4.20

- a) Plot the solubility of barium hydroxide in water (3 marks)

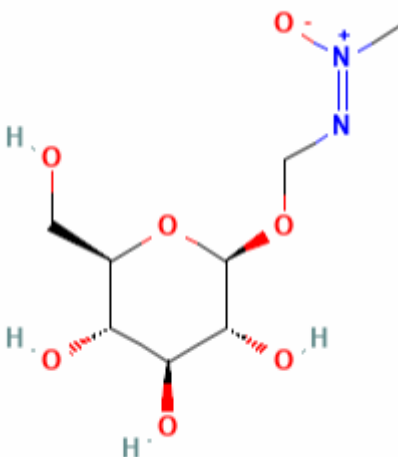
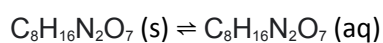


- b) What is the solubility of barium hydroxide at 70°C? (1 mark)

- c) Write the K_{sp} expression for barium hydroxide (1 mark).

- d) Calculate the K_{sp} of barium hydroxide at 70°C. (3 marks)

16. [5 marks] Cycad seeds are an important source of starch for some Aboriginal and Torres Strait Islander communities. However the plant seed contains the toxin cycasin which dissolves in water until the saturation point is reached.



- a) Explain how water acts as a solvent? (2 marks)

- b) Before the seed can be used in cooking the toxin has to be removed. Describe and explain ONE food preparation practice that uses solubility equilibria (3 marks).

Cycasin molecule

17. [3 marks] Solid lead(II) nitrate is added to 1.0L of 0.0010M sodium sulfate solution.

a. Write the net ionic equation (1 mark)

b. How many grams of lead nitrate should be added to the sodium sulfate solution above, for a precipitate of lead sulfate ($K_{sp} = 1.6 \times 10^{-8}$) to form? (Assume no change in volume when the solid is added). (2 marks)

18. [3 marks] You performed a first hand investigation to model an equilibrium reaction. Describe how this procedure models equilibrium and state a limitation of the model.

HSC Chemistry Assessment Task 1 – 2021 – Section I: Multiple choice Answer sheet

Circle the letter than corresponds to the correct answer. If you make a change clearly indicate which answer is correct.

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