

Hornsby Girls' High School

2022

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

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|---------------------------------------|----|
| • Section I - Multiple Choice marks | 10 |
| • Section II – Written Response marks | 40 |

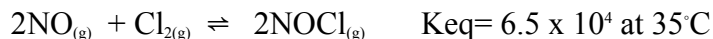
Section I

Attempt Questions 1–10

Allow about 10 minutes for this part

Use the multiple-choice answer sheet for Questions 1 – 10

1. Consider the following reversible reaction:



Which of the following statements describes the relative concentrations of reactants and products in this system when equilibrium is established in a closed vessel at 35°C ?

- A. The concentration of reactants and products will be equal.
- B. There will be a greater concentration of products than reactants.
- C. The reactant concentration will be greater than that of the products.
- D. The concentrations of NOCl and NO will be double the concentration of Cl_2 .

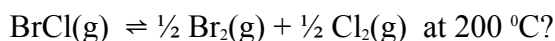
Use the following information to answer Questions 2 and 3

2. Bromine and chlorine gases can react to form the compound BrCl. The equation for the reaction is



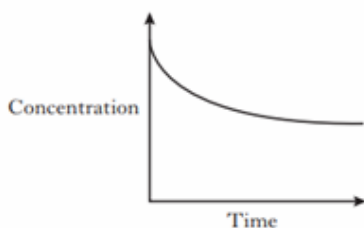
Bromine is dark brown in colour. Chlorine is a very light green and BrCl colourless.

Given the above information what is the K_{eq} for the reaction

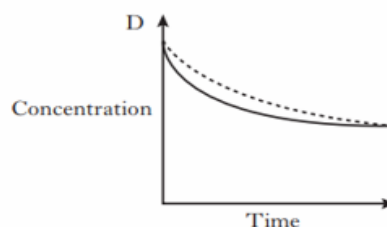
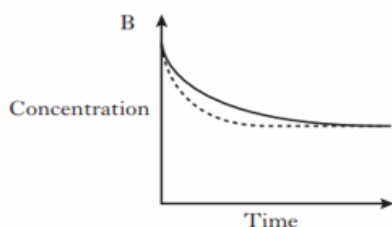
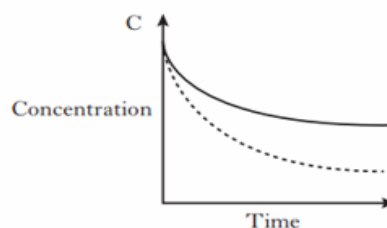
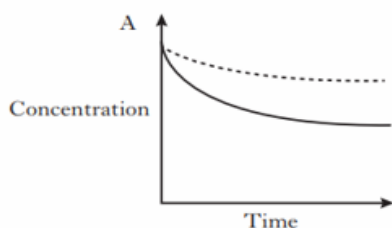


- A. 0.0044
 - B. 15
 - C. -225
 - D. 0.067
3. A change is made to an equilibrium mixture of the above gases and the brown intensity is seen to increase as equilibrium is re-established. The change could have been
- A. An increase in volume.
 - B. The addition of further chlorine gas.
 - C. An increase in temperature.
 - D. A decrease in temperature.

4. Which of the following metal phosphates has the lowest molar solubility?
- Barium phosphate.
 - Magnesium phosphate.
 - Calcium phosphate.
 - Lead (II) phosphate.
5. The graph represents the change in concentration of a reactant against time during a reversible chemical reaction.



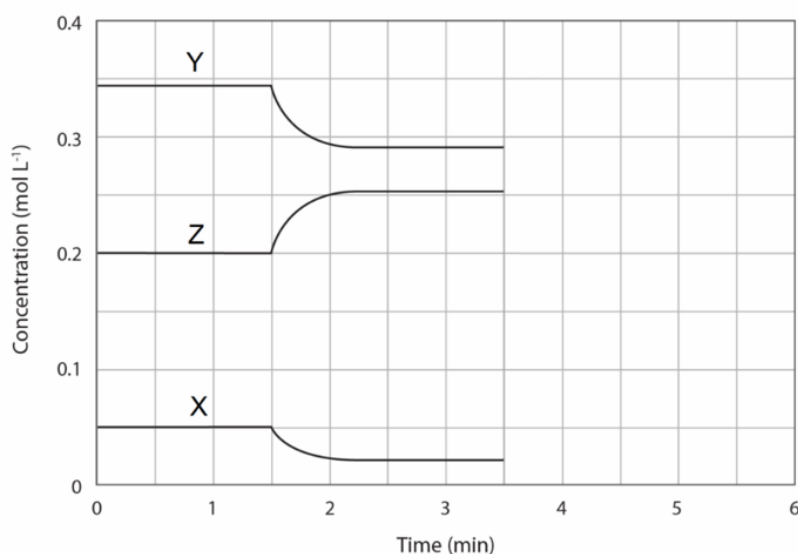
In which diagram below does the dotted line show the result of repeating the reaction using a catalyst?



6. An equilibrium is represented by the following equation. $3\text{F}_{(\text{g})} + \text{G}_{(\text{s})} \rightleftharpoons 3\text{J}_{(\text{g})}$ $\Delta\text{H} < 0$
Which of the following is **incorrect** for the indicated changes?

	indicated changes	position of equilibrium	forward rate	backward rate
A	increase total pressure by compression	no change	increase	increase
B	increase temperature	shifts left	decrease	increase
C	adding catalyst	no change	increase	increase
D	adding more F	shifts right	increase	no change

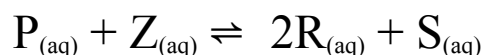
7. The concentration graph represents a mixture of three gases X,Y and Z, in a sealed container at room temperature. At 1.5 minutes, the container was placed in an ice bath.



Which of the following best represents the equilibrium system described by the graph?

- A. $2Z_{(g)} \rightleftharpoons X_{(g)} + 2Y_{(g)}$ and the forward reaction is exothermic.
- B. $X_{(g)} \rightleftharpoons 2Z_{(g)} + 2Y_{(g)}$ and the forward reaction is endothermic.
- C. $X_{(g)} + 2Y_{(g)} \rightleftharpoons 2Z_{(g)}$ and the forward reaction is exothermic.
- D. $X_{(g)} + 2Y_{(g)} \rightleftharpoons 2Z_{(g)}$ and the forward reaction is endothermic.

8. An equilibrium can be represented by the following equation:

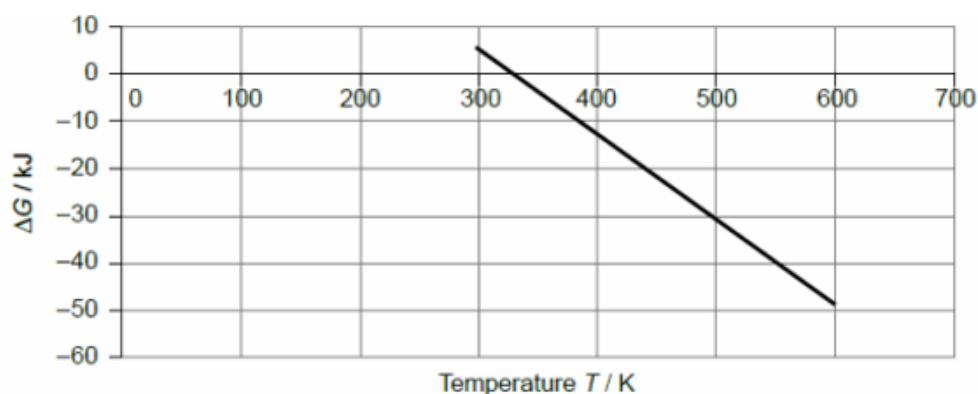


The total volume of the reaction mixture is 1 L and the equilibrium concentration of Z is 0.8 mol L^{-1} .

What will the new equilibrium concentration of Z be if 0.4 moles of Z is completely dissolved in the mixture?

- A. 1.2 mol L^{-1}
- B. Between 0.8 mol L^{-1} and 1.2 mol L^{-1}
- C. 0.8 mol L^{-1}
- D. Between 0.4 mol L^{-1} and 0.8 mol L^{-1}

9. The graph shows the values of ΔG for a reaction at different temperatures.



Which statement is correct?

- A. The standard entropy of the reaction is negative.
 - B. The standard enthalpy of the reaction is positive.
 - C. At higher temperatures, the reaction becomes less spontaneous.
 - D. The standard enthalpy change of the reaction is negative.
10. The Contact Process is used industrially to manufacture sulfuric acid. One of the steps in the process involves synthesis of sulfur trioxide which is made reversibly by oxidising sulfur dioxide with oxygen.
- 400 moles of sulfur dioxide and 600 moles of oxygen gas were placed in a 2000L reactor. At equilibrium, the concentration of sulfur trioxide is 0.095 mol L^{-1} . What is the value of K_{eq} for the synthesis of sulfur trioxide?
- A. 0.19
 - B. 0.75
 - C. 3.24
 - D. 3.99

Section II

Attempt Questions 11-15

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.

Question 11 (7 marks)

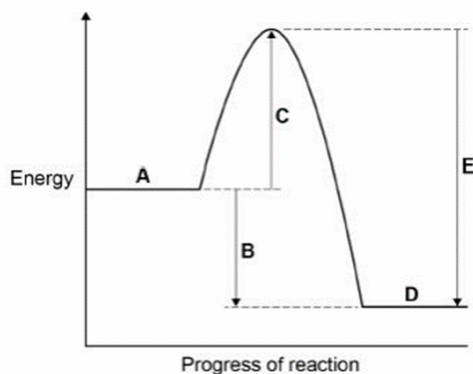
The following graph shows the combustion of ethanol energy profile at 25°C. The letters correspond to the following values:

$$A = 5020 \text{ kJmol}^{-1}$$

$$B = 1367 \text{ kJmol}^{-1}$$

$$C = 800 \text{ kJmol}^{-1}$$

$$D = 3653 \text{ kJmol}^{-1}$$



- a) Write the equation for the combustion of ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) and include the ΔH (2 marks)

- b) Use the following table to work out the entropy of the combustion of ethanol at 25°C (2 marks)

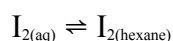
Species at 25°C	$S^\circ (\text{JK}^{-1}\text{mol}^{-1})$
$\text{CH}_3\text{CH}_2\text{OH}_{(l)}$	160.7
$\text{O}_{2(g)}$	205.1
$\text{CO}_{2(g)}$	213.7
$\text{H}_2\text{O}_{(g)}$	188.8

- c)

- c) Calculate Gibbs free energy for the combustion of ethanol at 25°C and explain the spontaneity of the combustion of ethanol. (3 marks)

Question 12 (4 marks)

- Iodine is soluble in both water and hexane. If iodine is added to a mixture of the two solvents, then the following equilibrium is set up (2 marks)

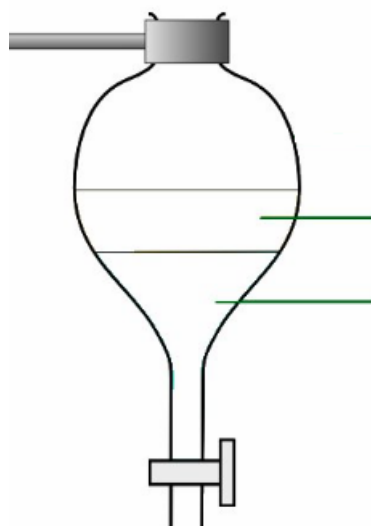


The equilibrium constant, known as the partition coefficient is 85.

The density of hexane is 0.66gcm⁻³ and the density of water is 1.00gcm⁻³.

- a) Choose **two** of the following to label the diagram appropriately

- hexane with high iodine concentration.
- hexane with low iodine concentration.
- water with high iodine concentration.
- water with low iodine concentration.



b)

- b) As water is a polar solvent and hexane is a nonpolar solvent. Use your knowledge about bonding to explain why

$I_{2(aq)} \rightleftharpoons I_{2(hexane)}$ has a K_{eq} of 85?

(2 marks)

Question 13 (14 marks)

The information in the table shows how the solubility of calcium hydroxide is affected by temperature.

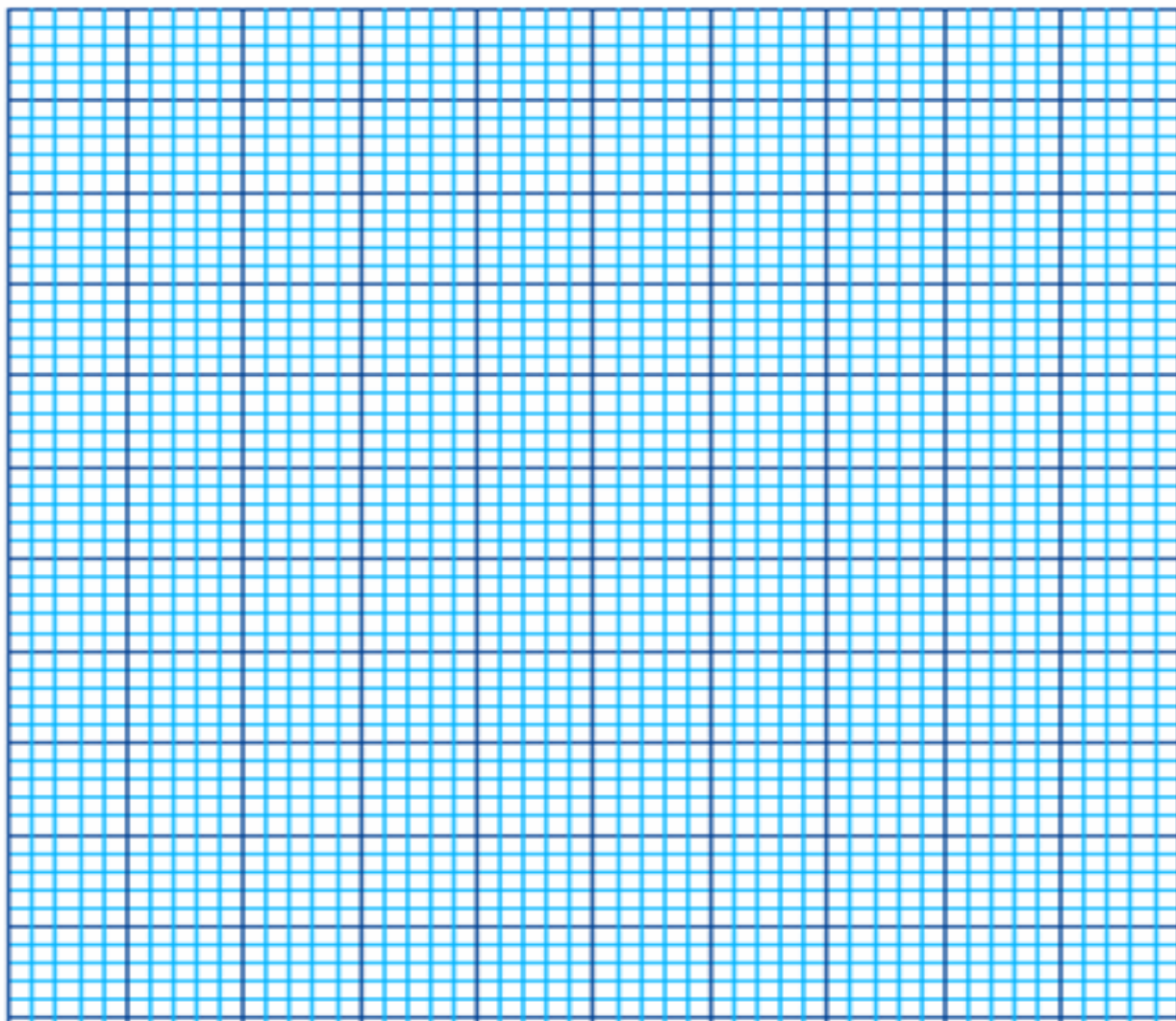
Temperature (°C)	Solubility (g/100g water)
0	0.19
10	0.18
20	0.17
40	0.14
60	0.12
80	0.09
90	0.08
100	0.07

- a) What is the independent and dependent variable? **(1 mark)**

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a)

b) Draw a solubility graph and line of best fit to represent this information (**3 marks**)



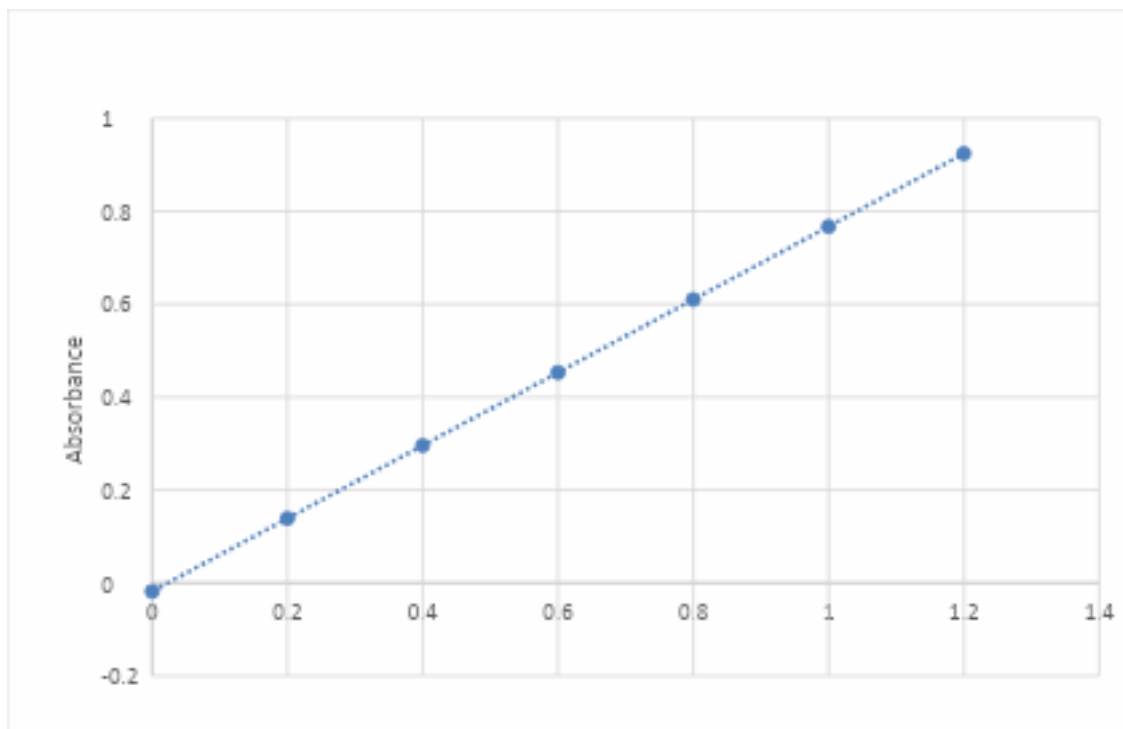
c) Use the graph to calculate the solubility product (K_{sp}) of the dissolution of calcium hydroxide at 70°C . Include a relevant chemical equation in your answer. (**3 marks**)

- d) 80mL of 0.05M potassium hydroxide and 20mL of 0.06M calcium nitrate is mixed at **70°C**. Predict if a precipitate of calcium hydroxide will be observed in the resultant mixture. **(4 marks)**

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- e) What is the molar solubility of $\text{Ca}(\text{OH})_2$ in 0.0860 M NaOH at **25°C** ? **(3 marks)**

Question 14 (5marks)

In class you performed a practical to calculate K_{eq} of $FeSCN^{2+}$. The following graph was obtained using standards of Fe^{3+} and SCN^- . The equilibrium constant was calculated as being **230**.



- a) When making up standards the $[Fe^{3+}]$ was 1.2M and the $[SCN^-]$ was 0.012M. Explain the importance of these concentrations. **(2 marks)**

- b) A sample at equilibrium had an absorbance of 0.5. Use the equation to calculate the concentration of $FeSCN^{2+}$ at equilibrium **(1 mark)**

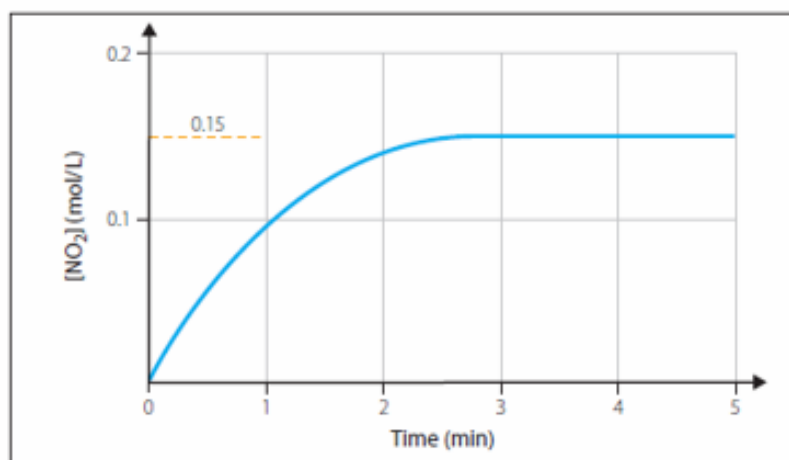
- c) The sample in b) was found to have a $[\text{SCN}^-]$ of 0.05M at equilibrium. Calculate the concentration of $[\text{Fe}^{3+}]$ at equilibrium. **(2 marks)**
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Question 15 (10 marks)

At room temperature, gaseous dinitrogen pentoxide decomposes to nitrogen dioxide and oxygen.

- a) Write a balanced equation for this reaction (**1 mark**) (USE whole numbers not fraction)
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- b) In an experiment 0.20 mole of dinitrogen pentoxide was placed in a 2.00L flask at **room temperature** and the concentration of nitrogen dioxide was measured as a function of time. The results are graphed below



- c) Use the graph and a RICE table to calculate the equilibrium constant for this reaction. (**3 marks**)
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- d) If an inert gas was added what would happen to the equilibrium if the pressure was kept constant? **(1 mark)**
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- e) If there were 5 moles of nitrogen dioxide, 4.5 moles of dinitrogen pentoxide and 0.2 moles of oxygen in a 10 L vessel at **room temperature** at equilibrium. How many moles of oxygen are needed to be added to the vessel to increase the amount of dinitrogen pentoxide by 0.25 moles? (Use a **RICE** table) **(5 marks)**
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