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Student Number

NORTH SYDNEY GIRLS HIGH SCHOOL



2022-23

HSC

Assessment Task 1

Chemistry

General Instructions

- Reading Time – 5 minutes
- Working Time – 55 minutes
- Write using a blue or black pen
- Draw diagrams using pencil
- NESA approved calculators may be used
- Show all relevant working in questions involving calculations.
- **Write your student number at the top of this booklet**
- **Write your answers in the space provided.**

Total Marks – 30

Weighting – 20 %

Part A – Questions 1-5

5 multiple choice questions

(5 marks)

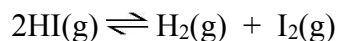
Part B – Questions 6 – 11

Extended Response questions

(25 marks)

Part A – Multiple Choice

1. At elevated temperatures, hydrogen iodide decomposes into hydrogen gas and iodine gas according to this equation:



The value of K_{eq} for this reaction is 0.020 at 500°C.

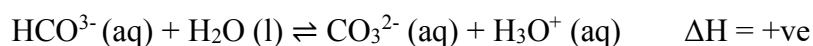
The reaction was carried out under the following conditions:

- $T = 500^\circ\text{C}$
- Volume of vessel = 1 L.
- Initial amount of HI = 2.0 mol, with no H_2 or I_2 present.
- At time t , the amount of HI = 1.16 mol.
- Temperature remained constant over the entire duration.

Which of the following statements correctly describes the system at time t ?

- (A) The system is at equilibrium.
 - (B) The system is favouring the forward reaction.
 - (C) The system is favouring the reverse reaction.
 - (D) The system has reached static equilibrium.
2. When aqueous potassium carbonate solution was added to aqueous barium chloride solution, a white precipitate formed. Which of the following statements is correct regarding the equilibrium mixture?
- (A) There are no carbonate ions in solution.
 - (B) There are no barium ions in solution.
 - (C) If some aqueous barium nitrate was added, more white precipitate would form.
 - (D) If some aqueous potassium nitrate was added, more white precipitate would form.

3. Hydrogen carbonate ions react with water to form the following equilibrium mixture.



For each of the changes shown below, identify the correct effect on the equilibrium position.

	H₃O⁺ ions are added	The temperature is increased	A catalyst is added
(A)	Forward reaction favoured	Forward reaction favoured	Forward reaction favoured
(B)	Backwards reaction favoured	Forward reaction favoured	Forward reaction favoured
(C)	Backwards reaction favoured	Forward reaction favoured	No change
(D)	Backwards reaction favoured	Backwards reaction favoured	No change

4. What is the solubility product (K_{sp}) expression for magnesium phosphate?

- (A) $[\text{Mg}^{2+}][\text{PO}_4^{3-}]$
- (B) $2[\text{Mg}^{2+}] 3[\text{PO}_4^{3-}]$
- (C) $[\text{Mg}^{2+}]^3[\text{PO}_4^{3-}]^2$
- (D) $[\text{Mg}^3][(\text{PO}_4)^2]$

5. Which of the following statements are true?

- I. Increasing the temperature of a substance causes entropy to increase.
- II. The process of melting has an associated negative enthalpy change.
- III. Combustion reactions always have an associated negative enthalpy change.
- IV. Photosynthesis has an associated negative entropy change.

- (A) I and III only
- (B) II and III only
- (C) I, II and IV
- (D) I, III and IV

Part B – Extended Response

Question 6 (6 Marks)

A mixture of carbon dioxide gas and hydrogen gas in a sealed container was left to establish equilibrium. The forward reaction produces methane gas and water vapor with an enthalpy change of -165 kJ mol^{-1} .

- a) Write a chemical equation for this reaction.

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- b) Identify the changes you would expect to occur if the water vapor was condensed.

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- c) Explain, using collision theory, how increasing the temperature would affect the equilibrium position.

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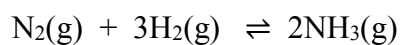
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Question 7 (3 marks)

The formation of ammonia gas from nitrogen and hydrogen gases takes place according to the equation:



Different amounts of the three gases were placed in a vessel and allowed to come to equilibrium at two different temperatures. The equilibrium concentrations of each species are tabulated below:

Temperature (°C)	[N ₂] (mol L ⁻¹)	[H ₂] (mol L ⁻¹)	[NH ₃] (mol L ⁻¹)
227	0.34	0.83	3.40
427	0.88	1.46	1.01

- a) Using the above data, determine if the forward reaction is exothermic or endothermic and justify your answer. **2**

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- b) The reaction is carried out at 227°C in a sealed high-pressure vessel which is connected to a piston. Once equilibrium is established, the piston is pushed so as to reduce the volume by half at constant temperature. **1**

When equilibrium is re-established, what effect will this change have on K_{eq} ?

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Question 8 (4 Marks)

At 700°C, 1.4 mol carbon dioxide gas reacts with 1.0 mol hydrogen gas to form carbon monoxide and water vapour. At equilibrium, there is 0.88 mol of carbon dioxide and 0.48 mol of hydrogen gas present.

Calculate the value of K_{eq} for this equilibrium if the reaction vessel is 2.0 L in volume.

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Question 9 (3 marks)

Calculate the molar solubility of copper (II) carbonate in a 1.50 mol L⁻¹ sodium carbonate solution.

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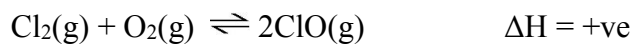
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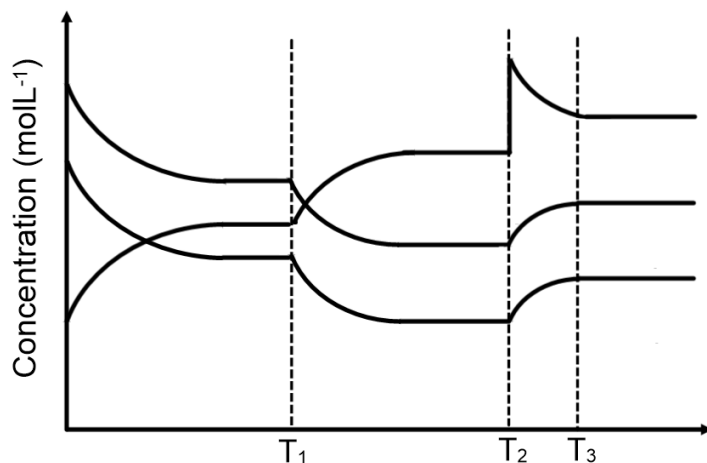
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Question 10 (4 marks)

Chlorine gas and oxygen gas react to form chlorine monoxide under extreme temperatures and pressures according to the equation:



A volume of each gas is placed in a reaction vessel at 550°C at time $T = 0$.



(a) Explain what is happening in this equilibrium system at each time indicated.

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(b) Compare the K_{eq} value just before T_1 to the K_{eq} value just after T_3 .

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Question 11 (5 marks)

Highly concentrated $\text{Pb}(\text{NO}_3)_2$ was gradually added to a solution containing 0.030 mol L^{-1} carbonate ions and 0.025 mol L^{-1} hydroxide ions. Eventually, two different precipitates formed.

a) At what concentration of Pb^{2+} did each of the precipitates start forming?

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b) Identify the anion that precipitated first and calculate what percentage of this anion had precipitated by the time the second anion began to precipitate.

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