G12 Chemistry: Class 9 Homework

1. Cyclopropane, C_3H_6 is used in the synthesis of organic compounds and as a fast-acting anaesthetic. It undergoes rearrangement to form propene, C_3H_6. If cyclopropane disappears at a rate of 0.25 mol/ L•s, at what rate is propene being produced? **[1 mark]**

2. Ammonia NH_3 reacts with oxygen to produce nitric oxide, NO, and water vapour.

   $$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

   At a specific time in the reaction, ammonia is disappearing at rate of 0.068mol/L•s. What is the corresponding rate of production of water? **[2 marks]**

3. Hydrogen bromide reacts with oxygen to produce bromine and water vapour.

   $$4HBr(g) + O_2(g) \rightarrow 2Br_2(g) + 2H_2O(g)$$

   How does the rate of decomposition of HBr (in mol/ L•s) compare with the rate of formation of Br_2 (also in mol/ L•s)? Express your answer as an equation. **[1 mark]**

4. Magnesium metal reacts with hydrochloric acid to produce magnesium chloride and hydrogen gas. Over an interval of 1.00s, the mass of Mg(s) changes by −0.011 g.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

a) What is the corresponding rate of consumption of HCl(aq) (in mol/s)? **[3 marks]**

b) Calculate the corresponding rate of production of $H_2(g)$ (in L/s) at 20°C and 101 kPa. **[3 marks]**

5. When heated, ethylene oxide decomposes to produce methane and carbon monoxide.

$$C_2H_4O(g) \rightarrow CH_4(g) + CO(g)$$

At 415°C, the following initial rate data were recorded. Determine the rate law equation and the rate constant at 415°C. **[4 marks]**

Experiment	**$[C_2H_4O]_0$ (mol/L)**	**Initial Rate (mol/ L•s)**
1	0.00285	5.84×10^{-7}
2	0.00428	8.76×10^{-7}
3	0.00570	1.17×10^{-6}

6. Iodine chloride reacts with hydrogen to produce iodine and hydrogen chloride.

$$2ICl + H_2 \rightarrow I_2 + 2HCl$$

At temperature T, the following initial rate data were recorded. Determine the rate law equation and the rate constant at temperature T. **[5 marks]**

Experiment	$[ICl]_0$ (mol/L)	$[H_2]_0$ (mol/L)	Initial Rate (mol/ L•s)
1	0.20	0.050	0.0015
2	0.40	0.050	0.0030
3	0.20	0.200	0.0060

6. The reaction of nitric oxide with hydrogen at 1280°C is: $2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g)$

Experiment	[NO] (mol/L)	$[H_2]$ (mol/L)	Initial rate (mol/ L•s)
1	5.0×10^{-3}	2.0×10^{-3}	1.3×10^{-5}
2	10.0×10^{-3}	2.0×10^{-3}	5.0×10^{-5}
3	10.0×10^{-3}	4.0×10^{-3}	10.0×10^{-5}

a) From the data collected above, determine the rate law and the rate constant. **[5 marks]**
b) Determine the rate of reaction when [NO] = 12.0×10^{-3} M and $[H_2] = 6.0 \times 10^{-3}$ M. **[1 mark]**

7. The iodine clock reaction is a common laboratory procedure to measure the rate of reaction. It involves a series of chemical reactions:

(1) $3I^-(aq) + S_2O_8^{2-}(aq) \rightarrow 2SO_4^{2-}(aq) + I_3^-(aq)$
(2) $I_3^-(aq) + S_2O_3^{2-}(aq) \rightarrow 3I^-(aq) + S_4O_6^{2-}(aq)$
(3) $2I_3^-(aq) + \text{Starch} \rightarrow \text{Blue/Black Complex} + I^-(aq)$

When the I_3^- from Reaction (1) comes in contact with starch from Reaction (3), it produces a characteristic blue/black colour. However, before that can happen, $S_2O_3^{2-}$ reacts with the I_3^- in Reaction (2) to produce colourless products. Since Reaction (2) is much faster than Reaction (3), Reaction (3) will not take place until all of the $S_2O_3^{2-}$ is used up. Once this occurs, the solution changes to a blue/black colour.

The table below shows the time it took for the reaction to change to a blue/black colour at various concentrations of I^- and $S_2O_8^{2-}$. Water was added to each trial to obtain a final volume of 100mL.

Trial	1.0M KI (aq)	0.1M $(NH_4)_2S_2O_8$ (aq)	Time (s) at 25°C	Time (s) at 45°C
1	12 mL	30 mL	17	3
2	6 mL	30 mL	36	7
3	12 mL	15 mL	36	7

a) From the data above, calculate the missing values below using $C_1V_1 = C_2V_2$ for the concentrations and $(\text{time})^{-1}$ for the average rates of reaction. **[12 marks]**

Trial	$[I^-]$	$[S_2O_8^{2-}]$	Avg Rate at 25°C	Avg Rate at 45°C
1				
2				
3				

b) Calculate the rate law and the rate constant using the values above at 25°C. **[5 marks]**
c) How does temperature affect the rate of a chemical reaction? **[1 mark]**