4.1 exercise 1 - orders of reaction

1. Explain what is meant by the term "rate of reaction".

2. The initial rates of the reaction $2A + B \rightarrow 2C + D$ at various concentrations of A and B are given below:

[A] moldm^{-3}	[B] moldm^{-3}	Initial rate /moldm^{-3}s^{-1}
0.01	0.20	0.10
0.02	0.20	0.20
0.01	0.40	0.40

a) What is the order of reaction with respect to A and B?

b) What is the overall order of reaction?

c) What is the rate constant?

d) What will be the rate of the reaction if the concentrations of A and B are both 0.01 moldm^{-3}?

3. For the reaction $2NO(g) + H_2(g) \rightarrow N_2O(g) + H_2O(g)$, the following rate data were collected:

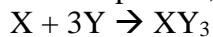| Initial [NO]/M	Initial [H$_2$]/M	Initial rate/Ms^{-1}
0.60	0.37	3.0 x 10^{-3}
1.20	0.37	1.2 x 10^{-2}
1.20	0.74	1.2 x 10^{-2}

What is the rate constant for the reaction?

What can you deduce about the rate-determining step of the reaction?

4. For the reaction $PCl_3 + Cl_2 \rightarrow PCl_5$, the following data were obtained:

Experiment No.	$[PCl_3]$/M	$[Cl_2]$/M	Rate /Ms^{-1}
1	0.36	1.26	6.0 x 10^{-4}
2	0.36	0.63	1.5 x 10^{-4}
3	0.72	2.52	4.8 x 10^{-3}

Deduce the rate equation and the rate constant.

5. Two compounds, X and Y, are known to undergo the reaction
   $X + 3Y \rightarrow XY_3$
Using the experimental results in the table below:

EXPERIMENT	Initial concentration of X/moldm^{-3}	Initial concentration of Y/moldm^{-3}	Initial rate of formation of XY_3/moldm^{-3}s^{-1}
1	0.100	0.100	0.00200
2	0.100	0.200	0.00798
3	0.100	0.300	0.01805
4	0.200	0.100	0.00399
5	0.300	0.100	0.00601

Find the rate constant.

6. The data in the table below relates to the reaction between hydrogen and nitrogen monoxide at 673K. $2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g)$

Experiment number	Initial concentration of H_2 /moldm^{-3}	Initial concentration of NO /moldm^{-3}	Initial rate of production of N_2 / moldm^{-3}s^{-1}
1	2.0 x 10^{-3}	6.0 x 10^{-3}	6.0 x 10^{-3}
2	3.0 x 10^{-3}	6.0 x 10^{-3}	9.0 x 10^{-3}
3	6.0 x 10^{-3}	1.0 x 10^{-3}	0.5 x 10^{-3}

Deduce the rate equation and calculate the rate constant.