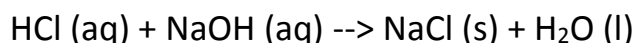


Answer on Question #67886, Chemistry / General Chemistry

The following experimental data were taken for the chemical reaction:



Experiment #	[HCl] (mol/L)	[NaOH] (mol/L)	Reaction Rate (mol/L•s)
1	0.01	0.10	2.0×10^{-3}
2	0.02	0.10	4.0×10^{-3}
3	0.01	0.20	8.0×10^{-3}

Determine:

- The rate order (exponents) for each reactant above. [2 marks]
- The rate law and the value of the rate constant, k . [2 marks]
- The overall order of the reaction and what type of reaction this indicates. [1 mark]

Solution:

- a) The rate order (exponents) for each reactant

$$\text{rate} = k[\text{NaOH}]^m[\text{HCl}]^n$$
$$k = \frac{\text{rate}}{[\text{NaOH}]^m[\text{HCl}]^n}$$

Find the exponent n :

$$k_1 = \frac{2.0 \times 10^{-3}}{[0.10]^m [0.01]^n}$$
$$k_2 = \frac{4.0 \times 10^{-3}}{[0.10]^m [0.02]^n}$$
$$k_1 = k_2$$
$$\frac{2.0 \times 10^{-3}}{[0.10]^m [0.01]^n} = \frac{4.0 \times 10^{-3}}{[0.10]^m [0.02]^n}$$
$$\frac{2.0 \times 10^{-3}}{4.0 \times 10^{-3}} = \frac{[0.10]^m [0.01]^n}{[0.10]^m [0.02]^n}$$
$$\frac{1}{2} = \left(\frac{1}{2}\right)^n$$
$$n = 1$$

Find the exponent m :

$$k_1 = \frac{2.0 \times 10^{-3}}{[0.10]^m [0.01]^n}$$
$$k_3 = \frac{8.0 \times 10^{-3}}{[0.20]^m [0.01]^n}$$
$$k_1 = k_3$$
$$\frac{2.0 \times 10^{-3}}{[0.10]^m [0.01]^n} = \frac{8.0 \times 10^{-3}}{[0.20]^m [0.01]^n}$$

$$\frac{2.0 \times 10^{-3}}{8.0 \times 10^{-3}} = \frac{[0.10]^m [0.01]^n}{[0.20]^m [0.01]^n}$$

$$\frac{1}{4} = \left(\frac{1}{2}\right)^m$$

$$m = 2$$

Answer: $n = 1$; $m = 2$.

b) The rate law and the value of the rate constant, k

$$rate = k[NaOH]^2[HCl]^1$$

$$k = \frac{rate}{[NaOH]^2[HCl]^1}$$

$$k_1 = \frac{2.0 \times 10^{-3}}{[0.10]^2 [0.01]^1} = 20$$

Test the law equation:

$$rate_3 = 20 \times 0.20^2 \times 0.01 = 0.008 = 8.0 \times 10^{-3}$$

Answer: $k = 20$.

c) The overall order of the reaction and what type of reaction this indicates.

Answer: It's the second-order bimolecular reaction. The type of reaction is double displacement.