Answer on Question #67886, Chemistry / General Chemistry

The following experimental data were taken for the chemical reaction:

HCl (aq) + NaOH (aq) --> NaCl (s) + H_2O (l)

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:

(a) The rate order (exponents) for each reactant above. [2 marks]

(b) The rate law and the value of the rate constant, k. [2 marks]

(c) The overall order of the reaction and what type of reaction this indicates. [1 mark]

Solution:

a) The rate order (exponents) for each reactant

$$rate = k[NaOH]^m[HCl]^n$$

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

Find the exponent **n**:

$$k_1 = \frac{2.0\times10^{-3}}{[0.10]^m[0.01]^n}$$

$$k_2 = \frac{4.0\times10^{-3}}{[0.10]^m[0.02]^n}$$

$$k_1 = k_2$$

$$\frac{2.0\times10^{-3}}{[0.10]^m[0.01]^n} = \frac{4.0\times10^{-3}}{[0.10]^m[0.02]^n}$$

$$\frac{2.0\times10^{-3}}{4.0\times10^{-3}} = \frac{[0.10]^m[0.01]^n}{[0.10]^m[0.02]^n}$$

$$\frac{1}{2} = (\frac{1}{2})^n$$

$$n = 1$$

Find the exponent **m**:

$$k_1 = \frac{2.0\times10^{-3}}{[0.10]^m[0.01]^n}$$

$$k_3 = \frac{8.0\times10^{-3}}{[0.20]^m[0.01]^n}$$

$$k_1 = k_3$$

$$\frac{2.0\times10^{-3}}{[0.10]^m[0.01]^n} = \frac{8.0\times10^{-3}}{[0.20]^m[0.01]^n}$$

$$\frac{2.0\times10^{-3}}{8.0\times10^{-3}} = \frac{[0.10]^m[0.01]^n}{[0.20]^m[0.01]^n}$$

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

$$m = 2$$

Answer: n = 1; m=2.

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

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

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

$$k_1 = \frac{2.0\times10^{-3}}{[0.10]^2[0.01]^1} = 20$$

Test the law equation:

$$rate_3 = 20\times0.20^2\times0.01 = 0.008 = 8.0\times10^{-3}$$

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.