

CHM136 General Chem II  
Rate Laws: Worksheet 1

Consider the following reaction:



At  $-10^\circ\text{C}$ , the following initial rates were measured:

$[\text{NO}]_0$	$[\text{Cl}_2]_0$	Initial Rate (mol/L-min)
0.10	0.10	0.18
0.10	0.20	0.36
0.05	0.20	0.09

a. What is the rate law for this reaction?

Rate =  $k[\text{NO}]^2[\text{Cl}_2]^1$       Rate =  $k[\text{NO}]^m[\text{Cl}_2]^n$

	Relative Rate	$\Delta$ in [ ]	Rate $\propto$	$[\text{NO}]^m$	$[\text{Cl}_2]^n$
$\text{Cl}_2$	$\frac{0.36}{0.18} = 2$	$\frac{[0.20]}{[0.10]} = 2$	$2 \propto$		$[2]^1 \therefore n=1$
$\text{NO}$	$\frac{0.36}{0.09} = 4$	$\frac{[0.10]}{[0.05]} = 2$	$4 \propto$		$[2]^2 \therefore m=2$

b. What is the overall order of the reaction?

$$\text{overall order} = m + n = 3$$

third order reaction

c. Calculate the value of the rate law constant.

$$k = 180 \text{ L}^2 \text{ mol}^{-2} \text{ min}^{-1}$$

$$k = \frac{\text{Rate}}{[\text{NO}]^2 [\text{Cl}_2]^1}$$

$$k = \frac{0.18 \text{ mol L}^{-1} \text{ min}^{-1}}{(0.10 \text{ mol L}^{-1})^2 (0.10 \text{ mol L}^{-1})^1} = 180 \text{ L}^2 \text{ mol}^{-2} \text{ min}^{-1}$$

d. What would the rate be if the  $[\text{NO}]_0 = [0.12]$  and  $[\text{Cl}_2]_0 = [0.18]$ ?

$$\text{Rate} = (180 \text{ L}^2 \text{ mol}^{-2} \text{ min}^{-1}) (0.12 \text{ mol L}^{-1})^2 (0.18 \text{ mol L}^{-1})$$

$$\text{Rate} = 0.47 \text{ mol L}^{-1} \text{ min}^{-1}$$