Initial Rates

Consider the following chemical reaction:

$2\ NO\ (g) + 2\ H_2\ (g) \rightarrow N_2\ (g) + 2\ H_2O\ (g)$

Use the data below to answer the following questions.

Experiment	H_2, atm	NO, atm	Rate, atm/s
1	0.263	0.100	1.84×10^{-4}
2	0.263	0.200	7.11×10^{-4}
3	0.263	0.240	1.03×10^{-3}
4	0.197	0.267	9.47×10^{-4}
5	0.191	0.267	9.21×10^{-4}
6	0.136	0.267	6.45×10^{-4}

a) Determine the order with respect to H_2.

$\frac{rate_5}{rate_6} = \frac{k \times 0.191^m \times 0.267^n}{k \times 0.136^m \times 0.267^n} = \frac{9.21 \times 10^{-4} atm/s}{6.45 \times 10^{-4} atm/s}$ $\frac{0.191^m}{0.136^m} = 1.43$

$1.40^m = 1.43$ **m = 1**

b) Determine the order with respect to NO.

$\frac{rate_2}{rate_1} = \frac{k \times 0.263^m \times 0.200^n}{k \times 0.263^m \times 0.100^n} = \frac{7.11 \times 10^{-4} atm/s}{1..84 \times 10^{-4} atm/s}$ $\frac{0.200^n}{0.100^n} = 3.86$

$2^n = 3.9$ **n = 2**

c) What is the overall order of the reaction?

3rd order overall

d) Write the rate law for the reaction.

Rate = $k[H_2][NO]^2$

e) What is the value of the rate constant, k?

Solve rate law for k. Use info from any experiment. From Exp. 1: $k = \frac{rate}{[H_2][NO]^2} = \frac{1.84 \times 10^{-4}\ atm/s}{(0.263\ atm) \times (0.100\ atm)^2} = \mathbf{0.0700\ atm^{-2}s^{-1}}$

f) What is the rate, in atm/s if the H_2 pressure is 0.155 atm and NO is 0.240 atm?

Rate = $0.0700\ atm^{-2}s^{-1} \times (0.155\ atm)(0.240\ atm)^2$ =

6.25×10^{-4} atm/s