BETH "KEY"

Method of Initial Rates

For problems 1-5 find the rate law for the reaction using the concentration/rate data. Determine the value of the rate constant along with the units.

1. $H_2O_2 + 2HI \rightarrow 2H_2O + I_2$

1&3 1&2

Trial	$[H_2O_2]$	[HI]	rate (mol/L/sec)
1	0.10 M	0.10 M	0.0076
2	0.10 M	0.20 M	0.0152
3	0.20 M	0.10 M	0.0152

RATE = $K[H_2O_2][HI]$

$K = \frac{0.0076 \frac{M}{s}}{0.10M \cdot 0.10M} = \frac{0.76 dm^3}{mol \cdot s}$

2. $H_2 + I_2 \rightarrow 2HI$

2&3 1&2

Trial	$[H_2]$	$[I_2]$	rate (mol/L/sec)
1	1.0 mol/L	1.0 mol/L	0.20
2	1.0	2.0	0.40
3	2.0	2.0	0.80

RATE = $K[H_2][I_2]$

$K = \frac{0.20 \frac{M}{s}}{1.0M \cdot 1.0M} = \frac{0.20 dm^3}{mol \cdot s}$

3. $2NO_2 + F_2 \rightarrow 2NO_2F$

1&2 1&3

Trial	$[NO_2]$	$[F_2]$	rate (mol/L/min)
1	1.0 mol/L	1.0 mol/L	1.0×10^{-4}
2	2.0	1.0	2.0×10^{-4}
3	1.0	2.0	2.0×10^{-4}

RATE = $K[NO_2][F_2]$

$K = \frac{1.0 \times 10^{-4} \frac{M}{min}}{1.0M \cdot 1.0M} = \frac{1.0 \times 10^{-4} dm^3}{mol \cdot min}$

4. $2NO + Br_2 \rightarrow 2NOBr$

Trial	[NO]	$[Br_2]$	rate (mol/L/hr)
1	1.0 mol/L	1.0 mol/L	1.30×10^{-3}
2	2.0	1.0	5.20×10^{-3} > 8x's
3	4.0	2.0	4.16×10^{-2}

RATE = $K[NO]^2[Br_2]^1$

We know NO is 2nd order so that's 4 of the 8 increase.

$4 \times ? = 8$ $? = 2$ $Br_2 = 1^{st}$

is due to Br_2. Since Br_2 MOLARITY DOUBLED, $4 \times 2 = 8$

$K = \frac{1.30 \times 10^{-3} M/hr}{(1M)^2 \cdot (1M)^1} = 1.30 \times 10^{-3} dm^9 \cdot mol^{-3} \cdot hr^{-1}$

5. $ClO_3^- + 9I^- + 6H^+ \rightarrow 3I_3^- + Cl^- + 2H_2O$

$2M^2 \cdot 2M = 4 \cdot 2 = 8$

Trial	$[ClO_3^-]$	$[I^-]$	$[H^+]$	rate
1	0.10 M	0.10 M	0.10 M	X
2	0.10	0.20	0.10	2X
3	0.20	0.20	0.10	4X
4	0.20	0.20	0.20	16X

RATE = $K[ClO_3^-][I^-][H^+]^2$

$K = \frac{x}{0.10M \cdot 0.10M \cdot (0.10M)^2}$

Given the rate law provided, predict the effect on the initial rate of the following changes in the conditions (temperature, concentration, volume)

6. Nitrogen monoxide gas and hydrogen gas react according to the rate law Rate = $k[NO]^2[H_2]$. How does the rate change if:

   a. the concentration of hydrogen is doubled. DOUBLES
   b. the concentration of nitrogen monoxide is doubled. 4x'S
   c. the concentration of hydrogen is cut in half. ↓ 2x'S
   d. the volume of the container is cut in half. M DOUBLES FOR BOTH. ↑4x'S • ↑2x'S = ↑8x'S
   e. the volume of the container is doubled. M IN HALF ↓4x'S • ↓2x'S = ↓ 8x'S
   f. the temperature is increased. K↑, RATE↑ ~ double for every 10°C.
   g. the concentration of nitrogen monoxide is doubled while the concentration of hydrogen is cut in half. ↑4x'S • ↓ 0.5x'S = ↑2x'S
   h. the concentration of hydrogen is doubled while the concentration of nitrogen monoxide is cut in half. ↓0.25x'S • 2x'S = ↓0.50
      $(\frac{1}{2})^2 = \frac{1}{4} = 0.25$

7. The rate law of a particular reaction between gases X, Y and Z is found to be Rate = $k[X]^0[Y]^2[Z]$. How does the initial rate change if:

   a. the concentration of X is doubled. NO CHANGE
   b. the concentration of Y is tripled. ↑ 9X'S
   c. the concentration of Z is quadrupled. QUADRUPLE
   d. the volume of the container is cut in half. M DOUBLES 4x'S • 2x'S = ↑ 8x'S
   e. the volume of the container is doubled. M IN HALF ↓4x'S • ↓2x'S = ↓ 8x'S
   f. the temperature is increased. K↑, RATE↑ ↓0.25 • .5 = .125
   g. the concentration of X is quadrupled while the concentration of Y and Z are doubled. ↑4x'S • ↑2x'S = ↑8x'S
   h. the concentration of Z is cut in half while the concentration of Y is doubled. ↓.5 • ↑4x'S = ↑2x'S
   i. the concentration of Y and Z are tripled while the concentration of X is cut in thirds. ↑9x'S • ↑3x'S = ↑ 27x'S