Rate Law Determination

Procedure:

Determination 1:

1. Dispense, from a buret, 5.00 mL of a 0.755 M $H_2C_2O_4$ solution into a clean, dry 20 x 150- mm test tube.

2. Dispense, from a buret, 6.00 mL of deionized water into a 125 mL flask.

3. Dispense, from a buret, 1.00 mL of a 0.100 M $KMnO_4$ solution into the beaker containing the deionized water. Swirl flask to mix the solution.

4. Quickly transfer the $H_2C_2O_4$ solution from the test tube into the flask containing the $KMnO_4$ solution, start the timer, and swirl continuously.

5. Stop the timer when the last trace of red disappears and the solution is yellow. Record on the Data Sheet:
   1. Volume of each reactant
   2. Volume of deionized water
   3. Elapsed time

6. Repeat steps 1-5 until you can reproduce the elapsed time to within 10 s. Record on data sheet.

7. Determinations 2 and 3:

   Follow the same procedure as used in determination 1, using the quantities of reagents designated for determinations 2 and 3. See Procedure Table below. Record all elapsed times on Data Sheet.

Reagent Proportions			
Reactants	Determination 1	Determination 2	Determination 3
$H_2C_2O_4$ solution, mL	5.00	10.00	5.00
$KMnO_4$ solution, mL	1.00	1.00	2.00
Deionized H_2O, mL	6.00	1.00	5.00

Results:

Determination Number	Calculated Initial Concentrations, mol/L		Average Elapsed Time, sec	*Reaction Rate ($x10^{-5}$), mol/L ◦s	Relative Rate
	$H_2C_2O_4$	$KMnO_4$			
1					
2					
3					

* Reaction Rate = $\frac{\text{change [} KMnO_4\text{]}}{\text{change in time}}$

Order of reaction with respect to:

(A) $H_2C_2O_4$ _____ (B) $KMnO_4$ _____

Overall reaction order: _____

Rate Law for the reaction: _____

Calculated rate constant, *k*, for the reaction: _____

Rate Law Determination Worksheet-Sample

Data:

Determination Number	Volume of $H_2C_2O_4$ solution, mL	Volume of $KMnO_4$ solution, mL	Volume of Deionized water, mL	Elapsed Time, sec
1	5.0 mL	1.0 mL	6.0 mL	290 sec
	5.0 mL	1.0 mL	6.0 mL	310 sec
Average Time Elapsed				300 sec

Determination Number	Volume of $H_2C_2O_4$ solution, mL	Volume of $KMnO_4$ solution, mL	Volume of Deionized water, mL	Elapsed Time, sec
2	10.0 mL	1.0 mL	1.0 mL	140 sec
	10.0 mL	1.0 mL	1.0 mL	160 sec
Average Time Elapsed				150 sec

Determination Number	Volume of $H_2C_2O_4$ solution, mL	Volume of $KMnO_4$ solution, mL	Volume of Deionized water, mL	Elapsed Time, sec
3	5.0 mL	2.0 mL	5.0 mL	145 sec
	5.0 mL	2.0 mL	5.0 mL	155 sec
Average Time Elapsed				150 sec

Results:

Determination Number	Calculated Initial Concentrations, mol/L		Average Elapsed Time, sec	Reaction Rate ($x10^{-5}$), mol/L ∘s	Relative Rate
	$H_2C_2O_4$	$KMnO_4$			
1	5/12 (.755M) =.315 M	1/12 (.10M) =.00833 M	300 sec	$\frac{.00833}{300} = 2.77 \times 10^{-5}$	1
2	10/12(.755M) = .629 M	1/12 (.10M) = .00833 M	150 sec	$\frac{.00833}{150} = 5.54 \times 10^{-5}$	2
3	5/12 (.755M) = .315 M	2/12 (.10M) = .0167 M	150 sec	$\frac{.0167}{150} = 11.13 \times 10^{-5}$	4

Rate = $\frac{\text{change [} KMnO_4\text{]}}{\text{change in time}}$

Order of reaction with respect to:

(A) $H_2C_2O_4$ 1st (B) $KMnO_4$ 2nd

Overall reaction order: 3rd

Rate Law for the reaction : Rate = $k[H_2C_2O_4]\,[KMnO_4]^2$

$$k = \frac{\text{Rate}}{[H_2C_2O_4]\,[KMnO_4]^2}$$

Calculated rate constant, *k*, for the reaction: $\frac{1.27\ L^2}{mole^2 \circ sec}$