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24	Iodine Clock Reaction - Determination of Ea	07/17/13

NAME	LAB PARTNER	LOCKER/DESK NO.	COURSE & SECTION NO.
Ana Chang Gonzalez	Chelsea Gould		CHEM 1412-312

7/17/2013 - Experiment 24 -

Iodine Clock Reaction - Determination of Ea

PURPOSE:

In this experiment we will again be exploring the effects of ~~de factors~~ temperature on the reaction mechanism. This reaction mechanism is the steps (or pathway) a reaction must take to reach completion. We will alter the temperature of our reactants (ranging from 0°C to 30°C), thus altering the rate of the reaction, in order to graphically and experimentally find Ea (energy of activation) for this reaction.

CHEMICAL DATA:

- potassium iodate (KIO_3) - CAS # 7758-05-6
  - skin: irritant, prolonged exposure may cause burns and ulcerations - immediately flush with water, remove stained clothing
  - eyes: irritant, - flush immediately for 15 mins
  - inhalation: respiratory tract irritation - move to fresh air
- sulfurous acid (H_2SO_3) - CAS # 7782-99-2
  - skin: burns, harmful if absorbed through skin - flush with water for 15 mins, remove stained clothing.
  - eyes: burns - flush for 15 mins immediately
  - inhalation: chemical burns to respiratory tract - move to fresh air
- water (H_2O) - CAS # 7732-18-5
  - non-corrosive, non-irritant, no first aid measures

PROCEDURE	OBSERVATIONS
1. Obtain: 100 mL grad cylinder, 2 10.00 mL pipettes, 2 pipet pumps, 2 hot plates, stir bar, 2 large test tubes, 4 150-250 mL beakers, 2 thermometers, wash bottles, stop watch.	

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2. rinse and label beakers, place 70 mL soln A and 70 mL soln B.
3. ID pipettes, thermometers, test tubes
4. use distilled H_2O for all baths
~~5. place therm A into soln A~~

MIXTURE 5. (room temp)
1. transfer 10.00 mL soln A into tube A
2. transfer 10.00 mL soln B into tube B
3. create H_2O bath (~100 mL DI H_2O)
4. place thermom. B into bath, take reading.
5. place soln A into bath, wait until temp soln A = temp bath
6. remove tubes, pour 80 mL H_2O from bath into beaker, place thermom
7. pour soln B into beaker, stir w/ motor
8. pour soln A, time, record T at time of color change.

T_i = 24.2 °C
$T_{\text{at change}}$ = 24.3 °C = 297 K
t = 21.27 sec

MIXTURE ~~2.~~ 1. (0°C)
1. transfer 10.00 mL soln A and 10.00 mL soln B to resp. test tubes
2. place ~100 mL H_2O in bath, adjust $T \approx 0$°C
3. place tubes of soln A and B in bath, once $T_{\text{soln A}} = T_{\text{bath}} \approx 0$°C, remove tubes.
4. pour 80 mL H_2O from bath into beaker
5. pour soln B into beaker, stir
6. pour soln A, time, take T

N/A - unable to get water bath to 0°C

MIXTURE 2. (5°C)
1. transfer 10.00 mL soln A and 10.00 mL soln B into resp. test tubes
2. place ~100 mL H_2O in bath, adjust $T \approx 5$°C

N/A - unable to get ~~water bat~~ solns to 5°C

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3 place tubes of Soln A and Soln B into bath, once $T_{\text{Soln A}} = T_{\text{bath}} \approx 5°C$, remove tubes.
4. pour beaker 80 mL Temperatured H_2O
5. pour Soln B into beaker, stir
6 pour Soln A into beaker, time and record T at change.

MIXTURE 3 (10°C)
1. transfer 10.00 mL Soln A and 10.00 mL Soln B into respective test tubes
2. place ~100 mL H_2O in bath, adjust $T \approx 10°C$
3. place tubes of Soln A and Soln B into bath, once $T_{\text{Soln A}} = T_{\text{bath}} \approx 10°C$, remove tubes.
4. pour ~~beak~~ 80 mL of ~~Tbath~~ bath H_2O to beaker (0°C)
5. pour Soln B into beaker, stir
6. pour Soln A into beaker, time and record Temp. at change.

MIXTURE 4 (15°C)
1. transfer 10.00 mL Soln A and 10.00 mL Soln B to resp. test tubes.
2. place ~100 mL H_2O in bath, adjust $T = 15°C$
3. place tubes of Soln A and Soln B into bath, once $T_A = T_{\text{bath}} \approx 15°C$, remove tubes.
4. pour 80 mL of bath H_2O to beaker
5. pour Soln B into beaker, stir
6. pour Soln A into beaker, time and record Temp at change.

$T_i = 24.2°C$
$T_{\text{at change}} = 24.8°C = 297\ K$
$T_i = 82.7°C$ sec
$T_{\text{at }\Delta} = 12.9°C = 286\ K$
$t = 27.00$ sec

N/A - unable to get water bath to 0°C

$T_i = 15.5°C$
$T_{\text{at }\Delta} = 18.1°C = 291\ K$
$t = 25.87$ sec

N/A - unable to get ~~water bath~~ bath to 5°C

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MIXTURE 6

1. transfer 10.00 mL soln A and 10.00 mL soln B into resp. tubes
2. place ~ 100 mL H_2O in bath, adjust T = 30-35°C
3. place tubes of soln A and soln B into bath, once $T_A = T_{bath} \approx 30°C$, remove tubes.
4. pour 80 mL H_2O from bath into clean beaker
5. pour soln B into beaker, stir
6. pour soln A into beaker, time and record temperature at change

T_i = 29.5 °C

$T_{at\,\Delta}$ = 20.1°C = 293 K

t = 21.01 sec

CONCLUSIONS:

In this experiment, we determined activation energy (Ea) for the iodine clock reaction by reacting the soln A (.02 M KIO_3) and soln B (.01 M H_2SO_3) at different temperatures. We noticed that as the temperature of the reactants increased, the time for the reaction to reach completion decreased. Graphing 1/Temperature (K^{-1}) versus ln(1/time), we obtained a ~~trendline~~ linear trendline for the data. The slope of the line equaled −2103.3. The Arrhenius equation, when simplified into the y=mx+b form, is ~~ln(rate)~~

$$\ln(rate) = \ln(A[KIO_3]^x[H_2SO_3]^y) + \left(\frac{-E_a}{R}\right)\left(\frac{1}{T}\right)$$

. Since the slope of the line = $-E_a/R$ ($R = 8.314\ J/mol\cdot K$), we can figure out Ea from our trendline slope (−2103.3). The value of Ea for this reaction is 17.49 kJ/mol.

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Experiment #24

Iodine Clock Reaction – Determination of E_a

Name ______________________

Instructor ______________________

Lab Section ______________________

Date ______________________

In-Lab Guidelines (This is a guide to the information that you should be observing while in the laboratory. Record this information in your Laboratory Notebook. Turn in the duplicate page(s) of your observations to your Instructor before you leave the laboratory period.)

Room Temperature __________ °C

Solution A Molarity KIO_3 = 0.02 M

Solution B Molarity H_2SO_3 = 0.01 M

Total volume for all trials should be 100 mL

T_i	Mixture	Soln A (mL)	Soln A (mL)	Vol H_2O (mL)	Temp of mixture at color change (°C)	Time (sec)
	1	10.00	10.00	80	0℃ —	—
	2	10.00	10.00	80	5℃	
8.7	3	10.00	10.00	80	10℃ 12.9	27.00
15.5	4	10.00	10.00	80	15 18.1	25.87
24.2	5	10.00	10.00	80	R.T. 24.3	21.27
29.5	6	10.00	10.00	80	30 20.1	21.01

Experimental Error and Observations:

Experiment #24

Iodine Clock Reaction – Determination of E_a

Name Ana Chang Gonzalez

Instructor Giesbrecht

Lab Section 312

Date 07/22/13

Post-Lab Report (Use the In-lab observations to complete the laboratory report. Turn in to your Instructor when you have completed the report.)

Molarity of KIO_3 stock solution 0.02 M Volume used 100 mL

Molarity of H_2SO_3 stock solution 0.01 M Volume used 100 mL

Ti(°C)	Trial	Temp at Change (°C)	Temp at Change (K)	1/T (K^{-1}) X	Time (sec)	1/time (sec^{-1})	*ln*(1/time) Y
8.7	1	12.9	286	0.00350	27.00	0.0370	-3.296
15.5	2	18.1	291	0.00344	25.87	0.0387	-3.253
24.2	3	24.3	297	0.00337	21.27	0.0470	-3.057
29.5	4	20.1	293	0.00341	21.01	0.0476	-3.045

You will use graphical analysis to determine E_a for this reaction. You will need to use Excel® to graphically analyze this data. Print your graph and the equation for the line. **Print your graph and attach that page to the back of this report.**

Based upon the slope of the graph calculate E_a for the reaction. (Show work)

$y = -2103.3x + 4.0517$

$m = -2103.3 = -\frac{E_a}{R}$

$E_a = 2103.3\cancel{K}\left(\frac{8.314 J}{mol \cdot \cancel{K}}\right)$

$E_a = 17490 \ J/mol$

$\boxed{E_a = 17.49 \ kJ/mol}$

Experimental Error (what errors may have occurred during the performance of this experiment and altered your results)

- the readings for temperature could be .1 °C or so off due to human error
- The amount of soln added could be slightly off from 10.00 mL.

Experiment #24

Iodine Clock Reaction – Determination of E_a

Name Ana Chang Gonzalez

Instructor Giesbrecht

Lab Section 312

Date 07/22/13

Post-Lab Questions (Turn in to your Instructor with the post laboratory report for this experiment.)

1. How would the recorded time for the blue color appear to be affected if Solution A and B were at room temperature when they were added to the trials run below room temperature? (Explain)

If soln A and B were added when their temperature was below room temperature, the time it took for the blue color to appear was much longer than if the solns were at room temperature. This is because reactions occur faster at higher temperatures. At higher temps, molecules collide with each other more often and collide with higher energy, causing reactions to reach completion quicker.

2. How would the recorded time for the blue color appear to be affected if Solution A and B were at room temperature when they were added to the trial run at temperature higher than room temperature? (Explain)

If soln A and B were added to the trial run at a temperature higher than room temp, the time it took for the blue color to appear was slightly shorter than if the solns were at room temp. This is because reactions occur faster at higher temps due to the fact that molecules collide with each other more often and with higher energy than at lower temperatures, causing reactions to reach completion faster.

3. Would the slope of a *ln*(*k*) versus 1/T (K) plot for a catalyzed reaction be more or less negative than the slope of the *ln*(*k*) versus 1/T (K) for the uncatalyzed reaction? Explain. Assume both rate laws for the catalyze and uncatalyzed reaction are first-order overall.

The slope of ln(k) vs. 1/T (K) for a catalyzed reaction would be more negative than the slope of the ln(k) versus 1/T (K) for the uncatalyzed reaction. This is because the reaction time for a catalyzed reaction is shorter, thus $\ln(\frac{1}{t})$ changes. Temperature does not change significantly, so $\frac{1}{T}$ stays the same. $\ln(\frac{1}{t})$ changes at a much faster rate for the catalyzed reaction than for the uncatalyzed, making the slope more negative.

1/T (K^-1)	ln(1/time)
0.0035	-3.296
0.00344	-3.253
0.00337	-3.057
0.00341	-3.045