CLOCK REACTION LAB name: _____ due date: _____

The time it takes for a chemical reaction to go to completion is easy to measure if a color change occurs when one of the reactants is used up. This kind of reaction is a "clock reaction". To tell how long a clock reaction takes, all you need to do is measure the time between mixing of the chemicals and the color change.

The clock reaction that you will use in this lab involves a starch solution and an iodine solution. In the presence of starch, molecular iodine turns blue black color. You will be mixing 2 different solutions called SOLUTION A and SOLUTION B, using different volumes of solution A will cause a change in the time the reaction takes to occur. We'll measure this affect and graph our results. Using a stop watch you will be able to measure the time required.

The second clock reaction will let you measure the affect that different temperatures have on reaction time. As you already learned, hotter reactants usually make faster reactions. We'll measure the affect ten different temperatures have on this same reaction, and graph our results on a second graph.

PART ONE—Measuring the Effect of Concentration of Reactants on Rate of Chemical Reactions

Obtain: two 10 mL graduated cylinders, label these A and B. Two clean beakers, one containing approximately 100 mL solution A, and another beaker containing 100 mL solution B. Get one similarly sized beaker, clean, to do your reactions in. Finally a smaller beaker with about 40 mL deionized water. Put an eyedropper into the water and another into solution A.

We will vary the amount of solution A in each of seven trials. Put the proper amount of solution A into a graduated cylinder, then fill to 10 mL with deionized water. Always use 10 mL of solution B. One student prepares with a stopwatch, the other pours both graduated cylinders into the reaction beaker. Immediately clock the length of time IN SECONDS that it takes for the reaction to occur. The first reaction will require some patience. Don't miss it.

Once the reaction finishes, and you record the length of time it took, wash out the reaction beaker with tap water, do not dry with paper towels. Move to trial two, etc.

Use your best estimate on the time if you miss the exact color change, or redo the trial. You should have 4 significant figures each time you clock a trial.

Convert the time to rate. The rate is equal to 1 over time in seconds. It will be a small decimal, and the unit will be sec^{-1}. Unusual units are our favorite.

Date table 1 for Concentration of Solution A vs. Rate of Reaction.

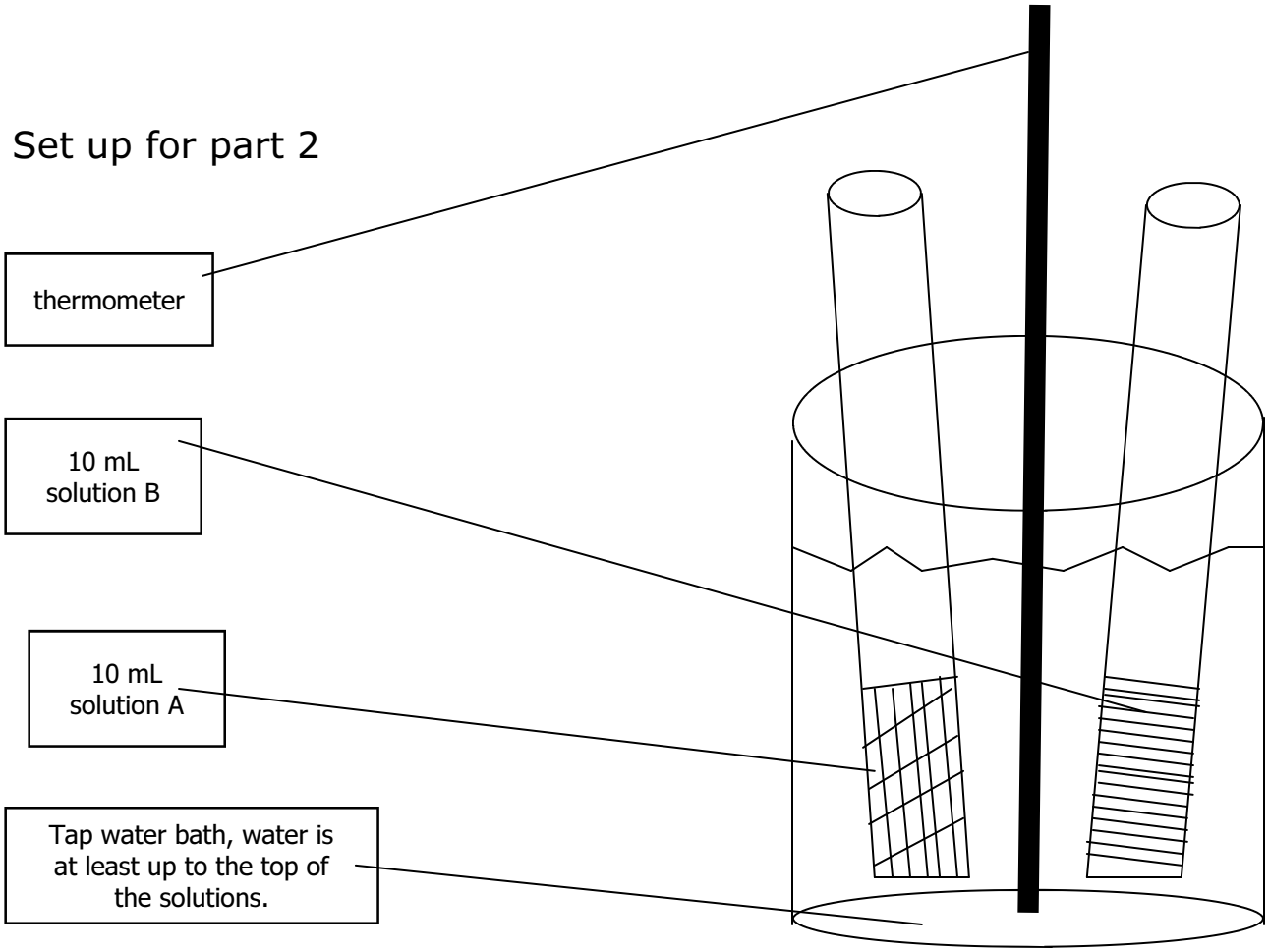
Solution A	D I Water	Solution B	Time	Rate
4.0 mL	6.0 mL	10.0 mL		
5.0 mL	5.0 mL	10.0 mL		
6.0 mL	4.0 mL	10.0 mL		
7.0 mL	3.0 mL	10.0 mL		
8.0 mL	2.0 mL	10.0 mL		
9.0 mL	1.0 mL	10.0 mL		
10.0 mL	Zero	10.0 mL		

Part 2-the affect of temperature on the rate of reaction.

As you have previously learned, hotter reactants will react faster. These trials will show clearly how that happens. Rather than take a lot of time to do repeated trials, each team will choose one temperature from the board. You will focus on getting your tubes of solution A and solution B to these exact temperatures, and do one trial perfectly. Put your data on the board, share the data your classmates add to the board. Everyone will use the same data to make this graph.

You will need 2 larger test tubes, each containing 10 mL of the solutions. Put tubes into a TAP WATER bath in a larger beaker. Put a thermometer into this bath water. Make your bath water the proper temperature, use ice, or Bunsen Burners, as needed. When your bath water is at the right temperature, so are your solutions. Put them into the reaction beaker, and time your reaction carefully. Determine the rate as well, post your data on the board, get the rest of the data too.

Set up for part 2



Temp °C	seconds	rate
5		
10		
15		
20		
25		
30		
35		
40		
45		
50		
55		
60		

You will have to use heat, or ice to change the temperature of the water bath. When the water bath is at proper temperature for at least one minute, the solutions are also at the proper temperatures.

Problems, do your own work, do not collaborate please.
A cover page with an introduction sentence for 2 points will start this all up.

1. Based upon your data, make a general statement about the effect of the concentration of the reactants on the rate of reaction. Write a whole sentence starting with: "As the concentration of the reactants increases..." [1 point]

2. Based upon your data, make a general statement about the effect of the temperature of the reactants on the rate of reaction. Write a whole sentence starting with: "As the temperature of the reactants increases..." [1 point]

3. In the reversible reaction $2NO_{2\,(G)} \rightleftharpoons N_2O_{4\,(G)}$ + energy
   What would happen if the pressure was increased on this reaction and WHY?
   Start your answer like this: "By increasing the pressure on this reaction... " [1 point]

4. The polar compound $(NH_2)_2CO$ is called urea and is an important fertilizer. It is made from a reaction between ammonia gas and carbon dioxide gas. Water vapor is a second product. Write the word equation for this reaction. [1 point]

5. Write the balanced chemical equation for the reaction for urea synthesis. [1 point]

6. Zinc citrate is written: $Zn_3(C_6H_5O_7)_2$ and is used in some toothpastes. It is formed from the reaction of zinc carbonate and citric acid as shown:

   $$3ZnCO_{3\,(S)} + 2C_6H_8O_{7\,(AQ)} \longrightarrow Zn_3(C_6H_5O_7)_{2\,(AQ)} + 3H_2O_{\,(L)} + 3CO_{2\,(G)}$$

   What would happen to the rate of reaction if you used powdered zinc carbonate rather than pea sized chunks of it, and WHY? [1 point]

7. Why do you draw best fit lines on both of the graphs (you should have)? Why not just connect all the dots? Is there a difference? Explain this. [1 point]

8. Define entropy, use examples of the 3 phases of water. Then write the formulas for 3 different compounds with different molar masses (all at the same temperature and pressure) + determine which has lowest and highest entropy. . [1 point]

9. If you have three identical solutions of $NaCl_{(AQ)}$, at three temperatures, 10°C, 30°C, and 31°C. which has the most and which has the least entropy? [1 point]

GRAPHING: You will make 2 graphs, plotting <u>rate as a function of concentration</u> (use the volume of solution A as a way to express the concentration that changes). Then graph the <u>rate as a function of temperature</u>. Your graphs must have titles, labels, and proper units. Bigger is better. Each graph is worth 4 points. DRAW ONLY BEST FIT LINES on your graphs. [8 points]

Your conclusion should discuss the Collision Theory of Reactions, list the 4 factors affecting rates of reactions, a sentence explaining why catalysts are different than the other three factors, and even though it's not technically part of this lab, <u>draw</u> 2 potential energy diagrams (exo & endo) label the ΔH, AC, AE, and show the affect of a catalyst with a dotted line on the both graphs. Define LeChatlier's Principle, use an example reaction and a few stresses to show you understand this well. [6 points]