

# Why Do Changes in Temperature and Reactant Concentration Affect the Rate of a Reaction?

## Your Task:

- 1) Based on materials provided, come up with two separate experiments that will allow you to determine how temperature *and* changes in the concentration of a reactant affect the rate of the reaction
- 2) Once you have determined how each factor affects the rate of a reaction, you will develop a conceptual model that can be used to explain why these factors influence reaction rate

You may use any of the following materials during your investigation

## Experiment #1

### Effect of *Changing Concentration of One Reactant* on Reaction Rate

- Sodium thiosulfate solution,  $\text{Na}_2\text{S}_2\text{O}_3$  , 0.15 M , 250 mL
- Hydrochloric acid solution, HCl, 2M , 25 mL
- Distilled Water
- **5** 150-mL beakers
- **2** graduated cylinders, 50mL or 100 mL
- **1** 10-mL graduated cylinder
- Permanent marker
- Stir rod
- Stopwatch or timer

# Getting Started: Exp #1

## Effect of *Changing Concentration of One Reactant* on Reaction Rate



What 2 variables are we going to focus on? (*independent variable—the variable that we are changing*)

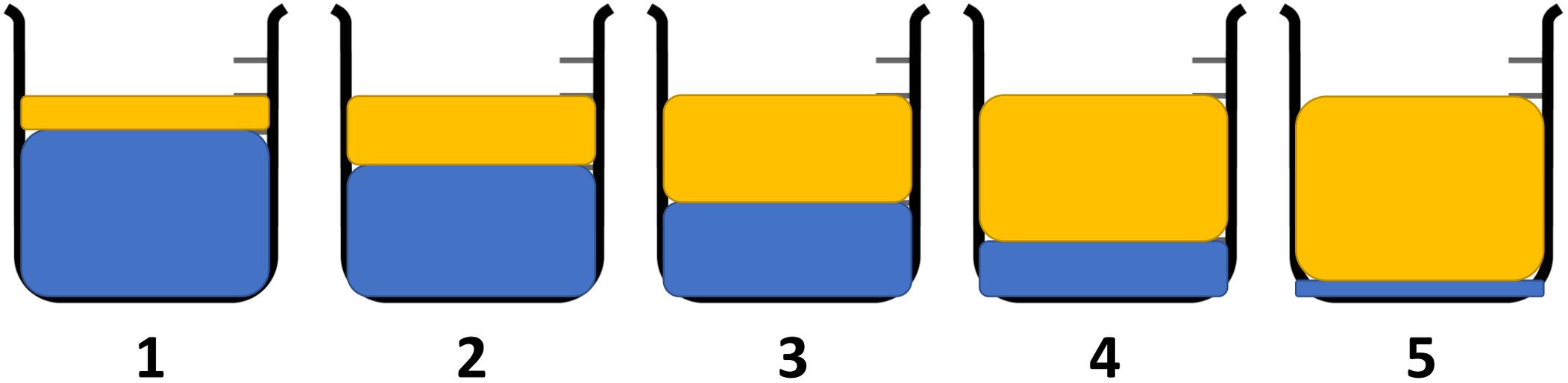
### **Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> concentration (molarity)**

- Since you are trying to determine what effect concentration has reaction rate, you will want multiple concentrations of Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>—I recommend 5 different concentrations
- Because you have 0.15 M Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> and distilled water available, you can simply use different amounts of each
  - \*\*remember, the more water you pour in, the less concentrated (more diluted) the Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> solution will become
  - \*\*you can use the dilution equation from last unit,  $M_1V_1 = M_2V_2$ , to determine the exact concentration later on

**The TOTAL volume in each beaker should be the same**

Beaker	1	2	3	4	5
0.15 M Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> (mL)					
Distilled Water (mL)					

All have the same TOTAL volume



# Getting Started: Exp #1

## Effect of *Changing Concentration of One Reactant* on Reaction Rate



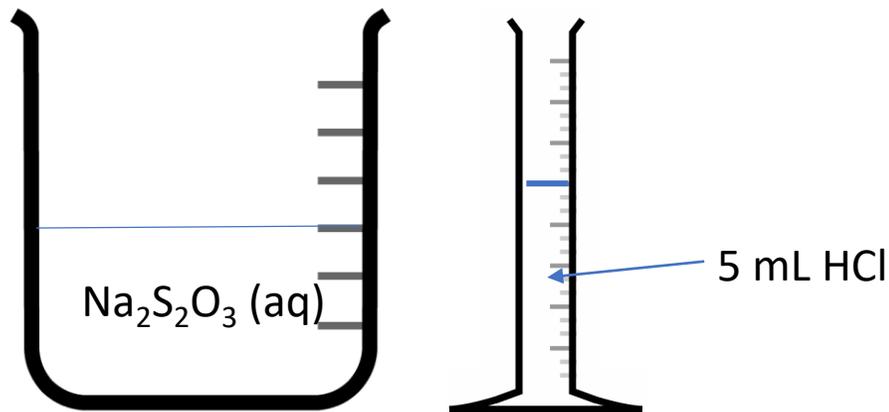
What 2 variables are we going to focus on?

Reaction Time (seconds)

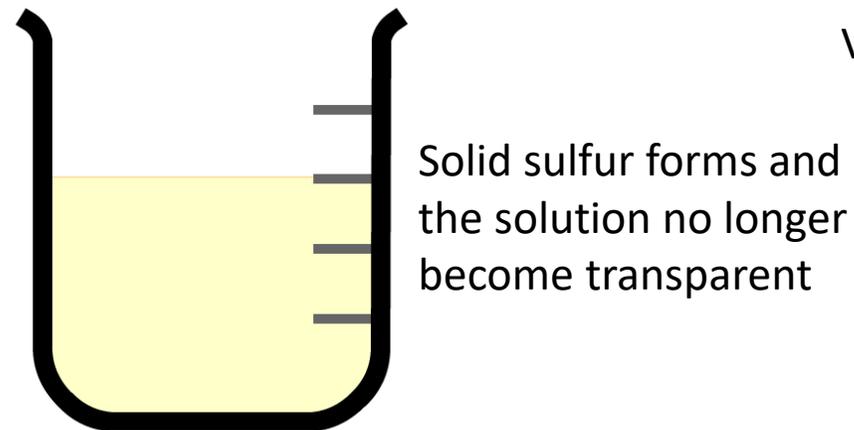
*(dependent variable—the variable that responds to the change being made)*

- Since measuring the reaction rate involves time, we will need to come to an agreement on when the reaction is “done” so that we all know when to stop the time.

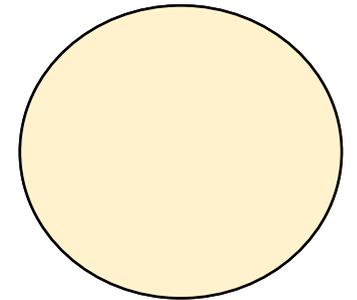
When should we start time?



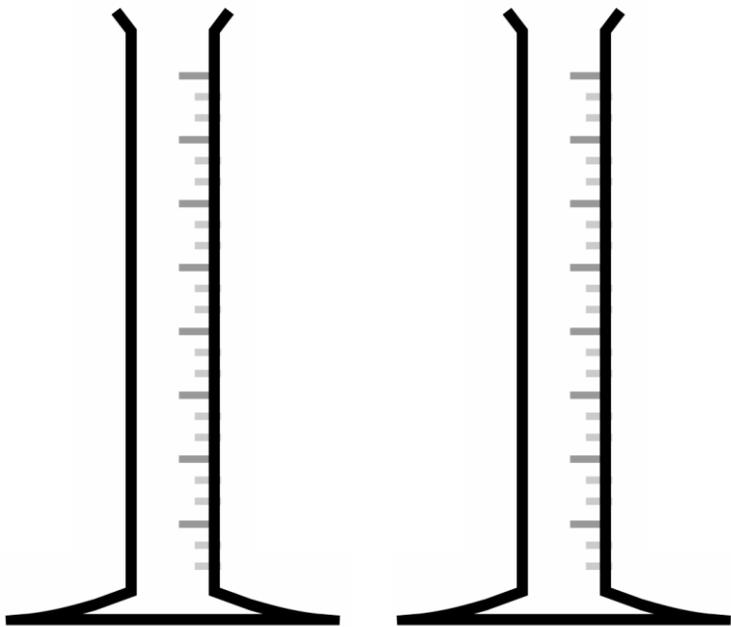
When should we end time?



View from top looking down

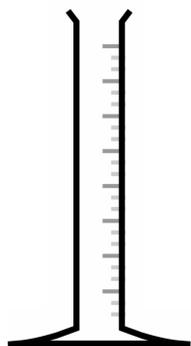


Recommend giving one quick stir (be consistent!)

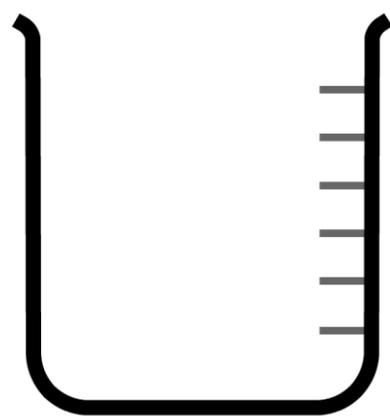


Used for measuring  $\text{Na}_2\text{S}_2\text{O}_3$  solution and water—keep separate!

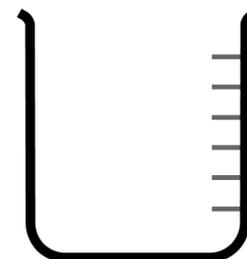
Used for measuring the 5 mL of HCl you use for each trial



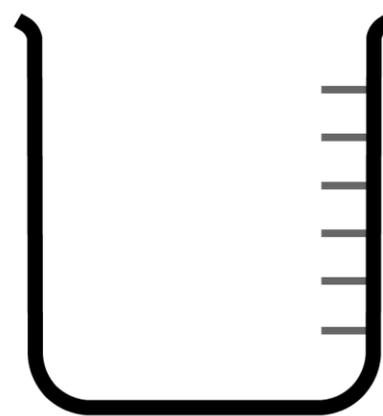
Used for “storing” water



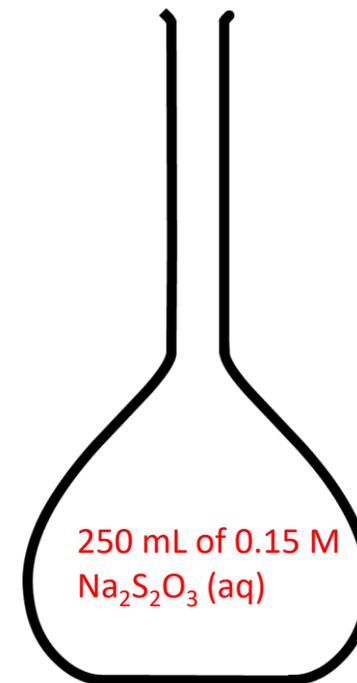
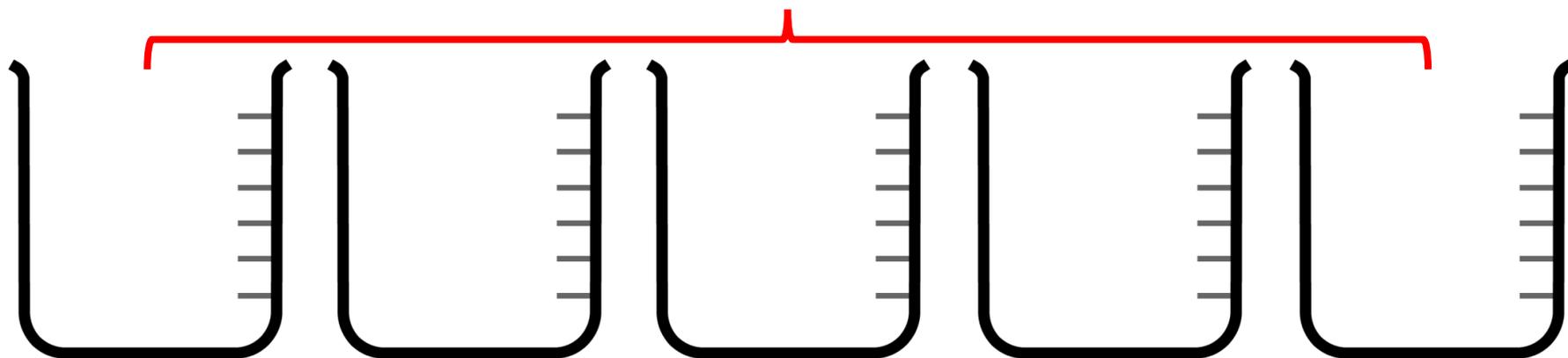
Used for “storing” HCl



Used for “storing”  $\text{Na}_2\text{S}_2\text{O}_3$  solution



These are for each of your 5 different concentrations



# Getting Started: Exp #1

## Effect of *Changing Concentration of One Reactant* on Reaction Rate

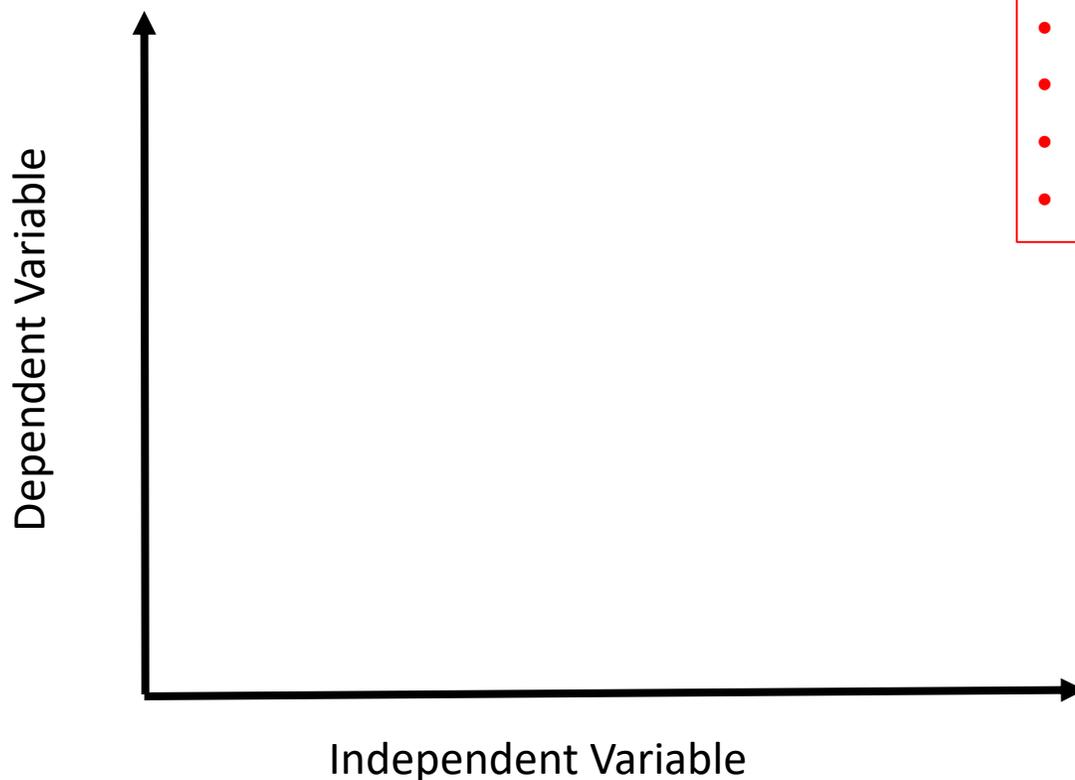
How will you organize your data?—you decide

- **Less is better**
- **Clear labels and units**

# Analysis: Exp #1

## Effect of *Changing Concentration of One Reactant* on Reaction Rate

What will you do with your data?



I recommend graphing your data electronically since some of the numbers will be a bit hard to accurately represent on a graph

- Excel
- Desmos (iPad app)
- Vernier Graphical Analysis (iPad app)
- Any other way you're aware of

# Conclusion: Exp #1

## Effect of *Changing Concentration of One Reactant* on Reaction Rate

### What will you do once you have determined the effect?

Once you have determined how concentration affects reaction rate, you will need to develop a conceptual model that can be used to explain why this factor influences reaction rate

*\*\*Hint: Reactants must collide in order for a reaction to take place*

<u>The Guiding Question:</u>	
<u>Our Claim:</u>	
<u>Our Evidence:</u>	<u>Our Reasoning:</u>

3 member group:

- 1 presenter (for argumentation session)
- 1 writer (writes argument on whiteboard)
- 1 “questioner” (will ask questions when listening to other arguments—writer will too)

2 member group:

- 1 writer & questioner
- 1 presenter

# ***Develop Your Argument***

**Question:** How does changing the concentration of one reactant affect the rate of a chemical reaction?

*Remember, a good scientific argument isn't just stating something you think is true and trying to explain it. A meaningful argument has 3 parts: there is a **claim**, **evidence** is provided to support that claim, and the person uses **reasoning** to account for why that evidence supports the claim based on any scientific knowledge that person has.*

**Claim:** This is the your answer to the question. Should be one sentence in length.

**Evidence:** This is any data that you gathered throughout your experiment that supports your claim. This can be quantitative (graphs, tables, etc.) or qualitative (things you observed or gathered from your senses)

**Reasoning:** This is where you try to explain why all of this makes any sense. Come up with some sort of particle-based explanation as to why the evidence you provided supports your claim. Use any of the scientific concepts you know to help your argument. This part should be relatively detailed and should consist of several sentences. You are welcome to add particle diagrams to help your reasoning section but the diagrams should not be the only reasoning you provide.

# Argumentation Session

Goal: To help you revise and improve your argument

- In order to improve your own argument, you have to be able to critique the arguments made by your classmates
- Ask questions

At the end of the session, each group will have an opportunity to revise their argument in order to make their argument better

## Class Discussion

- I introduce you to content material that is at the heart of this investigation
- Provides a more in depth understanding of what's going on



## Investigation Report

- Each student writes an investigation report to share the goal of the investigation, the method used during the investigation, and the final argument