RATE OF REACTION

TEACHER GUIDE

PLANNING

Here's a suggested schedule for this kit! The activities should be completed in order, but you can choose when the lessons take place over time.

ACTIVITY INFORMATION	SECTION (S)	TIME REQUIRED	DAY/ LESSON
ACTIVITY 1: CHEMICAL CLOCK When you mix a certain combination of chemicals, nothing happens – at first! **Time required: 1 h**	☐ Countdown to Change	60 minutes	Day 1
ACTIVITY 2: SET THE CLOCK Learn about rate of reaction and change the rate of the chemical clock. **Time required: 3 h**	☐ Reaction Time	90 minutes	Day 2
	☐ "C" How Fast It Goes	90 minutes	Day 3
ACTIVITY 3: THE SECRET INGREDIENT Find out how catalysts make reactions happen much faster by doing a super-charged experiment. **Time required: 3 h**	☐ More Foam, Please!	75 minutes	Day 4

Full schedule available with purchase

1

activity

CHEMICAL CLOCK

When this specific combination of chemicals is mixed, nothing happens – at first! But watch and wait, and your student will see a reaction that is often called predictable even though it can be surprising the first time one sees it.

COUNTDOWN TO CHANGE

WARNING! Contains hazardous chemicals. Do not eat or drink. Wash your hands after use.
WARNING! DO NOT EAT OR DRINK anything in this kit.
WARNING! CHOKING HAZARD - Small parts. Not for children under 3 years.

PREPARATION AND SUPERVISION

I

■ Your student will be performing what's called an Iodine Clock reaction.
• There are many variations of this reaction in chemistry, and this version is probably the safest one in terms of the chemicals required.
■ They will be using a pipet to transfer iodine to a container. If your student is not comfortable with using pipets yet, they may want to wear an apron or clothes that can get messy because iodine will stain most clothing.
■ The most technically challenging aspect of the reaction is getting the vitamin C tablets dissolved in the water and filtering the chunks that can't dissolve.
• Strong, rapid stirring will help make this go faster, along with using hot water (not boiling water since it would melt the plastic) and crushing the tablets with the stir rod once they're soft enough.
• While filtering, your student may need to use the stir rod to clear powder clogging the bottom of the filter.
■ The reaction should take about 30 seconds to happen – the mixture in the cup will change from clear to a dark blue-black color. When it changes, it does so almost instantly, and there is generally not much of an in-between stage.

CONTENT

• The reaction happens in two stages, a slow stage and a fast stage. Don't share this with your student quite yet, but here is the explanation:
  • In the first stage, or slow stage, two reactions are happening at the same time.
    • Reaction 1: Iodide (from the Lugol's solution) and hydrogen peroxide react to form elemental-form iodine and water:

$$H_2O_2 + I^- \rightarrow I_2 + H_2O$$

hydrogen peroxide + iodide → elemental iodine + water

    • Reaction 2: The elemental iodine formed in Reaction 1 reacts with vitamin C (ascorbic acid). As long as there is some ascorbic acid, this reaction, which forms colorless iodine, will keep going.

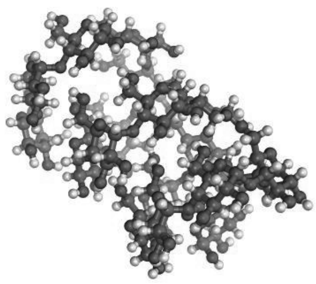
$$C_6H_8O_6 + H_2O + I_2 \rightarrow C_6H_6O_6 + I^-$$

ascorbic acid + water + elemental iodine → dehydroascorbic acid + iodide ion

  • In the second stage, or fast stage, when the vitamin C has all been used up, it can no longer react with elemental iodine, and a different reaction happens.
    • Reaction 3: Elemental iodine reacts with starch to form a bluish-black starch-iodine complex (large molecule).

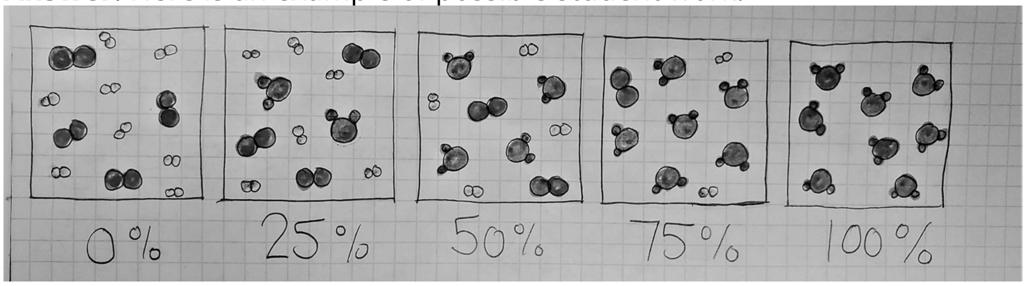
elemental iodine + starch → starch-iodine complex

    •The chemical formula for starch-iodine complex is unclear because it doesn't form defined crystals for scientists to study, but it has repeating units of iodine ions inside an "amyloid helix" – repeating starch subunits in a spiral shape.



Question 2: List the product(s).
Answer: The products are labeled in the equation above (calcium carbonate, sodium chloride, water, and carbon dioxide).
How to Help:
• Remind the student that products are produced in a chemical reaction, so they are shown after the arrow that represents the reaction happening.
• Review the structure of chemical equations in the first subsection as needed.

Question 3: Make particle-level drawings (showing a sample of atoms and molecules) for when the reaction shown here is 0 %, 25 %, 50 %, 75 %, and 100 % complete.
Answer: Here is an example of possible student work.



How to Help: *Check that your student's drawing shows only H2 and O2 when the reaction is at 0 % completion and only H2O when it is 100 % complete, with increasing product and decreasing reactant as it progresses from 0 % to 100 %.*

Question 4: Which of the drawings you made shows the reaction at equilibrium? Explain.
Answer: The last drawing (100 % reaction completion) shows the reaction at equilibrium because product is no longer being formed.
How to Help: *Help your student review the meaning and application of equilibrium; it means that the reaction is no longer happening in a measurable way. Since the reaction will continue until it is complete, equilibrium must occur when the reaction is complete.*

Question 5: List the reactants for the clock experiment you did in Activity 1.
Answer: The reactants are the chemicals they mixed: ascorbic acid, hydrogen peroxide, iodine, and starch.
How to Help:
• Reactants react with each other to form the products. The student should not yet know what the products of the reaction were.
• Water was also added, but it only helps the reaction happen and isn't a reactant itself.

Question 6: Was the reaction in Activity 1 fast or slow? Explain.
Answer: Answers may vary.
How to Help:
• The terms "fast" and "slow" are subjective, relative terms. Many reactions happen at rates that are slower or faster than the reaction in Activity 1.
• Accept any reasonable response as long as your student provides a logical reason or evidence, such as stating that it is slow because it happens much slower than an explosion or that it is fast because it happened much faster than rusting.

4 "C" HOW FAST IT GOES

Concentration and Collisions
• This subsection presents the collision theory to get students thinking about chemical reactions at a particle level and provide some introduction to the experiment that follows.
• The following vocabulary words are defined: solution, solvent, solute, concentration, and collision theory.

MULTIPLE AGES AND ABILITIES:

You can have multiple students do this experiment at the same time, having them add the tablets into the tubes so they can compare them while they all undergo the reaction (you can still time it, if you would like).
You could also have one student work the stopwatch while the other pours in the tablets. Or, you can have multiple students prep the tablets in their different sizes.

THINK ABOUT IT!

Question 1: Summarize the results of the experiment.
Answer: The smaller the size of the pieces, the faster the reaction.
How to Help: *Your student should have noticed that the fine powder was the fastest and the large pieces were the slowest.*

Question 2: Evaluate how well your predictions matched your results. Did you correctly predict which tablet size would react faster and slower? Attempt to explain any differences.
Answer: Answers will vary.
How to Help:
• This is a good time to address any misconceptions about how much of the tablets were exposed and how fast their reactions happened.
• Encourage your student to think about the reasons they made their original prediction and how doing the experiment provided evidence for their reasoning or showed them their reasoning was faulty because it didn't fit with the evidence.
• Students may incorrectly think that the smaller pieces have less mass and volume and will react more slowly because of that. Remind them that the total mass and volume are the same.

Seltzer Surface
• In this subsection, your student will delve into the relationship between surface area and rate of reaction.
• This topic can be fairly intuitive for the student if they've seen examples in everyday life (even if they are physical changes instead of chemical changes).
  • The physical change of dissolving sugar in powder form or in a sugar cube is a common example. Smaller pieces make it happen faster.
• The vocabulary term surface area is defined.

In-Text Question: You can think of surface area is the amount of an object that is exposed to its surroundings. Why would this make a reaction happen faster? Propose an explanation here based on how reactions happen.
Answer:
• The student should recall that collision theory means reactions can only happen when particles collide with each other with significant energy.
• The more of a reactant that is exposed to the other reactant(s), the more easily collisions can occur and the faster the reaction will proceed.
How to Help: *Review the part of Activity 2 that details collision theory if needed.*

LAUNCH

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Kit	SU-RATRXN
Instructions	IN-RATRXNT
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