

Chemical Reactions

Students are asked to decide if the chemical reaction which takes place as the iron in steel wool rusts to form iron oxide is exothermic or endothermic. To answer this question, students must design an experiment and apply concepts from Chapter 1.

◆ Expected Outcome

Students write a hypothesis that answers the question, “Is the chemical reaction that causes the iron in a piece of steel wool to form iron oxide (rust) when it is soaked in salt water exothermic or endothermic?” They must then devise an experiment with a control to test their hypotheses. One possibility is to use two identical thermometers (one is a control) and two large jars. The jars provide a convenient place to hold the thermometers during the experiment. After recording the initial temperature of both thermometers, wrap salt water-soaked steel wool around one thermometer, place each in a separate jar, and store the jars in a safe place away from direct sunlight. After 10 or 20 minutes, record the temperature again. Expect the second reading with the thermometer in the steel wool to be higher than the first, indicating that iron rusting is an exothermic chemical reaction.

◆ Content Assessed

This activity evaluates students’ understanding of energy flow in chemical reactions as described in Chapter 1.

◆ Skills Assessed

developing a hypothesis, designing an experiment, predicting, drawing conclusions, applying concepts

◆ Materials

- ◆ Provide each group with two Celsius thermometers and two small jars of approximately the same size.

- ◆ Place a glass bowl of steel wool submerged in salt water in a central location. There must be enough to allow each group a small handful.

◆ Advance Preparation

- ◆ Obtain jars, thermometers, steel wool, and salt water.
- ◆ Divide the class into as many groups as there are jars and thermometers.
- ◆ Place the steel wool in salt water at the start of the activity.

◆ Time

40 minutes

◆ Safety

Use thermometers that contain alcohol rather than mercury. Instruct students to wear safety goggles and disposable gloves during this activity. Also caution them to handle glass jars and thermometers carefully. Broken glass and steel wool can cause puncture wounds and become embedded in the eye.

◆ Monitoring the Task

- ◆ Before beginning, encourage students to reread the paragraphs on exothermic and endothermic reactions as well as those on synthesis, decomposition, and replacement reactions. Also, review the use of a control in an experiment.
- ◆ Advise students to keep jars away from direct sunlight. Stress that an initial temperature reading is mandatory when testing something that might affect temperature. Note, too, that excess liquid should be squeezed out of the steel wool.



Chemical Reactions

In assessing students' performance, use the following rubric.

	4	3	2	1
Developing a Hypothesis	Student's hypothesis is clearly stated as a possible answer to the question.	Student's hypothesis is general, but does address the question.	Student's hypothesis is vague, but demonstrates some understanding of the question.	Student's hypothesis does not demonstrate an understanding of the question.
Designing an Experiment	Student's experimental design positively tests the hypothesis.	Student's experimental design adequately tests the hypothesis.	Student's experimental design partially tests the hypothesis.	Student's experimental design does not test the hypothesis.
Applying Concepts	Student demonstrates mastery of the underlying concepts, including energy flow in chemical reactions.	Student demonstrates good understanding of the underlying concepts, including energy flow in chemical reactions.	Student demonstrates some understanding of the underlying concepts, including energy flow in chemical reactions.	Student demonstrates minimal understanding of the underlying chapter concepts.
Drawing Conclusions	Student's conclusion naturally follows from observed results.	Student's conclusion is well related to observed results.	Student's conclusion is somewhat related to observed results with evidence of conjecture.	Student's conclusion is minimally related to observed results with evidence of conjecture.



PERFORMANCE ASSESSMENT

Chemical Reactions

In Chapter 1 you learned that chemical reactions produce new substances. One sign that a chemical reaction has occurred is a change in temperature. If a reaction gives off heat energy, it is an exothermic reaction. In this activity, you will observe that salt water reacts chemically with the iron in steel wool to form iron oxide (rust). You must form a hypothesis to answer the question: "Is the chemical reaction that causes the iron in a piece of steel wool to form iron oxide when it is soaked in salt water exothermic?" Devise a plan to test your hypothesis using the materials your teacher has provided.

◆ Problem

Is the chemical reaction that causes the iron in a piece of steel wool to form iron oxide when it is soaked in salt water exothermic or endothermic?

◆ Suggested Materials

jars with a covers steel wool soaked in salt water pen or pencil
thermometers that fit in the jars paper

◆ Safety

Exercise caution when handling glass thermometers, jars, and steel wool. Wash hands after the activity.

◆ Devise a Plan

1. Form a hypothesis and record it on a separate sheet of paper.
2. Study the materials and decide how to use them to test your hypothesis.
3. Record the step-by-step procedure you will follow on the paper.
4. Predict what you expect to happen and record your prediction on the paper.

◆ Analyze and Conclude

After carrying out the plan you devised, answer the following questions on a separate sheet of paper.

1. Was your prediction correct? Explain your answer.
2. What can you conclude from your results?
3. Name two ways that you could increase the rate of this chemical reaction.
4. Iron combines with oxygen to form iron oxide, as illustrated in the following chemical equation: $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$. Is this an example of a synthesis reaction, a decomposition reaction, or a replacement reaction? Explain your answer.

