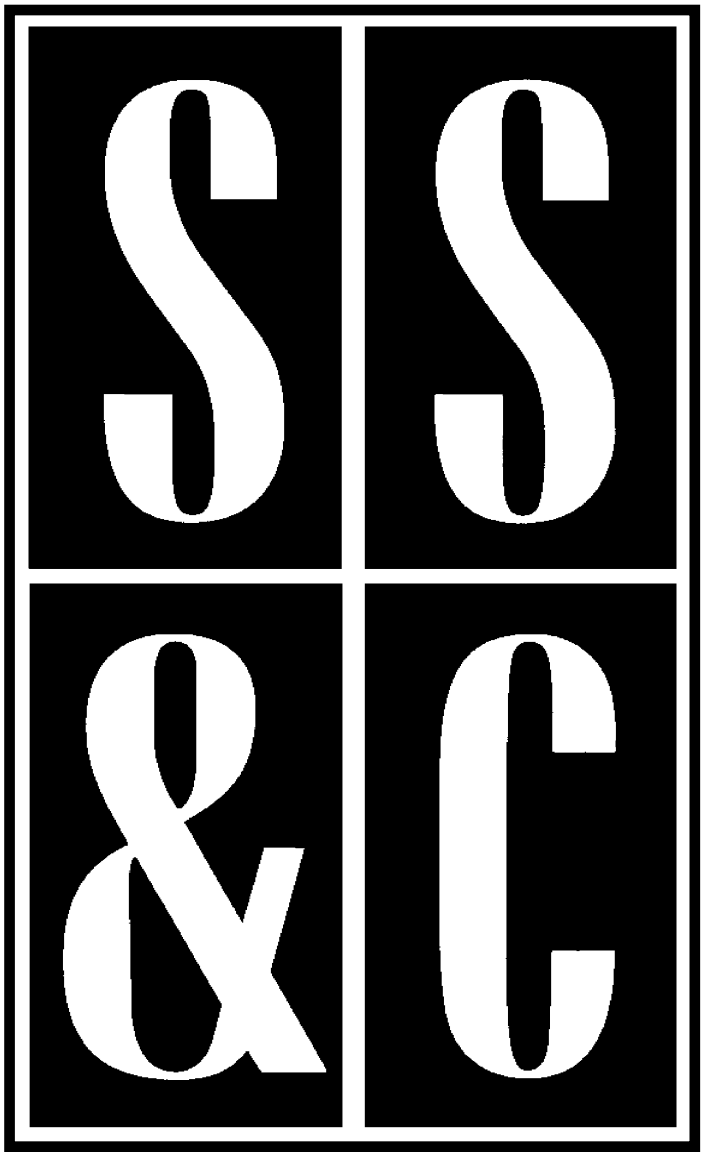
Scope, Sequence & Coordination

A National Curriculum Development and Evaluation Project for High School Science Education



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Scope, Sequence & Coordination

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National Science Education Standard—Physical Science

Chemical Reactions

Chemical reactions can take place in time periods ranging from the few femtoseconds (10^{-15} seconds) required for an atom to move a fraction of a chemical bond distance to geologic time scales of billions of years. Reaction rates depend on how often the reacting atoms and molecules encounter one another, the temperature, and on the properties—including shape—of the reacting species.

Teacher Materials

Learning Sequence Item:

968

Identifying and Explaining Reactions

March 1996
Adapted by:Cynthia Heath and Linda W. Crow

Chemical Reaction Rates. Using the particulate nature of matter, students should explain why temperature, concentration, and surface area are important factors in determining reaction rate. (*Chemistry, A Framework for High School Science Education, p. 70.)*

Contents

This micro-unit was adapted by **Cynthia Heath** (Northside High School, Pinetown, N.C.) and
Linda W. Crow (Baylor College of Medicine, Houston)

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Learning Sequence

Chemical Reaction Rates. Using the particulate nature of matter, students should explain why temperature, concentration, and surface area are important factors in determining reaction rate. (*Chemistry, A Framework for High School Science Education, p. 70.)*

Science as Inquiry	Science and Technology	Science in Personal and Social Perspectives	History and Nature of Science
Reactions that Produce Reactions **Lab Activity 1** Pasta Reactions **Lab Activity 2** A Handy Reaction **Lab Activity 3** Reactions in a Baggie **Activity 4** More Reacting Events **Activity 5** Explanations **Activity 6**	Thermocouples take the Heat **Reading 1**	The Mechanisms of Coagulation **Reading 2**	Gout and Genius: A Chemical Connection? **Reading 3**

Suggested Sequence of Events

Event #1

Lab Activity

1. Reactions that Produce Reactions (15 minutes)

Alternative or Additional Experiments

2. Pasta Reactions (10 minutes)
3. A Handy Reaction (10 minutes)

Event #2

Lab Activity

4. Reactions in a Baggie (10 minutes)

Event #3

Lab Activity

5. More Reacting Events (10 minutes)

Event #4

Lab Activity

6. Explanations

Event #4

Readings from Inquiry, Science and Technology, Personal and Social Perspectives, and History of Science. Students select two or three from list.

Reading 1 Thermocouples take the Heat
Reading 2 The Mechanisms of Coagulation
Reading 3 Gout and Genius: A Chemical Connection

The above readings can be found in the student version of this publication.

Assessment Recommendations

This teacher materials packet contains a few items suggested for classroom assessment. Often, three types of items are included. Some have been tested and reviewed, but not all.

1. Multiple choice questions accompanied by short essays, called justification, that allow teachers to find out if students really understand their selections on the multiple choice.

2. Open-ended questions asking for essay responses.

3. Suggestions for performance tasks, usually including laboratory work, questions to be answered, data to be graphed and processed, and inferences to be made. Some tasks include proposals for student design of such tasks. These may sometimes closely resemble a good laboratory task, since the best types of laboratories are assessing student skills and performance at all times. Special assessment tasks will not be needed if measures such as questions, tabulations, graphs, calculations, etc., are incorporated into regular lab activities.

Teachers are encouraged to make changes in these items to suit their own classroom situations and to develop further items of their own, hopefully finding inspiration in the models we have provided. We hope you may consider adding your best items to our pool. We also will be very pleased to hear of proposed revisions to our items when you think they are needed.

Science as Inquiry

Reactions that Produce Reactions

What are the characteristics of a chemical reaction?

Overview:

This activity uses a reaction that produces a gas.

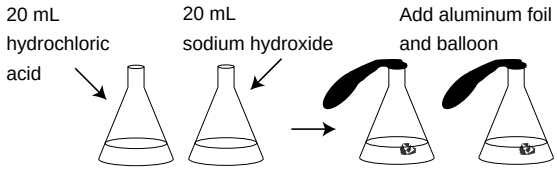
Materials:

Per lab group:

20 mL of 3 M hydrochloric acid (266 conc. reagent/liter)
20 mL of 3 M sodium hydroxide (120 g of sodium hydroxide per liter)
2-250 mL flask (either Florence or Erlenmeyer)
2 large (8–9 inch) round balloons
2 small squares of aluminum foil (approx. 5 cm × 5 cm)
2 lengths of string (approx. 2 feet)
candle
meter stick

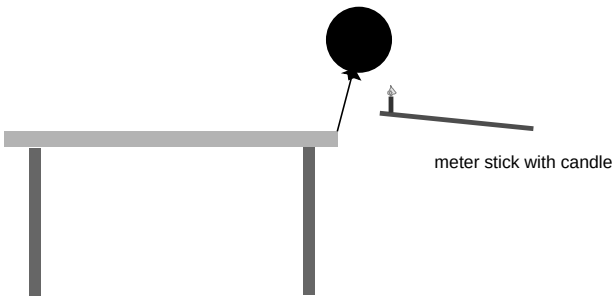
Procedure:

Have students place 20 mL of 3 M hydrochloric acid in one flask and 20 mL of 3 M sodium hydrox-



ide in the other flask. Next they drop a wadded piece of aluminum foil into each flask and quickly place a balloon over the opening. **Caution:** These are concentrated solutions and students should be told to use them carefully.

As the reaction occurs, the balloons will become inflated. Have them knot the ends of the balloons



and attach a string. They then tie the balloons to one end of their lab table. Using a meter stick with a candle attached to one end with a rubber band, the teacher lights each balloon to test the gas as a demonstration.

Background:

When aluminum is placed into a strong acid or base, it reacts, producing hydrogen gas. In both situations the oxide film on the aluminum is dissolved, resulting in the direct contact between aluminum and the acid or base.

Zinc and gallium will behave in a similar manner. Solid drain cleaners often will contain both the aluminum metal and sodium hydroxide. As water is added, the sodium hydroxide dissolves and reacts with the aluminum. Hydrogen gas is produced that bubbles and breaks up large pieces of materials that may be clogging the drain.

Production of a gas is one of the common indicators of a chemical reaction and a chemical change.

Variations:

Repeat the experiment using zinc instead of aluminum.

Adapted from:
Summerlin, L. R., Christie L. Borgford and Julie Ealy, *Chemical Demonstrations—Sourcebook for Teachers,* Vol., 2, 2nd Ed., 1988.

Science as Inquiry

Pasta Reactions

What are the characteristics of a chemical reaction?

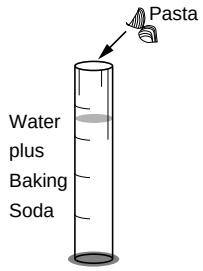
Overview:

This activity uses a reaction that produces a gas.

Materials:

Per lab group:

large graduated cylinder, beaker or jar, 100 mL or larger
water
2 tablespoons of baking soda
broken, dried pasta
100 mL vinegar



Procedure:

Have students fill a large cylinder, beaker or jar with water and place 2 tablespoons of baking soda in the water. Students add a small amount of dried pasta.

Background:

The acetic acid in the vinegar reacts with the baking soda to produce carbon dioxide gas. These gas bubbles cling to the pasta and cause it to rise to the surface. As the bubbles break the surface, the pasta falls.

Variations:

Substitute soda pop for the water and baking soda. Try raisins instead of pasta.

Adapted from:
Summerlin, L. R., Christie L. Borgford and Julie Ealy, *Chemical Demonstrations—Sourcebook for Teachers,* Vol., 2, 2nd Ed., 1988.

Science as Inquiry

A Handy Reaction

What are the characteristics of a chemical reaction?

Materials:

Per lab group:

ammonium chloride (a pinch)
calcium hydroxide (a pinch)
disposable plastic gloves

Procedure:

Students place a small amount of ammonium chloride in the palm of their hand that is covered with a glove. They add an equal amount of calcium hydroxide on top of the ammonium chloride. Then they briskly rub their hands together.

Background:

The friction between the two solids begins the decomposition of the ammonium chloride. It decomposes into ammonia gas and hydrochloric gas. The calcium hydroxide reacts with the hydrochloric gas to produce calcium chloride and water. Only the ammonia gas will be detected.

The production of gas is an indicator for a chemical reaction.

Variations:

Another reaction of two solids is to mix potassium iodide and lead nitrate and rub it in your hands. A yellow compound, lead iodide, will be produced.

Adapted from:
Summerlin, L. R., Christie L. Borgford and Julie Ealy, *Chemical Demonstrations—Sourcebook for Teachers,* Vol., 2, 2nd Ed., 1988.

Science as Inquiry

Reactions in a Baggie

What the the indicators of a chemical reaction?

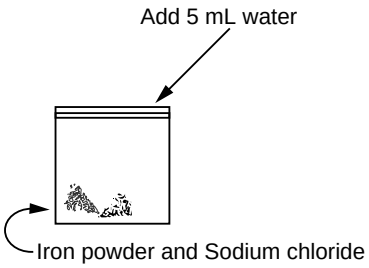
Overview:

This activity uses a reation that produces heat.

Materials:

Per lab group:

25 g of iron powder
1 g of sodium chloride
1 recloseable plastic bag
1 tablespoon of vermiculite
5 mL of water



Procedure:

Prior to class, the 25 grams of iron powder and 1 gram of sodium chloride can be added to small baggies. Have students add the 5 mL of water and close the bag.

Background:

Heat is produced by this reaction of iron and oxygen. The sodium chloride provides the catalyst. This is commonly used in commercial hand warmers.

Heat production is an indicator of a chemical reaction.

Variations:

Drugstores often sell chemical ice bags (ammonium nitrate). Obtain one of these to demonstration the absorption of heat during a chemical reaction.

Adapted from:
Crow, Linda W., *Fiery Reactions,* Baylor College of Medicine, Houston, 1995.
Summerlin, L. R., Christie L. Borgford and Julie Ealy, *Chemical Demonstrations—Sourcebook for Teachers,* Vol., 2, 2nd Ed., 1988.

Science as Inquiry

More Reacting Events

What the the indicators of a chemical reaction?

Overview:

Formation of a precipitate is a common indicator of a chemical reaction. This activity involves a precipitate-producing reaction.

Materials:

Per lab group:

200 mL limewater (3.6 g/liter)
1 mL of cobalt nitrate solution
1 250-mL beaker

Procedure:

Students place 200 mL of clear lime water in a beaker. Limewater is calcium hydroxide. It must be prepared the day before. The concentration of the cobalt nitrate is not critical. It can be very dilute and can be created by chemical dumping. Students add 1 mL of cobalt nitration solution.

Background:

This reaction produces a blue precipitate, cobalt hydroxide. The production of a precipitate is another indicator of a chemical reaction and a chemical change. This easily projects using a petri dish and an overhead projector.

Variations:

There are many examples of precipitates. One interesting one is to mix 10 mL of tin II chloride (0.1 M) with 90 mL of mercury chloride (0.1 M). First pour the mercury chloride into the tin II chloride. With fresh solutions, mix 10 ml of the mercury chloride with 90 mL of the tin II chloride.

Adapted from:
Summerlin, L. R., Christie L. Borgford and Julie Ealy, *Chemical Demonstrations—Sourcebook for Teachers,* Vol., 2, 2nd Ed., 1988.

Science as Inquiry

Explanations

Overview:

This is the culminating event for this microunit. First discuss the results of the lab activities, then proceed with this one.

Materials:

Per lab group:

notebook paper, poster paper, or butcher-block paper

markers, colored pencils, pens

Procedure:

After a discussion period, ask students to describe what is going on in each reaction in the actual liquids. They could use words or drawings to do this. Remind them of their model building work in 908.

Background:

The particulate model describes solids, liquids and gas in terms of particles and space between these particles. Good student explanations will move toward describing variations; those reactions using particles. Students could act out what is occurring in those situations.

Consumables

Item	Quantity (per lab group)	Event
ammonium chloride	1 pinch (1 g)	3*
bag, recloseable plastic	2	4
balloons, round, 8 inch	2	1
calcium chloride	1 pinch (1 g)	3*
candle	1 per class	1
cobalt nitrate solutoin	1 mL	5
foil, aluminum	2 square, 5 cm x 5 cm	1
gloves, disposable	1 pair	3*
hydrochloric acid 3M	20 mL	1
iron, powder	25 g	4
lime water	200 mL	5
markers, pencils, pens	1	6
paper, notebook, poster, or butcher-block	1	6
pasta, small dried	2–3 pieces	2
soda, baking	2 Tbl	2*
sodium chloride	1 g	4
sodium hydroxide 3M	20 mL	1
string	2 ft	1
vermiculite	1 Tbl	4
vinegar	100 mL	2*
water	50 mL, 4 mL	1, 2*, 4

Non-Consumables

Item	Quantity (per lab group)	Event
beaker, 250 mL	1	5
cylinder, graduated 100 mL	1	2*
flask, 250 mL	2	1
meter stick	1 per class	1

Activity Key
1. Reactions that Produce Reactions
2. Pasta Reactions*
3. A Handy Reaction*
4. Reactions in a Baggie
5. More Reacting Events
6. Explanations

*Indicates Alternative Activity