Name _____ Class _____ Date _____

Skills Worksheet

CONNECTION TO SOCIAL STUDIES

Cross-Disciplinary

Fireworks

Read the following paragraphs, and complete the exercises below.

Although no one really knows when pyrotechnics—fireworks—were first used, most people credit the Chinese with the invention. The key to fireworks is black powder, which gives firecrackers their bang and gives skyrockets their flight. Today's preparation for making black powder differs little from the one used in first- or second-century China.

Through the years, pyrotechnicians experimented to improve on the visual display of fireworks. They discovered that packing certain chemical compounds with the black powder could create colored flames, sparks, and smokes. In some fireworks, black powder is used with additional ingredients that produce various types of sparks. In other fireworks, such as the stars that are shot out of rockets, potassium nitrate, salts of antimony, and sulfur may be used. For colored fire, potassium chlorates are combined with a metal salt that provides the color. The table below lists some elements and the colors that they produce.

ELEMENTS USED IN MANY FIREWORKS

Element	Symbol	Color or effect
Copper	Cu	Blue
Sodium	Na	Yellow
Lithium	Li	Red
Strontium	Sr	Red
Barium	Ba	Green
Magnesium	Mg	Bright white flames
Aluminum	Al	Silver and white sparks
Zinc	Zn	Thick smoke clouds
Antimony	Sb	Glitter effects

EXERCISES

1. What chemicals would create a fireworks display of red, white, and blue?

_____

2. What chemicals might be responsible for green, glittering firework stars?

_____

3. Why are fireworks dangerous?

_____

Name _____ Class _____ Date _____

Skills Worksheet **INTEGRATING BIOLOGY**

Cross-Disciplinary

Organisms that Glow

Read the following paragraphs, and complete the exercises below.

Bioluminescence is light that originates in an organism—a plant or an animal. The light, which is more of a glow, is produced by chemical reactions. In these reactions, chemical energy is converted to light, which is radiant energy. The conversion is almost 100 percent efficient. Therefore, very little energy is given off as heat in the process. For this reason, bioluminescence is sometimes called cold light.

Most bioluminescent organisms are *marine,* meaning that they are found in the sea. Glowing organisms in the sea range from the microscopic, such as dinoflagellates, to several varieties of fish, jellyfish, shrimp, and squids. The dinoflagellates are single-celled, luminous organisms that glow when they are stimulated by physical motion, such as the rolling of the ocean waves. When washed ashore, dinoflagellates will glow in response to the physical action of a person walking on them.

Almost all marine bioluminescence is blue-green. This color signals mealtime to the many creatures for whom glowing organic matter in the sea is a main source of food. These creatures flock to anything that glows, hoping to find a meal. Instead, many of these creatures become a meal for predatory fish. Some predators have bioluminescent parts, which they use as lures.

EXERCISES

1. Explain how the following two facts may be related: Most sea organisms cannot see colors other than blue. Almost all marine bioluminescence is blue-green.

_____

_____

2. Chemical reactions that release energy are called exothermic, and reactions that absorb energy are endothermic. How is bioluminescence best classified? Explain your answer.

_____

_____

3. Another type of naturally occurring light is fluorescence, in which light is first absorbed from a source and then given off. How does fluorescence differ from bioluminescence?

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

INTEGRATING ENVIRONMENTAL SCIENCE

Cross-Disciplinary

Fertilizers: Friend or Foe?

Read the following paragraphs, and complete the exercises below.

Plants cannot survive without an adequate supply of nitrogen, phosphorus, and potassium. When the soil has too little of these nutrients, farmers can replenish it by adding fertilizers. Natural fertilizers, such as manure, have been used since ancient times. Unfortunately, natural fertilizers are often difficult to transport, and they are hard to find in some areas.

Manufactured fertilizers, on the other hand, are a relatively recent development. Because manufactured fertilizers are more readily available and easier to transport, they have become an essential part of modern agriculture. They allow farmers to grow healthier plants in less space than was possible before.

Ammonia is an example of a manufactured fertilizer. Treating the soil with ammonia gives the soil a greater nitrogen content. Because ammonia in liquid or gaseous form can be difficult or expensive to use, it is often converted into solid ammonium compounds that are easy to apply.

Although fertilizers have many advantages, they also have disadvantages. Excess fertilizer can run off into rivers and lakes, causing harm to fish or other animals. Over the long term, fertilizer in rivers and lakes can cause aquatic plants to grow so rapidly that they impede the flow of the water, turning the area into a bog. Excess fertilizer can also contaminate food and drinking water, making it unsafe.

EXERCISES

1. What element does ammonia replenish in the soil?

_____

2. What are the advantages of using fertilizers?

_____

_____

3. What are the disadvantages of using fertilizers?

_____

_____

4. Given your answers to items 2 and 3, do you think farmers should continue to use fertilizers? Explain your answer.

_____

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

REAL WORLD APPLICATIONS

Cross-Disciplinary

Hot Meals on Hand

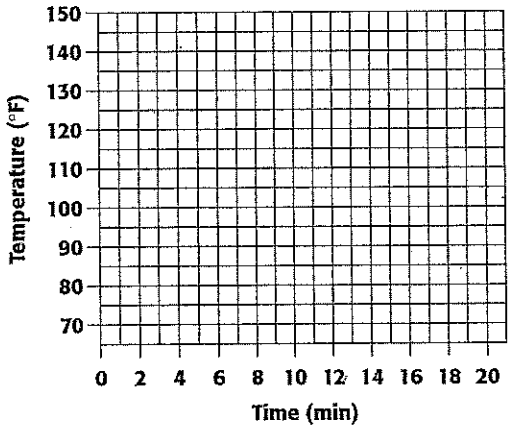
Read the following paragraph, and complete the exercises below.

Commercial self-heating meals contain a package of precooked food along with a bag that holds a porous pad containing a magnesium-iron alloy. When salt water is mixed with the metal alloy, the metals corrode vigorously. This corrosion is an exothermic reaction, which raises the temperature of the food. The energy released as heat by the chemical reaction can add about 75°F to the temperature of the container.

EXERCISES

1. Using the data in the table below, plot a graph of temperature versus time for a self-heating meal that was stored just below 70°F.

Time elapsed (min)	Temperature (°F)
1	70
2	75
3	100
4	130
5	145
6	148
7	150
8	150
9	150
10	148
11	145
12	144
13	143
14	142
15	140
16	140
17	140
18	138
19	135
20	134



2. Food between 135°F and 145°F is suitable for eating. According to your graph, how soon would this meal be ready to eat?

_____

_____

3. Once it reaches eating temperature, how long will the meal stay within that range?

_____

_____

Name _____ Class _____ Date _____

Skills Worksheet

CONNECTION TO FINE ARTS

Cross-Disciplinary

The Chemistry of Art

Read the following paragraphs, and complete the exercises below.

When the damp, salty air of New York Harbor reacted with the iron of the internal supports of the Statue of Liberty, the chemical reaction weakened the supports. Certainly Frédéric Auguste Bartholdi (1834–1904), who designed the statue and chose its site, did not plan this result. However, many sculptors use their knowledge of chemical reactions and the properties of metals to create specific effects. A good example of this practice is a sculpture by Pablo Picasso (1881–1973) known as the Chicago Picasso.

The Chicago Picasso was purposely built of a steel alloy that reacts readily with the oxygen in air. Exposure to air causes this metal to develop a permanent reddish-brown surface coating. The coating prevents the metal from oxidizing further.

DIFFERENT BRONZES TURN DIFFERENT COLORS

Bronze is another metal that has long been used for sculpture. Historically, bronze has been an alloy of copper and tin. However, modern bronze is also made from alloys of copper and silicon, aluminum, or manganese to achieve specific chemical and physical properties. When exposed to air and moisture, bronzes develop a patina, or film, on their outer surface. Some films—depending on composition—are a rich black-brown color; some are green. Once bronze forms a patina, it weathers well and can last for hundreds of years.

Other metals used by sculptors include aluminum, which will not decay unless it is near salt water, and silver, which can be polished to a dazzling shine. Artists and sculptors often use the electrical-chemical process of plating to coat objects made of a less-expensive metal with a very thin coating of silver rather than make the whole piece silver.

EXERCISES

1. If an artist has been asked to design a sculpture for an ocean lighthouse, what metals should be avoided? Explain your answer.

_____

2. Do you think knowing about chemical reactions and the properties of metals is important to architects as well as to sculptors? Explain your answer.

_____

_____

3. Why might a sculptor electrochemically plate a lead statue with silver?

_____

Name _____ Class _____ Date _____

Skills Worksheet

CONNECTION TO SOCIAL STUDIES

Cross-Disciplinary

Alchemists' Theory of the Elements

Read the following paragraph, and complete the exercises below.

In the Middle Ages, many alchemists, who practiced philosophy and primitive science, believed that all matter was made from some combination of the four elements—earth, air, fire, and water. They were convinced that they could change one substance into another by changing the balance of its elements. They were encouraged by observing that when water evaporated, a bit of sediment always remained. They concluded that water had been changed to earth.

EXERCISES

Today, scientists know that for one substance to become another, a chemical reaction must take place. Key evidence of a chemical reaction includes a change in properties, a change in color, and the release or absorption of energy. Keep these facts in mind as you analyze the following experiment.

Martel, an alchemist in the Middle Ages, fills a shallow bowl with seawater and sets it in an open, sunlit window. In time, the water disappears but the bottom and sides of the bowl are coated with a white powdery substance.

1. Alchemists had to rely primarily on their senses to analyze substances. How could Martel quickly test the powdery substance in the bowl to determine if it had properties similar to those of the original seawater? What would he discover?

_____

_____

2. Martel decided to try his experiment again using water from a muddy river. What might he discover about color change when the water evaporated?

_____

_____

_____

3. Did Martel's experiments produce a chemical reaction? What is your evidence?

_____

_____

_____