4.2 Physical and Chemical Properties

Here is a summary of what you will learn in this section:

- Physical properties describe the characteristics of a substance that can be observed or measured.
- Chemical properties describe the reactivity of a substance and ways in which it forms new substances.
- Physical properties include hardness, conductivity, colour, density, melting point, solubility, and viscosity.
- Chemical properties include combustibility and reaction with water or acid.

Figure 4.17 A fire produces many changes in matter.

The Chemistry of a Campfire

A fire can be fascinating to watch (Figure 4.17). Although all the flames look similar, each particular spark and flicker is unique — never to be repeated in exactly the same way. With investigation, however, some patterns become clear. Chemistry reveals that all forms of burning are variations on a theme. Every fire needs the same three components: fuel, oxygen gas, and heat.

In a campfire, the fuel is wood, a complex natural material that is rich in carbon. Carbon reacts with oxygen in the air but only if the air can reach the carbon in the wood. This is why the first step in building a campfire is usually to split a log into tiny splinters, called kindling. By chopping a thick log into kindling, much more carbon in the wood is exposed to the air. Oxygen gas has easy access to the carbon at the surface of the wood and so can react with it.

The components of a fire must be in just the right balance. When lighting a fire, extra oxygen is sometimes needed. This is why gentle blowing on the first embers of the fire can help. There is enough oxygen in the breath to provide the extra boost. It is important not to blow the heat of the first sparks away from the fuel, however, as this will blow out the fire. Because combustion releases heat, there is no need to keep relighting the flame.

Changes in Properties

Fires produce new substances. One of these is invisible carbon dioxide gas. It is formed when oxygen from the air and carbon in the wood chemically combine. Where does all the wood go while it is burning? Most of the solid matter in a wood log changes into a gas and simply blows away. What is left is ash. Ash is a mixture of carbon compounds that did not have a chance to burn before the fire went out and other substances that simply do not burn. If left to burn for long enough, a fire can become smothered in its own ashes.

During Reading

Thinking Literacy

Understanding Vocabulary

Authors often provide additional information — called an “elaboration” — to help you understand a new term or word. As you find new terms or expressions, look not just for a definition but also for added information that clarifies the term.

B5 Quick Lab

Observing a Physical Change

Soda pop contains carbon dioxide. In the air, carbon dioxide exists as a gas. However, when carbon dioxide is dissolved in water, this is not the case. The particles of water and carbon dioxide are attracted to each other, so they intermix, forming a solution. Disrupting these attractions produces a change that you will observe.

When a substance undergoes a physical change, such as melting, its appearance or state may change but its composition stays the same. For example, melted chocolate ice cream has the same composition as frozen chocolate ice cream. In contrast, a chemical change results in the formation of a new substance or substances.

Purpose

To investigate a change in matter

Materials & Equipment

- 2 glasses
- soda pop
- chewy mint candy

CAUTION: Do not eat or drink anything in the lab, including the soda pop and candy.

Procedure

1. Fill the two glasses about $\frac{2}{3}$ full with soda pop.
2. Into one glass, drop a piece of the mint candy. Observe what happens in both glasses, and record your observations.

Questions

3. Adding candy to the soda pop caused a mainly physical change that disrupted the attraction between particles of liquid. How did you recognize this physical change?
4. Can you tell whether the composition of the candy changed after it was added to the soda pop? Why or why not?
5. Consider the change that took place. Suggest one reason that you would describe it as a physical change. Suggest one reason that you might also describe it as a chemical change.
6. In the procedure, you were instructed to fill two glasses with soda pop in step 1 but to add candy to only one glass. What is the reason for this?
7. Suggest ways to modify the procedure to produce an interesting effect or display involving the change in properties. Check with your teacher before trying it out.

Physical Properties of Water

Figure 4.18 Water sticks to itself, forming droplets (cohesion), and to the spider web (adhesion).

All life on Earth depends on water. Our bodies are about 70 percent water. Some plants are 95 percent water. A characteristic of water is that it sticks to itself, a property that is known as **cohesion**. Due to cohesion, water forms beads on non-absorbent surfaces, such as glass. Water also sticks to other substances, a property known as **adhesion** (Figure 4.18). Adhesion allows you to mop up water with a towel.

A **physical property** describes a characteristic of a substance that can be observed or measured. One example of a physical property is the melting point of a substance. Water has many interesting physical properties that make it very useful to organisms. For example, adhesion and cohesion help move water up through the stems of plants, including tall trees. Its ability to be a liquid at room temperature is another.

Figure 4.19 In winter, fish are protected from freezing temperatures by the ice at the surface of the water. People can use this same ice as a platform when fishing.

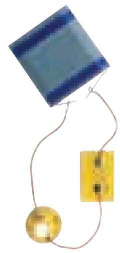
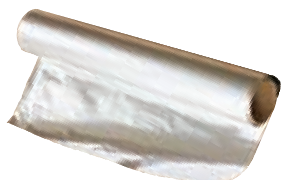
Most materials shrink when they freeze. Water does not. Due to special interactions between water particles during freezing, water actually expands. This makes ice less dense than liquid water. As a result, ice floats on water. Why is this important? In winter, the ice on a body of water shelters the fish below. Floating ice can also make a useful temporary roadway or platform for ice fishing (Figure 4.19). However, the same properties that make water useful can also cause problems. As ice forms, it widens cracks in roads. In addition, snow and ice on the roofs of houses can cause damage when it melts and refreezes. Not only is the ice heavy, it can block gutters and downspouts that are meant to keep water flowing off the roof and away from the sides of the building.

Observing Physical Properties

Figure 4.20 The pieces of beach glass show a variety of physical properties.

Figure 4.20 shows a dull, red, clouded piece of beach glass. Three physical properties of the glass include its lustre (shiny or dull), its colour, and its transparency (how see-through it is). Other physical properties can be observed using special equipment. For example, you could measure the mass and the volume of the glass to determine its density. Table 4.1 lists a number of other physical properties.

Table 4.1 Physical Properties of Matter

Property	Description	Examples	What It Looks Like
Colour and lustre	The light a substance reflects gives it colour and lustre (shine).	The names for some substances, such as gold, are also the names of colours. Gold has lustre; concrete is dull.	 Gold and silver coins
Conductivity	Conductivity is the ability of a substance to conduct electricity or heat. A substance that conducts electricity or heat is called a conductor. A substance with little or no conductivity is an insulator.	Most metals are good conductors. Copper is a very good conductor of electricity and so is used to make electric wires. Styrofoam® and glass are insulators.	 Electric circuit with wires to conduct electricity
Density	Density is the amount of mass in a given volume of a substance.	The density of pure water is 1 g/mL. The density of gold is 19 g/mL. Water is denser than oil, but gold is denser than water.	 Fluids and solids with different densities
Ductility	Any solid that can be stretched into a long wire is said to be ductile.	Copper is a common example of a ductile material.	 Copper wire
Hardness	Hardness is a substance's ability to resist being scratched. Hardness is usually measured on the Mohs hardness scale from 1 to 10.	The mineral talc is the softest substance on the Mohs hardness scale (1). Emerald is quite hard (7.5). Diamond is the hardest (10).	 An emerald gemstone
Malleability	A substance that can be pounded or rolled into sheets is said to be malleable.	Aluminum foil is an example of a malleable substance. Metals such as gold and tin are also malleable.	 Aluminum foil
Viscosity	Viscosity is the resistance of a fluid to flow.	Syrup has a high viscosity compared to water.	 Pancake syrup

Observing Chemical Properties

A **chemical property** describes the ability of a substance to change into a new substance or substances. Chemical properties include how a substance interacts with other substances, such as acids, or how it reacts to heat or light. A **chemical change** always results in the formation of a new substance or substances. For example, when zinc metal and hydrochloric acid are mixed, they undergo a chemical change that produces two new substances: hydrogen gas and a compound called zinc chloride. A **chemical reaction** is a process in which a chemical change occurs.

Chemical properties can be observed only when a chemical change occurs. If you mix baking soda and vinegar, you will produce a chemical change that involves the formation of gas bubbles. In general, evidence of chemical change can include a great variety of changes, including colour, odour, temperature, the production of light, the formation of a new solid inside a liquid, or the production of a new gas (Figures 4.21 and 4.22). Table 4.2 lists various chemical properties.

Suggested Activities

B7 Inquiry Activity on page 156
B8 Inquiry Activity on page 158
B9 Design a Lab on page 160

Table 4.2 Examples of Chemical Properties

Chemical Properties
Absorbs heat during reaction
Combustible
Forms gas when heated
Reacts with acid
Reacts with water
Emits heat during reaction
Emits light during reaction
Forms a precipitate (solid) in a solution

Figure 4.21 Fireflies contain a chemical called luciferin. When luciferin reacts with oxygen, light is emitted.

Figure 4.22 Chemical changes made this banana ripe — and then rotten.

Heat and Chemical Change

Applying heat to a substance can result in chemical changes. For example, when baking powder is heated, it undergoes a chemical change that results in the production of carbon dioxide gas. This is very useful in cooking. It is this chemical reaction of baking powder in some baked foods that produces the gas needed to lift the cake and make it light and fluffy (Figure 4.23). If you forget to add baking powder to a cake batter, the cake will be flat and dense.

Figure 4.23 When baking powder in a cake batter is heated, it produces a new substance: a gas.

Heating causes many different kinds of substances to react. Burning is another example of this kind of chemical change. Paper is combustible and so will simply burst into flame when raised above a certain temperature. **Combustibility** is the ability of a substance to react quickly with oxygen to produce heat and light.

When some substances are mixed, their reaction absorbs heat. A chemical cold pack, for example, depends on a reaction that absorbs heat (Figure 4.24). Typically, a chemical cold pack is filled with water but also has an inner bag or tube full of chemicals. The inner compartment keeps its contents separated from the water until it is time to use the cold pack. When the inner bag is popped open, the chemicals within mix with the water in the cold pack. The reaction removes heat from the surroundings, and so the pack feels cold to the touch.

Figure 4.24 A chemical cold pack has an inner compartment containing reactive chemicals and an outer compartment containing water.

Learning Checkpoint

1. What is a physical property?
2. List three physical properties of water.
3. What is a chemical property?
4. List three examples of chemical properties.
5. How does a physical change differ from a chemical change?

Controlling Changes in Matter to Meet Human Needs

In our everyday lives, there are many examples of how understanding and controlling changes in matter help us meet our basic needs. Consider the freeze-dried foods business. Freeze-drying is a way to preserve foods so that they can be eaten months and sometimes years later. As well, freeze-drying makes foods easy to prepare: all you have to do is add hot water (Figure 4.25).

In the freeze-drying process, the food is first frozen to convert the water content in the food to ice. The frozen food is then put in a pressure chamber, and the pressure is reduced until the ice sublimes (changes from a solid to a gas). The result is that about 98 percent of the water in the original food item is removed. This leaves a food that is about 10 percent its original mass and that, once packaged, does not need to be refrigerated. Freeze-drying is also used by biologists to study tissue samples and by restoration experts to rescue important documents that are water damaged.

During hot, dry weather, hikers are often restricted from making campfires. However, a fire-free heating pouch has been developed. The freeze-dried food is placed in the heating pouch. The pouch contains the elements magnesium and iron, as well as salt, which is a compound. When water is added to these chemicals, the resulting chemical change releases enough heat to warm the freeze-dried contents.

Figure 4.25 Freeze-drying removes the water from food, which preserves the food until it is time to eat.

From Corn to Biodegradable Plastic Wrap

Being able to change materials from one form to another allows us to make products that are not only useful but which also support a sustainable environment. For example, chemicals made from corn can be used to make juice bottles, remove paint or nail polish, and fuel some cars. Corn is put through a chemical change called fermentation. Once this chemical process is complete, the new substances are recovered, purified, and made into solvents, biodegradable plastics, and automobile fuel.

Solvents are substances that dissolve other substances. Solvents are useful for making inks and nail polish and for removing paint. Corn-based solvents are not as harmful to the environment as some other types of solvents (Figure 4.26). An advantage of corn-based biodegradable plastics is that they can be broken down by bacteria. However, making and using corn-based products also has its drawbacks. People sometimes cut down rainforests to make way for cornfields. Corn that would otherwise be used for food is sometimes diverted to make disposable products.

Figure 4.26 The inks used here contain solvents made from corn.

Take It Further

Adding cornstarch to plastic is one way to make the plastic biodegradable. Find out about other "green" products by visiting ***ScienceSource***.

B6 STSE *Science, Technology, Society, and the Environment*

Polyethylene Plastic

Polyethylene plastic is flexible, heat resistant, and strong. Children play with polyethylene toys, athletes drink from polyethylene bottles, and police officers wear polyethylene vests. Unlike some other types of plastic, polyethylene is considered safe to use in food containers.

What happens to polyethylene products when we no longer need them? If they cannot be re-used, another option is to recycle them. Some types of polyethylene break down more easily when exposed to sunlight. These types of plastics are considered photodegradable. This process releases tiny pieces of polyethylene.

1. Make a list of items you used today that are made from polyethylene. Identify which items you could live without and which are necessities.
2. Describe two ways you could help decrease the amount of polyethylene that goes into landfills.
3. What are some possible benefits of using photodegradable polyethylene to make disposable food containers or shopping bags? What are some possible problems with this type of plastic?

B7 *Inquiry Activity* **Skills References 1, 2, 6**

SKILLS YOU WILL USE
- Observing and recording observations
- Using appropriate formats to communicate results

Using Properties to Identify Pure Substances

Question

How can you identify a substance from its properties?

Materials & Equipment

- cornstarch
- magnesium sulphate powder
- sodium chloride powder
- sodium hydrogen carbonate powder
- sodium nitrate powder
- sodium thiosulphate powder
- spot plate
- blank sheet of paper
- grease pencil
- scoopulas
- magnifying lens
- medicine droppers
- water
- 0.5 M hydrochloric acid
- 5% iodine solution
- unknown substances

CAUTION: Iodine will stain your skin and clothing.

Procedure

1. In your notebook, make an observation table like the one below.
2. Read the labels of the six known white substances, and note any hazard symbols or cautions.

Part 1 — Appearance

3. Place the spot plate on a piece of paper. Label the top of the spot plate with the tests you will conduct.
4. Label the left of the spot plate with the identity of two or more of the six known white substances. Using a clean scoopula each time, deposit a sample of each substance in a separate well in the first column of the spot plate.

Figure 4.27 Placing substances in the spot plate

Table 4.3 Pure Substances Observation Table

Substance	Appearance	Crystal Shape	Water	Acid	Iodine
Cornstarch					
Magnesium sulphate					
Sodium chloride					
Sodium hydrogen carbonate					
Sodium nitrate					
Sodium thiosulphate					
Unknown # ___					

B7 *Inquiry Activity (continued)*

5. Closely observe each white substance. In your table, record as many observations as you can about the appearance of each substance.

Part 2 — Shape

6. Use the magnifying lens to observe the crystal shape of each white substance. Record the crystal shape of each substance as "regular" or "irregular."

Part 3 — Water

7. Use a clean scoopula to place a bit of the first substance into three more wells in the same row. Do the same for the second substance.
8. Using a medicine dropper, add a few drops of water to the second well of the second and third rows. Record your observations.

Part 4 — Acid

9. Using a clean medicine dropper, add a few drops of hydrochloric acid to the third well of the second and third rows. Record your observations.

Part 5 — Iodine

10. Using a clean medicine dropper, add a few drops of iodine to the fourth well of the first and second rows. Record your observations.
11. Clean out the spot plate as directed by your teacher.
12. Repeat steps 3–11 for the remaining white substances.

Part 6 — Unknown Substance

13. Repeat steps 3–11 for an unknown substance provided by your teacher. Be sure to record the unknown substance number in the table.
14. Clean up your work area. Follow your teacher's instructions to safely dispose of all materials used. Wash your hands thoroughly.

Analyzing and Interpreting

15. For each white substance, there is one unique property that distinguishes it from the others. Identify this property for each white substance.
16. Which results from this inquiry were not what you expected? Explain.
17. How can the properties of the six white substances be used to identify the unknown substance?
18. What is the identity of the unknown substance? Explain how your observations support your conclusion.

Skill Practice

19. Identify the chemical and physical properties you observed in this activity.

Forming Conclusions

20. Write concluding statements to describe the chemical and physical properties of each substance that you examined.

B8 *Inquiry Activity* **Skills References 1, 2**

SKILLS YOU WILL USE
- Observing and recording observations
- Justifying conclusions

Investigating Physical and Chemical Changes

You can use a chemical reaction to change one substance into another substance that has different physical and chemical properties. You can also use heat to change the properties of substances.

Question

What are some characteristics of physical changes and chemical changes?

Materials & Equipment

- scoopulas
- sodium carbonate powder
- 250-mL beaker
- medicine dropper
- 0.5 M hydrochloric acid
- aluminum muffin tin
- white table sugar
- candle
- candle holder
- matches
- tongs or wooden clothespin
- 3 test tubes
- 0.5 M solution of sodium carbonate
- 0.5 M solution of copper(II) sulphate
- two 5-mL measuring spoons
- test-tube rack
- copper(II) sulphate (solid)
- water
- stirring rod

CAUTION: Copper(II) sulphate is poisonous and can stain your clothes and skin. Keep your hair tied back when working near open flames.

Procedure

1. Copy the following observation table into your notebook. Be sure to leave a row for each test.

Test 1 — Sodium carbonate and hydrochloric acid

2. Using a scoopula, add a small amount (the size of a pea) of sodium carbonate powder to the beaker. In your observation table, describe the appearance of the sodium carbonate powder.
3. Using a clean medicine dropper, obtain a few drops of hydrochloric acid. Observe the hydrochloric acid, and record what you see in your observation table.
4. Write a statement about the kinds of evidence for physical or chemical change that you will look for when you add the hydrochloric acid to the sodium carbonate.
5. Add five to eight drops of hydrochloric acid to the sodium carbonate. Record your observations.

Test 2 — Sugar and heat

6. Obtain an aluminum muffin tin. Use a clean scoopula to put a small amount of sugar (the size of a pea) in the centre of the aluminum muffin tin. Record your observations of the sugar.
7. Suggest possible ways that the sugar might change with heating.
8. Place the candle securely in a candle holder, then light the candle.
9. Using tongs or a wooden clothespin, hold the aluminum muffin tin over the candle's flame. Slowly move the muffin tin back and forth over the flame to heat the sugar. Record your observations.
10. Place the aluminum muffin tin in a safe place to cool.

Table 4.4 Observations of Physical and Chemical Changes

	Observations		
Test	**Before Change**	**During Change**	**After Change**
Sodium carbonate and hydrochloric acid			

B8 *Inquiry Activity (continued)*

Test 3 — Copper(II) sulphate and sodium carbonate

11. Using a measuring spoon, add 5 mL of copper(II) sulphate solution to a clean test tube. Using a different measuring spoon, add 5 mL of sodium carbonate solution to another test tube. In your observation table, describe the appearance of each solution.

12. Write a suggestion about what you think will happen when the solutions are combined.

13. Combine the solutions, and record your observations.

14. Dispose of the solutions as directed by your teacher.

Test 4 — Copper(II) sulphate and water

15. Using a scoopula, add a small amount (the size of a pea) of solid copper(II) sulphate to a clean test tube. In your observation table, describe the appearance of the substance.

16. Write a suggestion about what you think will happen when you add water to the copper(II) sulphate.

17. Fill the test tube $\frac{2}{3}$ full of water and record your observations. Use a stirring rod to mix the water and copper(II) sulphate, and record any additional observations.

18. Clean up your work area. Follow your teacher's instructions to safely dispose of all materials used. Wash your hands thoroughly.

Analyzing and Interpreting

19. Which of the changes that you observed were physical? How do you know?

20. Which of the changes that you observed were chemical? How do you know?

Skill Practice

21. Identify two properties for each of the following.

(a) sodium carbonate

(b) white table sugar

(c) copper(II) sulphate

Forming Conclusions

22. Create a flowchart that a classmate could follow in order to identify physical and chemical changes.

Figure 4.28 Adding water to copper(II) sulphate

SKILLS YOU WILL USE
- Selecting instruments and materials
- Observing and recording observations

Properties of Common Substances

Elements, compounds, and mixtures are part of everyday life. From the kitchen to the chemistry lab, we make use of different substances for their different properties.

Question

How can you use chemical and physical properties to distinguish among common substances?

Figure 4.29 Common substances

Figure 4.30 Possible materials and equipment

CAUTION: Keep your hair tied back when working near open flames. Take note of safety precautions for the substances you will be working with.

Design and Conduct Your Investigation

1. Choose at least three substances to investigate. They may be substances from your chemistry lab or from home.
2. Decide which properties you will investigate. Select some from the list below, or add others.
   - colour and lustre
   - combustibility
   - conductivity
   - density
   - hardness
   - melting point
   - solubility
   - texture
   - reaction with acid
   - reaction with water
3. Have your teacher approve your list of test substances and the properties you wish to investigate.
4. Plan your procedure. Think about these questions:
   (a) How will you observe different properties, and what materials and equipment will you need to make these observations?
   (b) How will you record your results?
   (c) How will you organize and present your results?
5. Write up your procedure. Show it to your teacher for approval before carrying it out.
6. Carry out your procedure, and collect your observations.
7. Present your findings in a poster or in another form suggested by your teacher.

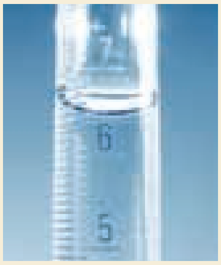
4.2 CHECK and REFLECT

Knowledge

1. What does a physical property describe about a substance?
2. For each of the following substances, list four physical properties.
   (a) water
   (b) iron metal
   (c) baking soda (sodium hydrogen carbonate)
3. What does a chemical property describe about a substance?
4. Identify each of the following observations as evidence of either a physical change or a chemical change.
   (a) A piece of copper is heated until it melts.
   (b) A piece of aluminum corrodes in a solution of acid.
   (c) A piece of paper burns in a candle flame.
   (d) A piece of plastic is stretched until it breaks.
   (e) Table salt boils at 1465°C.
5. From the following list, indicate which items would make good conductors.
   (a) copper
   (b) Styrofoam®
   (c) iron
   (d) woollen mitten
6. What is the difference between the properties of ductility and malleability?

Connect Your Understanding

7. Would you rather mop up spilled milk with a paper towel or a plastic bag? Use the terms "adhesion" and "cohesion" to explain your choice.
8. Identify each of the following as a statement that describes either a physical property or a physical change.
   (a) Ice melts.
   (b) Hydrogen is a colourless gas.
   (c) You chop a carrot.
   (d) A diamond jewel is hard.
   (e) Copper wire bends easily.
   (f) The ruby slippers are red.
9. Examine this photograph of the graduated cylinder. What properties of water allow it to form a meniscus (the curve in the water)?



Question 9

10. Use diagrams and captions to explain what happens to the particles of matter in each of the following situations.
    (a) Butter melts.
    (b) Water boils on a stove.
    (c) Water vapour in the air cools and forms raindrops.
11. Do water and vegetable oil have the same freezing point? How do you know for sure?

Reflection

12. Name an object that you use every day, such as earphones, a plastic mug, or your toothbrush. What would you like to find out about this object's properties now that you have completed this section?

For more questions, go to ***ScienceSource***.

Investigating CAREERS in Science

Great CANADIANS in Science Lee Wilson

Figure 4.31 Dr. Lee Wilson wants his research to make a difference in the world.

For Dr. Lee Wilson, chemistry is not just a research subject — it is a source of solutions to problems that touch our lives. Dr. Wilson is an award-winning professor of chemistry at the University of Saskatchewan, where he teaches and conducts research (Figure 4.31). He hopes his work will made a big difference in medical and environmental science.

Dr. Wilson's special interest is in nanostructured materials. Nanostructured materials are made from components too small to be seen even with a light microscope. These components, which are less than 0.0001 mm in size, are very useful for making membranes with tiny pores. Such membranes can be used as filters to purify water of toxic chemicals.

The opaque white material looks very ordinary, despite its special properties. Dr. Wilson says that the material acts like a sponge. Instead of trapping water, however, the material traps small particles, such as contaminants.

Personal experience has been a major motivating factor in Dr. Wilson's work. While working in rural Alberta, his father became dangerously ill due to contaminated water and had to have surgery. Dr. Wilson would like to see his research used so that even remote communities can protect their water supplies.

Dr. Wilson feels it is important to be a scientist with a conscience. Scientists should do work that benefits society as a whole, he says.

He also says it is important to follow your passion. "When I have a passion for something, whether it be a problem to solve or an idea of interest, it is the passion that carries me through the hardship, despite how difficult the challenges in solving the problem or learning a new skill may be." Dr. Wilson was the first in a small Metis community in Manitoba to go to university, the first in his family to complete a university degree, and the first Metis student to get a PhD from the University of Saskatchewan.

Today he mentors young Aboriginal students participating in science fairs and camps and his own graduate students (Figure 4.32). His advice to young scientists is to get a good education, take lots of science courses, but also to take courses in the arts. Scientists need to be able to communicate, he says, not just do research in a lab.

Questions

1. How is Dr. Lee Wilson's work being applied to improve the environment?
2. *ScienceSource* Use the Internet to research nanostructured materials. What are nanostructured materials, and how are they different from other substances?

Figure 4.32 Dr. Lee Wilson working with his students

Home Quit

Science in My FUTURE — The Art of Chemistry

Lost Wax — Found Metals

Figure 4.33 Foundry artisans working with hot liquid metal

Figure 4.34 The final product

Imagine sculpting a beautiful object or statue in clay and then transforming it into a single solid piece of metal. This is the job of a foundry artisan. A foundry artisan is a master of both the art and science of manipulating matter. A foundry is a place where metals such as gold and iron are fashioned into specialized parts. The metal is first melted until it becomes a liquid and then poured into a mould where it can harden and take on a new shape. An artisan adds creativity to the process, often making one-of-a-kind pieces of art.

It may take an artist a week or a month to make a clay sculpture. When it is ready, the sculpture is brought to a foundry, where the work is completed. The clay sculpture is covered with silicone rubber to form a mould. The mould is a "negative" version of the clay sculpture. Hot wax is poured into the mould to coat the inside. This step is repeated until a "positive" version of the clay sculpture has been created. This looks just like the original clay sculpture. A second negative of the sculpture is made by coating the wax with a ceramic material, which is a solid that can withstand the heat of molten metal without breaking. Melting away the wax creates an empty vessel into which molten metal can be poured.

One major step remains before the cast metal piece of art is complete. A hot furnace is used to heat aluminum, silver, iron, or gold until it melts. The metal is then poured into the empty mould, where it takes on the shape of the original clay sculpture (Figure 4.33). After allowing the mould to cool slowly, it is removed and the metal piece is sanded and polished to add the finishing touches. The cast metal art is now ready for sale or shipping to the museum or person who commissioned it (Figure 4.34).

The work of a foundry artisan takes a combination of skills and talents. Being able to visualize the finished product from the start is important. A foundry artisan is creative, pays attention to detail, and has the self-discipline to meet deadlines. Also, an artisan must know how to work safely in the foundry.

Most artisans apprentice with an expert in order to learn the specific skills they need for foundry work. Many have been to art college or studied the arts in university. It is common for artisans to be self-employed, and so basic business training can be helpful.

Questions

1. The process of casting a piece of artwork in metal involves making several positive and negative versions of the final cast object. Sketch a flow chart that identifies these steps.
2. *ScienceSource* Research where you can take courses in jewellery casting or foundry art.