WORKING AS A SCIENTIST

GETTING OFF TO A SAFE START

Science activities and investigations can be a lot of fun. You have the chance to work with new equipment and substances. These can be dangerous, however, so you have to pay attention! You also have to know and follow special rules. Here are the most important rules to remember.

	Follow your teacher's	Act responsibly.	Be science-ready.
	 directions. 1. Listen to your teacher's directions, and follow them carefully. Ask your teacher for directions if you are not sure what to do. Never change anything, or start an activity on your own, without your teacher's approval. Get your teacher's approval before you start an experiment that you have designed yourself. 	 Pay attention to your own safety and the safety of others. Tell your teacher immediately if you see a safety hazard, such as broken glass or a spill. Also tell your teacher if you see another student doing something that you think is dangerous. Tell your teacher about any allergies or medical problems you have, or about anything else your teacher should know. Do not wear contact lenses while doing experiments. Read all written instructions carefully before you start an activity. Clean up and put away any equipment after you are finished. 	 Come prepared with your student text, notebook, pencil, worksheets, and anything else you need for an activity or investigation. Keep yourself and your work area tidy and clean. Wash your hands carefully with soap and water at the end of each activity or investigation. Never eat, drink, or chew gum in the science classroom. Wear safety goggles or other safety equipment when instructed by your teacher. Keep your clothing and hair out of the way. Roll up your sleeves, tuck in loose clothing, and tie back loose hair. Remove any loose jewellery.
282	Skills Handbook		NEL

SAFE SCIENCE

Follow these instructions to use chemicals and equipment safely in the science classroom.

HEAT, FIRE, AND ELECTRICITY

- Never heat anything without your teacher's permission.
- Always wear safety goggles when you are working with fire.
- Keep yourself, and anything else that can burn, away from heat or flames.
- Never reach across a flame.
- Before you heat a test tube or another container, point it away from yourself and others. Liquid inside can splash or boil over when heated.
- Never heat a liquid in a closed container.
- Use tongs or heat-resistant gloves to pick up a hot object.
- Test an object that has been heated before you touch it. Slowly bring the back of your hand toward the object to make sure that it is not hot.
- Know where the fire extinguisher and fire blanket are kept in your classroom.
- Never touch an electrical appliance or outlet with wet hands.
- Keep water away from electrical equipment.

CHEMICALS



- If you spill a chemical (or anything else), tell your teacher immediately.
- Never taste, smell, touch, or mix chemicals without your teacher's permission.
- Never put your nose directly over a chemical to smell it. Gently wave your hand over the chemical until you can smell the fumes.
- Keep the lids on chemicals you are not using tightly closed.
- Wash your hands well with soap after handling chemicals.
- Never pour anything into a sink without your teacher's permission.
- If any part of your body comes in contact with a chemical, wash the area immediately and thoroughly with water. If your eyes are affected, do not touch them but wash them immediately and continuously with cool water for at least 15 min. Inform your teacher.

HANDLE WITH CARE

GLASS AND SHARP OBJECTS

- Handle glassware, knives, and other sharp instruments with extra care.
- If you break glassware or cut yourself, tell your teacher immediately.
- Never work with cracked or chipped glassware. Give it to your teacher.
- Use knives and other cutting instruments carefully. Never point a knife or sharp object at another person.
- When cutting, make sure that you cut away from yourself and others.

LIVING THINGS



- Treat all living things with care and respect.
- Never treat an animal in a way that would cause it pain or injury.
- Touch animals only when necessary. Follow your teacher's directions.
- Always wash your hands with soap after working with animals or touching their cages or containers.

Caution Symbols

The activities and investigations in *B.C. Science Probe 7* are safe to perform, but accidents can happen. This is why potential safety hazards are identified with caution symbols and red type (Figure 1). Make sure you read the cautions carefully and understand what they mean. Check with your teacher if you are unsure.

Safety Symbols

The following safety symbols are used throughout Canada to identify products that can be hazardous (**Figures 2** and **3**). Make sure that you know what each symbol means. Always use extra care when you see any of these symbols in your classroom or anywhere else.

Wash your hands with soap and water after each time you work with the plants.

Figure 1

Potential safety hazards are identified with caution symbols and red type.



Figure 2

Hazardous Household Product Symbols (HHPS) appear on many products that are used in the home. Different shapes show the level of danger.



Figure 3

Workplace Hazardous Materials Information System (WHMIS) symbols identify dangerous materials that are used in all workplaces, including schools.

PRACTICE

In a group, create a safety poster for your classroom. For example, you could create a map of the route your class should follow when a fire alarm sounds, a map of where safety materials (such as a fire extinguisher and a first-aid kit) are located in your classroom, information about the safe use of a specific tool, or a list of safety rules.

MEASUREMENT AND MEASURING TOOLS

Refer to this section when you need help with taking measurements.

Measuring is an important part of doing science. Measurements allow you to give exact information when you are describing something.

These are the most commonly used measurements:

• Length • Volume

• Mass

Temperature

The science community and most countries in the world, including Canada, use the SI system. The SI system is commonly called the metric system.

The metric system is based on multiples of 10. Larger and smaller units are created by multiplying or dividing the value of the base units by multiples of 10. For example, the prefix *kilo-* means "multiplied by 1000." Therefore, one kilometre is equal to one thousand metres. The prefix *milli-* means "divided by 1000," so one millimetre is equal to 1/1000 of a metre. Some common SI prefixes are listed in **Table 1**.

Prefix	Symbol	Factor by which unit is multiplied	Example	
kilo	k	1000	1 km = 1000 m	
hecto	h	100	1 hm = 100 m	
deca	da	10	1 dam = 10 m	
		1		
deci	d	0.1	1 dm = 0.1 m	
centi	с	0.01	1 cm = 0.01 m	
milli	m	0.001	1 mm = 0.001 m	

Table 1 Common SI Prefixes

To convert from one unit to another, you simply multiply by a conversion factor. For example, to convert 12.4 m (metres) to centimetres (cm), you use the relationship 1 cm = 0.01 m, or 1 cm = $\frac{1}{100}$ m.

12.4 m = ? cm 1 cm = 0.01 m (12.4 th) $\left(\frac{1 \text{ cm}}{0.01 \text{ th}}\right) = 1240 \text{ cm}$

Any conversion between quantities with the same base unit can be done like this, once you know the conversion factor.

PRACTICE

- a) Convert 23 km (kilometres) to metres (m) and to millimetres (mm).
- b) Convert 675 mL (millilitres) to litres (L).
- c) Convert 450 g (grams) to kilograms (kg) and to milligrams (mg).

If you are not sure which conversion factor you need, look at the information in the box below and in the boxes on pages 286 and 287.

Measuring Length

Length is the distance between two points. Four units can be used to measure length: kilometres (km), metres (m), centimetres (cm), and millimetres (mm).

10 mm = 1 cm	100 cm = 1 m
1000 mm = 1 m	1000 m = 1 km

You measure length when you want to find out how long something is. You also measure length when you want to know how deep, how tall, how far, or how wide something is. The metre is the basic unit of length (Figure 4 on the next page).



Figure 4

Metric rulers are used to measure lengths in millimetres and centimetres, up to 30 cm. Metre sticks measure longer lengths, up to 100 cm.

PRACTICE

Which unit—millimetres, centimetres, metres, or kilometres—would you use to measure each quantity?

- a) the width of a scar or mole on your body
- b) the length that your toenails grow in one month
- c) your height
- d) the length that your hair grows in one month
- e) the distance between your home and Calgary
- f) the distance between two planets

Tips for Measuring Length

- Always start measuring from the zero mark on a ruler, not from the edge of the ruler.
- Look directly at the lines on the ruler. If you try to read the ruler at an angle, you will get an incorrect measurement.
- To measure something that is not in a straight line, use a piece of string (Figure 5). Cut or mark the string. Then use a ruler to measure the length of the string. You could also use a tape measure made from fabric.





Figure 5

Measuring Volume

Volume is the amount of space that something takes up. The volume of a solid is usually measured in cubic metres (m³) or cubic centimetres (cm³). The volume of a liquid is usually measured in litres (L) or millilitres (mL).

1000 mL = 1 L	$1 L = 1000 cm^3$
$1 \text{ cm}^3 = 1 \text{ mL}$	$1000 L = 1 m^3$

The volume of a rectangular solid is calculated by measuring the length, width, and height of the solid and then by using the formula





Volume is also used to measure the amount of liquid in a container. Scientists use special containers, such as beakers and graduated cylinders, to get precise measurements of volume.

You can also use liquid to help measure the volume of irregularly shaped solids, such as rocks. To measure the volume of an irregularly shaped solid, choose a container (such as a graduated cylinder) that the irregular solid will fit inside. Pour water into the empty container until it is about half full. Record the volume of water in the container, and then carefully add the solid. Make sure that the solid is completely submerged in the water. Record the volume of the water plus the solid. Calculate the volume of the solid using the following formula:

Volume of solid = (volume of water + solid) - volume of water



PRACTICE

What volume of liquids do you drink in an average day? Use the illustrations of volume measurements to help you answer this question.



Tips for Measuring Volume

- Use a beaker that is big enough to hold twice as much liquid as you need. You want a lot of space so that you can get an accurate reading.
- To measure liquid in a graduated cylinder (or a beaker or a measuring cup), make sure that your eyes are at the same level as the top of the liquid. You will see that the surface of the liquid curves downward. This downward curve is called the meniscus. You need to measure the volume from the bottom of the meniscus (Figure 6).





• Use a graduated cylinder to get the most accurate measurement of volume.

Measuring Mass

Mass is the amount of matter in an object. In everyday life, weight is often confused with mass. For example, you probably state your weight in kilograms. In fact, what you are really stating is your mass. The units that are used to measure mass are grams (g), milligrams (mg), kilograms (kg), and metric tonnes (t).

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\begin{array}{ll} 1000 \ g = 1 \ kg & 1000 \ kg = 1 \ t \\ 1000 \ mg = 1 \ g & \end{array}
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Scientists use balances to measure mass. Two types of balances are the triple-beam balance (Figure 7) and the platform, or equal-arm, balance (Figure 8).



Figure 7

A triple-beam balance: Place the object you are measuring on the pan. Adjust the weights on each beam (starting with the largest) until the pointer on the right side is level with the zero mark. Then add the values of each beam to find the measurement.



Figure 8

A platform balance: Place the object you are measuring on one pan. Add weights to the other pan until the two pans are level. Then add the values of the weights you added. The total will be equal to the mass of the object you are measuring.

Tips for Measuring Mass

- To measure the mass of a liquid, first measure the mass of a suitable container. Then measure the mass of the liquid in the container. Subtract the mass of the container from the mass of the liquid and the container.
- To measure the mass of a powder or crystals, first determine the mass of a sheet of paper. Then place the sample on the sheet of paper, and measure the mass of both. Subtract the mass of the paper from the mass of the sample and the sheet of paper.

Measuring Temperature

Temperature is the degree of hotness or coldness of an object. In science, temperature is measured in degrees Celsius.

 $0^{\circ}C =$ freezing point of water $20^{\circ}C =$ warm spring day $37.6^{\circ}C =$ normal body temperature $65^{\circ}C =$ water hot to touch $100^{\circ}C =$ boiling point of water



Measuring the temperature of water

Each mark on a Celsius thermometer is equal to one degree Celsius. The glass contains a coloured liquid—usually mercury or alcohol. When you place the thermometer in a substance, the liquid in the thermometer moves to indicate the temperature.

Tips for Measuring Temperature

- Make sure that the coloured liquid has stopped moving before you take your reading.
- Hold the thermometer at eye level to be sure that your reading is accurate.