Science 10

Question, Investigate, Discover!

A Teaching Resource

NOVA SCOTIA

SCIENCE 10

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Contents

Introduction

The curriculum described in *Foundation for the Atlantic Canada Science Curriculum* (Nova Scotia Department of Education and Culture 1998) and *Atlantic Canada Science Curriculum: Science 10* (Nova Scotia Department of Education 2012) was planned and developed collaboratively by regional committees. The process for developing the common science curriculum for Atlantic Canada involved regional consultation with the stakeholders in the education system in each Atlantic province. The Atlantic Canada science curriculum is consistent with the science framework described in the Pan-Canadian Common Framework of Science Learning Outcomes K to 12.

Science 10: A Teaching Resource is a practical curriculum support document designed to assist teachers in the effective delivery of the curriculum prescribed for Science 10. It includes a range of experiments, investigations, and activities for students for each of the four units: Weather Dynamics, Chemical Reactions, Motion, and Sustainability of Ecosystems. Each unit is 25% of the course.

This resource complements the curriculum guide, *Atlantic Canada Science Curriculum: Science 10* and the textbook, *Nova Scotia Science 10* (Anderson and Bocknek 2012), which are being used in Nova Scotia schools.

Unit 1: Earth and Space Science: Weather Dynamics (25%)

Activity 1: Weather Maps and Forecasts

Question

- **How do you read weather maps?**

Part 1: Map Reading

Using a weather map from the Internet or your teacher, work with a partner, and answer each of the following questions about weather maps:

1. Where is a low pressure system? Barometric reading: ___________

   ____

   Give place name or latitude and longitude: ____________________

   ____

   Where is a high pressure system? Barometric reading: ___________

   ____

   Give place name or latitude and longitude: ____________________

   ____

2. Describe the weather conditions of the three weather stations nearest your chosen low pressure system. Fill in the following information:

Weather Readings: Low Pressure

Information	Station 1	Station 2	Station 2
Barometric Value			
Cloud cover (%)			
Change in barometer			
Wind speed/direction			
Precipitation			
Type of high cloud			
Type of low cloud			
Temperature			
Dew Point			

Outcomes

Students will be expected to

- use weather instruments effectively and accurately for collecting local weather data and collect and integrate weather data from regional and national weather observational networks (213-3, 213-6, 213-7)
- identify questions and analyze meteorological data for a given time span and predict future weather conditions, using appropriate technologies (214-10, 331-5, 212-1)

3. Describe the weather conditions of the three weather stations nearest the chosen high-pressure systems. Fill in the following information:

Weather Readings: High Pressure

Information	Station 1	Station 2	Station 2
Barometric Value			
Cloud cover (%)			
Change in barometer			
Wind speed/direction			
Precipitation			
Type of high cloud			
Type of low cloud			
Temperature			
Dew Point			

4. Are there any areas of your map that indicate high winds? How can you tell? Give two reasons.

____

____

____

5. Identify a frontal system—warm or cold. In what direction is the frontal system moving? Describe the characteristics of the front.

____

____

____

____

6. Based on your map, what type of weather would you predict for our area in the next 24 hours? Give reasons to explain your forecast.

____

____

Part 2: Storm Watch!

Using a weather map, find weather illustrations that include the following:

- continuous shading—continuous rain
- hatching—intermittent rain
- comma mark—drizzle
- asterisk—snow
- triangle with a dot inside—ice pellets
- side swirl with dot or comma—freezing rain, drizzle
- inverted triangle with dot above it—rain shower
- inverted triangle with asterisk above it—snow shower
- two triangles inverted one over the other—hail shower
- “R”-shaped symbol—thunderstorm
- continuous yellow shading—fog
- continuous shading in brown—smoke, dust

Part 3: The Weather Person

Choose a series of weather maps for the next five days in your area. Imagine that you are the weather reporter. Give your official long-range forecast for the public. Be as detailed as you can based on the data available to you. Watch the weather forecast for the next five days and compare your forecast to what actually occurs.

Teacher Notes

Background Information

Check weather sites on the Internet for up-to-date information.

Activity 2: Building a Home Weather Station

Outcomes

Students will be expected to

- use weather instruments effectively and accurately for collecting local weather data and collect and integrate weather data from regional and national weather observational networks (213-3, 213-6, 213-7)
- identify questions and analyze meteorological data for a given time span and predict future weather conditions, using appropriate technologies (214-10, 331-5, 212-1)

Questions

- **How are changes in the hydrosphere and atmosphere observed and measured?**
- **How does a weather station work?**
- **What is humidity?**
- **What is pressure?**

Introduction

Accurate weather forecasting starts with careful and consistent observations. Observations can be made using instruments such as rain gauges, barometers, anemometers, hygrometers, and thermometers. At weather stations such as the ones run by Environment Canada, these instruments are quite sophisticated. Much simpler home versions of these instruments can be constructed to create a home weather station.

Part 1: Measuring Humidity

- Do the Find Out Activity 1-1C: Effects of Atmosphere Pressure, p. 18, from *Nova Scotia Science 10*.
- Do the Find Out Activity 1-1B: Temperature in the Atmosphere, p. 12, from *Nova Scotia Science 10*.
- Do the Think About It Activity 2-1B: Using the Humidex Scale, p. 51, *Nova Scotia Science 10*.

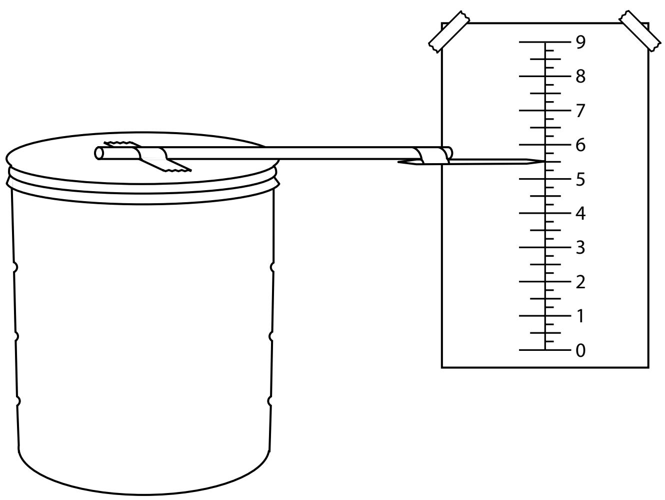
Part 2: Measuring Pressure

Follow the procedure below to build a home barometer.

Materials

- drinking straw
- heavy duty rubber band
- masking tape
- plastic wrap/balloon
- scissors
- small can (approximately 10 cm in diameter)
- thermometers
- toothpick
- unlined index card

Procedure



1. Tightly cover the top of the can with plastic wrap/balloon, using a rubber band to hold the plastic wrap/balloon in place. The cover should be taut so that the can will be airtight.
2. Place the straw, with the toothpick attached, horizontally on the plastic wrap/balloon so that one-half of the straw is on the can. Tape the straw to the middle of the plastic wrap/balloon so that it will not fall off.
3. Tape an index card to the wall. The straw will act as a pointer. Carefully record the location of the straw on the index card. If desired, lines can be drawn at equal intervals on the index card to make observing the changes easier. After 15 minutes, record the new location of the straw on the index card. Continue checking and recording the straw location as often as desired. It will change day to day and even hour to hour. Be careful not to place your barometer near a window, as the barometer is sensitive to temperature as well as air pressure.

Just as you can feel pressure from the water at the bottom of a swimming pool, there is also air pressure from the weight of air in the atmosphere. In this experiment, high pressure will make the plastic cave in, and the straw go up. Low pressure will make the plastic puff up, and the straw go down. If possible, check your measurements with a real barometer. Notice what happens to the barometer when a big storm comes.

Leave your barometer intact for ongoing data collection.

Part 3: Measuring Wind

- Do the Find Out Activity 1-2C: The Nova Scotia Wind Atlas, p. 37, from *Nova Scotia Science 10*.
- Do Conduct an Investigation 2-1E: Determining Wind Speed, p. 59, *Nova Scotia Science 10*.

Part 4: Measuring Precipitation

Rain clouds are made of droplets of water so small there are billions of them in a single cloud. How much rain falls during a shower, or during a day, week, or month? You can find out by measuring it with a rain gauge.

Materials

- a straight-sided glass jar
- paper
- plastic ruler
- plastic wrap
- scissors
- tape

Procedure

Stand the ruler inside the glass container so that the ruler rests on the bottom of the container. Tape it at the top, to the inside of the jar, to keep the ruler in place. Now, place your rain gauge outside, and measure the amount of rainfall (or snowfall) that occurs each day for a week. Place the rain gauge in an area away from trees and buildings, as this may effect the amounts. Also, you may wish to glue the jar to a block or platform of wood so that it does not tip in the wind. Record your data in a table of your own design.

Leave your rain gauge intact for ongoing data collection.

Observing Weather without Instruments

The human eye represents one of the best weather instruments. Much of what we know about the weather is a result of direct human observation conducted over thousands of years. Although being able to identify clouds is interesting in itself, observing clouds on a regular basis and keeping track of the weather associated with certain kinds of clouds will show the connection between cloud types and weather.

Recognizing cloud types can help predict the kind of weather to expect in the near future.

Procedure

Make copies of the observation tables given on the next page. You will use these tables to record seven consecutive days of information that you will collect using the weather instruments you constructed. You will compare your data to the information given daily on Environment Canada's weather website at www.weatheroffice.gc.ca/canada_e.html. Use the data for the location that is geographically closest to you.

A Week's Worth of Weather

Name: ______________________________

Group members: ______________________________

Week of ____________________ to ____________________

Our Weather Station

Date	Sun	Mon	Tues	Wed	Thurs	Fri	Sat
Time							
Barometric pressure (rising or falling)							
Temperature °C							
Relative humidity							
Wind direction							
Wind speed							
Precipitation (type)							
Precipitation (mm)							
General weather condition							

Environment Canada's Information

Date	Sun	Mon	Tues	Wed	Thurs	Fri	Sat
Time							
Barometric pressure (rising or falling)							
Temperature °C							
Relative humidity							
Wind direction							
Wind speed							
Precipitation (type)							
Precipitation (mm)							
General weather condition							

Activity 3: The Weather

Questions

- **What decisions do we face due to weather conditions?**
- **How are our lives affected by changing weather conditions (short term) and changing climate (long term)?**
- **What causes these weather patterns?**

Materials

- hardware:
  - computer(s) with Internet connection, and CD-ROM player
  - digital camera
  - printer
  - projection system
  - scanner
  - video camera
- software:
  - database or spreadsheet software
  - desktop publishing software
  - e-mail software
  - encyclopedia on CD-ROM
  - image-processing software
  - Internet web browser
  - multimedia software
  - web page development software
  - word-processing software

Procedure

You will be developing a slide show, a newsletter or brochure, and a web page to help you meet the following outcomes:

- describe examples of Canadian contributions to weather forecasting and satellite imaging, showing how scientific knowledge evolves (117-10, 115-6)
- analyze and report on the risks, benefits, and limitations of society's responses to weather forecasting (118-7, 214-11, 116-1)

Outcomes

Students will be expected to

- describe examples of Canadian contributions to weather forecasting and satellite imaging, showing how scientific knowledge evolves (117-10, 115-6)
- analyze and report on the risks, benefits, and limitations of society's responses to weather forecasting (118-7, 214-11, 116-1)

Choose one of the following topics to base your research on:

- aurora borealis
- blizzard
- chinook
- El Niño / La Niña
- hail
- hurricane
- ice storm
- jet stream
- lightning
- snow
- thunderstorm
- tornado

You must also

- provide illustrations that will show aspects of the phenomenon
- provide a historical account of an actual weather event (on your chosen topic) that has significantly affected human activity
- provide a description of a career related to your particular topic or to weather in general
- provide a complete list (bibliography) of all your information sources, including websites, people interviewed, e-mail, encyclopedias, books, magazines, and television shows

Teacher Notes

Background Information

This could be used as a culminating activity—done throughout the unit.

This project relies completely on access to computers. The students will need to create a slide show using a program such as PowerPoint, a brochure using a program such as Microsoft Publisher, and a web page using a program such as FrontPage.

Activity 4: Past, Present, and Future

Question

- **Does folklore have any science to explain it?**

Background Information

Throughout the entire history of humanity, people have been known to worship weather gods or practice rituals that would bring about the desired meteorological outcome. For instance, the nursery rhyme "Rain, rain, go away, come again some other day" was once part of a ritual performed by Druids to stop the rain.

Most of these mythologies and rituals have given way to a more scientific approach to weather involving radar, weather satellites, barometers, thermometers, hygrometers, and computers. However, in spite of all of this technology, weather folklore persists in every corner of the globe.

Folklore is accumulated wisdom. Most weather expressions are remembered simply because they often work, although they are generally less reliable than a modern weather forecast. Folklore is often derived from human experience and understanding of weather. However, some weather events are unpredictable, either by scientific forecasting or folklore beliefs. For example, the intensity of a winter is affected by many factors that cannot all be accounted for by science or folklore.

The Truth behind the Folklore

Procedure

Explain the scientific basis for each example of folklore below. Also, indicate what segment of the population would most likely be influenced by, and use, this folklore.

- Red sky at night, sailor's delight; red sky in morning, sailors take warning.
- The higher the clouds, the better the weather.
- Sun or moon halos indicate a coming rain (or snow), the larger the halo, the nearer the precipitation.

Outcomes

Students will be expected to

- describe examples of Canadian contributions to weather forecasting and satellite imaging, showing how scientific knowledge evolves (117-10, 115-6)
- identify and report the impact of accurate weather forecasting from the personal to the global point of view (118-2, 117-6, 114-6)

- When smoke descends, good weather ends.
- A cow with its tail to the west, makes weather the best; a cow with its tail to the east, makes weather the least.

Find at least two more examples of weather folklore that are based on scientific principles and explain them. Find the historical significance of the folklore and how your examples came to be used as predictors for weather. Note your findings in your science journal.

Teacher Notes

Background Information

You may wish to find other folklore/sayings about weather (and about topics from other units in Science 10).

Activity 5: Weather Predictions

Question

- **How are technology and science able to help us predict weather?**

Procedure

Use library or electronic sources to answer each of the following questions about weather predictions.

- Weather Watching
  - List three forms of technology that help us predict the weather.
  - How did people use animal behaviour to predict seasonal weather before technology?
  - Explain how animal behaviour might actually indicate some types of weather.
  - What signs in the sky allow people to predict weather? Explain.
- Can jet planes change the weather?
- Explain how jet planes could cause the cool, rainy weather in Chicago.
- Groundhog Day
  - Explain the Groundhog Day tradition and its historical roots.
  - Does Groundhog Day really predict seasonal weather? Explain.
- Cricket Weather Report
  - What part of the weather do crickets give information about? Is this useful?

Summary

Choose one of the following:

- Write a riddle, poem, or song that explains some of the interesting or unique ways that people predict the weather.
- Draw a cartoon strip that explains some of the interesting or unique ways that people predict the weather.

Teacher Notes

Background Information

Teachers may wish to check various weather websites for up-to-date information.

Outcomes

Students will be expected to

- identify and report the impact of accurate weather forecasting from the personal to the global point of view (118-2, 117-6, 114-6)
- analyze and report on the risks, benefits, and limitations of society's responses to weather forecasting (118-7, 214-11, 116-1)

Activity 6: Weather Hazards

Outcomes

Students will be expected to

- use weather instruments effectively and accurately for collecting local weather data and collect and integrate weather data from regional and national weather observational networks (213-3, 213-6, 213-7)

Question

- **What does a weather hazard/disaster look like?**

Procedure

Prepare an article for a newspaper about an actual hazard or disaster resulting from weather phenomena. This can be a recent or historical event. Be sure to research your event so that your facts are accurate. Possible strategies to include in your report:

- interview of a specialist or eyewitness
- photos or sketches
- explanation of weather related to that geographical area; how weather systems and phenomena occur
- past history of the region, if applicable
- details of occurrence—people involved, land use, cost of clean-up and recovery
- applicable statistics for the event—storm force magnitude, length of time, areas flooded or in drought

Arrange your information as a front-page cover story. You may include interesting headlines and colour photos or sketches to catch people's attention.

Teacher Notes

Background Information

As a class, determine the features of the article. Some things that might be included:

- headline
- journalist's name (you)
- name of news agency (AP—Associated Press; CP—Canadian Press; etc.)
- date—be sure that the article corresponds to the time period!
- length—250–300 words
- a map to illustrate the location of the event
- format—electronic or print

Activity 7: Weather Technology

Outcomes

Students will be expected to

- Illustrate and display how science attempts to explain seasonal changes and variations in weather patterns for a given location (215-5)

Question

How are weather and technology related?

Procedure

Part 1: Software Developer

1. Computer technology is central to weather forecasting. Research what is required for developers to create and maintain weather information for the public. Report your findings.
2. How do you decide what data to collect?

Part 2: Meteorologist Technician

1. Name two careers that require meteorological technicians.
2. What do these technicians do?
3. Where do they get training?
4. Pick one career. What skills and knowledge are needed to do the job?

Part 3: Broadcast Meteorologist

1. Where would you find these broadcasters?
2. What do they do? What do they need to know to do this job?
3. What kinds of weather instruments do they use in their work?
4. How do they use the data they collect?
5. Find a weather map (on the Internet). Try to interpret the weather from the map.

Part 4: Warning Preparedness Meteorologist

1. What is the job of this person?
2. What is a day like in this job when a tornado or other disaster is developing?
3. Who do these meteorologists teach to use and interpret their services?
4. What instruments do these meteorologists use in their work?
5. How do they use the data collected?

Part 5: Why it Matters

1. Answer the "Why it Matters" questions on page 81 of *Nova Scotia Science 10*.
2. Write a script that would last about 30 seconds to explain to a university audience what tomorrow's weather for the country is expected to be.
3. a) How accurate is a weather forecast?
   b) Are the atmospheric conditions at Earth's surface the only factor? Explain. If there are other factor(s), list them and explain their use.
   c) How does technology play a part in this?
4. Pick a weather instrument. Write a paragraph that discusses how the instrument has changed over time.
5. What are the effects of weather on industry where you live? Identify the industry, the weather, and the results. What technology is involved?
6. Are there limitations in weather forecasting? What are some? How does technology play a part in this?
7. Do "Measuring Fog," on page 43 of *Nova Scotia Science 10*.

Activity 8: How Hot Does It Get?

Outcomes

Students will be expected to

- use scientific theory, identify questions about, illustrate, and explain heat energy transfers that occur in the water cycle (331-1, 214-3)

Questions

- **Does the colour of a substance affect the amount of light energy that is changed to heat energy?**
- **How hot does the surface of dry sand get when light shines on it?**
- **How hot does the surface of water get when light shines on it?**
- **How hot does air get when light shines on it?**
- **How hot does a mixture of sand and water get when light shines on it?**
- **How hot does damp potting soil get when light shines on it?**
- **Does vegetation affect how hot soil gets when light shines on it?**

Background Information

Light energy that is not reflected from the surface of a substance is absorbed and turned into heat energy. Dark-coloured substances absorb more light energy and thus turn more of the light energy into heat energy. The heat energy makes the molecules of the substance move. Kinetic energy is the energy of motion. Because the molecules of different substances are different, different substances have different amounts of energy. For example, it takes more heat energy to change the temperature of water 1°C than to change the same mass of dry sand 1°C. This property of substances is called specific heat capacity. A substance with a low specific heat capacity needs very little heat energy to make its temperature change.

Safety ⚠

- Wear safety goggles.
- Avoid breathing dust from the sand.
- Be careful when handling thermometers.

Materials

- alcohol thermometers
- clear plastic food trays with lids for the heating dishes (from grocery store)
- lamps with 100-watt bulbs
- metre sticks
- potting soil
- sand
- sheets of coloured paper, including white and black
- small plant in the same potting soil as a control
- water

Procedure

As a class, plan the experiment. In groups, conduct an investigation to help answer your question. After the data are collected, compare results for each group. In planning investigations,

- list which variables must be controlled in each investigation
- list which variables are manipulated
- list which variables are responding
- decide the number of trials to be done
- write a hypothesis and prediction for your investigation
- write out your materials list and your procedure
- identify and list the safety precautions for your investigation
- get teacher approval

Results

In your group,

- record "suitable" data and display the data for presentation
- determine what happens to heat and temperature in your experiment

As a class,

- report and collate results
- compare the results in each experiment and discuss how the results relate to the heating and transfer of heat of various substances
- discuss and write about how solar energy can be turned into heat energy

Teacher Notes

Background Information

Divide the class into groups. Assign each group a question. The groups may compare their answers. Students will have an opportunity to compare qualitatively the heat capacities of various Earth substances. Of the substances investigated, water requires the most heat energy to change its temperature 1°C, while air will require the least heat energy to change its temperature. Have students use the same scales on their graphs so they can compare the slopes of the lines. The steeper the slope, the lower the heat capacity. Try using temperature probes for measuring the temperature. The data collected can be entered on a spreadsheet and displayed graphically.

Activity 9: How Do Molecules Behave?

Questions

- **How do water molecules in a solid at absolute zero and at –1°C behave?**
- **How do water molecules in a liquid phase behave?**
- **How do water molecules at the boiling point behave?**

Outcomes

Students will be expected to

- use scientific theory, identify questions about, illustrate, and explain heat energy transfers that occur in the water cycle (331-1, 214-3)

Procedure

Devise an investigation that will help answer the above questions.

Results

- Write about your observations.
- Make sketches of the molecular activity.

Analysis

- What do you think will happen to the water molecules as they lose kinetic energy?
- If the water molecules lose kinetic energy, what else is being lost?
- How do water molecules in a solid at absolute zero and at –1°C behave?
- How do water molecules in a liquid phase behave?
- How do water molecules at the boiling point behave?

Teacher Notes

Background Information

This is an alternate activity for the above outcome.

Heat energy can cause one state of matter to change into another state. The particular state of a type of matter depends both on the matter itself and the temperature.

There are three states of matter to consider: solid, liquid, and gas.

A solid is something that maintains its shape. The atoms or molecules of a solid vibrate in a fixed position. At the melting point, the atoms vibrate enough so that they break out of their fixed positions and the solid becomes a liquid.

A liquid maintains its volume, but takes the shape of its container. The atoms of a liquid still vibrate, but they also move around slowly. At the boiling point, atoms throughout the liquid vibrate more, and gas bubbles rise to the surface. The liquid then changes completely to a gas.

A gas has no fixed volume, but takes up the volume of its container. The atoms of a gas move around quickly and are spaced far apart. When heat is applied to a gas, the atoms move faster.

It would be interesting to have the students complete this activity before you give them the background information, to determine the extent of their understanding of how molecules behave in different states of matter. Repeat the activity again after they have the information, and have them observe the differences in their behaviour as molecules.

Procedure

Create a large square on the ground with masking tape, leaving one side open. The marked area represents an open pot. Students will pretend that they're water in the pot. Individuals will be molecules as a solid (ice) changes to a liquid and then to a gas.

Ask the class to arrange themselves in the pot as if they were ice. (Everyone begins by standing close together at the bottom of the pot and opposite the opening while vibrating slightly.)

Say something like, "You're molecules in ice. You're frozen solid. But the pot has been placed on a burner. You're beginning to get a little warmer." (Everyone sways a little from side to side to represent atoms vibrating to a greater extent. The particles are close together.)

"It's getting warmer. You're melting. You're becoming a liquid." Have the students discuss what is happening as they go from a solid to a liquid.

"It's getting even warmer." (The students should now move more rapidly and take up more space.)

"It's really hot. You're boiling." (All students should be moving very quickly around the pot while vibrating quickly. Some students should leave the pot to represent the beginning of evaporation.)

"You're a vapour now." (All students should leave the pot and move quickly all over the place while vibrating as fast as they can. Ideally they should move in a straight line until they hit something then bounce off and move in a straight line in a new direction.)

You could now repeat the process, going from liquid in a pot to a solid.

Analysis

Draw and label a graph for water going from a solid to a vapour.

Label the state(s) on the graph.

Draw a picture of each of the stages of the graph.

The students should also answer the following questions:

- What do you think will happen to the water molecules as they lose kinetic energy?
- If the water molecules lose kinetic energy, what else is being lost?
- What is the difference between a vapour and a gas? Explain.

Activity 10: Weather Report

Outcomes

Students will be expected to

- identify and report the impact of accurate weather forecasting from the personal to the global point of view (118-2, 117-6, 114-6)
- analyze and report on the risks, benefits, and limitations of society's responses to weather forecasting (118-7, 214-11, 116-1)

Question

- **What are some impacts and trends in the weather?**

Procedure

Create a report using one or more of the following themes:

- the societal impact of
  - disasters: hurricanes, tornadoes, blizzards, great storms from the past (local, provincial, regional, national, global)
  - seasons (tourism, agriculture, fishing, etc.)
  - weathering
- weather trends—comparing patterns/trends: local, regional, national, global (for example, same latitude and same ocean can have different weather or climate)
- weather folklore versus evolving technology: reliable and accurate data collecting with respect to weather forecasting
- weather expressed through various media:
  - art (masters to present)
  - music (classical to contemporary)
  - poetry, literature
- impact of weather on historical events
- history of weather prediction
- microclimates

Possible Resources

- almanacs
- community elders
- Environment Canada
- Internet
- magazines such as *National Geographic* and *Canadian Geographic*
- newspapers (look for commentaries, cartoons, financial pages, articles, letters to the editor)
- TV weather reports
- various organizations such as Bedford Institute of Oceanography (BIO), Department of Fisheries, Department of Natural Resources

Unit 2: Physical Science: Chemical Reactions (25%)

Activity 11: Consumers and Chemicals

Question

- **What are some relationships between consumers and chemicals?**

Procedure

- Do Find Out Activity 3-1A: Can you Judge a Product by its Label?, p. 101, *Nova Scotia Science 10*.

Introduction to Neutralization

Like most chemical reactions, the products of a neutralization reaction are predictable: a salt and water. Salts are ionic compounds composed of a metallic and a non-metallic ion and they are soluble in water.

A neutralization reaction may be represented generally as

$$\text{Acid} + \text{Base} \rightarrow \text{Salt} + \text{Water}$$

$$HX(aq) + MOH(aq) \rightarrow MX(aq) + H_2O(l)$$

where "X" represents the anion of the acid and "M" represents the cation of the base.

- Do Conduct an Investigation 4-2D: Neutralization Reactions and Salts, p. 172, *Nova Scotia Science 10*.

Introduction to Chemicals for Consumers

Acid neutralization is big business these days. Whether it is a cheap over-the-counter remedy (Tums or Rolaids) or an expensive prescription brand (Prevacid or Nexium), people are buying antacids in record amounts. Antacids are bases that react with excess stomach acid, neutralizing it. Along with Tums and Rolaids, the commercial brands include Zantac, Pepcid, Milk of Magnesia, and Alka Seltzer. The active ingredient in these over-the-counter preparations is usually magnesium carbonate or calcium carbonate. The carbonates react with acids such as hydrochloric acid (stomach acid).

Outcomes

Students will be expected to

- investigate and collaborate to describe science and technology relationships and their functions (116-3, 117-7, 215-6, 116-5)

Testing the Effectiveness of Antacids

Antacids are advertised under many brand names. Consumers purchase these products to reduce stomach acids. Is an antacid product effective in neutralizing elevated levels of stomach acid?

Advertisements for antacids often make claims about the antacid's ability to "consume" excess stomach acid. How valid are these claims? In this activity, you will perform tests to find out.

Question

- Is one brand-named antacid more effective than another antacid product in neutralizing acid?

Materials

- 4 tall, clear glasses
- baking soda (sodium bicarbonate)
- cabbage juice indicator strips or commercial indicator strips
- grapefruit juice
- measuring cup
- Rolaids, regular strength
- spoons
- Tums, regular strength

Procedure

Use the Consumers and Chemicals activity sheet to record your findings.

1. Pour 125 mL of grapefruit juice into each of the four glasses.
2. Test the first glass of juice using an indicator strip. If you are using cabbage juice indicator strips, the colour reference is as follows:

Cabbage Juice Indicators

Approximate pH	2	4	6	8	10	12
Colour of extract	red	purple	violet	blue	teal	green

3. Read the label on the Tums package and determine the recommended dosage. Crush that number of tablets and drop the powdered tablets into the second glass of grapefruit juice. Stir with a spoon until thoroughly dissolved. Test and record the pH after mixing.
4. Repeat Part 2 for Rolaids.
5. Repeat Part 3 using 2 mL or 5 g of baking soda.
6. Flush the glasses of juice down the sink with plenty of water. Wash the glasses, and then wash your hands thoroughly.

Consumers and Chemicals

Name: ______________________________ Date: ________________

Record the colour and approximate pH in the table below.

Neutralization Reactions

Antacid	Colour	pH
grapefruit juice		
Tums		
Rolaids		
baking soda		

Analysis

1. What is the active ingredient in each of the antacids that you tested? Write a chemical equation to show how one of the antacids neutralizes the citric acid in grapefruit juice.

2. List the antacids from most effective to least effective. Give reasons to support your answer.

3. Calculate the cost of a single dose of each antacid. Which is the least expensive antacid? Is it also the least effective one? Explain, using data to support your answer.

4. Based on the data you have collected and the price per dose that you have calculated, make a recommendation about which antacid to use for occasional indigestion.

Activity 12: Chemical Names and Formulas

Question

- **How are chemical compounds named?**

Outcomes

Students will be expected to

- name and write formulas for common ionic compounds and molecular compounds and describe the usefulness of the IUPAC nomenclature system (319-1, 114-8)
- classify simple acids, bases, and salts, based on their characteristics, name and formula (319-2)

Introduction

The guidelines set forth by the International Union of Pure and Applied Chemistry (IUPAC), when followed correctly, ensure that a particular substance will have a standard name internationally.

The IUPAC is based in Paris, France. Members of the committee meet periodically to discuss a variety of topics, including standardizing the naming of newly discovered elements and compounds.

The process of naming and writing formulas for chemical compounds is very precise and follows a set of guidelines established by scientists. The reason for this complex and precise set of guidelines is to enhance communication among scientists. If the rules for naming chemical compounds were vague or unclear, scientists in different parts of the world might develop vastly different names for substances, making communication difficult or impossible. Miscommunication of this sort can also lead to safety hazards if compounds are not correctly identified.

Procedure

Part 1

A. Do Think About It Activity 3-1B: Patterns in Ion Formation, p. 105, and Think About it Activity 3-2A: What's in a name?, p. 110, from *Nova Scotia Science 10*.

B. Use the polyatomic ion sheet in Appendix A to help you complete the following table.

Polyatomic Substances

	iodate	selenate	citrate	hydroxide
lithium		Li_2SeO_4		
magnesium				$Mg(OH)_2$
iron (III)	$Fe(IO_3)_3$			
lead (IV)			$PB_3(C_6H_5O_7)_4$	
ammonium				

Part 2

For each formula, write the name of the compound:

Naming Ionic Compounds

Chemical Formula	Name
a. $CaSO_4$	
b. $Ba(OH)_2$	
c. NH_4Cl	
d. $Ca_3(AsO_3)_2$	
e. $NaC_2H_3O_2$	
f. $Mg_3(AsO_3)_2$	
g. $Al_2(SO_4)_3$	
h. NaCNO	
i. NH_4NO_3	
j. $K_2Cr_2O_7$	
k. $Al(OH)_3$	
l. KSCN	
m. $NaHCO_3$	
n. MgS_2O_8	
o. $(NH_4)_3PO_4$	
p. KOH	
q. PbO_2	
r. $CuBr_2$	
s. Fe_2Se_3	

Part 3

Names and Formulas for Binary Molecular Compounds

Write the name for each of the following binary molecular compounds.
Explain why you think the name you chose is correct.

Naming Binary Molecular Compounds

Chemical Formula	Name
1. As_4O_{10}	tetrarsenic decoxide "Tetra" is included because there are 4 arsenic atoms, "deca" because there are 10 oxide atoms. The "a" is dropped from "tetra" to avoid a double "a" in the name, while the "a" at the end of most of the prefixes is dropped when followed by "oxide."
2. BrO_3	bromine trioxide When there is only one atom of the cation, "mono" is not used. There are three oxygen atoms in the anion, so the prefix "tri" is attached.
3. BrN	bromine mononitride When there is only one atom of the cation, "mono" is not used. The prefix "mono" is used here in the anion because there is one atom of nitrogen present.
4. N_2O_3	
5. NI_3	
6. SF_6	
7. XeF_4	
8. PCl_3	
9. CO	

10. PCl_5	
11. P_2O_5	
12. S_2Cl_3	
13. C_3N_4	
14. SO_2	
15. P_4O_{10}	
16. RnF_6	
17. OF_2	
18. ClO_2	
19. SiO_2	
20. CF_3	

21. N_2S_5	
22. CO_2	
23. SO_3	
24. XeF_6	
25. KrF_2	
26. $BrCl_8$	
27. SCl_4	
28. PF_3	
29. XeO_3	
30. SeO_4	

Part 4

Give the formula for each of the following compounds.

Formulas for Binary Molecular Compounds

Name	Formula
chlorine monoxide	
oxygen difluoride	
bromine monophosphide	
dinitrogen monoxide	
nitrogen trifluoride	
sulphur tetrachloride	
xenon trioxide	
carbon dioxide	
diphosphorous pentoxide	
phosphorous trichloride	
sulphur dioxide	
bromine pentafluoride	
disulphur dichloride	
selenium trifluoride	
iodine trichloride	
silicon tetrachloride	
krypton difluoride	
iodine monoxide	
silicon trichloride	
carbon trichloride	
dinitrogen pentasulphide	
carbon monoxide	
sulphur trioxide	
dinitrogen trioxide	
dinitrogen monoxide	
xenon hexafluoride	
sulphur hexafluoride	
phosphorous pentachloride	
nitric oxide	
nitrous oxide	

Teacher Notes

Polyatomic Substances (Answer Key)

Cation \ Anion	iodate	selenate	citrate	hydroxide
lithium	$LiIO_3$	Li_2SeO_4	$Li_3C_6H_5O_7$	$LiOH$
magnesium	$Mg(IO_3)_2$	$MgSeO_4$	$Mg(C_6H_5O_7)_2$	$Mg(OH)_2$
iron (III)	$Fe(IO_3)_3$	$Fe_2(SeO_4)_3$	$FeC_6H_5O_7$	$Fe(OH)_2$
lead (IV)	$Pb(IO_3)_4$	$Pb(SeO_4)_2$	$PB_3(C_6H_5O_7)_4$	$Pb(OH)_4$
ammonium	NH_4IO_3	$(NH_4)_2SeO_4$	$(NH_4)_3C_6H_5O_7$	NH_4OH

Activity 13: Building Compounds

Outcomes

Students will be expected to

- name and write formulas for common ionic compounds and molecular compounds and describe the usefulness of the IUPAC nomenclature system (319-1, 114-8)
- classify simple acids, bases, and salts based on their characteristics, name, and formula (319-2)

Questions

- **What are binary ionic compounds composed of?**
- **How is the formula for a binary ionic compound written?**

Materials

- chemistry tiles set, various forms are available

Procedure

Rules for using chemistry tiles:

- You must have a rectangle when you are done.
- Positive ions go on the left.
- Negative ions go on the right.
- When writing the formula, write the positive ion followed by a subscript that tells how many tiles are used and then the negative ion followed by a subscript that tells how many tiles are used.

Part 1

Determine the formulas of the binary ionic compounds formed from these combinations of ions, and record your results below.

Bionic Ionic Compounds

Ions	Formula
1. H^+ and Br^-	HBr
2. Na^+ and Cl^-	
3. K^+ and I^-	
4. Cu^+ and F^-	
5. Fe^{2+} and S^{2-}	
6. Sn^{2+} and S^{2-}	
7. Cr^{2+} and O^{2-}	
8. Ni^{2+} and S^{2-}	
9. Co^{3+} and P^{3-}	
10. Fe^{3+} and N^{3-}	
11. Al^{3+} and P^{3-}	
12. Fe^{3+} and P^{3-}	
13. Cu^{2+} and Br^-	
14. Al^{3+} and Cl^-	
15. Sn^{2+} and N^{3-}	
16. Cu^{2+} and F^-	
17. Cu^+ and P^{3-}	
18. Li^+ and S^{2-}	
19. Ni^{2+} and N^{3-}	
20. Ni^{2+} and I^-	
21. K^+ and S^{2-}	
22. Co^{3+} and O^{2-}	
23. Cu^+ and O^{2-}	
24. K^+ and P^{3-}	

Part 2

Determine the formulas of the complex ionic compounds formed from these combinations of ions, and record your results in the table below.

Formulas for Complex Ionic Compounds

Ions	Formula
1. NH_4+ and S^{2-}	$(NH_4)_2S$
2. Ni^{+} and PO_4^{3-}	
3. Cu^{+} and PO_4^{3-}	
4. Cu^{+} and $C_2H_3O_2^{-}$	
5. Fe^{2+} and NO_3^{-}	
6. Sn^{2+} and $C_2O_4^{2-}$	
7. Cr^{2+} and NO_3^{-}	
8. Ni^{2+} and NO_3^{-}	
9. Co^{3+} and CO_3^{2-}	
10. Fe^{3+} and NO_3^{-}	
11. Al^{3+} and $C_2H_3O_2^{-}$	
12. Fe^{3+} and CrO_4^{2-}	
13. Cu^{2+} and SO_3^{2-}	
14. Al^{3+} and SO_4^{2-}	
15. Sn^{2+} and NO_3^{-}	
16. Cu^{2+} and NO_3^{-}	
17. Cu^{+} and CrO_4^{2-}	
18. Li^{+} and CO_3^{2-}	
19. Ni^{2+} and P^{3-}	
20. Ni^{2+} and NO_3^{-}	
21. K^{+} and $C_2H_3O_2^{-}$	
22. Co^{3+} and SO_4^{2-}	
23. Cu^{+} and $C_2H_3O_2^{-}$	
24. K^{+} and SO_3^{2-}	

Analysis

- Based on the formulas that you wrote in Parts 1 and 2, propose a definition for (a) binary ionic compounds and (b) complex compounds.

Teacher Notes

Background Information

Binary compounds contain two different elements. Binary ionic compounds are made up of a metallic element and a non-metallic element. Ionic compound formulas are written with the positive ion first and then the negative ion. For example, the compound formed between lithium (Li^+) and chloride (Cl^-) would be written LiCl.

Complex compounds contain polyatomic ions. Polyatomic ions contain more than one atom, such as nitrate (NO^{3-}). Ionic formulas are written the same whether they are binary or complex. The only difference is the possible use of parentheses around the polyatomic ion. For instance, to write the formula for barium nitrate, which has one barium ion (Ba^{2+}) and two nitrate ions (NO^{3-}), we must use parentheses. The formula would be $Ba(NO^3)^2$. Parentheses are used only when there is more than one of the polyatomic ions.

Depending on the problem-solving ability of your students, you may wish to lead them through the use of the chemistry tiles first. If they are good at working independently, the rules for using chemistry tiles should be sufficient to get them started.

Answers

Part 1

Bionic Ionic Compounds

Ions	Formula
1. H^+ and Br^-	HBr
2. Na^+ and Cl^-	NaCl
3. K^+ and I^-	KI
4. Cu^+ and F^-	CuF
5. Fe^{2+} and S^{2-}	FeS
6. Sn^{2+} and S^{2-}	SnS
7. Cr^{2+} and O^{2-}	CrO
8. Ni^{2+} and S^{2-}	NiS
9. Co^{3+} and P^{3-}	CoP
10. Fe^{3+} and N^{3-}	FeN
11. Al^{3+} and P^{3-}	AlP
12. Fe^{3+} and P^{3-}	FeP
13. Cu^{2+} and Br^-	$CuBr_2$

14. Al^{3+} and Cl^{-}	$AlCl_3$
15. Sn^{2+} and N^{3-}	Sn_3N_2
16. Cu^{2+} and F^{-}	CuF_2
17. Cu^{+} and P^{3-}	Cu_3P
18. Li^{+} and S^{2-}	Li_2S
19. Ni^{2+} and N^{3-}	Ni_3N_2
20. Ni^{2+} and I^{-}	NiI_2
21. K^{+} and S^{2-}	K_2S
22. Co^{3+} and O^{2-}	Co_2O_3
23. Cu^{+} and O^{2-}	Cu_2O
24. K^{+} and P^{3-}	K_3P

Part 2

Formulas for Complex Ionic Compounds

Ions	Formula
1. NH_4+ and S^{2-}	$(NH_4)_2S$
2. Ni^{+} and PO_4^{3-}	Ni_3PO_4
3. Cu^{+} and PO_4^{3-}	Cu_3PO_4
4. Cu^{+} and $C_2H_3O_2^{-}$	$CuC_2H_3O_2$
5. Fe^{2+} and NO_3^{-}	$Fe(NO_3)_2$
6. Sn^{2+} and $C_2O_4^{2-}$	SnC_2O_4
7. Cr^{2+} and NO_3^{-}	$Cr(NO_3)_2$
8. Ni^{2+} and NO_3^{-}	$Ni(NO_3)_2$
9. Co^{3+} and CO_3^{2-}	$Co_2(CO_3)_3$
10. Fe^{3+} and NO_3^{-}	$Fe(NO_3)_3$
11. Al^{3+} and $C_2H_3O_2^{-}$	$Al(C_2H_3O_2)_3$
12. Fe^{3+} and CrO_4^{2-}	$Fe_2(CrO_4)_3$
13. Cu^{2+} and SO_3^{2-}	$CuSO_3$
14. Al^{3+} and SO_4^{2-}	$Al_2(SO_4)_3$
15. Sn^{2+} and NO_3^{-}	$Sn(NO_3)_2$
16. Cu^{2+} and NO_3^{-}	$Cu(NO_3)_2$
17. Cu^{+} and CrO_4^{2-}	Cu_2CrO_4
18. Li^{+} and CO_3^{2-}	Li_2CO_3
19. Ni^{2+} and P^{3-}	Ni_3P_2
20. Ni^{2+} and NO_3^{-}	$Ni(NO_3)_2$
21. K^{+} and $C_2H_3O_2^{-}$	$KC_2H_3O_2$
22. Co^{3+} and SO_4^{2-}	$Co_2(SO_4)_3$
23. Cu^{+} and $C_2H_3O_2^{-}$	$CuC_2H_3O_2$
24. K^{+} and SO_3^{2-}	K_2SO_3

Activity 14: It's in the Cards

Question

- **How many formulas can you make?**

Materials

- deck of ions/subscript cards

Procedure

The Rules of the Game

Decide which game you wish to play. It could be Fish, a variation of Concentration, or make up your own game. The players will try to make a chemical formula that uses their cards.

Outcomes

Students will be expected to

- name and write formulae for common ionic compounds and molecular compounds and describe the usefulness of the IUPAC nomenclature system (319-1, 114-8)

Teacher Notes

Background Information

Create a deck of cards using the ions listed below. Each ion should be on a separate card. Appendix E includes Chemical Ion Cards that can be photocopied, or print the ions on labels and affix to blank index cards.

Sample Ions Cards

Ba^{2+}	Be^{2+}	Cu^{2+}	Sr^{2+}
Na^{+}	Mg^{2+}	Cu^{3+}	Sc^{3+}
Ca^{2+}	Ag^{+}	Fe^{2+}	Al^{3+}
Li^{+}	K^{+}	H^{+}	Hg^{2+}
Pb^{2+}	V^{3+}	Fe^{3+}	Sn^{+}
Zn^{2+}	Ni^{3+}	Cr^{3+}	Rb^{+}
NO_3^{-}	HCO_3^{-}	CrO_4^{-}	S^{2-}
NO_2^{-}	PO_4^{-}	AsO_3^{2-}	O_2^{-}
SO_4^{2-}	HPO_4^{2-}	$C_2H_3O_2$	F^{-}
SO_3^{2-}	NH_4^{+}	$H_2PO_4^{-}$	N^{3-}
HSO_4^{2-}	OH^{-}	I^{-}	Br^{-}
CO_3^{2-}	ClO_4^{-}	Cl^{-}	P^{3-}

Activity 15: Product Labels

Outcomes

Students will be expected to

- name and write formulas for common ionic compounds and molecular compounds and describe the usefulness of the IUPAC nomenclature system (319-1, 114-8)
- classify simple acids, bases, and salts based on their characteristics, name, and formula (319-2)

Questions

- **What compounds are found on labels of products in the supermarket or drugstore, or at home?**
- **What are the formulas for these compounds?**

Background Information

If your cat took chemistry, would she eat this stuff? The following are the listed ingredients for a food treat for cats: flour, liver, dried whole egg, glycerin, pregelatinized wheat flour, shrimp by-products, wheat gluten, torula dried yeast, *calcium sulphate*, cheese meal, *phosphoric acid*, animal fat (preserved with butylated hydroxyanisole, otherwise known as BHA), *potassium chloride*, *salt*, *potassium sorbate* (a preservative), wheat middlings, colour, *chlorine chloride*, *calcium carbonate*, *iron(II) sulphate*, vitamin E supplement, *zinc oxide*, BHA, *copper(II) oxide, cobalt carbonate*, *manganese oxide*, vitamin A supplement, *potassium iodide*, D-calcium pantothenate, vitamin B12 supplement, vitamin D3 supplement, *water*, sufficient for processing.

The italicized compounds are examples of the types of compounds for which you have learned nomenclature rules.

Procedure

Read product labels to find compounds formed. For each compound, the following information will be required:

- name of compound as it appears on the label
- formula
- name of the product in which it is found

Other requirements:

- Complete the Product Labels sheet.
- A compound may be used only once.
- Names must be of compounds, not elements.
- The list must be numbered and alphabetized and include at least 12 different compounds.

Product Labels

Name: ______________________________ Date: ______________

Food Treats for Cats

Chemical Compound	Formula
calcium carbonate	
calcium sulphate	
chlorine chloride	
cobalt carbonate	
copper(II) oxide	
iron(II) sulphate	
manganese oxide	
phosphoric acid	
potassium chloride	
potassium iodide	
potassium sorbate	
salt	
zinc oxide	

Name	Fomula	Product

Teacher Notes

Background Information

This activity allows students to use their nomenclature skills to decode ingredient lists for food products.

The students will need a copy of the polyatomic ion sheet (see Appendix A) as well as access to the formulas for other ions that are not listed on the ion sheet.

Sample Results

Other results will vary depending on the products selected by each student.

Chemical Compound	Formula
calcium carbonate	$CaCO_3$
calcium sulphate	$CaSO_4$
chlorine chloride	$ClCl$
cobalt carbonate	$CoCO_3$
copper(II) oxide	CuO
iron(II) sulphate	$FeSO_4$
manganese oxide	MnO
phosphoric acid	H_3PO_4
potassium chloride	KCl
potassium iodide	KI
potassium sorbate	KC_5H_7COO
salt	$NaCl$
zinc oxide	ZnO

Activity 16: Chemical Cubes

Questions

- **How many compounds can you make from rolling your cubes?**
- **What are their names and formulae?**

Procedure

Part 1

The first player rolls the dice and combines pairs of dice to make as many combinations as possible. The charges on the ions must be opposite, but equal magnitudes. Write down the ion pairs as the player forms them.

Each player takes five turns at rolling the dice. Make a table and record the combinations. Duplicate combinations will be ignored.

After both players have rolled, they set about naming their compounds.

Part 2

Use the same rules as Part 1. This time the combination of ions must be opposite and have unequal charges. Write the formula.

You may consult ion tables for help.

Roll #1	Br^-	Cu^+	Mg^{2+}	CO_3^{2-}	NO_2^-

Sample Part 1 Combinations:

$Cu^+ + Br^- \rightarrow CuBr$

$Cu^+ + NO_2^- \rightarrow CuNO_2$

$Mg^{2+} + CO_3^{2-} \rightarrow MgCO_3$

Sample Part 2 Combinations:

$Cu^+ + CO_3^{2-} \rightarrow Cu_2CO_3$

$Mg^{2+} + Br^- \rightarrow MgBr^2$

$Mg^{2+} + NO_2^- \rightarrow Mg(NO_2)_2$

A data table can be used to help students record their results.

Outcomes

Students will be expected to

- name and write formulas for common ionic compounds and molecular compounds and describe the usefulness of the IUPAC nomenclature system (319-1, 114-8)
- classify simple acids, bases, and salts based on their characteristics, name, and formula (319-2)

Chemical Cubes

Name: ____ Date: _____________

Combination	Formula	Compound Name

Teacher Notes

Materials

- 1 set of ion dice
- 1 polyatomic ion sheet per student
- paper and pen/pencil

Background Information

Ion dice can be made easily and cheaply. Half-inch wooden cubes and wood markers or tole paints can be purchased at craft stores. Print the desired ions on each face:

Die #1: SeO_4^{2-}, Cl^{1-}, Sn^{2+}, Mn^{3+}, Na^{1+}, NO_3^{1-}

Die #2: IO_4^{1-}, K^{1+}, SO_3^{2-}, Br^{1-}, Mg^{2+}, Ni^{3+}

Die #3: NH_4^{1+}, Au^{3+}, CO_3^{2-}, OH^{1-}, ClO^{1-}, Pb^{2+}

Die #4: H^{1+}, PO_4^{3-}, P^{3-}, SO_4^{2-}, Fe^{3+}, Cu^{2+}

Die #5: Ba^{2+}, CN^{1-}, Cu^{1+}, O^{2-}, N^{3-}, Co^{3+}

Procedure

Students pair up and compete to form the most ionic compounds from the throw of their ion dice cubes. This is an excellent way for students to review their knowledge of ions and formula writing.

Alternate Activity

Question

- How many ion partners can you find?

Procedure

1. Place an element tag around your neck. Are you a cation (+) or an anion (–)?
2. Find an ion that you can bond with.
3. In a table, write your element symbol and the charge, along with your partner's element and charge.
4. Write the formula of the compound you form.

5. Determine the name of your new compound and write it in the table.
6. Find a new partner. Repeat steps 3–5.

Creating Compounds

Cation (+)	Anion (-)	Compound Formula	Compound Name
Ra^{+}	Cl^{-}	$RaCl_2$	radium chloride

Activity 17: Evidence of Chemical Reactions

Questions

- **What evidence is observed for chemical reactions?**
- **What do the results mean?**

Background Information

When a chemical reaction occurs, the starting materials (the reactants) change into new substances (the products). There are a number of ways that we can determine whether a reaction takes place between two (or more) reactants. In this experiment, you will examine the reaction between road salt ($CaCl_2$) and baking soda ($NaHCO_3$) to observe the experimental evidence of a chemical reaction. An indicator, bromothymol blue, will be used to determine the pH level or the level of acidity. Bromothymol blue turns yellow when solutions have a pH level greater than pH = 8, therefore they become slightly basic.

For this experiment, use a pH probe and a graphing calculator to monitor the changes in temperature.

Materials

- 10 mL graduated cylinder
- balance
- bromothymol blue
- $CaCl_2$
- graphing calculator
- $NaHCO_3$
- pH probe
- scoopula
- temperature probe
- zippered sandwich bags

Outcomes

Students will be expected to

- perform experiments, using appropriate instruments and procedures, to identify substances as acids, bases, or salts, based on their characteristic properties (212-8, 213-5)
- investigate chemical reactions while applying WHMIS standards, using proper techniques for handling and disposing of materials (213-9, 117-5)

Procedure

- Prepare your equipment. Practise using the equipment before the experiment. You might want to make notes for future reference.
- Decide on the data that will be collected. It could be quantitative (temperature, pH) and/or qualitative.
- Write the equation for the reaction of $CaCl_2$ and $NaHCO_3$. Balance it. Determine the ratio of $CaCl_2$ to $NaHCO_3$ that would be needed to make a chemical reaction. Check your results with your teacher. When approved, add your amounts of $CaCl_2$ and $NaHCO_3$ into a zippered sandwich bag. Place the samples together in one corner of the bag.
- Measure 5 mL of bromothymol blue and pour carefully into the opposite corner. Do not let the powders mix with the indicator.
- Put the probe in the bag and seal the bag as much as possible, being careful not to let the powders and the indicator mix just yet. Start collecting your data.
- After about 20 seconds, shake the bag gently so that the powders and the indicator mix. Be careful not to tear the bag.
- After you have completed your experiment, tidy your work space.

Observations

- Record the initial and final temperatures of the reaction.
- Identify all of the changes observed during the reaction.
- Prepare a graph of your results.
- Fill in the Evidence of Chemical Reactions Form.

Evidence of Chemical Reactions Form

Name: ____ Date: ______________

Data Table: $CaCl_2$ and $NaHCO_3$

Analysis

1. What evidence was observed that a chemical reaction had taken place?	3. The result of this experiment produces a solution that produces a specific colour when tested with a pH indicator. Was this solution acidic or basic? Explain.
2. Was the reaction endothermic or exothermic? How could you tell?	

Attach your graph.

Teacher Notes

This experiment should be conducted in the chemistry laboratory.

Assessment

The Evidence of Chemical Reactions Form should be completed to show that the students have recorded, identified, and graphed the data. There is no need for a formal lab report; this sheet can be marked as complete, incomplete, or unacceptable and passed in at the end of the class. This helps the students complete an assignment and also eases the volume of marking.

Activity 18: Cabbage Juice Chemistry

Question

- **What effect do various household products have on cabbage juice?**

Outcomes

Students will be expected to

- represent chemical reactions and the conservation of mass using balanced symbolic equations (321-1)
- design and carry out experiments, controlling variables and interpreting patterns, to illustrate how factors can affect chemical reactions (212-3, 213-2, 321-3, 214-5)

Background Information

Chemists use indicators to test whether a substance is an acid or a base. Indicators work by turning a distinctive colour in the presence of an acid or a base. You can make your own indicator from red cabbage. You can also make indicators from the juice of blackberries or cherries.

Red cabbage juice turns a wide variety of colours depending on the strength of the acid or base that is being added to it. Use the following chart to help you determine the pH of the household products you are testing.

Cabbage Juice Indicators

Approximate pH	2	4	6	8	10	12
Colour of extract	red	purple	violet	blue	teal	green

Safety ⚠

- Some household products can cause skin irritations. Do not allow these to contact skin; rinse thoroughly with water if they do.

Materials

- 1000 mL beaker
- 4–5 250 mL beakers
- 500 mL beaker
- a head of red cabbage
- distilled water
- filter paper / paper towel
- hot plate
- knife and cutting board
- latex gloves
- milk
- sieve
- substances to test:
  - antacid tablets
  - baking soda
  - bathroom cleaner
  - cream of tartar
  - laundry detergent
  - lemon juice
  - lime juice
  - orange juice
  - shampoo
  - soft drinks
  - vinegar

Procedure

Part 1: Preparing the Indicator (may be done in advance)

Chop red cabbage finely. Boil 500 mL of water in 1000 mL beaker. Add the red cabbage carefully to the boiling water and take the beaker off the heat. Let it stand for 30 minutes (or longer) until it is completely cool. Strain the liquid into a 500 mL beaker and throw away the used cabbage. The liquid should be a dark reddish-purple colour. The colour will change when you add acids or bases.

Part 2: Testing the Household Products

- For runny liquids, pour 125 mL of liquid into a 250 mL beaker; then add 5 mL of red cabbage extract and stir the mixture.
- For viscous (thick) liquids such as shampoo and dish liquid, dilute the liquid with 75 mL of distilled water; then add 5 mL of red cabbage extract to the solution.
- For solids, place 5 mL of the solid in 125 mL of distilled water and stir until the solid dissolves. Then add 5 mL of red cabbage indicator to the solution.
- Use the Cabbage Juice Chemistry table to record your results.

Part 3: At-home pH Survey (extension)

- Soak some filter paper in cabbage juice indicator. Allow the paper to dry; then cut it into strips.
- Conduct an at-home pH survey of other household items. Tape your strips to a piece of notebook paper, label them, and bring them back to class.
- Compile your results with your group.

Cabbage Juice Chemistry

Name: ____ Date: __________________

Material	Extract Colour	Observations	pH
antacid tablets			
baking soda			
bathroom cleaner			
cream of tartar			
laundry detergent			
lemon juice			
lime juice			
milk			
orange juice			
shampoo			
soft drink			
vinegar			

Analysis

1a. What types of products are mostly household acids?

1b. What types of products are mostly household bases?

2. Using the information you've collected, explain what properties of acids and bases make them useful household technologies.

3. Give two examples of society influencing the science and technology of household products.

4. Give two examples of how the science and technology of acids and bases are an integral part of your life. Use examples that do not involve household products.

5. If you were to mix an antacid solution with a lemon juice solution, what would you expect to happen? Why? Predict the final pH of this mixture.

Teacher Notes

This experiment should be conducted in the chemistry laboratory.

Background Information

You could prepare the red cabbage indicator in advance to save time in class. Strips of red cabbage indicator-soaked filter paper can be refrigerated and will last for months.

Sample Results

- The acids will be lemon and orange juices, vinegar (acetic acid), cream of tartar (tartaric acid), sour milk, or almost any food items.
- Pure distilled water is the only substance that should be neutral.
- Baking soda is a weak base, as are most shampoos.
- The strong bases will be bathroom cleaners, laundry detergent, and antacid tablets.

Activity 19: Reaction Investigation

Outcomes

Students will be expected to

- investigate chemical reactions while applying WHMIS standards, using proper techniques for handling and disposing of materials (213-9, 117-5)
- perform experiments, using appropriate instruments and procedures, to identify substances as acids, bases, or salts, based on their characteristic properties (212-8, 213-5)

Questions

- **What do composition, decomposition, replacement, and double replacement reactions look like in the laboratory?**
- **What are the balanced equations for these reactions?**

Safety ⚠

- Wear safety glasses, gloves, and an apron.
- Use caution when heating objects with a Bunsen burner.
- Do not directly observe burning magnesium.

Materials

- Bunsen burner
- ceramic plate
- well plate
- Beral pipet
- 150 mL beaker
- crucible tongs
- test tube holder
- 7 test tubes (15 × 180 mm) and rack
- 5 wood splints
- 0.1 M silver nitrate
- 0.1 M sodium chloride
- 0.1 M zinc acetate
- 0.1 M sodium sulphide
- 0.5 M copper(II) sulphate solution
- 0.1 M sodium phosphate
- 3 M hydrochloric acid
- balance, preferably electronic
- distilled water
- 4 cm strip of magnesium ribbon
- 4 cm strip of copper foil
- copper(II) carbonate
- copper sulphate pentahydrate
- sodium hydrogen carbonate
- zinc piece
- plug of steel wool
- calcium piece
- spatula
- weighing boats

Procedure

Part 1: Combustion Reactions

1a. Using crucible tongs, heat a strip of copper foil in the inner cone of the Bunsen burner flame. Note any changes in the copper. Allow the strip to cool and use your spatula to scrape some of the product from the foil. Record your observations in the Reaction Investigation Data Table provided or make your own.

1b. Place a ceramic plate next to the Bunsen burner. Using crucible tongs, heat a 4 cm strip of magnesium ribbon in the Bunsen burner flame. Do not observe the burning magnesium directly because the magnesium burns with such intensity that direct observation could harm your eyes. As soon as the magnesium ignites, remove it from the flame and hold it over the ceramic plate. Once the reaction stops, examine the product and record your observations.

Part 2: Decomposition Reactions

2a. Place approximately 1 g of sodium hydrogen carbonate in a 15 × 180 mm test tube. Clamp the tube in a burette clamp or test tube holder and heat the tube gently with your Bunsen burner. Hold a burning splint in the mouth of the test tube. Record your observations.

2b. Using a clean test tube, repeat (a) using 1 g of copper sulphate.

2c. Using a clean test tube, repeat (a) using 1 g of copper(II) carbonate. Heat the tube intensely for two minutes.

Part 3: Single Replacement Reactions

3a. Place a clean test tube in the test tube rack. Add 5 mL of 3 M hydrochloric acid. Place a small zinc piece in the tube. Using your test tube holder, invert a clean test tube over the reacting tube for one minute. Light a wood splint and hold it to the mouth of the inverted tube. Record your observations.

3b. Place a small piece of steel wool (iron) in a clean test tube. Add 10 mL of 0.5 M copper(II) sulphate. Record your observations.

3c. Pour 10 mL of distilled water into a clean test tube. Add a small piece of calcium metal to the tube. Test the tube for hydrogen by holding a burning wood splint at the mouth of the tube. Record your observations.

Part 4: Double Replacement Reactions

4a. Place 2 drops of 0.1 M silver nitrate in well A1 of the well plate. Add 2 drops of 0.1 M sodium chloride. Record your results.

4b. Place 2 drops of 0.1 M zinc acetate in well A3 of the well plate. Add 2 drops of 0.1 M sodium phosphate. Record your observations.

4c. Place 2 drops of 0.1 M sodium sulphide in well A5 of the well plate. Add 2 drops of 3 M hydrochloric acid. Test the odour by wafting the air above the test tube toward you. Record your observations.

Analysis

- Complete the data table for this experiment and include chemical equations for the reactions.

Reaction Investigation

Name: ____ Date: _____________

Reaction Investigation Data Table

Description of Reactant(s)	Observations during Reaction	Description of Product(s)

Reaction Investigation Equation Table

Part	Balanced Equation
1a	
1b	
2a	
2b	
2c	
3a	
3b	
3c	
4a	
4b	
4c	

Teacher Notes

Background Information

If the solutions are not prepared, allow preparation time.

Precut the metal pieces to avoid waste. The solutions are easily dispensed from 250 mL dropping bottles. Be sure all secondary containers are properly labelled. The solid chemicals can be from labelled beakers. Students should have a basic knowledge of the types of chemical reactions and how to balance chemical reactions. The experiment may be split into two 40-minute periods.

Disposal of Materials ⚠

Dispose of the materials properly according to the *Science Safety Guidelines* (Nova Scotia Department of Education 2005).

Teacher Notes

Sample Results

The completed data and equations tables in this section show typical results for this lab.

Reaction Investigation Data Table

Step	Description of Reactant(s)	Observations during Reaction	Description of Product(s)
1a	lustrous metal flexible	flame turns green	gray/black powder
1b	lustrous metal	bright light	white powder
2a	white powder	splint goes out water droplets form	water droplets CO_2 gas
2b	blue crystal	colour changes water droplets form	water droplets white powder
2c	green powder	powder darkens splint goes out	CO_2 gas evolved black powder
3a	acid-clear zinc-lustrous metal	metal disappears and bubbles form splint produces a "pop"	hydrogen formed
3b	gray steel wool blue liquid	wool turns brown blue less intense	brown residue light-blue liquid
3c	metal: grayish lump water	bubbling occurs as metal disappears splint produces a "pop"	hydrogen evolved
4a	clear liquids	turbid	white precipitate formed
4b	clear liquids	turbid	white precipitate formed
4c	clean liquids	bubbles form strong odour given off	strong smelling gas formed

Reaction Investigation Equation Table

Part	Balanced Equation
1a	$2\ Cu(s) + O_2\ (g) \rightarrow 2\ CuO(s)$
1b	$2\ Mg(s) + O_2\ (g) \rightarrow 2\ MgO(s)$
2a	$2\ NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$
2b	$CuSO_4 \bullet 5\ H_2O(s) \rightarrow CuSO_4(s) + 5\ H_2O(g)$
2c	$CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$
3a	$2\ HCl(aq) + Zn(s) \rightarrow ZnCl_2(aq) + H_2(g)$
3b	$Fe(s) + CuSO_4(aq) \rightarrow Cu(s) + FeSO_4(aq)$
3c	$Ca(s) + 2\ H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$
4a	$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$
4b	$3\ Zn(C_2H_3O_2)_2(aq) + 2\ Na_3PO_4(aq) \rightarrow 6\ NaC_2H_3O_2(aq) + Zn_3(PO_4)_2(s)$
4c	$Na_2SO_3(aq) + 2\ HCl(aq) \rightarrow 2\ NaCl(aq) + H_2O(l) + SO_2(g)$

Activity 20: Dissolve This

Outcomes

Students will be expected to

- represent chemical reactions and the conservation of mass using balanced symbolic equations (321-1)
- design and carry out experiments, controlling variables and interpreting patterns, to illustrate how factors can affect chemical reactions (212-3, 213-2, 321-3, 214-5)

Question

- **What factors affect the rate of solution?**

Materials

- 250 mL beakers, 3
- clock with second hand, or stopwatch
- distilled water (cold, room temperature, and hot)
- hot plate
- safety glasses
- stirring rod
- sugar cubes

Procedure

Part 1

Place 150 mL of water in a beaker and put it on the hot plate so it will be hot when you need it. Place 150 mL of cold water in a beaker. Drop in a sugar cube. In a data table of your own design, record the time it takes for the cube to fully dissolve. Repeat this procedure with room-temperature water and again with hot water. Empty the contents of the beakers down the drain and clean the beakers for reuse in Part 2.

Part 2

Repeat Part 1, but use a stirring rod to continuously agitate the solution while the cube is dissolving. Again, record the time it takes for the sugar cube to dissolve. Empty the contents of the beakers down the drain and clean the beakers for reuse in Part 3.

Part 3

Repeat Part 1, but crush the sugar cube before adding it to the beakers. Record the time it takes for the sugar to dissolve. Empty the contents of the beakers down the drain and clean the beakers for reuse in Part 4.

Part 4

Repeat Part 2, but crush the sugar cube before adding it to the beakers. Record the time it takes for the sugar to dissolve. Empty the contents of the beakers down the drain and clean the beakers. Return the cleaned equipment to its storage area.

Dissolve This

Name: ____ Date: ______________

Data Table: Rate of Solution

Analysis

1. Identify the variables in this experiment using the categories of controlled, manipulated, and responding. ______ ______ ______ ______ ______	2. Provide two everyday examples where a substance has been dissolved. ______ ______ ______ ______ ______
3. What effect did each manipulated variable have on the responding variable(s)? Draw or describe this effect.	

Teacher Notes

Background Information

Before beginning the experiment, students should know the definition of **solvent**, **solute**, **insoluble**, and **rate**. These terms should be part of students' analysis of the activity.

Students should find that the hotter water (solvent) and the crushed sugar cube (solute) dissolves the fastest (rate).

It would be interesting to extend the activity to include solutes that do not dissolve well (or at all) in water, or perhaps the solute might only dissolve in hot water or only when crushed.

Extension

Have the students act out what the molecules of the solute are doing when a solvent is being heated, when it is cold, when it is being shaken, and when it is just sitting at room temperature.

Activity 21: Types of Chemical Reactions

Introduction

A chemical equation is a very useful device for communicating information about chemical changes. The equation contains both qualitative and quantitative information relating to the nature and quantity of the substances involved in the chemical reaction. It may also include the energy change involved.

Atoms are the basic building blocks of all matter. The Law of Conservation of Mass is used in balancing equations. This law can be stated in any of the following ways:

- Matter can be neither created nor destroyed during a chemical change.
- The total mass of all substances after a chemical change must be equal to the total mass of all substances before a chemical change.
- There can be no loss of mass or gain of mass during a chemical change.
- The number of atoms at the beginning of a reaction (reactants are on the left side of the equation) must equal the number of atoms at the end of the reaction (products are on the right side of the equation).
- The subscripts in a correct formula tell the number of atoms in one molecule. The coefficients (numbers in front of a formula) in a correctly balanced equation tell the number of molecules involved in a reaction.

One way to balance equations:

1. Make sure that each individual formula is correct and that the charges balance, if applicable.
2. Check that products are correct for the type of reaction.
3. Balance metals first.
4. Balance non-metals next.
5. Balance polyatomic ions that are found on both sides (treat these as a whole unit). Complex ions should be broken down into individual units **only** when found on one side and not the other (e.g., $NaHCO_3 \xrightarrow{\Delta} Na + H_2 + C + O_2$).
6. Balance H.
7. Balance O.
8. Check both sides of the equation to see if it is balanced and add coefficients as appropriate.

Outcomes

Students will be expected to

- represent chemical reactions and the conservation of mass using balanced symbolic equations (321-1)
- design and carry out experiments, controlling variables and interpreting patterns, to illustrate how factors can affect chemical reactions (212-3, 213-2, 321-3, 214-5)

Quite often, balancing oxygen and hydrogen will involve water on one side or the other of the equation. Water can be balanced as hydrogen and oxygen or as hydrogen and hydroxide (OH); use whichever method works with the equation you are trying to balance.

Remember, you cannot change a subscript to balance the equation, nor can you add new elements or polyatomic ions.

We will explore and explain four categories of reactions: synthesis, decomposition, single displacement, and double displacement reactions.

Three of these reaction types are also known by other names:

- synthesis—also known as composition, addition, or combination
- single replacement— also known as single displacement
- double replacement—also known as double displacement

For this activity, begin with synthesis and decomposition reactions.

Synthesis Reactions

During a synthesis reaction, two or more reactants combine to produce a new product. This can be represented symbolically by a general equation:

$$X + Y \rightarrow XY$$

In words, the general form of a synthesis reaction is:

element or compound + *element or compound* → *compound*

Most often the reactants in a synthesis reaction are elements. Occasionally more than two elements or compounds may be involved as reactants, but these reactions are rarer. The majority of spontaneous synthesis reactions are exothermic.

Decomposition Reaction

In a decomposition reaction, a compound breaks down into two or more simpler compounds or elements. The general equation is

$$XY \rightarrow X + Y$$

In words, the general form of a decomposition reaction is

compound → *element or compound* + *element or compound*

Many spontaneous decomposition reactions are endothermic. This is supported by the fact that most stable chemical substances will only break apart, or decompose, into simpler substances when energy, such as heat or electricity, is supplied.

Single Displacement Reactions

In a single displacement reaction, one element takes the place of (displaces) another element in a compound. There are two general symbolic forms of equations for a single displacement reaction:

$$A + BX \rightarrow AX + B \quad \text{or} \quad AX + Y \rightarrow AY + X$$

In the first general form, a metal A displaces another metal B that is already combined with a non-metal. In the second general form, a halogen X displaces another halogen Y that is already in combination with a metal.

Written in words, the general forms would be

metallic element + *compound* → *metallic element* + *compound*

or

halogen + *compound* → *halogen* + *compound*

The most common type of single displacement reaction involves one metal element displacing a second metal cation from a compound. For example:

$$Mg + CuCl_2 \rightarrow Cu + MgCl_2$$

This type of reaction proceeds because metals have different tendencies to lose electrons, forming cations. Magnesium tends to lose electrons more easily than copper, which makes magnesium more reactive. Therefore, in the reaction above, magnesium's higher activity level will allow it to replace copper in a compound with chlorine.

The second pattern of single displacement reaction involves a non-metal halogen (F, Cl, Br, I) displacing a second non-metal halogen anion from a compound. For example:

$$Cl_2 + 2KBr \rightarrow 2KCl + Br_2$$

Because chlorine is a more active halogen, it will replace bromine in combination with potassium.

Double Displacement Reactions

In a double displacement reaction, the cations of two different compounds exchange places, forming two new compounds. The symbolic general form of the equation is:

$$WX + YZ \rightarrow WZ + YX$$

The general form of a double displacement reaction is:

$$\textit{compound} + \textit{compound} \rightarrow \textit{compound} + \textit{compound}$$

In this type of reaction, of which there are literally hundreds of examples, the positive and negative portions of two compounds are interchanged. Double displacement reactions are often characterized by the reaction of two aqueous solutions producing an insoluble precipitate.

Balance the following equations. Name the reaction types. Organic equations are included in this list. The hydro carbon reacts with oxygen producing carbon dioxide and water.

1. ___ Cu + ___ O_2 $\rightarrow$ ___ CuO
2. ___ H_2O $\rightarrow$ ___ H_2 + ___ O_2
3. ___ Fe+ ___ H_2O $\rightarrow$ ___ H_2 + ___ Fe_3O_4
4. ___ $AsCl_3$ + ___ H_2S $\rightarrow$ ___ As_2S_3 + ___ HCl
5. ___ KNO_3 $\rightarrow$ ___ KNO_2 + ___ O_2
6. ___ Fe_2O_3 + ___ H_2 $\rightarrow$ ___ Fe + ___ H_2O
7. ___ $CaCO_3$ $\rightarrow$ ___ CaO + ___ CO_2
8. ___ Fe + ___ S_8 $\rightarrow$ ___ FeS
9. ___ H_2S + ___ KOH $\rightarrow$ ___ H_2O + ___ K_2S
10. ___ $NaCl$ $\rightarrow$ ___ Na + ___ Cl_2
11. ___ Al + ___ H_2SO_4 $\rightarrow$ ___ H_2 + ___ $Al_2(SO_4)_3$
12. ___ H_3PO_4 +___ NH_4OH $\rightarrow$ ___ H_2O+___ $(NH_4)_3PO_4$
13. ___ C_3H_8 + ___ O_2 $\rightarrow$ ___ CO_2 + ___ H_2O
14. ___ Al + ___ O_2 $\rightarrow$ ___ Al_2O_3
15. ___ CH_4 + ___ O_2 $\rightarrow$ ___ CO_2 + ___ H_2O
16. ___ C_5H_{12} + ___ O_2 $\rightarrow$ ___ CO_2 + ___ H_2O
17. ___ K_2SO_4 + ___ $BaCl_2$ $\rightarrow$ ___ KCl + ___ $BaSO_4$
18. ___ KOH + ___ H_2SO_4 $\rightarrow$ ___ K_2SO_4 + ___ H_2O

19. ___ $Ca(OH)_2$ + ___ NH_4Cl → ___ NH_4OH + __ $CaCl_2$

20. ___ C + ___ SO_2 → ___ CS_2 + ___ CO

21. ___ Mg_3N_2 + ___ H_2O → ___ $Mg(OH)_2$ + ___ NH_3

22. ___ V_2O_5 + ___ Ca → ___ CaO + ___ V

23. ___ Na_2O_2 + ___ H_2O → ___ NaOH + ___ O_2

24. ___ Fe_3O_4 + ___ H_2 → ___ Fe + ___ H_2O

25. ___ Cu +___ H_2SO_4 → ___ Cu_SO_4 +___ H_2O +___ SO_2

26. ___ Al + ___ H_2SO_4 → ___ H_2 + ___ $Al_2(SO_4)_3$

27. ___ Si_4H_{10} + ___ O_2 → ___ SiO_2 + ___ H_2O

28. ___ NH_3 + ___ O_2 → ___ N_2H_4 + ___ H_2O

29. ___ $C_{15}H_{30}$ + ___ O_2 → ___ CO_2 + ___ H_2O

30. ___ BN + ___ F_2 → ___ BF_3 + ___ N_2

31. ___ $C_{12}H_{26}$ + ___ O_2 → ___ CO_2 + ___ H_2O

32. ___ $C_7H_6O_3$ + ___ O_2 → ___ CO_2 + ___ H_2O

33. ___ Na + ___ ZnI_2 → ___ NaI + ___ Zn

34. ___ CH_3NO_2 + ___ Cl_2 → ___ CCl_3NO_2 + ___ HCl

35. ___ $Ca_3(PO_4)_2$ + ___ SiO_2 + ___ C → ___ $CaSiO_3$ + ___ CO + ___ P

36. ___ Al_2C_6 + ___ H_2O → ___ $Al(OH)_3$ + ___ C_2H_2

37. ___ NaF + ___ CaO + ___ H_2O → ___ CaF_2 + ___ NaOH

38. ___ LiH + ___ $AlCl_3$ → ___ $LiAlH_4$ + ___ LiCl

39. ___ CaF_2 + ___ H_2SO_4 + ___ SiO_2 → ___ CaSO4 + ___ SiF4 + ___ H_2O

40. ___ $CaSi_2$ + ___ $SbCl_3$ → ___ Si + ___ Sb + ___ $CaCl_2$

41. ___ TiO_2 + ___ B_4C + ___ C → ___ TiB_2 + ___ CO

42. ___ NH_3 + ___ O_2 → ___ NO + ___ H_2O

43. ___ SiF_4 + ___ NaOH → ___ Na_4SiO_4 + ___ NaF + ___ H_2O

44. ___ NH_4Cl + ___ CaO → ___ NH_3 + ___ $CaCl_2$ + ___ H_2O

45. ___ NaPb + ___ C_2H_5Cl → ___ $Pb(C_2H_5)_4$ + ___ Pb + ___ NaCl

46. ___ Be_2C + ___ H_2O → ___ $Be(OH)_2$ + ___ CH_4

47. ___ NpF_3 + ___ O_2 + ___ HF → ___ NpF_4 + ___ H_2O

48. ___ NO_2 + ___ H_2O → ___ HNO_3 + ___ NO

49. ___ $LiAlH_4$ + ___ BF_3 → ___ LiF + ___ AlF_3 + ___ B_2H_6

Write a balanced chemical equation for each of the following word equations. Use the periodic table in your textbook and the polyatomic ion sheet from Appendix A to help you. Be sure to write a skeleton equation and a balanced equation for each question.

1. potassium chloride + silver nitrate → potassium nitrate + silver chloride
Skeleton:
Balanced:
2. aluminum hydroxide + sodium nitrate → aluminum nitrate + sodium hydroxide
Skeleton:
Balanced:
3. aluminum metal + copper(II) chloride → aluminum chloride + copper metal
Skeleton:
Balanced:
4. potassium oxalate + tin(IV) phosphate → potassium phosphate + tin(IV) oxalate
Skeleton:
Balanced:
5. barium chloride + fluorine → barium fluoride + chlorine
Skeleton:
Balanced:
6. lead(IV) sulphide + oxygen → lead(IV) oxide + sulphur dioxide
Skeleton:
Balanced:
7. sodium tartrate + mercury(II) nitrate → sodium nitrate + mercury(II) tartrate
Skeleton:
Balanced:
8. diphosphorus pentoxide + water → hydrogen phosphate
Skeleton:
Balanced:
9. lithium aluminum hydride + boron trifluoride → lithium fluoride + aluminum fluoride + diboron hexahydride
Skeleton:
Balanced:

Activity 22: Balancing Chemical Equations

Question

- **How do you balance chemical equations?**

Procedure

Chemical equations are a shorthand representation of what occurs during a chemical reaction. Experimental evidence indicates that mass, energy, and atoms are conserved during reactions, and equations must reflect this (Law of Conservation of Mass and Energy).

To balance an equation, several steps are involved. These will eventually become second nature to you as you become experienced in this skill.

One way to balance equations:

1. Make sure that each individual formula is correct and that the charges balance, if applicable.
2. Check that products are correct for the type of reaction.
3. Balance metals first.
4. Balance non-metals next.
5. Balance polyatomic ions that are found on both sides (treat these as a whole unit). Complex ions should be broken down into individual units **only** when found on one side and not the other (e.g., $NaHCO_3 \xrightarrow{\Delta} Na + H_2 + C + O_2$).
6. Balance H.
7. Balance O.
8. Check both sides of the equation to see if it is balanced and add coefficients as appropriate.

Outcomes

Students will be expected to

- represent chemical reactions and the conservation of mass using balanced symbolic equations (321-1)

Balance the following equations. Remember that water separates as H+/OH–, so it is often written as HOH.

1. ___ $H_2O \xrightarrow{\Delta}$ ___ H_2 + ___ O_2
2. ___ CH_4 + ___ $O_2 \xrightarrow{\Delta}$ ___ CO_2 + ___ H_2O
3. ___ H_2 + ___ $Cl_2 \rightarrow$ ___ HCl
4. ___ N_2 + ___ $H_2 \rightarrow$ ___ NH_3
5. ___ $NaCl$ + ___ $Ca(OH)_2 \rightarrow$ ___ $NaOH$ + ___ $CaCl_2$
6. ___ CS_2 + ___ $Cl_2 \rightarrow$ ___ CCl_4 + ___ S_2Cl_2
7. ___ $Al_2(SiO_3)_3$ + ___ $LiF \rightarrow$ ___ AlF_3 + ___ Li_2SiO_3
8. ___ $P_2O_5 \rightarrow$ ___ P_4 + ___ O_2
9. ___ Ag + ___ $H_2S \rightarrow Ag_2S$ + ___ H_2
10. ___ Na + ___ $HOH \xrightarrow{\Delta}$ ___ $NaOH$+ ___ H_2

Activity 23: Observing Chemical Reactions

Question

- **What does a chemical reaction look like?**

Background Information

When a chemical reaction occurs, one or more of the following is usually observed:

Colour change: The colour(s) of the final product(s) might be different from the colours of the starting material(s).

Odour change: The odour(s) of the final material(s) might be noticeably different from the odours of the starting material(s).

Change of state: The final material(s) might include a substance in a state that differs from the starting material(s). Most commonly, a gas or a solid is produced.

- Evolution of a gas can be indicated in many ways; for instance, by bubbling, emission of a visible coloured gas, or the reaction of a burning wood splint.
- When some liquid solutions are mixed together, one of the products can be partially insoluble. This solid product—the precipitate—will fall to the bottom of the solution.

Energy change: When a chemical reaction occurs, energy in the form of heat, light, sound, or electricity is absorbed (endothermic) or released (exothermic). For most chemical reactions, the energy absorbed or released is in the form of heat. A common example of an energy change is the combustion (burning) of a fuel.

Materials

- apple
- baking soda
- glasses (tall, clear, and colourless)
- lemon juice
- milk
- plates
- vinegar

Outcomes

Students will be expected to

- design and carry out experiments, controlling variables and interpreting patterns, to illustrate how factors can affect chemical reactions (212-3, 213-2, 321-3, 214-5)
- represent chemical reactions and the conservation of mass using balanced symbolic equations (321-1)

Procedure

Make a copy of the table below and fill it in for each of the indicated combinations. When you are making observations, you should not taste any of these combinations. You may smell them.

1. Cut an apple into eight pieces. Place four pieces on a plate and leave them exposed to the air. Take the other four pieces and coat them with lemon juice and set them on another plate. Set these plates aside until you have finished the other experiments.
2. Measure 25 mL of baking soda into a tall, clear, colourless glass. Now measure 50 mL of vinegar into the same glass. Make your observations (sight, smell, touch). Empty the contents down the drain of your sink and rinse the sink and your glass with plenty of warm water.
3. Measure 75 mL of milk into the glass. Swirl the milk in the glass and observe what happens. Now measure an equal quantity of vinegar into the same glass. Swirl the glass again and make your observations. Empty the contents of the glass down the drain with lots of water. Wash the glass thoroughly.
4. Make your observations of the apple slices.

Data Table: Chemical Reactions

Combinations	Descriptions of Reactants	Descriptions of Products	Evidence of Reaction
vinegar + baking soda			
milk + vinegar			
apple + air			
apple + lemon juice			

Analysis

- Many people use baking soda and vinegar as a drain cleaner. Suggest a reason why.
- Based on your observations of baking soda and vinegar (an acid), why would bakers put baking soda and an acid in a cake?
- Give reasons why you should conclude that a reaction occurred between the lemon juice and apple slices?

Teacher Notes

This experiment should be conducted in the chemistry laboratory.

Activity 24: Rates of Chemical Reactions

Outcomes

Students will be expected to

- design and carry out experiments, controlling variables and interpreting patterns, to illustrate how factors can affect chemical reactions (212-3, 213-2, 321-3, 214-5)

Question

- **How does a specific factor affect the rate of the reaction of an antacid tablet with water?**

Background Information

The rate of a reaction describes how fast reactants form products in a chemical reaction. Chemical reactions can be sped up or slowed down by altering the surface area, concentration, and temperature of the reactants. In this activity you will choose one of these factors to study and determine how it affects the rate of the reaction of an antacid tablet with water.

Materials

- 0.15 mol/L HCl solution
- 0.30 mol/L HCl solution
- 0.45 mol/L HCl solution
- antacid tablets (maximum of 12 per group)
- beakers
- heat source (for heating water)
- mortar and pestle (for crushing antacid tablets)
- water

Procedure

Your teacher may assign a specific factor or may allow you to choose your own. You will not be provided with a procedure for this activity. Rather, your group must design its own purpose and procedure. The Experimental Design template (Appendix A) will help you with the purpose and procedure.

Each group must pass in one good copy of their completed Experimental Design sheet.

Teacher Notes

This experiment should be conducted in the chemistry laboratory.

Activity 25: Double Displacement Reactions

Outcomes

Students will be expected to

- represent chemical reactions and the conservation of mass using balanced symbolic equations (321-1)

Questions

- **What are double displacement reactions?**
- **What observations can you make about the reactions?**
- **What is a precipitate?**
- **Write balanced word and chemical equations for each test.**

Background Information

This experiment is an introduction to double displacement reactions. Double displacement reactions are reactions that occur between two ionic compounds and that result in an exchange of partners.

Example:

$AgNO_3(aq)$	+	$NaCl(aq)$	→	$AgCl(s)$	+	$NaNO_3(aq)$
silver I nitrate (aqueous)	plus	sodium chloride (aqueous)	yields	silver I chloride (a solid precipitate)	plus	sodium nitrate (aqueous)

In this reaction, we have two ionic compounds ($AgNO_3$ and NaCl), which react to yield two new ionic compounds (AgCl and $NaNO_3$). Note how the positive ions have exchanged negative ion partners.

Materials

- copper(II) sulphate solution
- iron(III) chloride solution
- iron(III) sulphate solution
- lead(II) nitrate solution
- pipettes
- potassium iodide solution
- sodium chloride solution
- sodium phosphate solution
- well plate

Procedure

You will be observing 10 chemical reactions in this activity. You should use the large wells on your plate. Fill in the data table with your observations. Use five drops of each solution.

Using the following example, write a word equation and a balanced chemical equation for each reaction (1–10).

Example:

$AgNO_3(aq)$	+	$NaCl(aq)$	→	$AgCl(s)$	+	$NaNO_3(aq)$
silver nitrate	plus	sodium chloride	yields	silver chloride	plus	sodium nitrate

Data Table: Observations from Well Plate

1. iron(III) chloride solution + sodium hydroxide solution	Precipitate formed? ☐ Yes ☐ No	Colour of precipitate:
Observation:		
Word equation:		
Balanced chemical equation:		
2. iron(III) sulphate solution + sodium hydroxide solution	Precipitate formed? ☐ Yes ☐ No	Colour of precipitate:
Observation:		
Word equation:		
Balanced chemical equation:		
3. copper(II) sulphate solution + sodium hydroxide solution	Precipitate formed? ☐ Yes ☐ No	Colour of precipitate:
Observation:		
Word equation:		
Balanced chemical equation:		

4. lead(II) nitrate solution + potassium iodide solution	Precipitate formed? ☐ Yes ☐ No	Colour of precipitate:
Observation:		
Word equation:		
Balanced chemical equation:		
5. iron(III) chloride solution + sodium phosphate solution	Precipitate formed? ☐ Yes ☐ No	Colour of precipitate:
Observation:		
Word equation:		
Balanced chemical equation:		
6. iron(III) chloride solution + copper(II) sulphate solution	Precipitate formed? ☐ Yes ☐ No	Colour of precipitate:
Observation:		
Word equation:		
Balanced chemical equation:		
7. lead(II) nitrate solution + sodium hydroxide solution	Precipitate formed? ☐ Yes ☐ No	Colour of precipitate:
Observation:		
Word equation:		
Balanced chemical equation:		
8. iron(II) sulphate solution + lead(II) nitrate solution	Precipitate formed? ☐ Yes ☐ No	Colour of precipitate:
Observation:		
Word equation:		
Balanced chemical equation:		

9. copper(II) sulphate solution + sodium phosphate solution	Precipitate formed? ☐ Yes ☐ No	Colour of precipitate:
Observation:		
Word equation:		
Balanced chemical equation:		
10. lead(II) nitrate solution + sodium phosphate solution	Precipitate formed? ☐ Yes ☐ No	Colour of precipitate:
Observation:		
Word equation:		
Balanced chemical equation:		

Teacher Notes

Answers

Data Table: Observations from Well Plate

1. iron(III) chloride solution + sodium hydroxide solution	Precipitate formed? ☑ Yes ☐ No	Colour of precipitate: orange
Observation: iron(III) chloride solution was orange in colour; sodium hydroxide solution was colourless		
Word equation: iron(III)chloride + sodium hydroxide → iron(III) hydroxide + sodium chloride		
Balanced chemical equation: $FeCl_3 + 3NaOH \rightarrow Fe(OH)_3 + 3NaCl$		
2. iron(III) sulphate solution + sodium hydroxide solution	Precipitate formed? ☑ Yes ☐ No	Colour of precipitate: orange
Observation: iron(III) sulphate solution was orange in colour; sodium hydroxide solution was colourless		
Word equation: iron(III) sulphate + sodium hydroxide → iron(III) hydroxide + sodium sulphate		
Balanced chemical equation: $Fe_2(SO_4)_3 + 6NaOH \rightarrow Fe(OH)_3 + 3Na_2SO_4$		
3. copper(II) sulphate solution + sodium hydroxide solution	Precipitate formed? ☑ Yes ☐ No	Colour of precipitate: blue
Observation: copper(II) sulphate solution was blue in colour; sodium hydroxide solution was colourless		
Word equation: copper(II) sulphate + sodium hydroxide → copper(II) hydroxide + sodium sulphate		
Balanced chemical equation: $CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$		
4. lead(II) nitrate solution + potassium iodide solution	Precipitate formed? ☑ Yes ☐ No	Colour of precipitate: yellow
Observation: lead(II) nitrate solution was colourless; potassium iodide solution was colourless		
Word equation: lead(II) nitrate + potassium iodide → lead(II) iodide + potassium nitrate		
Balanced chemical equation: $Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + 2KNO_3$		

5. iron(III) chloride solution + sodium phosphate solution	Precipitate formed? ☐ Yes ☑ No	Colour of precipitate:
Observation: iron(III) chloride solution was orange in colour; sodium phosphate solution was colourless		
Word equation: iron(III) chloride + sodium phosphate → no reaction		
Balanced chemical equation: $FeCl_3 + Na_3PO_4 \rightarrow$ no reaction		
6. iron(III) chloride solution + copper(II) sulphate solution	Precipitate formed? ☐ Yes ☑ No	Colour of precipitate:
Observation: iron(III) chloride solution was orange in colour; copper(II) sulphate solution was blue in colour		
Word equation: iron(III) chloride + copper(II) sulphate → no reaction		
Balanced chemical equation: $2FeCl_3 + 3CuSO_4 \rightarrow$ no reaction		
7. lead(II) nitrate solution + sodium hydroxide solution	Precipitate formed? ☑ Yes ☐ No	Colour of precipitate: white
Observation: lead(II) nitrate solution was colourless; sodium hydroxide solution was colourless		
Word equation: lead(II) nitrate + sodium hydroxide → lead(II) hydroxide + sodium nitrate		
Balanced chemical equation: $Pb(NO_3)_2 + 2NaOH \rightarrow Pb(OH)_2 + 2NaNO_3$		
8. iron(II) sulphate solution + lead(II) nitrate solution	Precipitate formed? ☑ Yes ☐ No	Colour of precipitate: white
Observation: iron(III) sulphate solution was orange in colour; lead(II) nitrate solution was colourless		
Word equation: iron(II) sulphate + lead(II) nitrate → iron(II) nitrate + lead(II) sulphate		
Balanced chemical equation: $Fe_2(SO_4)_3 + 3Pb(NO_3)_2 \rightarrow 2Fe(NO_3)_2 + 3PbSO_4$		
9. copper(II) sulphate solution + sodium phosphate solution	Precipitate formed? ☑ Yes ☐ No	Colour of precipitate: blue
Observation: copper(II) sulphate solution was blue in colour; sodium phosphate solution was colourless		
Word equation: copper(II) sulphate + sodium phosphate → copper(II) phosphate + sodium sulphate		
Balanced chemical equation: $3CuSO_4 + 2Na_3PO_4 \rightarrow Cu_3(PO_4)_2 + 3Na_2SO_4$		

<table>
<tr><td>10. lead(II) nitrate solution + sodium phosphate solution</td><td>Precipitate formed?
☑ Yes ☐ No</td><td>Colour of precipitate:
blue</td></tr>
<tr><td colspan="3">Observation:
lead(II) nitrate solution was colourless; sodium phosphate solution was colourless</td></tr>
<tr><td colspan="3">Word equation:
lead(II) nitrate + sodium phosphate lead(II) phosphate + sodium nitrate</td></tr>
<tr><td colspan="3">Balanced chemical equation:
$3Pb(NO_3)_2 + 2Na_3PO_4 \rightarrow Pb_3(PO_4)_2 + 6NaNO_3$</td></tr>
</table>

Activity 26: Acids and Bases

Question

- **What is the difference between acids and bases?**

Introduction

Acids, bases, and salts are substances that you encounter every day. The soap you wash with is probably a base. Acids and bases combine to produce salts. When you look at the ingredients on a food label, many have combinations that involved acids, bases, and salts. There are many substances that can be classified into acids, bases, and salts.

Procedure A

1. Design two experiments to identify acids, bases, and salts.
2. Have your procedure for one experiment approved by your teacher.
3. Do the experiment.
4. Identify WHMIS standards throughout your experiment.
5. Identify the acids, bases, and salts. Write appropriate equations.
6. Give specific examples of indicators and their uses.
7. Report your findings.

Procedure B

Nomenclature and Formula Writing

Use your periodic table and polyatomic ion sheet to work through this activity.

Bases

Bases are named in the same way as any other compound that contains a polyatomic ion. The polyatomic ion in this instance will always be hydroxide (OH). To name the base, then, you simply write the name of the cation and the word "hydroxide."

Outcomes

Students will be expected to

- investigate chemical reactions while applying WHMIS standards, using proper techniques for handling and disposing of materials (213-9, 117-5)
- perform experiments, using appropriate instruments and procedures, to identify substances as acids, bases, or salts, based on their characteristic properties (212-8, 213-5)
- describe how neutralization involves tempering the effects of an acid with a base or vice versa (321-2)

Example 1: NaOH

Solution: Na is Sodium, OH is hydroxide; therefore the compound is sodium hydroxide.

To write the formula for a base, see Example 2 below.

Example 2: magnesium hydroxide

Mg^{2+} OH^{-}

Solution: Because magnesium has a charge of 2+ and hydroxide has a charge of 1–, the molecule will require two hydroxide ions. Therefore, the formula for magnesium hydroxide will be $Mg(OH)_2$. The subscript 2 indicates that there are two hydroxide ions.

Give the name for each of these compounds:

1. LiOH
2. $Ca(OH)_2$
3. KOH
4. $Ra(OH)_2$
5. RbOH

Write the formula for each of these compounds:

6. strontium hydroxide
7. barium hydroxide
8. iron(III) hyroxide
9. aluminum hydroxide
10. francium hydroxide

Acids

Recognizing an Acid: All acids contain hydrogen as the cation. Acids are also aqueous (in water). Therefore, when you see a formula that begins with hydrogen and is aqueous, you know the compound is an acid.

Note: H_2O should not be considered an acid, even though it has hydrogen as the cation. Water is a unique compound that is not easily categorized.

Naming an Acid: There are two general categories of acids: binary and ternary. Binary acids contain hydrogen and a non-metallic ion. Ternary acids contain hydrogen and a polyatomic ion.

All binary acids are named the same way:

1. The prefix “hydro” is used to indicate hydrogen.
2. The root of the anion is used.
3. The suffix “ic” is attached.
4. The word “acid” is used as the second word in the name.

Example 3: $HCl(aq)$

Solution: “Hydro” is used in place of hydrogen. Chlorine’s root is “chlor.” The suffix “ic” is then attached, followed by the second word “acid.” The name, therefore, is hydrochloric acid.

Example 4: $HBr(aq)$

Solution: Hydrobromic acid (Hydro from hydrogen, brom from bromine, and ic as the suffix, followed by acid)

Ternary acids are slightly more complicated to name. You first have to identify the polyatomic ion in the formula. If its name ends in “ate,” then the suffix it has as an acid is “ic.” If its name ends in “ite,” then the suffix it has as an acid is “ous.” Otherwise the polyatomic ion’s name is unchanged. The presence of hydrogen is not indicated in the name of a ternary acid. Because the word “acid” is part of the name, you are expected to know that hydrogen is the cation.

Example 5: $HClO(aq)$

Solution: The polyatomic ion is ClO, hypochlorite. Because this ion ends in “ite,” it becomes an “ous” acid.

hypochlorous acid

Example 6: $HClO_2(aq)$

Solution: The polyatomic ion is ClO2, chlorite. Because this ion ends in “ite,” it becomes an “ous” acid.

chlorous acid

Example 7: $HClO_3(aq)$

Solution: The polyatomic ion is ClO3, chlorate. Because this ion ends in “ate,” it becomes an “ic” acid.

chloric acid

Example 8: $HClO_4(aq)$

Solution: The polyatomic ion is ClO_4, perchlorate. Because this ion ends in “ate,” it becomes an “ic” acid.

perchloric acid

Name the following acids:

11. $H_3PO_4(aq)$
12. $H_2CO_3(aq)$
13. $H_2SO_4(aq)$
14. $HIO_3(aq)$
15. $HF(aq)$
16. $HFO_2(aq)$

Write the formulas for these acids:

17. hydroiodic acid
18. nitric acid
19. sulphurous acid
20. phosphorous acid
21. acetic acid
22. stearic acid

Activity 27: Household Chemicals

Question

- **Can the unknown solutions be identified?**

Background Information

In this experiment, you will observe the chemical properties of five household chemicals:

- sugar ($C_{12}H_{22}O_{11}$)
- baking soda ($NaHCO_3$)
- table salt (NaCl)
- Epsom salt ($MgSO_4$)
- potassium iodide (KI, added to salt to prevent goiter)

Materials

- 0.1 mol/L lead(II) nitrate
- 0.1 mol/L silver nitrate
- 10 mL graduated cylinder
- 150 mm test tubes
- 2 medicine droppers
- baking soda
- Epsom salt
- potassium iodide
- salt
- sugar
- test tube holder

Procedure

In this experiment, you will observe the behaviour of five household chemicals with solutions of silver nitrate and lead(II) nitrate in order to identify unknown solutions.

1. In a test tube, place approximately 0.1 g of sugar measured by comparison with 0.1 g sample that is on display. Add 5 mL of distilled water to the test tube. Shake the test tube gently to dissolve the solid. Repeat this procedure using 0.1 g quantities of baking soda, salt, Epsom salt, and potassium iodide in place of sugar.
2. To each of the five test tubes from Step 1, add 5 drops of lead(II) nitrate and shake gently. Keep these test tubes for comparison with the results of Step 4.

Outcomes

Students will be expected to

- perform experiments, using appropriate instruments and procedures, to identify substances as acids, bases, or salts, based on their characteristic properties (212-8, 213-5)
- investigate chemical reactions while applying WHMIS standards, using proper techniques for handling and disposing of materials (213-9, 117-5)

3. Using five clean test tubes, repeat the procedure from Step 1. To each of the five test tubes, add 5 drops of silver nitrate and shake gently. Keep these test tubes for comparison with the results of Step 4. **Caution:** Silver nitrate solution causes brown stains on skin or clothing. Wash away any spills with plenty of water.
4. Obtain two unknown household chemicals from your teacher. Test each unknown with lead(II) nitrate and silver nitrate as outlined in parts 1–3. Use the results of this experiment to identify your unknowns.

Observations

Chemical	Observations	
	lead(II) nitrate	silver nitrate
sugar		
baking soda		
salt		
Epsom salt		
potassium iodide		
unknown 1		
unknown 2		

Analysis

- What is the identity of the first unknown? How do you know?
- What is the identity of the second unknown? How do you know?

Teacher Notes

Background Information

Other chemicals may be used at your discretion. See *Science Safety Guidelines* (Nova Scotia Department of Education 2005) for information about the safe use of chemicals.

Activity 28: Changing the Rate of a Chemical Reaction

Question

- **What factors affect the rate of a chemical reaction?**

Safety ⚠

- Hot water should be handled with extreme care. Wear oven mitts when pouring the hot water into the glass and when handling the glass.

Materials

- 2 covered containers large enough to hold 1500 mL of water
- 3 identical tall, clear, colourless, heat-safe glasses
- clock with second hand or stopwatch
- electric kettle, or pot with pouring spout and a hot plate
- glass measuring cup
- instant coffee (must be instant) or a similar substitute
- measuring spoons
- oven mitts
- small bowl (approximately 50 mL)
- spoon

Procedure

Pre-experiment

Cold water: Pour 2000 mL of water into a container, cover it, and leave in the refrigerator for several hours (overnight preferably).

Room-temperature water: Pour 2000 mL of water into a container, cover it, and leave on the counter for several hours (overnight preferably).

Design a data table to record each part of this experiment. Be sure to label the data table. Ensure rows are large enough to include written descriptions of the reactions.

Outcomes

Students will be expected to

- design and carry out experiments, controlling variables and interpreting patterns, to illustrate how factors can affect chemical reactions (212-3, 213-2, 321-3, 214-5)
- represent chemical reactions and the conservation of mass using balanced symbolic equations (321-1)

Experiment

Hot water: When you are ready to conduct the investigation, measure 1750 mL of water into an electric kettle or a pot with a spout. Bring this water to a boil and then shut off the kettle or hot plate.

Part 1

Measure 250 mL of cold water into a glass. Pour 15 mL of instant coffee into the glass. In Part 1 of your data table, describe the dissolving of the coffee granules at 15-second intervals.

Repeat this procedure with room temperature water and again with hot water. (Be careful!)

Empty the contents of the glasses down the drain and clean them for reuse in Part 2.

Part 2

Measure 250 mL of cold water into a glass. Pour 15 mL of instant coffee into the glass and stir until dissolved. In Part 2 of your data table, record the time it took for the coffee granules to dissolve while being stirred.

Repeat this procedure with room temperature water and again with hot water.

Empty the contents of the glasses down the drain and clean them for reuse in Part 3.

Part 3

Repeat Part 1, but crush the coffee granules to a fine powder before adding it to the glasses. To powder the coffee, measure 15 mL of granules into a small bowl. Then take a spoon and press down firmly on the granules. Repeat this process until the coffee is powdery.

Record your observations in Part 3 of your data table. Empty the contents of the glasses down the drain and clean the glasses for reuse in Part 4.

Part 4

Repeat Part 2, but use coffee powder instead of granules. Record the time in Part 4.

After you have finished, clean all supplies thoroughly and put them away.

Analysis

- Identify the variables in this experiment using the categories "controlled," "manipulated," and "responding."
- What effect did each manipulated variable have on the responding variable(s)? Describe this effect in paragraph form.
- Based on the data you have described, state a conclusion about the quickest way to dissolve coffee.
- Using the knowledge you have gained from this investigation, describe how each of the following factors affects the rate of a chemical reaction:
  - temperature
  - surface area
  - agitation (stirring)

Teacher Notes

Background Information

Science 10 requires students to be in the chemistry laboratory when doing chemistry experiments.

Below is the beginning of a data table for this experiment.

Sample Instant Coffee Description Data Table

Water	Time	Description
		Part 1
cold	0	
	15	
	30	
	45	

Activity 29: Careers in Chemistry

Outcomes

Students will be expected to

- investigate and collaborate to describe science and technology relationships and their functions (116-3, 117-7, 215-6, 116-5)

Question

- **What are some science- and technology-based careers related to chemistry?**

Background Information

Careers related to chemistry are many, but most of us would have difficulty identifying more than two or three. This activity gives you the opportunity to see how an interest in chemistry can become a career. It also allows you to express your creativity in the design and construction of a pamphlet.

Procedure

Research a career in science or technology that is related to chemistry. Have a list of at least five different careers, since everyone must describe a different career.

Once you have chosen a career to research, be sure to include a thorough description of what the career entails, job prospects, educational requirements, and earning potential.

Design a recruiting pamphlet that includes all the information that you have gathered. The pamphlet should be from a fictitious company that is trying to hire the type of people that you have researched. The pamphlet should be on a piece of letter-size paper (8.5" × 11") and folded so that there are 6 panels on which to place information. Your pamphlet should be colourful and visually appealing as well as informative.

Teacher Notes

Technology Integration

Microsoft Publisher contains templates for several pamphlet styles that could be used if time and computers are available.

Note: See Appendix B for a list of some careers in chemistry.

Background Information

A variety of graphic organizers are suitable for this activity. *Nova Scotia Science 10* has sample graphic organizers in the appendix. For further information, teachers may wish to access the *Nova Scotia Science 10 Teacher Resource* and the "Nova Scotia Science 10 Connect" Moodle (www.connectschool.ca).

To login to the Moodle, you will need your school email address.

Activity 30: Chemicals and Our Environment

Outcomes

Students will be expected to

- investigate and collaborate to describe science and technology relationships and their functions (116-3, 117-7, 215-6, 116-5)

Questions

- **How are chemicals, the environment, the economy, and society related?**
- **Are the connections dependent?**

Procedure

Industries have developed chemical processes to convert raw materials into desired products. Usually, however, other unwanted products, called by-products, are also produced. Sometimes, these products are useful to other industries and can be sold. For example, in the industrial production of ethanol from corn, carbon dioxide gas is produced. This gas is captured, compressed, and sold to other industries and consumers. In other cases, the products are not commercially useful and are treated as wastes. The disposal of these wastes must be dealt with at the lowest cost to the industry, while also paying attention to how their disposal affects the environment.

Do Think About It Activity 4-2B: Fighting Back, p. 167, *Nova Scotia Science 10*.

Researching Other Industrially Important Chemicals

Canada has many manufacturing plants producing industrial chemicals, pharmaceuticals, agrochemicals, paint, and cleaning agents. There are many familiar chemicals, like nitric acid (a colourless, corrosive, poisonous liquid that gives off choking fumes in moisture):

- ammonia
- ammonia phosphate
- ammonia nitrate
- benzene
- chlorine
- hydrochloric acid
- phosphoric acid
- polyethylene
- sodium chlorate
- sodium hydroxide
- toluene
- urea
- xylene

Select one of the chemicals from the list or another one approved by your teacher. Conduct research at your school, local library, or the Internet to answer the following questions:

- What is the source of this chemical?
- How is it prepared?
- What benefits do it and its associated applications provide for society?
- What risks do the chemical, its processes, and its associated applications have for the environment?

Prepare a report to communicate your findings.

Be sure to include a bibliography to identify your sources of information.

Teacher Notes

Background Information

As a class, make a rubric to use for the assessment of the report.

Guidelines for a bibliography/references style should be provided for all to follow.

Other chemicals may be used at your discretion. See *Science Safety Guidelines* (Nova Scotia Department of Education 2005) for information about the safe use of chemicals.

Unit 3: Physical Science: Motion (25%)

Activity 31: Position and Displacement

Questions

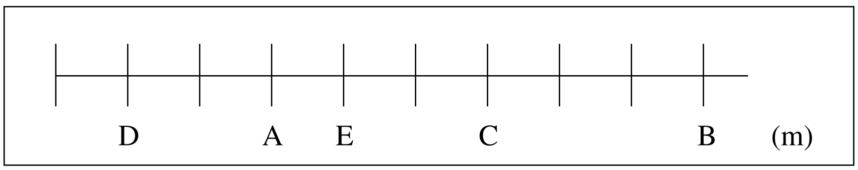
- **How do you identify position on a number line?**
- **How do you calculate distance travelled using a number line?**
- **How do you calculate displacement using a number line?**

Outcomes

Students will be expected to

- use instruments and terminologies effectively and accurately for collecting data in various experiments (212-9, 213-3)

Procedure



1. In order to find the positions of each of the letters on the number line above, you need four things. Indicate below what they are, and then place any that are not present on your diagram.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. How many dimensions are you working with in this problem? How do you know? Give a complete answer that demonstrates that you understand what dimension means.

____

____

____

____

2. Be sure to include proper units and directions. Give the table a title.

Letter	Position
A	
B	
C	
D	
E	

3. Distance depends on the path taken. State how you can determine the distance travelled using the number line.
4. Displacement is based on where you started and where you ended. Therefore, the path is not a requirement to figure out displacement. State how you can determine the displacement using the number line.
5. Displacement can also be defined as a change in position. State how you could determine your displacement if your initial and final positions were known.
6. Complete the table below. Be sure to include a title and proper units and signs when necessary.

Journey Description	Distance	Displacement
A to B to C		
C to B to A		
E to B to A		
E to D to A to B		
A to C to B to E		
A to B to C to D to E		
E to D to C to B to A		

Teacher Notes

Background Information

A position is a point in space. When we identify the position of an object, we specify the location of its centre of mass. The point that is the position or location of an object does not occupy any space. In one-dimensional space, the position of an object is either positive or negative and can be identified with one number.

Positions require an origin (to set the frame of reference), a scale (which provides the magnitude and units), and positive or negative (to indicate direction). The units for position can be cm, m, km, etc. Positions to the right of the origin are usually called positive. Positions to the left of the origin are usually called negative. It is a vector quantity because it requires a magnitude, unit, and direction to be fully described.

Distance is the measure of separation between points along the path travelled. Distance refers to how much ground an object has covered during its motion. It is a scalar quantity because it requires only a magnitude and units to be fully described. On a number line, it can be determined by counting the number of spaces travelled along the path and multiplying by the scale of the number line.

Displacement is the absolute change in position of an object, irrespective of the path it took to get there. Displacement is therefore measured in a straight line from the point of origin to the final position, and it includes direction.

To calculate displacement on a number line, count the spaces along the path from the start point to the endpoint. Multiply by the scale of the number line and add the sign indicating the direction of movement.

Activity 32: Talking about Speed

Outcomes

Students will be expected to

- distinguish among constant, average, and instantaneous speed and velocity of an object (325-3, 212-2)
- using linear experimentation with appropriate technologies, analyze graphically and quantitatively the relationship among distance, time, and speed (scalar quantities) and the relationship among position, displacement, time, and velocity (vector quantities) (325-1, 212-7, 325-2)
- describe and evaluate the design and functions of motion technology (114-3, 115-4, 118-3)

Question

- **How do the runner's average speeds compare?**

Materials

- graph paper
- ruler

Runners' Speeds

	Angela	Ben
Time (seconds)	Distance (m)	Distance (m)
0	0	0
10	7.5	7.0
20	16.0	14.5
30	24.0	20.5
40	34.5	31.0
50	45.0	47.0
60	47.0	49.0
70	51.0	54.0
90	90	69.0

Analysis

1. Explain the motion of each runner throughout the race by interpreting the data table above.
2. What was Angela's average speed after 50 seconds of running?
3. What was Ben's average speed after 50 seconds of running?
4. If the race had been stopped after 51 seconds, who do you believe would have been further ahead and why?
5. Examine the data for t = 90 seconds. If the race had lasted for 90 seconds, who would have won?
6. Are you able to use average speed to predict where someone will be at a specific point in time? Explain.

Teacher Notes

Background Information

Average speed is a measure of distance travelled divided by the time interval taken to travel that distance. On a distance/time graph, it will be found by taking the slope of the line connecting the two points of interest.

Average speed is not a good predictor of where an object will be at any specific time in that interval (meaning it makes it difficult to extrapolate where you were at any time in the past or will be in the future).

Teachers could ask students to explain the difference between constant speed and average speed.

Activity 33: Describing Graphs

Outcomes

Students will be expected to

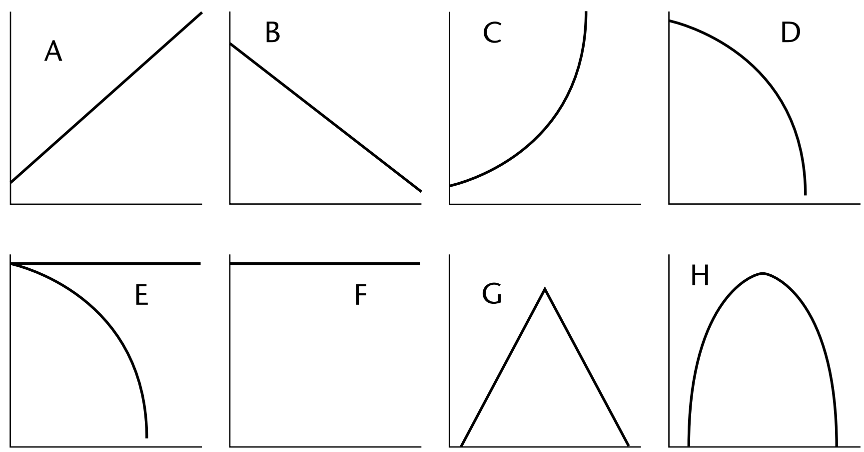
- distinguish among constant, average, and instantaneous speed and velocity of an object (325-3, 212-2)
- using linear experimentation with appropriate technologies, analyze graphically and quantitatively the relationship among distance, time, and speed (scalar quantities) and the relationship among position, displacement, time, and velocity (vector quantities) (325-1, 212-7, 325-2)
- describe and evaluate the design and functions of motion technology (114-3, 115-4, 118-3)

Question

- **What motions can be matched to the following graphs?**

Procedure

For each description of a physical situation, identify which of the graphs below could represent the motion of the object. Note: For some situations, more than one graph may be acceptable. All of the graphs are of position versus time.



Motion 1: A ball is dropped from a height of 4 m above the floor. The origin is the point from which the ball was released.

Motion 2: A ball is rolled along a horizontal surface toward the origin at a constant speed. The ball starts out 1 m from the origin.

Motion 3: A ball is rolled along a horizontal surface until it hits a wall and rebounds toward the origin.

Motion 4: A block sits at rest on a table 1 m above the floor. The origin is the floor.

Motion 5: A car is parked on a hill. The origin is the bottom of the hill.

Teacher Notes

Background Information

Horizontal lines on position/time graphs indicate no change of position, or the object is at rest.

Diagonal lines represent constant motion. Positive slope indicates positive direction or movement to the right. Negative slope indicates negative direction or movement to the left in a horizontal problem.

Curved lines indicate acceleration. If the curve is increasing, the object is speeding up. If the curve is decreasing, the object is slowing down.

In vertical problems, positive slope indicates upward movement. Negative slope indicates downward motion.

You might start with vertical problems and then move into horizontal problems.

Activity 34: Reading Position/Time Graphs

Outcomes

Students will be expected to

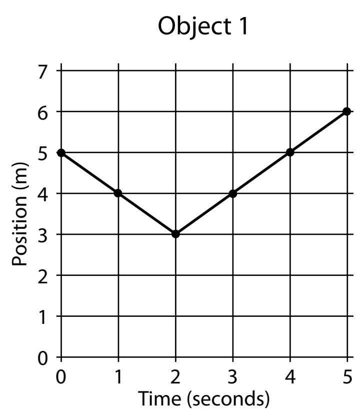
- distinguish among constant, average, and instantaneous speed and velocity of an object (325-3, 212-2)
- using linear experimentation with appropriate technologies, analyze graphically and quantitatively the relationship among distance, time, and speed (scalar quantities) and the relationship among position, displacement, time, and velocity (vector quantities) (325-1, 212-7, 325-2)
- describe and evaluate the design and functions of motion technology (114-3, 115-4, 118-3)

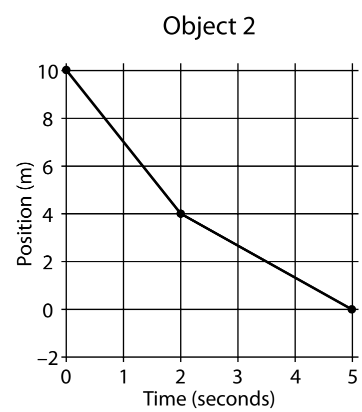
Question

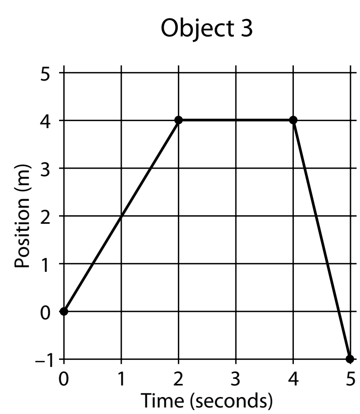
- **What types of information can be gathered from position/time graphs, and how?**

Procedure

- Use the graphs below to answer the analysis questions.







Analysis

1. How far is Object 2 from the origin at time = 2 seconds? Describe how you found the answer.
2. Which object takes the least amount of time to get to the position +3 m? Describe how you found the answer.
3. Which of the objects is closest to the origin at time = 4 seconds? Describe what you were looking for and comparing to get your answer.
4. Which object had the fastest average velocity during the first 4 seconds? Describe how you found the answer.
5. Which object had the largest displacement between time = 0 and time = 3 seconds? Show your work for each object and then compare.
6. Which object travelled the farthest during the total time? Describe how you found the answer.
7. Which object had the segment of fastest negative velocity? Describe how you found the answer.

Activity 35: Uniform Motion

Outcomes

Students will be expected to

- use instruments and terminologies effectively and accurately for collecting data in various experiments (212-9, 213-3)

Question

- **How does a displacement/time graph show uniform motion?**

Materials

- recording timer
- tickertape

Procedure

1. With a partner, set up the timer and thread one end of the tape into it.
2. Holding on to the end of the tape, walk several steps while your partner operates the timer. Pull the tape as smoothly and steadily as possible.

Analysis

- Select a convenient unit of time. A timer may have a period of 1/60 s. Then six dots would represent 0.10 s, a convenient unit.
- Draw a line across the tape through the first dot on the tape.
- Draw a line through every sixth dot all the way along the tape.
- Now measure, in centimetres, the total distance travelled from the first dot up to the end of each marked time interval.
- Record this information in a data table similar to this:

Time/Distance

time (s)	0.0	0.10	0.20	0.30	0.40	0.50	0.60	...	1.40	1.50
distance (cm)										

- Draw a displacement/time graph, with time plotted horizontally and distance vertically. Make the graph as large as possible.
- Find the average speed for the trip by dividing the total distance travelled by the total time taken. Be sure to use the correct unit for the speed.

- Draw a straight line from the first point on the graph to the last point on the graph. Recall the definition of slope from your knowledge of mathematics and find the slope of this line. What does this slope tell you?
- What shape would the graph have if the motion were absolutely uniform?
- What shape would the graph have if the motion were uniform, but faster? Slower?

Teacher Notes

Background Information

Ticket tape timers may be found in the physics laboratory. Practice with the equipment before collecting the data may be helpful.

You may wish to model the measurement of the ticket tape.

A tickertape timer acts as a clock or stopwatch. The timer, equipped with a carbon disk, places dots on a long strip of paper (tickertape) at regular time intervals as the tape is being pulled through the device. One end of the tickertape is attached to the object of which we want to measure the motion.

The tickertape timer places a dot on the paper every 1/60th of a second. This means that 60 spaces between the dots on the paper represent one second. The spacing of the dots on the tape are timed and therefore are dependent only on the rate at which the paper is being pulled through.

The carbon disk and tickertape must be placed on the device such that the plunger will strike the disk and leave a mark on the tickertape. This can be accomplished two ways:

1. Place the carbon disk right side up and run the tickertape across the top of it.
2. Place the carbon disk upside down and run the tickertape underneath it. Students might find that their carbon disk flies off if it is placed on top of the tickertape.

Activity 36: Moving!

Outcomes

Students will be expected to

- use instruments and terminologies effectively and accurately for collecting data in various experiments (212-9, 213-3)

Question

- **How does moving faster affect the distance travelled?**

Materials

- beanbags, 15 per group of four

Option 1

- 3 coloured markers
- metre stick
- roll of newsprint
- tape

Option 2

- 3 pieces of different coloured chalk (to mark directly on the floor)

Procedure

Complete the following hypothesis before you begin your activity.

If you walk at a (faster/slower) speed, the distance travelled in each time interval will be (shorter/longer).

Work in groups of four and choose roles: clapper, regular walker, slow walker, and fast walker. One student (the clapper) will act as the timer and will clap out a steady, slow beat (the same for each trial).

Alternative 1

1. One student (the regular walker) will walk and will drop one beanbag at each clap. Leave the beanbags where they fall.
2. The next student (the fast walker) will walk on a parallel path faster than the first student did and drop a beanbag every time the clap occurs.
3. Finally, a third student will walk on another parallel path, but slower than the first student did, and drop a beanbag at every clap.

Alternative 2

1. Students lay out a strip of newsprint. The first student (the regular walker) walks alongside the newsprint; another student has a metre stick with a marker taped on the end and walks alongside. When the clap occurs, mark the point where the walker is at that instant. Record which part of the walker's body you are following.
2. Tape a different colour marker to the end of the metre stick. Follow the same procedure for the fast walker.
3. Tape a third colour marker to the end of the metre stick. Follow the same procedure for the slow walker.

Alternative 3

1. The first student (the regular walker) walks in a straight line; another student walks alongside with a piece of coloured chalk. When the clap occurs, mark on the floor the point where the walker is at that instant. Record which part of the walker's body you are following.
2. Using a different colour chalk, follow the same procedure for the fast walker.
3. Using a third colour chalk, follow the same procedure for the slow walker.

Once all three students have walked, examine the results carefully.

Analysis

- Determine whether or not your hypothesis was proven to be true, and state what evidence you used in deciding.
- Discuss possible sources of error.

Teacher Notes

Background Information

This activity requires four students to work as a group to investigate the relationship between speed and distance if time is kept constant.

Activity 37: Tickertape Experiment: How Far Did the Car Go?

Outcomes

Students will be expected to

- use instruments and terminologies effectively and accurately for collecting data in various experiments (212-9, 213-3)

Questions

- **How is a tickertape timer used to measure motion?**
- **How far does the constant motion vehicle go in one second?**

Materials

- carbon paper disk
- ruler
- tape (i.e., masking, scotch)
- tickertape timer
- tickertape
- toy car

Procedure

1. Thread the tickertape through the timing device (under the carbon disk) as shown in class.
2. With the timers off, practice getting the car moving at a constant pace away from the device. Write down a couple of tips about how you are going to set up and use the equipment to ensure constant speed.
3. Once you have practised a few times, do a run with the timer turned on. Do not allow the timer to continue running once the paper has been pulled through.

Analysis

1. Examine your tape to locate a region that shows constant speed. Write in your observations what you were looking for that indicated to you that the car had gone at a constant speed.
2. Draw a line through the first dot of your constant speed section. You then need to determine how many spaces between dots would indicate a time interval of 1/10 of a second. (Hint: Think ratios.) Show this in your calculations.
3. Draw a line through the last dot in each group of dots that indicates a 1/10 of a second interval on your tape.

4. If you find that you do not have enough dots to show one second of motion, you must repeat the experiment. You can re-use the tickertape if you flip it over.
5. Measure the distance from one line to the next and record it in a table of values with the proper heading. (Think carefully about what you have measured.) (Ensure that you record to the nearest 0.5 mm.) Indicate the standard error in the measurements at the top of the table (e.g., +/- 0.05 cm). In your observations, explain what prompted you to choose that error.
6. Calculate the percentage uncertainty for your measurements and indicate if the error is acceptable. If it is not, explain in your conclusions what you could do to reduce it.

Extension

- Explain how you were able to calculate the total distance that the constant motion vehicle travelled in one second.

Teacher Notes

Background Information

A tickertape timer acts as a clock or stopwatch. The timer, equipped with a carbon disk, places dots on a long strip of paper (tickertape) at regular time intervals as the tape is being pulled through the device. One end of the tickertape is attached to the object, such as a toy car, of which we want to measure the motion.

The tickertape timer places a dot on the paper every 1/60th of a second. This means that 60 spaces between the dots on the paper represent one second. The spacing of the dots on the tape are timed and therefore are dependent only on the rate at which the paper is being pulled through.

The carbon disk and tickertape must be placed on the tickertape timer such that the plunger will strike the carbon paper disk and leave a mark on the tickertape. This can be accomplished two ways:

1. Place the carbon disk right side up and run the tickertape across the top of it.
2. Place the carbon disk upside down and run the tickertape underneath it. Students might find that their carbon disk flies off if it is placed on top of the tickertape.

Activity 38: Matching Data, Graphs, and Words

Outcomes

Students will be expected to

- distinguish among constant, average, and instantaneous speed and velocity of an object (325-3, 212-2)
- use instruments and terminologies effectively and accurately for collecting data in various experiments (212-9, 213-3)

Question

- **Which graphs match which data?**

Introduction

There is a common cliché; maybe you've heard it:

A picture is worth a thousand words.

In science, graphs are pictures that help scientists tell what is going on with their data. You may have also heard that *data can tell a story*. If you know how to read them, graphs can tell you that story.

In this activity, you will practise interpreting position/time graphs.

Materials

- data set cards
- graph cards
- motion description cards

Procedure

1. Match each of the graphs with its data set.
2. Assuming that X represents time in seconds and that Y represents position in metres, match each of the cards with its data set and graph.

Graph Matching Table

Data Set	Graph	Motion Description Card
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Teacher Notes

Background Information

The data, graphs, and words for this activity are found in Appendix C: Cards, Data Tables, and Graphs.

Graph Matching Table (Answer Key)

Data Set	Graph	Motion Description Card, Set A	Motion Description Card, Set B
1	D	5A	5B
2	I	1A	1B
3	J	7A	7B
4	G	10A	10B
5	C	8A	8B
6	H	2A	2B
7	A	6A	6B
8	B	4A	4B
9	E	3A	3B
10	F	9A	9B

Activity 39: Motion Sensors

Outcomes

Students will be expected to

- distinguish among constant, average, and instantaneous speed and velocity of an object (325-3, 212-2)
- using linear experimentation with appropriate technologies, analyze graphically and quantitatively the relationship among distance, time, and speed (scalar quantities) and the relationship among position, displacement, time, and velocity (vector quantities) (325-1, 212-7, 325-2)
- describe and evaluate the design and functions of motion technology (114-3, 115-4, 118-3)

Question

- **What do various motions look like on a motion sensor?**

Materials

- motion sensor

Procedure

A motion sensor can be used to examine the motion of objects that move toward it or away from it. Practise with a motion sensor before collecting data.

1. Create a table like the one below. Be sure to include a title for your table.
2. Indicate your own motion and predict what shape the graph will have.
3. After setting up the motion sensor properly, record your data.

Description of Motion	Predicted Position/ Time Graph	Graph on Sensor

Analysis

1. If your predicted graph was different from what you expected, why was it different?
2. What combinations of motion could produce the following shapes?
   a. A steep-sided mountain with a flat top.
   b. Two mountains with sharp peaks.
   c. Two mountains with one peak smaller than the other.
   d. The uppercase letter V.
   e. The uppercase letter U.
   f. The lowercase letter m.
3. Indicate what type of motions produce the following lines on a position/time graph.
   a. a horizontal line
   b. a diagonal line with a positive slope
   c. a diagonal line with a negative slope
   d. a curved line

Teacher Notes

Background Information

A motion sensor can be used to examine the motion of objects that move toward it or away from it. It is important to note some of the limitations of the device:

1. Objects will not be effectively picked up by the sensor when they are closer than about 50 cm.
2. The sensor beam widens at about 15° from the sensor, so students should ensure that the path they are using is free of other moving objects.
3. Tell students to aim the sensor at the torso (if they are trying to measure the motion of a person).
4. Students might need to hold a book in front of them (to help the sensor pick them up).
5. It is difficult for students to achieve the motion requested. Teachers should have other objects on hand that will produce the motion requested, such as carts on a ramp.

Activity 40: Toying with Motion

Outcomes

Students will be expected to

- use instruments and terminologies effectively and accurately for collecting data in various experiments (212-9, 213-3)
- distinguish among constant, average, and instantaneous speed and velocity of an object (325-3, 212-2)
- using linear experimentation with appropriate technologies, analyze graphically and quantitatively the relationship among distance, time, and speed (scalar quantities) and the relationship among position, displacement, time, and velocity (vector quantities) (325-1, 212-7, 325-2)

Question

- **What is constant velocity?**

Materials

- metre stick
- stop watch
- slow moving toy with wheels

Procedure

Start with the toy in motion near one end of a table (or the floor) and start timing when it passes a predetermined point. This could be from the end of the table or some other point on the path.

At specific times (1-second or 2-second intervals), mark each location (position) of the toy. (A piece of chalk or masking tape could be used, or marks on a length of paper stretched beside the motion).

Measure the distance travelled from the origin for each mark and record the results in a data table like the one below.

Time (s)	0	1	2	3	4	5
Position (cm)						

From the data table, plot a graph of position versus time. Time is considered to be the manipulated variable. Draw a line of best fit through the plotted points.

Analysis

- What pattern is suggested by the plotted points?
- In general, what should a position/time graph for a constant velocity look like?
- After drawing in the line of best fit, identify two convenient well-spread points and do a careful calculation of the slope. Include the correct units in your calculation. What do you think is being measured by this value?
- From the information obtained, can you predict how far the toy should go in 1 second? 2 seconds? 5 seconds? 30 seconds?

Teacher Notes

Background Information

This activity requires students to draw a line of best fit and to calculate the slope of this line.

An alternative would be to use graphing technology.

Students can bring their own toy cars or they can be purchased at a dollar store.

Activity 41: Interpreting and Doing Problems, Part 1

Outcomes

Students will be expected to

- distinguish among constant, average, and instantaneous speed and velocity of an object (325-3, 212-2)
- using linear experimentation with appropriate technologies, analyze graphically and quantitatively the relationship among distance, time, and speed (scalar quantities) and the relationship among position, displacement, time, and velocity (vector quantities) (325-1, 212-7, 325-2)
- describe and evaluate the design and functions of motion technology (114-3, 115-4, 118-3)

Questions

- **What information does this problem give?**
- **What do you want to find out?**
- **How can the unit be used to help you solve the problem?**
- **What kind of picture could represent what is happening in the question?**

Procedure

1. Read the problem below and circle all the information that you think will help you solve the problem.

   A bus travelled at a constant velocity of 60 km/h west for 1.0 hours. What was the displacement of the bus?

2. In problem solving, the information that you think will help solve the problem is written in a list that can be called givens (knowns). When writing the given information, you want to write as much information as you see. For example, you should include signs and units with each quantity that you are given. On the Problem-Solving Organizer 1, enter the information that you are given in the correct column.
3. The problem poses a question that asks you to find out something. This is your unknown quantity. Write what you want to find out (unknown) on the Problem-Solving Organizer 1.
4. Both knowns and unknowns consist of two parts: a number, or quantity, and a unit; e.g., 1.0 h, where 1.0 is the quantity and h (hour) is the unit. Using the units alone—a technique known as "unit analysis"—can often help you figure out what mathematical operation you have to do to wind up with the right answer. Use the Unit Analysis box on the Problem-Solving Organizer 1.
5. A diagram can be used to describe what is happening in a problem. For motion problems, a common form of diagram is called a motion map. A motion map consists of arrows that indicate motion, or dots that indicate the object is at rest. The length of the arrow can be used to represent how fast the object is going and the direction of motion as well. If the arrows are all the same size, that indicates constant motion. On the Problem-Solving Organizer 1, draw a motion map for this problem.

Activity 42: Interpreting and Doing Problems, Part 2

Question

- **How can this problem be solved?**

Procedure

1. Read the problem below and complete the Problem-Solving Organizer 2.

   A trip to Halifax took 2.5 hours. If the trip meter (odometer) read 275 km at the end of the trip, what was the average speed during the trip in km/h?

2. Using the skills developed in the previous activity, complete the parts of the Problem-Solving Organizer 2 used in that activity.
3. In problem solving, we want to show the relationship between the quantities we know and the quantities we want to know. This can be written in the form of a formula. In class you have learned the basic formula for constant and average motion. Decide which type of motion this problem involves and write the basic formula in the correct blank on the Problem-Solving Organizer 2.
4. What should the section for conversions be used for?
5. What is meant by the term **order of operations**, and when and how should it be used to help you solve the problem?
6. Write a concluding sentence that tells the complete answer to the problem (include units and directions if known).

Outcomes

Students will be expected to

- distinguish among constant, average, and instantaneous speed and velocity of an object (325-3, 212-2)
- using linear experimentation with appropriate technologies, analyze graphically and quantitatively the relationship among distance, time, and speed (scalar quantities) and the relationship among position, displacement, time, and velocity (vector quantities) (325-1, 212-7, 325-2)
- describe and evaluate the design and functions of motion technology (114-3, 115-4, 118-3)

Teacher Notes

Background Information

Teachers should ensure that students develop proper problem-solving techniques in this unit. The problem-solving techniques used in the motion unit should be carried over to the other Science 10 units as well. The organizers used in parts 1 and 2 can be found on pages 136–137.

Students might have trouble with unit analysis and rearranging equations. Teachers should provide a wide variety of opportunities for these skills to be developed.

Teachers should model proper problem-solving techniques in examples done in class.

Problem-Solving Organizer 1

Name: ____ Date: ________________

<table>
<tr><td colspan="3">Problem</td></tr>
<tr><td>Given (known)</td><td rowspan="2">Unit Analysis</td><td rowspan="2">Diagram (if vertical)</td></tr>
<tr><td>Find Out (unknown)</td></tr>
<tr><td colspan="3">Diagram (if horizontal)</td></tr>
</table>

Problem-Solving Organizer 2

Name: ______________________________ Date: ______________

<table>
<tr><td colspan="4">Problem</td></tr>
<tr><td>Given (known)</td><td>Basic Formula</td><td rowspan="3">Unit Analysis</td><td rowspan="3">Diagram (if vertical)</td></tr>
<tr><td>Find Out (unknown)</td><td>Formula Rearranged</td></tr>
<tr><td>Conversions</td><td>Work</td></tr>
<tr><td colspan="3">Diagram (if horizontal)

Sentence that answers the question:
____
______________________________</td><td>Solution</td></tr>
</table>

Activity 43: Canadians in Motion

Outcomes

Students will be expected to

- identify and imagine questions that could be investigated using relevant research in science and technology (114-6, 117-8)
- describe examples of Canadian contributions to science and technology in the area of motion (117-10)

Question

- **What are some Canadian contributions to motion?**

Procedure

Work in pairs on this activity. Pick an innovation, accomplishment, or achievement from the following list:

- Avro Jetliner
- Bluenose
- bushplanes (such as the Beaver and the Norseman)
- Canadair waterbomber
- Canadarm and Canadarm2
- completion of a national railway
- Confederation Bridge
- fuel cells for use in electric cars and buses
- G-suit
- rotary snowploughs for trains
- Silver Dart
- snowmobile and Ski-Doo
- St. Lawrence Seaway
- Trans-Canada Highway
- variable pitch propeller

1. Research your topic. Answer the following five basic questions about your topic. Be sure to record sources you used to find your answers.

   Who? When? Where? Why? How?

2. Write down five of your own questions about the innovation, accomplishment, or achievement of your topic. When you have found the answer to one of your questions, record the source(s) you used to find your answer. You must have a minimum of three different sources of information.

Activity 44: Investigating Canadians' Science and Technology Contributions to Motion

Question

- **What contributions have Canadians made to science and technology in the area of motion?**

Materials

- computers with Internet
- other reference materials for research
- screen for viewing as a class
- video camera and software

Procedure

In groups of three to five students, research a specific Canadian contribution to science and technology in the area of motion. Include the following details:

- design contributions
- recent developments
- global impact

Using your research, develop a live-action documentary or infomercial. The presentation should be lively and informative. It should feature all group members equally.

Teacher Notes

Background Information

As a class, design a rubric to help with the assessment.

This activity provides students an opportunity to express themselves and showcase their talents while presenting scientific information. If the groups are teacher-selected, pay attention to mixing the groups for a good balance of artistic types and scientific ones. These presentations could be an entertaining way to conclude the study of motion.

Outcomes

Students will be expected to

- identify and imagine questions that could be investigated using relevant research in science and technology (114-6, 117-8)
- describe examples of Canadian contributions to science and technology in the area of motion (117-10)

Unit 4: Life Science: Sustainability of Ecosystems (25%)

Activity 45: Snow

Questions

- **What is the effect of snow cover on a terrestrial environment?**
- **Why can snow be considered a mineral?**
- **What term is given to snow crystals that form under the snow at ground level?**
- **If an organism cannot adjust to the range of temperatures in Canada, can it be found in our ecosystems?**

Outcomes

Students will be expected to

- predict and analyze the impact of external factors on the sustainability of an ecosystem, using a variety of formats (212-4, 214-3, 331-6)
- diagnose and report the ecosystem's response to short-term stress and long-term change (213-7, 215-1, 318-4)

Materials

- clipboard
- data sheet
- metre stick
- pencils, 2 or 3
- reinforced alcohol thermometer (thermometer taped to wooden ruler works well)
- shovel
- watch or timer

Background Information

In Canada, the most critical abiotic factor is climate, particularly temperature. Some organisms must adjust to temperatures higher than 35°C in summer, others to temperatures as low as –50°C in winter. Many have to deal with very wide seasonal differences in temperature.

Safety ⚠

- Dress appropriately.
- Take particular care with thermometers; they are fragile. Be sure your thermometer has been well reinforced.

Procedure

1. Your teacher will provide you with the current outdoor temperature and the average depth of the snow at your snow station site.
2. Record the temperature of the air and the snow depth.
   - Predict the temperature you would expect at the air/snow interface. Record. Justify your prediction.
   - Predict the temperature you would expect at the snow/ground interface. Justify your prediction.
3. Proceed outside to the snow station site assigned to you by your teacher.
   - Describe your snow station site in terms of location, vegetation, exposure to wind and sun, slope, etc.
   - Measure the snow depth by pushing the metre stick into the snow until it contacts the ground.
   - Record the depth (in centimetres) on your data sheet.
4. Dig a hole, about 20 x 20 cm, in the snow down to ground level. Immediately measure the temperature at the snow/ground interface. Fill in the hole when finished.
   - Place the full length of the thermometer at the snow/ground interface. Leave it in position for two minutes, and then remove it and immediately read the temperature.
   - Record the temperature on your data sheet.
   - Insert the thermometer at a point halfway between the air/snow and snow/ground interface. Read the temperature after two minutes.
   - Record the temperature on your data sheet.
5. Measure the temperature at the snow/air interface (surface). The thermometer must be shaded and not permitted to sink below the snow surface. Allow it to stabilize for at least two minutes before reading the thermometer.
   - Why is it necessary to shade the thermometer?
   - Record the temperature on your data sheet.

Completing Data and Examining Results

- Record the data from your group.
- Record the temperature data for the snow/air interface, midpoint, and ground/snow interface from each group in a graph/data table of your own design. Make a class data table.
- Examine your collected data and compare it with the predictions you made before going outside.
- How did your predictions compare with your actual data? Explain.
- How do the results from other groups compare with yours?
- Is there any value in averaging the class data? Comment.
- Does any relationship appear to exist between temperatures and snow depth? Discuss.

Analysis

- What might account for the temperature data you recorded?
- List any positive effects of snow indicated by your data.
- What are some potentially negative effects of snow and low temperatures on organisms in the wintertime?
- From the point of view of organisms, which would be the preferable winter environment: cold with snow cover or cold without snow cover? Explain your reasoning.
- Suggest one or two practical applications of the knowledge gained from this activity.
- What is the effect of snow cover on a terrestrial environment?
- Why can snow be considered a mineral?
- What term is given to snow crystals that form under the snow at ground level?
- If an organism cannot adjust to the range of temperatures in Canada, can it be found in our ecosystems?

Teacher Notes

Background Information

Sustainability of Ecosystems will be completed at different times of the year. This activity can still be done should there be a major snowfall (+25 cm) that seems likely to remain for two or three days. You might have to remind students about the impact of abiotic factors on an ecosystem if considerable time has passed since completion of the unit.

Teachers may review how to use a thermometer under natural conditions in outdoor locations.

Safety ⚠

- Remind students to dress appropriately for spending 20–30 minutes in the snow.
- Broken thermometers can easily pierce skin. Warn students about the fragility of these instruments.
- Be sure to use alcohol thermometers.

Activity 46: Factors that Affect Sustainability

Questions

- **What are the components of sustainable ecosystems?**
- **How are populations and sustainability connected?**
- **How can human activities affect sustainability? How have understandings progressed?**
- **What "shift" is happening with regard to perspectives on sustainability?**

Materials

- *Nova Scotia Science 10* (textbook)

Procedure

1. List biotic and abiotic characteristics of an ecosystem. Compare your list with a partner. Then, compare your list with pages 282–283 of your textbook. Do Activity 7-1A: Similar Ecosystems Around the World, page 285, of your textbook.
2. Look at figures 7.6 and 7.9 (pages 288 and 290) from your textbook. Explain how the two graphs are similar and how they are different. Explain why there is a difference. Do Activity 7-2A: Graphing Population Change, page 291, from your textbook.
3. Do Activity 7-2D: What Happens When Food Is Limited, pages 298–299, from your textbook.
4. Read Science Watch: Sable Island National Park, page 300, from your textbook. Answer the questions on page 300. Discuss the answers with your classmates.
5. Do Activity 8-1B: Nova Scotia's Most Wanted—Not! from your textbook, page 328.
6. Read Science Watch: Restoration Ecology, page 331, from your textbook. In groups, discuss answers to the questions on page 331.
7. Do Activity 8-1D: Resilience of a Grassland Ecosystem, page 334. Pass in your results.
8. Do Activity 8-2C: Investigating a Local Environmental Project, page 348, from your textbook.

Outcomes

Students will be expected to

- diagnose and report the ecosystem's response to short-term stress and long-term change (213-7, 215-1, 318-4)
- predict and analyze the impact of external factors on the sustainability of an ecosystem, using a variety of formats (212-4, 214-3, 331-6)
- describe how the classification involved in the biodiversity of an ecosystem is responsible for its sustainability (214-1, 318-6)
- question and analyze how a paradigm shift in sustainability can change society's views (114-1)

Activity 47: Acadian Forest Research Project

Outcomes

Students will be expected to

- identify, investigate, and defend a course of action on a multi-perspective social issue (118-9, 215-4, 118-5)
- describe how different geographical locations can sustain similar ecosystems (331-7, 318-3)
- identify and describe peer review, Canadian research, and global projects where science and technology affect sustainable development (114-5, 116-1, 117-3, 118-1)
- describe how different geographical locations can sustain similar ecosystems (331-7, 318-3)

Questions

- **What is sustainability of an ecosystem? Explain.**
- **How does a study differ from an experiment?**
- **What does research tell us about our Acadian forest?**
- **What is the importance of collecting data and interpreting it for various ecosystems?**
- **Can all ecosystems be sustainable?**

Safety ⚠

- Let an adult know where you are going to be during the survey.
- During hunting season, you should wear hunter orange.
- Wear protective gloves when handling soil.
- Students and teachers should consult the *Science Safety Guidelines* (Nova Scotia Department of Education 2005) for complete safety rules.

Procedure

Sustainability of an ecosystem is the focus. Many places may be used such as parks, towns, and so on. A theoretical discussion could also happen. Parts A and B provide options for this activity.

Part A: Data and Sample Collection

- Locate an area of Acadian forest. Any forest in Nova Scotia qualifies.
- Measure an area three metres by three metres. Temporarily mark the area using string and corner stakes. If this is not your own land, make sure you have permission to use it.
- Sit down, look, listen, smell—do this for about fifteen minutes so you get a good sense of the area.
- Draw a site map that shows the general location of the plot (provide enough information so that someone else can find it).
- Write a general description of the site, such as slope, direction, steepness, drainage, etc.
- Measure the temperature of the soil and air.

- Make a scale aerial map of the plot, showing the location of the different plants (plants do not need to be identified by name). Make a side view drawing of the plot using a suitable scale. To do this you will have to measure or estimate the height and diameter of the trees.
- Make tallies of your observations as you investigate the area for evidence of plants, larger animals, insects, water, and human activity. Evidence of larger animals might be footprints (make sketches), hair on twigs, scat, or bark rubbed off trees. Evidence of human activity could be cut down trees, garbage, or footprints. Your observations of insects should include a count of each type of insect you see (spiders, centipedes, etc.).
- Collect samples and/or take pictures of the following and place them in labelled, self-sealing bags (do not take samples from a national park):
  - plants: take enough of the plants to press and identify without permanently damaging the site
  - leaf litter: collect the first 5 cm of soil under a layer of leaves
  - soil sample at a depth of 20 cm
  - water sample from the soil sample hole
  - any garbage within the plot
- Add any other observations of your area that you feel are important or interesting.
- Turn in your labelled sample bags to your teacher.

Part B: Report

- Make a display of your findings and be prepared to answer questions about your research project. The project display should be no larger than two classroom desks. It must include at least the following:
  - a paragraph that describes how the life forms found in your plot are dependent upon each other
  - sketches of animal prints, with identification, for the animals that would live in your plot
  - an analysis of the soil sample
  - list of garbage found
  - pH results
  - a list of the evidence of human activity
- Be prepared to tell the class about your project in three to five minutes and answer questions from other students.
- Write a formal report of your findings. Photocopies of originals used in the display are acceptable for the report.

Teacher Notes

Background Information

The Acadian Forest Research Project is intended to give students an opportunity to know more about the Acadian forest environment. Acadian forest includes any forest in Nova Scotia; however, if you live in an urban area, woodlands are part of the local environment as well. This project may be carried out in a park or backyard. Students do not have to find out the names of the organisms they encounter; they just have to recognize differences. Some of the more ambitious students will work on identifying the different species. The Nova Scotia Department of Natural Resources and the Nova Scotia Museum of Natural History have information available for students and teachers that may be helpful. Weather and precipitation data are available online.

This project can be used as the framework for most of the Sustainability unit. It requires students to investigate cycling of matter, soil composition, trophic levels, food webs, and many more of the outcomes. If this project is assigned within the first few days of the unit, it will create a "need to know" in the students because of the requirements.

This project could also be used as a culminating experience at the end of the unit.

Follow-up discussion or writing assignment:

> *You hear on the news that your research plot is going to be bulldozed. What is your response to the news? What action would you take?*

Evaluation

Develop a rubric and scoring scheme with the students.

Safety ⚠

- Students should let an adult know where they are going to be during their survey.
- During hunting season, students should wear hunter orange.
- Students should wear protective gloves when handling soil.
- Students and teachers should consult the *Science Safety Guidelines* (Nova Scotia Department of Education 2005) for complete safety rules.

Activity 48: Populations

Questions

- **Does population make a difference?**
- **Does human population (it reached 7 billion on October 31, 2011) have an influence on other populations?**

Outcomes

Students will be expected to

- describe how the classification involved in the biodiversity of an ecosystem is responsible for its sustainability (214-1, 318-6)
- predict, and portray the impact of external factors on the ecosystem, using a variety of formats (212-4, 214-3, 331-6)
- distinguish between biotic and abiotic factors, determining the impact on the consumers at all trophic levels due to bioacculmulation, variability, and diversity (318-2, 318-5)

Introduction

A population is a group of organisms of the same species that exists in the same place at the same time. A population changes with time as members of the population leave or join. A natural population will change according to birth rates and death rates, and immigration and emigration. The formula for the rate of population growth over a given period of time is:

$$\frac{(\text{number of births}) - (\text{number of deaths}) + (\text{number of immigrants}) - (\text{number of emigrants})}{\text{total population at beginning of period}}$$

Extremely fast growth is called a population explosion, which can occur when a new species is introduced into an ecosystem in which there are few, if any, predators, a plentiful food supply, and abundant space. The population of such a species can grow very fast and is sometimes able to take over an ecosystem, changing the nature of interactions among other species. The introduction of Purple Loosestrife into wetlands is an example. While indigenous wetland plants support biodiversity, Purple Loosestrife is not a food source or shelter for any organism. As a result, it can gradually take over and reduce a diverse ecosystem to a single plant species that does not interconnect with other organisms.

A population extinction can occur when greater numbers of species leave a population than enter it. A population will steadily decrease if the death rate is higher than the birth rate, or if migration out is higher than migration in. Low population numbers can lead to inappropriate mating practices, during which harmful gene combinations can occur. Such genetic weakness, combined with steady decline in numbers, leads to the extinction of the population. There are numerous examples of this process occurring in Canada, especially as a result of human activity. Overfishing, poaching, reduction of or complete loss of habitat, for example, have resulted in population extinctions.

Table 1: Population Growth

Time (years)	Population (in millions)
0	0.0
1	3.5
2	4.9
3	6.3
4	7.5
5	8.7
6	16.2
7	33.1
8	40.3
9	43.5
10	45.0
11	46.4
12	46.2
13	46.1
14	46.2

The data in Table 1: Population Growth represent typical population growth. Choose an appropriate scale and construct a line graph of the data. Be sure to label the axes and the graph itself.

Table 2: Population Explosion

Time (years)	Population (in millions)
0	0.0
1	0.5
2	8.0
3	12.2
4	17.5
5	17.5
6	41.6
7	80.0
8	175.0
9	39.8
10	39.8
11	20.5

The data in Table 2: Population Explosion represent a typical population explosion. Choose an appropriate scale and construct a line graph of the data. Be sure to label the axes and the graph itself.

Table 3: Population Extinction

Time (years)	Population (in millions)
0	4.5
1	6.3
2	7.2
3	10.0
4	21.7
5	41.6
6	81.9
7	39.8
8	20.5
9	11.4
10	9.6
11	7.2
12	5.5
13	0

The data in Table 3: Population Extinction represent a typical population extinction. Choose an appropriate scale and construct a line graph of the data. Be sure to label the axes and the graph itself.

Compare all three tables. What do you notice about the slopes of all three lines? Make some comments about the graphs for population growth, population explosion, and population extinction.

Activity 49: Sustainable Choices

Question

- **In what ways are careers and sustainability linked?**

Procedure

Produce a story of a scientist or technologist who contributed to the sustainability of ecosystems. Your story may be presented in different forms to share with the class. Be sure to include the following information:

- date and place of birth
- social and cultural background
- education
- scientific or technological contribution (what was it, beneficial/non-beneficial)
- brief description of development of contribution
- one fact not already mentioned that you found interesting, relevant, and why
- how the career involves sustainability
- choices and influences that were made by society that impacted this person's work
- "Today's problems were yesterday's solutions." How does this statement apply to this career?
- how this person's career in the past compares with this career today
- optional solutions this person may explore

Be sure to include the sources of information that you used.

Teacher Notes

Students may present themselves as their chosen scientist/technologist as they include all the information about their career and sustainability.

Sustainability involves a paradigm shift. This concept opens student discussion about how our world can exist for their grandchildren.

Outcomes

Students will be expected to

- identify, investigate, and defend a course of action on a multi-perspective social issue (118-9, 215-4, 118-5)
- identify and describe peer review, Canadian research, and global projects where science and technology affect sustainable development (114-5, 116-1, 117-3, 118-1)

Activity 50: Extending Science

Outcomes

Students will be expected to

- diagnose and report the ecosystem's response to short-term stress and long-term change (213-7, 215-1, 318-4)
- distinguish between biotic and abiotic factors, determining the impact on the consumers at all trophic levels due to bioaccumulation, variability, and diversity (318-2, 318-5)
- predict and analyze the impact of external factors on the sustainability of an ecosystem, using a variety of formats (212-4, 214-3, 331-6)
- describe how the classification involved in the biodiversity of an ecosystem is responsible for its sustainability (214-1, 318-6)

Questions

- **How does biodiversity affect the sustainability of an ecosystem?**
- **How are the environment, economy, and social factors related to sustainability?**
- **What is the connection(s) between safety and science?**

Challenge

Extend your knowledge of science, and your creativity, to complete one of the following assignments:

- Write a science-fiction short story that illustrates how biodiversity affects sustainability of ecosystems. Remembering that science fiction is based on science fact, include concepts, facts, and terminology from our study of ecosystems. Your story must be at least 1250 words in length (approximately two single-spaced, typed pages).
- Write a poem that illustrates how biodiversity affects sustainability of ecosystems. The poem must be at least 24 lines long and contain a minimum of 10 terms from our study of ecosystems. The poem should make scientific sense.
- Draw a cartoon strip, with captions, that illustrates how biodiversity affects sustainability of ecosystems. The cartoon must be at least 10 frames in length and contain a minimum of 10 terms from our study of ecosystems. The cartoon should make scientific sense.
- Write a science-fiction short story, a poem, or a cartoon strip that shows a concern for safety and the need for rules and regulations within the context of scientific and technological activities. Remembering that science fiction is based on science fact, include concepts, facts, and terminology from our study of safety.

Teacher Notes

Background Information

This might be a culminating activity, or you might work with English language arts teachers.

This assignment could begin with an individual brainstorming activity in which students make a list of each of the following: people's names (famous, infamous, unknown), places, and events (rainstorm, robbery, last school dance). Students then choose one item from each list and use these as a starting point for the poem or short story.

Students do not construct and learn science concepts and relationships effectively through passive absorption. Students learn when they can link new ideas and skills to prior knowledge through active engagement in listening, speaking, reading, writing, and thinking.

The process of trying to communicate what they know and understand can lead students to examine their understanding more deeply and completely. By using formal and informal writing strategies, students begin to think their way through a new concept, making sense of the associations, bits of information, questions, and feelings. Writing assignments also offer opportunities for teachers to gain insight into the understandings of students' concepts. Teachers may then address undeveloped conceptions, unanswered questions, and misunderstandings that students might have.

This type of activity could help students consolidate their learning in a way that allows them to retain and apply it.

Appendices

Appendix A: Templates and Resources

This appendix includes the following templates and resources:

Experimental Design

Activity title: ______________________________

My name: ______________________________

Partners names: ______________________________

Date: ______________________________

1. Question: The purpose of this activity is to answer the following question(s):

____

____

____

2. Hypothesis: Our hypothesis (what we believe will happen) is

____

____

____

3. We believe this will happen because ______________________________

____

____

4. What are we going to do to prove or disprove our hypothesis?

____

____

____

____

____

____

5. What do we need for materials?

6. Which variable are we going to change (the manipulated/independent variable)?

7. Which variable(s) will respond to the change (the responding/dependent variable)?

8. What things do we need to keep constant over the run of the experiment?

9. What safety precautions do we need to take?

10. How many trials should we do?

11. How will we know we are getting "good" data?

12. What data do we need to collect? How will we record the data?

13. How will we display the data?

14. How will we analyze the data?

Procedure

Design your experiment.

STOP HERE. Have your teacher approve your plan. _______________ (teacher's initials)

Note observations and data below while performing your experiment.

Observations:

Data:

Analysis

After you have completed your experiment, complete the following questions.

1. What do the data mean? (What do the data tell us?)

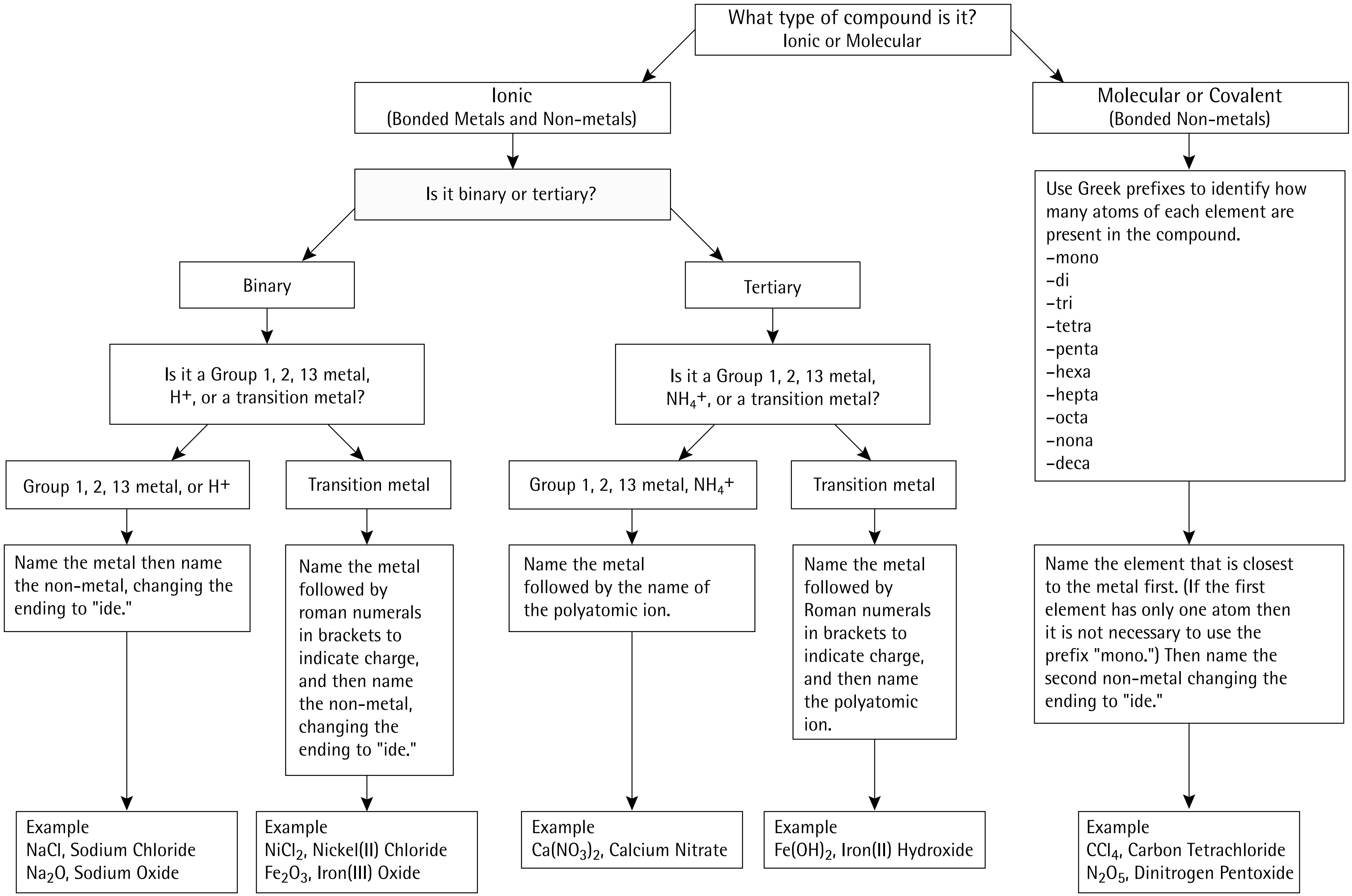
2. Do the data support, or not support, our hypothesis? Explain your answer.

3. Interpret any other findings.

4. Are there any changes that have to be made to the procedure? Explain why.

5. Are there any questions arising from the experiment that could be further investigated?

Sample Compound Classification Flowchart



Polyatomic Ion Sheet

acetate	CH_3COO^- or $C_2H_3O_2^-$
ammonium	NH_4^+
arsenate	AsO_3^{3-}
benzoate	$C_6H_5COO^-$
bismuthate	BiO_3^-
borate	BO_3^{3-}
bromate	BrO_3^-
carbonate	CO_3^{2-}
chlorate	ClO_3^-
chlorite	ClO_2^-
chromate	CrO_4^{2-}
citrate	$C_6H_5O_7^{3-}$
cyanamide	HCN^-
cyanate	OCN^- or CNO^-
cyanide	CN–
dichromate	$Cr_2O_7^{2-}$
dihydrogen phosphate	$H_2PO_4^-$
dihydrogen phosphite	$H_2PO_3^-$
fluorite	FO_2^-
formate	$HCOO^-$
glutamate	$C_5H_8NO_4^-$
hydrogen carbonate (or bicarbonate)	HCO_3^-
hydrogen oxalate	$HC_2O_4^-$

hydrogen phosphate	HPO_4^-
hydrogen phosphite	HPO_3^{2-}
hydrogen sulphate (or bisulphate)	HSO_4^-
hydronium	H_3O^+
hydroxide	OH^-
hypochlorite	ClO^-
iodate	IO_3^-
lactate	$C_3H_5O_3^-$
nitrate	NO_3^-
perchlorate	ClO_4^-
periodate	IO_4^-
permanganate	MnO_4^-
peroxide	O_2^{2-}
phosphate	PO_4^{3-}
phthalate	$CH_4O_4^{2-}$
silicate	SiO_3^{2-}
stearate	$C_7H_{35}COO^-$
sulphate	SO_4^{2-}
tartrate	$C_4H_4O_6^{2-}$
tetraborate	$B_4O_7^{2-}$
thiocyanate	SCN^-
thiosulphate	$S_2O_3^{2-}$
tripolyphosphate	$P_3O_{10}^{5-}$

Nomenclature Riddles

Question

- **Answer each of the riddles in the space provided. Elements in the response compose the base, the main body, or the entire answer for these riddles.**

Clue	Element
1. Mickey Mouse's favourite dog	plutonium
2. Superman's home planet	
3. A university	
4. You press laundry with this	
5. Ready, set, __________	
6. Doctors do this	

Make your own riddles and share with your classmates.

Outcomes

Students will be expected to

- name and write formulas for common ionic compounds and molecular compounds and describe the usefulness of the IUPAC nomenclature system (319-1, 114-8)

GRASP Problem-Solving Method

Investigation: ____

Question: ____

Given: What do you know?

____

____

____

Required: What do you want to know?

____

____

____

Analysis: What formula can you use?

____

____

____

Solution: Show your work.

____

____

____

____

____

Paraphrase: State the answer in a sentence.

____

____

____

____

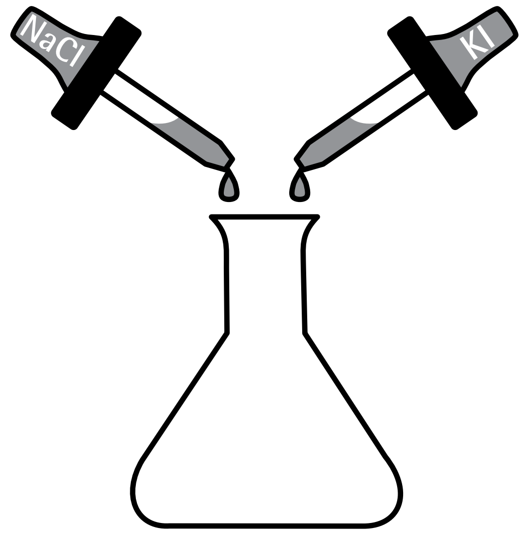
____

Grid Paper (0.5 cm)

Vocabulary Organizer

Vocabulary term	Drawing (visual cue)
Definition	Personal association or characteristic (to help you remember)

Sample Vocabulary Organizer

Vocabulary term	Drawing (visual cue)
double displacement reactions Example: sodium chloride + potassium iodide yields _____	
Definition Double displacement reactions are reactions between two compounds where the cations exchange anions.	**Personal association or characteristic (to help you remember)** square dancing

Concept Overview

Key word or concept:	Write an explanation or definition in your own words. You will be paraphrasing.
Drawing	
	List some facts (at least five).
Create your own questions about the concept.	

Create an analogy.

Issue-Based Article Analysis

When you read the article, did it inform you but not raise any concerns? If so, use the fact-based article analysis sheet. If the article presented a certain point of view about an issue under dispute, use this sheet.

Issue (written as a question).	Write a summary in your own words (paraphrase).
Drawing	
What is the author's opinion? Give one piece of evidence.	What is your opinion?
Relevance to today. This is important or not important because ...	

Fact-Based Article Analysis

When you read the article, did it present a certain point of view about an issue under dispute? If so, use the issue-based article analysis sheet. If the article informed you but did not raise any concerns, use this sheet.

Key concept (written in a sentence).	Write an article summary or definition in your own words. Do not list facts. Give an overview..
Drawing	
	List your questions (at least two).
What are the facts? List at least five.	List at least five key words.

Relevance to today. This is important or not important because ...

Appendix B: Careers

Question

- **Do all careers fit in a "career cluster" easily?**

Procedure

- Match possible careers to the career cluster or career code.
- Identify other careers that are not listed.

Career Clusters and Definitions

Career Code	Career Cluster	Description
1	Agriculture, Food, and Natural Resources	Processing, production, distribution, financing, and development of agricultural commodities and natural resources
2	Arts, Culture, A/V Technology, and Communications	Creating, exhibiting, performing, and publishing multimedia content
3	Building and Construction	Providing opportunities in the building trades environment
4	Business, Finance, Management, and Administration	Organizing, directing, and evaluating functions essential to productive business operations
5	Canadian Forces Occupations	Providing a variety of the above careers when enrolled in the Canadian Forces
6	Education and Training	Providing education and training services, as well as related learning support services
7	Health Services	Providing diagnostic and therapeutic services, health informatics, support services, and biotechnology research and development
8	Law, Security, and Public Safety	Providing legal, public safety, protective, and emergency prepareness services
9	Manufacturing and Processing	Processing materials into intermediate or final products
10	Marketing, Sales, and Promotion	Performing marketing activities to reach organizational objectives
11	Mechanical Repair and Precision Crafts	Providing installation, repair, maintenance, and service to appliances, industrial equipment, and personal and commercial vehicles
12	Personal and Commercial Services	Providing for families and serving human needs
13	Science, Engineering, and Information Technology	Performing engineering services, technical design, scientific inquiry, and information technology (IT) services
14	Social, Sport, and Recreational Services	Providing social and recreational services
15	Transportation, Distribution, and Logistics	Managing movement of people, materials, and goods by road, pipeline, air, rail, and water

Listed below are examples of careers that you might be interested in exploring.

Earth and Space Science: Weather Dynamics

- Agrometeorology
- Applied or Engineering
- Meteorologist
- Atmospheric Scientist
- Climatologist
- Dynamic Meteorologist
- Environmental Engineer
- Environmental Meteorologist
- Flight Dispatcher
- Hydrometeorology
- Meteorologist
- Operational Meteorologist
- Paleoclimatology
- Physical Meteorologist
- Satellite Image Manager
- Synoptic Meteorologist

Physical Science: Chemical Reactions

- Agricultural Chemist
- Analytical Chemist
- Anesthesiologist
- Biochemist
- Cardiologist
- Chemical Analyst
- Chemical Engineering
- Chemical Technologist
- Chemist
- Clinical Chemist
- Consumer Product Analyst
- Crime Lab Analyst
- Criminologist
- Dialysis Technician
- Environmental Chemist
- Fertilizer Industry Worker
- Fingerprint Technician
- Food Chemist
- Forensic Chemistry
- Forensic Scientist
- Forestry Researcher
- Forestry Technologist
- Genetic Engineer
- Hazardous Waste Manager
- Industrial Chemist
- Industrial Hygienist
- Inorganic Chemist
- Materials Scientist
- Medical Technician
- Microbiologist
- Oil and Petroleum Worker
- Opthalmologist
- Organic Chemist
- Patent Examiner
- Pathologist
- Pediatrician
- Perfumer
- Pesticides Expert
- Petrochemical Worker
- Pharmaceutical Chemist
- Pharmacist
- Pharmacologist
- Physical Chemist
- Plastic Products Science
- Pollution Control Chemist
- Polymer Chemist
- Production Chemist
- Pulp and Paper Chemistry
- Pyrotechnics Expert
- Quality Control Chemist
- Researcher
- Sales Representative (retail and/or wholesale)
- Sanitation Inspector
- Science Publishing
- Secondary School Teacher
- Spectroscopist
- Technical Writer
- Technologist
- Textile Chemistry
- Toxicologist
- Water Resources Specialist
- Wine Industry Specialist
- X-ray Technician

Physical Science: Motion

- Aeronautics Engineer
- Air Pollution Control Specialist
- Astronautics Engineer
- Astronomer
- Astrophysicist
- Atmospheric Scientist
- Atomic Physicist
- Ballistics Expert
- Bio-Engineer
- Bio-Physicist
- Ceramic Engineer
- Civil Engineer
- Computational Physicist
- Computer Scientist
- Condensed-Matter Physicist
- Educator
- Electric Power Generation Technician and/or Engineer
- Electrical Engineer
- Geophysicist
- Hydrologist
- Industrial Physicist
- Mathematical Physicist
- Mathematician
- Mechanical Engineer
- Medical Physicist
- Mineralogist
- Nuclear Physicist
- Optical Physicist
- Physician
- Physicist, Research and Development
- Power Engineer
- Power Generation and Transmission Technician and/or Engineer
- Radiologist
- Reactor Operator
- Scientist, Plasma Fusion Centre
- Solar Physicist
- Space Physicist
- Surface Physicist
- Systems Analyst
- Technical Staff Member
- Theoretical Physicist

Life Science: Sustainability of Ecosystems

- Agricultural Scientist
- Air Quality Analysis/Control
- Aquaculturalist
- Biological Controller
- Botanist
- Economic Entomologist
- Energy Conservation/Planning/ Policies Expert
- Environmental Consultant: Education, Engineering, Law, Lobbying, Planning, Policy Analysis, and Protection
- Fisheries Manager
- Forester
- Geologist
- Geotechnical/Civil Engineer
- Groundwater Manager
- Horticulturalist
- Landscaper for Architecture
- Meteorologist
- Mining/Mineral Exploration/ Reclamation Technician and/or Planner
- Natural Resource Manager
- Oceanography/Marine/Coastal Scientist/Technician
- Oil and Gas Services
- Petroleum Engineer
- Plant Scientist
- Remote Sensing / GIS Technician
- Reservoir Engineer
- Soil Scientist
- Space and Planetary Scientist
- Sustainable Developmenter
- Transport Engineer/Planner
- Urban and Regional Planner
- Waste Manager
- Wildlife Biologist

Appendix C: Cards, Data Tables, and Graphs

The following cards, data tables, and graphs may be used with Activity 38: Matching Data, Graphs, and Words.

Motion Description 1A

The object starts at the origin and has a constant speed to the right.

Motion Description 2A

The object is at four metres to the right of the origin and stands still.

Motion Description 3A

The object starts four metres to the left of the origin and moves at a constant speed to the right.

Motion Description 4A

The object starts at the origin and is slowing down to the right.

Motion Description 5A

The object starts at the positive side of the origin and is slowing down as it moves left.

Motion Description 6A

The object starts at the positive side of the origin and moves at a constant speed to the left.

Motion Description 7A

This graph shows something that is physically impossible. No one object can be in all of these positions at the same time.

Motion Description 8A

The object starts at the origin and speeds up while travelling to the right.

Motion Description 9A

The object starts four metres to the left of the origin and speeds up to the right.

Motion Description 10A

The object starts four metres to the left of the origin and moves at a constant speed to the left.

Motion Description 1B

The object starts at the origin. It moves at a constant positive rate.

Motion Description 2B

The positive position is not changing.

Motion Description 3B

The object starts four metres to the left of the origin and moves at a constant positive rate.

Motion Description 4B

The object starts at the origin and the positive rate of change is decreasing.

Motion Description 5B

The object starts at the positive side of the origin and the negative rate of change is decreasing.

Motion Description 6B

The object starts at the positive side of the origin and moves at a constant negative rate.

Motion Description 7B

This graph shows something that is physically impossible. No one object can be in all of these positions at the same time.

Motion Description 8B

The object starts at the origin and the positive rate of change is increasing.

Motion Description 9B

The object starts at a negative position and the positive rate of change is increasing.

Motion Description 10B

The object starts on the negative side of the origin and moves at a constant negative rate.

Data Set 1	
Time (s)	Position (m)
0.2	+5.0
0.4	+2.5
0.8	+1.25
2.0	+0.50
3.0	+0.33
4.0	+0.25
5.0	+0.20

Data Set 2	
Time (s)	Position (m)
0	0
1	+1
2	+2
3	+3
4	+4
5	+5
6	+6
7	+7
8	+8
9	+9
10	+10

Data Set 3	
Time (s)	Position (m)
4	0
4	+1
4	+2
4	+3
4	+4
4	+5
4	+6
4	+7
4	+8
4	+9

Data Set 4	
Time (s)	Position (m)
0	-4
1	-5
2	-6
3	-7
4	-8
5	-9

Data Set 5	
Time (s)	Position (m)
0	0
1	+1
2	+4
3	+9
4	+16
5	+25
6	+36
7	+49
8	+64
9	+81
10	+100

Data Set 6	
Time (s)	Position (m)
0	+4
1	+4
2	+4
3	+4
4	+4
5	+4
6	+4
7	+4
8	+4
9	+4
10	+4

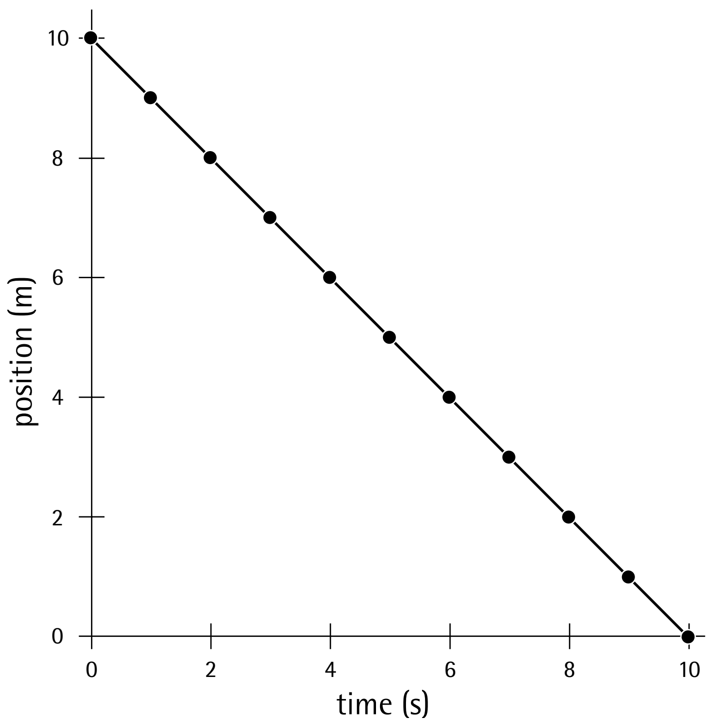
Data Set 7	
Time (s)	Position (m)
0	+10
1	+9
2	+8
3	+7
4	+6
5	+5
6	+4
7	+3
8	+2
9	+1

Data Set 8	
Time (s)	Position (m)
0	0
1	+1.00
2	+1.41
3	+1.73
4	+2.00
5	+2.23
6	+2.44
7	+2.64
8	+2.82
9	+3.00

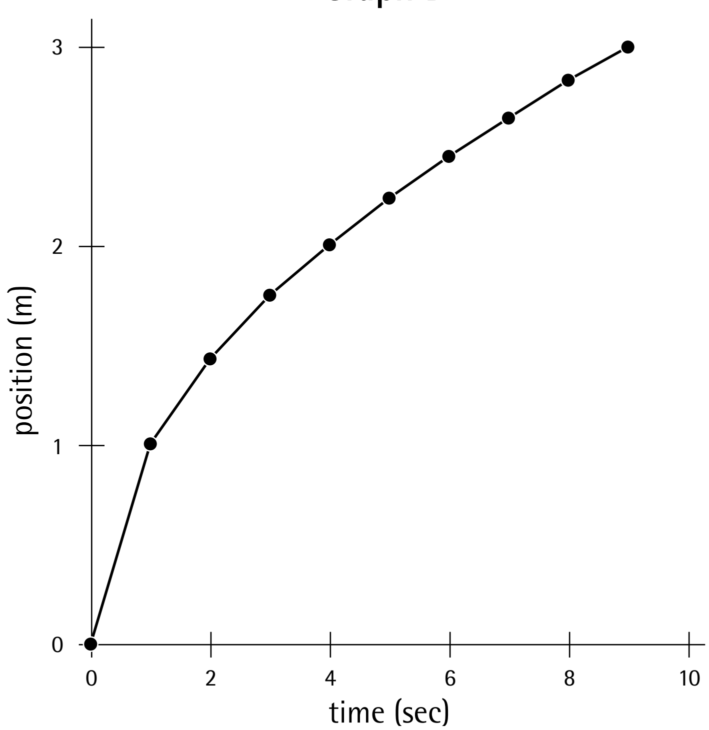
Data Set 9	
Time (s)	Position (m)
0	-4
1	-3
2	-2
3	-1
4	0
5	+1

Data Set 10	
Time (s)	Position (m)
0	-4
1	-3
2	-1
3	+2
4	+6
5	+11

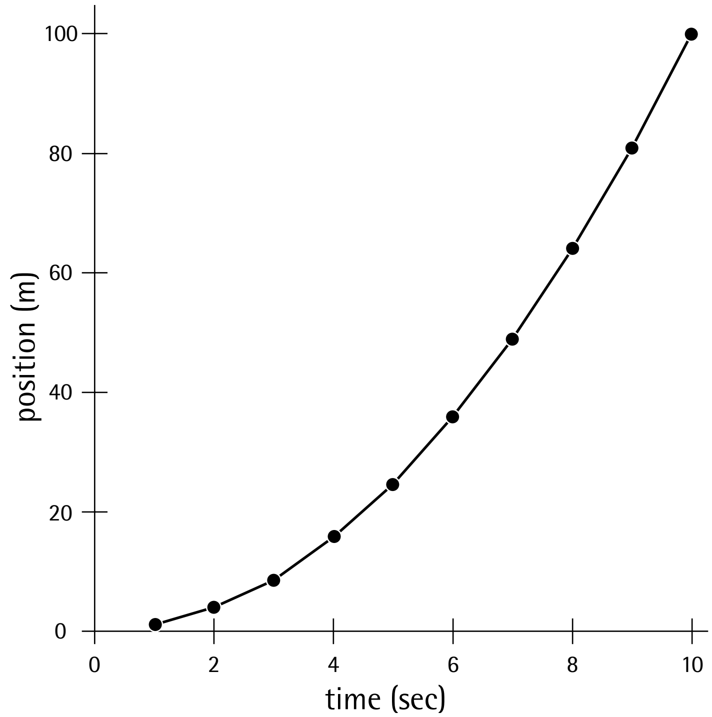
Graph A



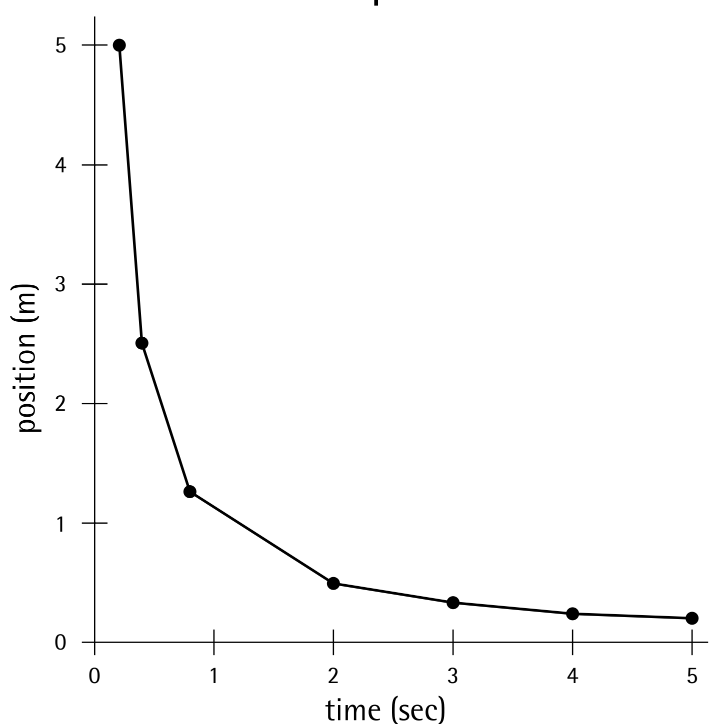
Graph B



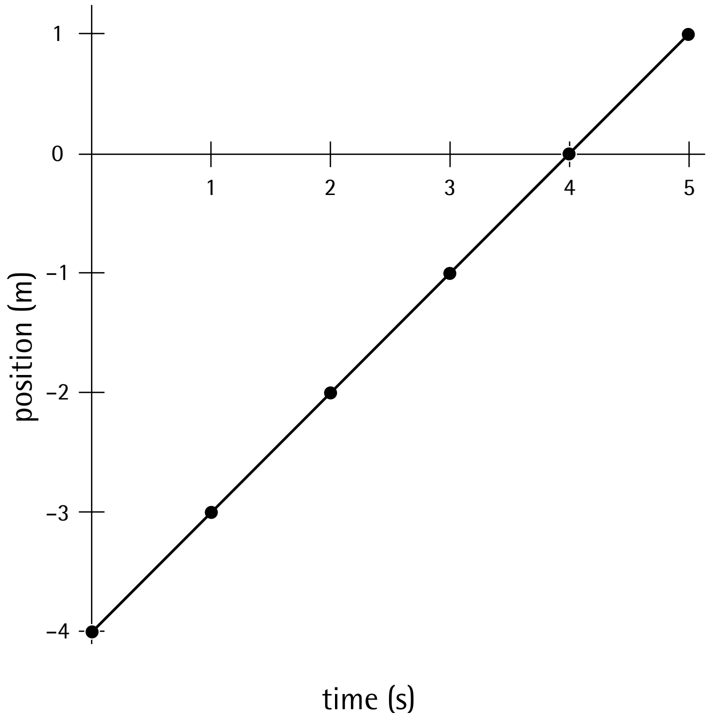
Graph C



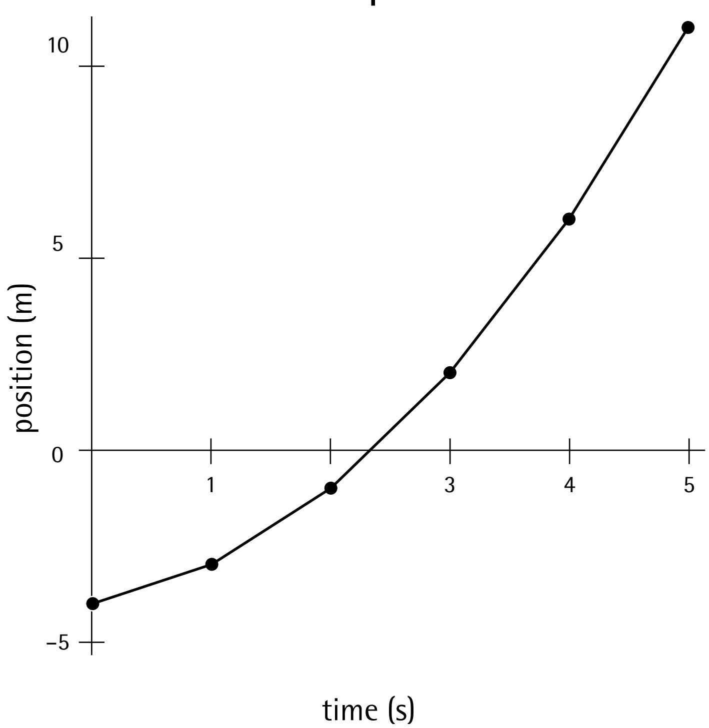
Graph D



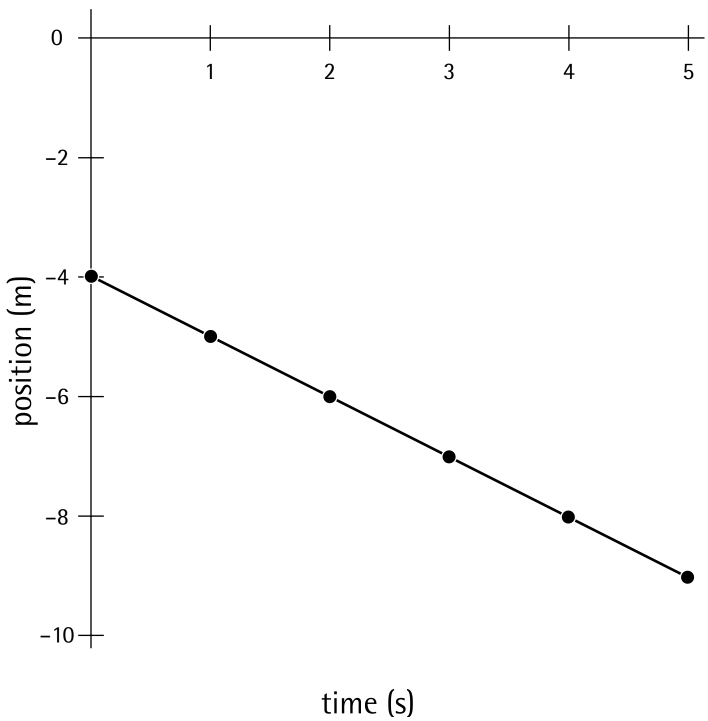
Graph E



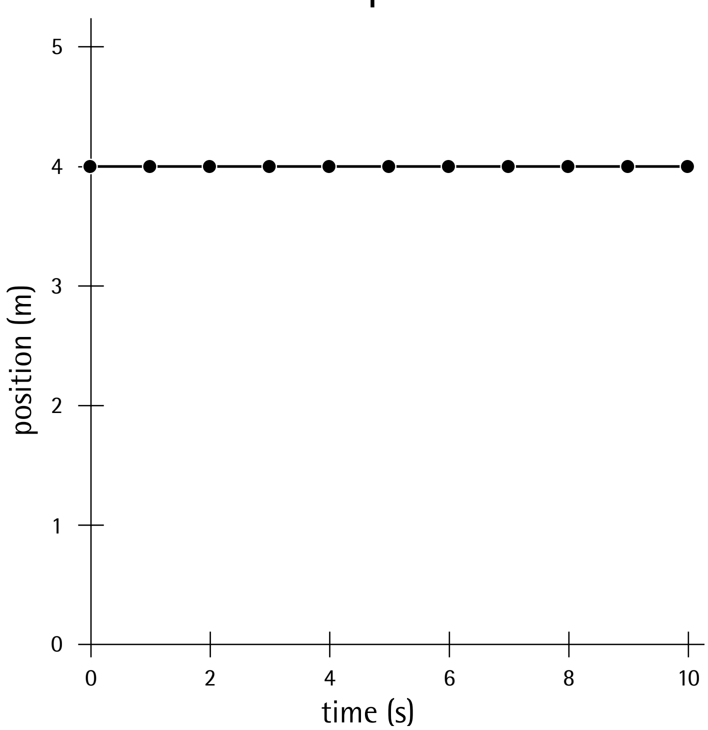
Graph F



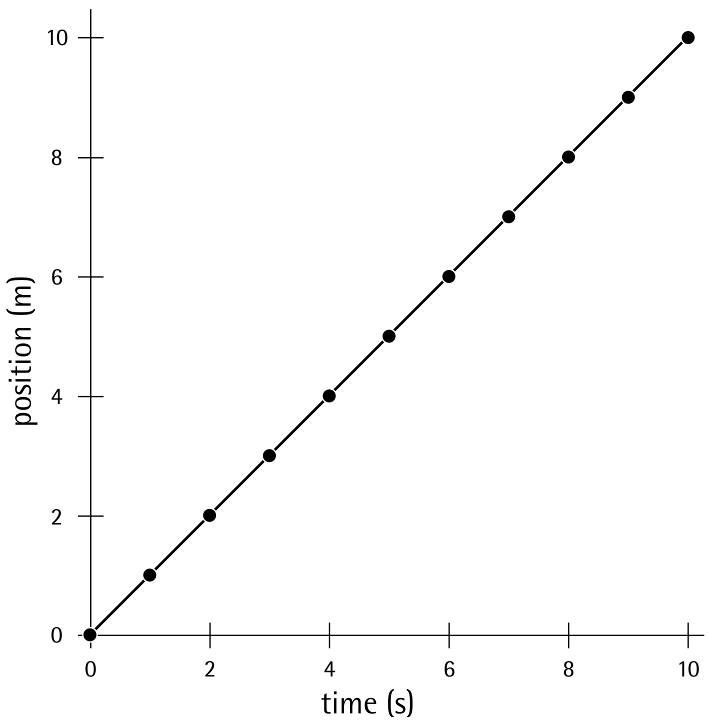
Graph G



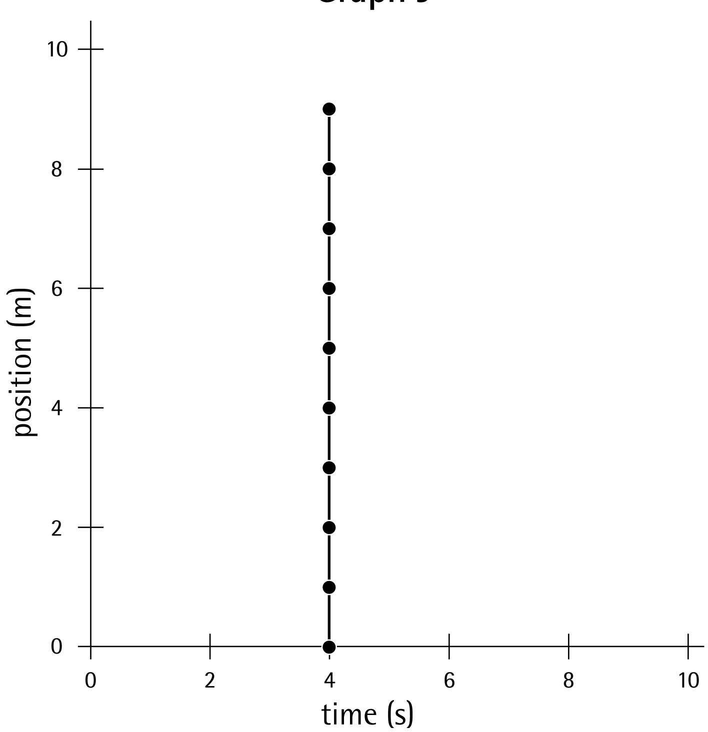
Graph H



Graph I



Graph J



Appendix D: Alternate Activities

Pressure and Mass

Questions

- **Does air have mass?**
- **Can air apply pressure?**
- **What do high-pressure and low-pressure weather systems mean?**

Outcomes

Students will be expected to

- use weather data to describe and explain heat transfers in the hydrosphere and atmosphere showing how these affect air and water currents (331-2)

Materials

- air pump
- needle valve
- soccer ball or basketball
- balance scale

Safety ⚠

- Do not over-inflate the ball.
- Moisten the needle valve with tap water, not saliva.

Procedure

Write a procedure for the activity.

Results

Record the masses of the empty ball and inflated ball.

Analysis

- Compare the masses of the empty ball and inflated ball.
- Use your findings to explain high- and low-pressure weather systems.

Teacher Notes

Background Information

Sometimes students have difficulty comprehending the idea that air has mass and is attracted to Earth by gravity. This activity helps students understand the concept of air pressure and the difference between low-pressure systems and high-pressure systems.

Materials

- balance
- bicycle pumps (students may bring them from home)
- needle valves (may be borrowed from the physical education teacher)
- soccer balls or basketballs

Procedure

Measure the mass of the deflated "empty" soccer ball using a balance. Then pump up the ball to its designated pressure and re-measure its mass. The inflated ball has more air molecules inside it and therefore has greater mass than the deflated ball. Have the students hold the deflated ball over their head and ask how much pressure it is exerting down on them. Ask the students to hold the more massive inflated ball over their head and ask, "Compared to the deflated ball of lower mass, how much pressure does the inflated ball apply to you?" The high-pressure ball is the equivalent of the high-pressure system and the deflated ball is the equivalent of the low-pressure system.

Suggestions for Extension and Follow-up

Ask students to hold the inflated ball (the one with greater pressure inside) over their head and tell which ball applies more pressure to their hands/body, the ball with high-pressure or the low-pressure one. Which ball has greater density of molecules? Which kind of pressure system has a greater density of molecules?

Appendix E: Chemical Ion Cards

The following chemical ion cards may be used with Activity 14: It's in the Cards. Teachers may wish to make multiple copies for students' use.

Ba^{2+}	Be^{2+}
Cu^{2+}	$Sr^{2}+$
Na^{+}	Mg^{2+}
Cu^{3+}	Sc^{3+}
Ca^{2+}	Ag^{+}
Fe^{2+}	Al^{3+}
Li^{+}	K^{+}

H^+	Hg^{2+}
Pb^{2+}	V^{3+}
Fe^{3+}	Sn^+
Zn^{2+}	Ni^{3+}
Cr^{3+}	Rb^+
NO_3^+	HCO_3^-
CrO_4^-	S^{2-}

NO_2^{-}	PO_4^{3-}
AsO_4^{2-}	O^{2-}
SO_4^{2-}	HPO_4^{2-}
$C_2H_3O_2^{-}$	F^{-}
SO_3^{2-}	NH_4^{+}
$H_2PO_4^{-}$	N^{3-}
HSO_4^{2-}	OH^{-}

I^-	Br^-
CO_3^{2-}	ClO_4^-
Cl^-	P^{3-}

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