DISCOVERING SCIENCE 9
TEACHER'S RESOURCE

UNIT 1: ATOMS, ELEMENTS, AND COMPOUNDS

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McGraw-Hill Ryerson

UNIT 1: OVERVIEW

Unit 1 provides students with an introduction to the study of chemistry by focussing on atoms and elements as the basic building blocks of matter. Understanding how elements combine to make compounds leads to the study of naming as well as an introduction to chemical change. As the photograph on the opening page shows, we can now visualize matter on the atomic scale. We are also beginning to control individual atoms to the point where materials can be built atom by atom.

Throughout this unit, models about the nature of matter and its transformations are at the heart of the numerous explorations and activities. In Chapter 1, safety in the science classroom is followed by an examination of how atomic theory explains the composition and behaviour of matter. In Chapter 2, students apply some of what they learned in Chapter 1 to the study of elements as the basic building blocks of matter. In Chapter 3, students venture into the field of chemical compounds, distinguishing between ionic and covalent compounds and seeing how they can be transformed during chemical and physical changes.

Chapter 1: Atomic theory explains the composition and behaviour of matter.
Understanding basic concepts of how to work safely in a laboratory setting is an important precursor to studying science through active participation in laboratory activities. Chapter 1 starts by reviewing safety rules, WHMIS symbols, and other hazard symbols. With this beginning, a framework of safe conduct in the laboratory is established.

Students are then introduced to matter and its physical and chemical properties. This concept will be picked up in Chapter 2 when describing the elements, as well as in Chapter 3, when students distinguish between ionic and covalent compounds and between physical and chemical change.

The last part of the chapter looks at a brief history of the study of atoms through the eyes of Dalton, Thomson, Rutherford, and Bohr. Students are encouraged to consider different atomic theories as a refinement that resulted from layer upon layer of new information that came from classic experiments. A model for the atom is presented, which identifies and locates protons, neutrons, and electrons within the atom and describes some of their properties.

Chapter 2: Elements are the building blocks of matter.
Elements are the focus of Chapter 2, and within that subject, students are exposed to the names and symbols of a group of important elements, take a "tour" of a smaller set of them, and then classify elements, first according to their properties and then by the arrangement of electrons in energy levels.

As a central organizing principle for the elements, the periodic table is examined and the meanings of atomic number, atomic mass, and mass number are examined. Four important families (alkali metals, alkaline earth metals, halogens, and noble gases) are identified. Trends within the periodic table, such as the location of metals, metalloids, and non-metals, as well as the location of transition metals and gases, are examined. In relating atomic theory to the Bohr-Rutherford periodic table, students will be led to discover that Bohr diagrams for atoms and ions of the elements present a stunning pattern when related to the position of elements within the periodic table.

Chapter 3: Elements combine to form compounds.
The last chapter of Unit 1 begins by revealing that most compounds fall into one of two categories of compounds—covalent or ionic—based on whether they form by sharing electrons between atoms or by transferring electrons between atoms, producing ions that are then held together by electrostatic attraction. Names of ionic compounds are an important focus for this chapter. Students study simple binary compounds made of only a metal and a non-metal.

Chapter 3 concludes with an introductory study of chemical versus physical change and how these changes can be observed and described. Applications of chemical change related to harnessing combustion, preventing corrosion, and producing traditional materials are examined.

MULTIPLE INTELLIGENCES CORRELATION FOR UNIT 1 ACTIVITIES AND INVESTIGATIONS

The table below shows the multiple intelligences engaged in the activities and investigations for this unit, in order to help you plan for differentiated instruction in your science lessons, as your students require. For more information about differentiated instruction and multiple intelligences, see the Introduction and Implementation section in this Teacher's Resource.

Multiple Intelligences:	VL	VS	BK	MR	LM	N	E	IA	IE
UNIT 1: Atoms, Elements, and Compounds									
Find Out Activity: Combining Chemicals	■	■	■					■	■
Chapter 1: Atomic theory explains the composition and behaviour of matter.									
Think About It Activity 1-1A: Science Lab Safety	■	■					■		■
Think About It Activity 1-1B: Safety Guidelines for Your Lab	■	■			■		■		■
Find Out Activity 1-2A: Bag of Change	■	■	■		■			■	■
Think About It Activity 1-2B: A Chemical Family	■	■			■		■		■
Conduct an Investigation 1-2C: Physical and Chemical Properties	■	■	■		■			■	■
Think About It Activity 1-3A: The People Behind the Atom	■	■			■		■		■
Conduct an Investigation 1-3B: Slivers of Silver	■	■	■		■			■	■
Chapter 2: Elements are the building blocks of matter.									
Find Out Activity 2-1A: Meet the Elements	■	■	■		■			■	■
Conduct an Investigation 2-1B: Generating and Burning Hydrogen Gas	■	■	■		■			■	■
Think About It Activity 2-1C: Essential Elements	■	■			■			■	■
Think About It Activity 2-2A: Understanding the Periodic Table	■				■			■	
Think About It Activity 2-2B: The Modern Periodic Table	■	■			■			■	■
Think About It Activity 2-3A: Looking for Patterns in Atoms	■	■			■			■	■
Conduct an Investigation 2-3B: Flaming Metal Ions	■	■	■		■			■	■
Chapter 3: Elements combine to form compounds.									
Find Out Activity 3-1A: The Synthesis of Oxygen	■	■	■		■			■	■
Conduct an Investigation 3-1B: The Synthesis and Detection of Copper	■	■	■		■			■	■
Find Out Activity 3-2A: What's in a Name?	■	■			■			■	■
Find Out Activity 3-3A: Magnesium in Dilute Acid	■	■	■		■			■	■
Design an Investigation 3-3B: Detecting Vitamin C in Fruit Drinks	■		■		■			■	■
Core Lab Conduct an Investigation 3-3C: Observing Changes in Matter	■	■	■		■			■	■
Unit 1 Project: Corroding Nails	■	■	■		■			■	■
Unit 1 Integrated Research Investigation: Chemical Contents	■		■		■				■

Multiple Intelligence codes:
VL = Verbal-Linguistic Intelligence; VS = Visual-Spatial Intelligence; BK = Body-Kinesthetic Intelligence; MR = Musical-Rhythmic Intelligence; LM = Logical-Mathematical Intelligence; N = Naturalist Intelligence; E = Existential Intelligence; IA = Intrapersonal Intelligence; IE = Interpersonal Intelligence

Planning Chart for Activities and Investigations for Unit 1: Atoms, Elements, and Compounds

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
UNIT 1: Atoms, Elements, and Compounds			
Find Out Activity: Combining Chemicals	• 1 day before: – Gather chemicals and equipment.	For each group: – 400 mL beaker – 50 mL water – 150 mL vinegar – 5 raisins – 25 g baking soda	• 20 min
Chapter 1: Atomic theory explains the composition and behaviour of matter.			
Think About It Activity 1-1A: Science Lab Safety	• Day of instruction: – Have a clear policy regarding the place of backpacks, electronic devices, and suitable attire in your lab setting.	None	• 15 min
Think About It Activity 1-1B: Safety Guidelines for Your Lab	• 1 day before: – Gather materials.	For each group: – poster paper (could be legal-sized paper) – coloured markers, pencil crayons, or paints	• 20 min
Find Out Activity 1-2A: Bag of Change	• 1 day before: – Gather materials and apparatus. – Practise the activity so you can identify the changes and observe what happens when a bag over-inflates.	For each group: – Chemical A (sodium hydrogen carbonate powder, $NaHCO_3$) – Chemical B (calcium chloride powder, $CaCl_2$) – Chemical C (bromothymol blue indicator solution) – 2 small spoons for measuring A and B – 50 mL graduated cylinder – 2 resealable plastic bags – water	• 30 min
Think About It Activity 1-2B: A Chemical Family	• Day of instruction: – Optional: Photocopy BLM 1-11, A Chemical Family.	None	• 20 min
Conduct an Investigation 1-2C: Physical and Chemical Properties	• 1 week before: – Ensure that all of the metal samples are ordered/available. • 1 day before: – Gather apparatus and materials. – Prepare hydrochloric acid solution. – Ensure students know how to use a Bunsen burner. – Optional: Photocopy BLM 1-6, Using a Bunsen Burner.	For each group: – Bunsen burner or propane burner – 5 cm metal strips of aluminum, magnesium, iron, copper, silver, lead – small pieces of aluminum, magnesium, iron, copper, silver, lead – steel wool – hydrochloric acid (1.0 mol/L solution) in a dropper bottle – bar magnet – tongs – heat resistant pad – electrical conductivity kit	• 40 min
Think About It Activity 1-3A: The People Behind the Atom	• 1 week before: – Book the library or computer lab, if desired. – Decide what sort of format(s) will be accepted for this investigation. – Consider whether assessment rubrics will be used.	For each student: – access to the Internet and/or other research material	• 40 min

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
Conduct an Investigation 1-3B: Slivers of Silver	• 1 week before: – Prepare silver nitrate solution and get pieces of copper ready. – Ensure a class set of microscopes and slides is available.	For each group: – microscope slide – microscope – copper ribbon – silver nitrate solution in dropper bottle	• 20 min
Chapter 2: Elements are the building blocks of matter.			
Find Out Activity 2-1A: Meet the Elements	• 1 day before (longer if elements must be collected): – Have a set of elements ready. – Optional: Photocopy BLM 1-15, Meet the Elements.	For class: – 1 set of elements – several conductivity testers – several magnets	• 30 min
Conduct an Investigation 2-1B: Generating and Burning Hydrogen Gas	• 1 day before: – Assemble the reagents and equipment. – Optional: Photocopy BLM 1-18, Assessing Attitudes.	For each group: – medium-diameter test tube – large-diameter test tube (to fit over medium test tube) – test tube rack – candle – matches – wooden splints – dilute hydrochloric acid solution (1.0 M HCl) – zinc metal (mossy) – test tube holder – chemical waste container	• 40 min
Think About It Activity 2-1C: Essential Elements	• 1 week before: – Book the library or computer lab, if desired. – Decide what sort of format(s) will be accepted for this investigation. – Consider whether assessment rubrics will be used.	For each student: – access to the Internet and/or other research material	• 30–60 min
Think About It Activity 2-2A: Understanding the Periodic Table	• No advance preparation necessary	None	• 15 min
Think About It Activity 2-2B: The Modern Periodic Table	• Day of instruction: – Photocopy BLM 1-21, Simplified Periodic Table. – Optional: Photocopy BLM 1-19, The Modern Periodic Table; and BLM 1-20, Groups in the Periodic Table.	For each student/group: – BLM 1-21, Simplified Periodic Table	• 30 min
Think About It Activity 2-3A: Looking for Patterns in Atoms	• 1 day before: – Photocopy BLM 1-22, Bohr-Rutherford Diagram Template; BLM 1-23, Looking for Patterns in Atoms; and BLM 1-26, Electron Arrangements of the First 20 Elements.	For each student/group: – coloured pencils or felt pens – Optional: BLM 1-22, Bohr-Rutherford Diagram Template; BLM 1-23, Looking for Patterns in Atoms; and BLM 1-26, Electron Arrangements of the First 20 Elements	• 15 min
Conduct an Investigation 2-3B: Flaming Metal Ions	• 2 days before: – Make the chemical solutions and ensure all equipment is ready.	For each group: – felt pen – 9 small test tubes – test tube rack – wooden splints that have been soaked in a selection of solutions containing metal ions – Bunsen burner – diffraction-grating glasses (optional)	• 30 min

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
Chapter 3: Elements combine to form compounds.			
Find Out Activity 3-1A: The Synthesis of Oxygen	• 1 day before: – Prepare chemicals and collect equipment.	For each group: – liquid dish soap – medium test tube in a test tube rack – 3% or 6% hydrogen peroxide solution (H_2O_2) – candle and lighter – scoopula – potassium iodide (KI) crystals – 2 wooden splints	• 30 min
Conduct an Investigation 3-1B: The Synthesis and Detection of Copper	• 1 day before: – Make the chemical solutions and ensure all equipment is ready.	For each group: – copper(II) chloride solution – two 400 mL beakers – aluminum foil – crucible tongs – waste container – dilute hydrochloric acid solution (HCl) – wooden splint – paper towel – Bunsen burner	• 40 min
Find Out Activity 3-2A: What's in a Name?	No advance preparation necessary	For each student/group: – periodic table, such as BLM 1-19, The Modern Periodic Table, or page 50 of the student textbook	• 10 min
Find Out Activity 3-3A: Magnesium in Dilute Acid	• 1 day before: – Get chemicals and equipment ready.	For each group: – one 400 mL beaker – 2 medium-sized test tubes – water – rubber stopper fitted with glass tubing – rubber tubing – another small piece of glass tubing to fit inside rubber tubing (optional) – dilute hydrochloric acid solution (1.0 M HCl) – magnesium metal – paper towel – test tube clamp or tongs – candle and lighter or matches – wooden splints	• 30 min
Design an Investigation 3-3B: Detecting Vitamin C in Fruit Drinks	• 1 day before: – Make the chemical solutions and ensure all equipment is ready.	For each group: – 1 vitamin C tablet, 100 mg or less – mortar and pestle – 100 mL beaker – water – stirring rod – 10 mL graduated cylinder – 2 medicine droppers – iodine-starch solution – up to 8 medium test tubes – samples of fruit juices or other beverages	• 40 min

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
Core Lab Conduct an Investigation 3-3C: Observing Changes in Matter	• 1 day before: – Make solutions and assemble equipment.	For each group: – calcium chloride solution ($CaCl_2$) – two 100 mL beakers – 100 mL graduated cylinder – 3 small test tubes, labelled "Ca^{2+} ion," "Li^+ ion," and "unknown ion" – 3 wooden splints – lithium carbonate solution – ring stand and ring – funnel – filter paper – Bunsen burner – crucible tongs – felt pen – test tube rack	• 40 min
Unit 1 Project: Corroding Nails	• 1 day before: – Assemble reagents and equipment.	For each group: – 6 test tubes – 6 iron nails – cotton ball – water – calcium chloride – vegetable oil – 2 stoppers – test tube holder	• 30 min to get started, then several minutes per day for up to a week to make observations
Integrated Research Investigation: Chemical Contents	• 1 week before: – Book library or computer lab, if desired. – Decide what sort of format(s) will be accepted for this investigation. – Consider whether assessment rubrics will be used.	For each group: – access to the Internet	• 60 min

TALKS AND TOURS

Speaker and field trip recommendations for Unit 1:

- Invite people who work in chemistry related fields to visit the class, such as pharmacists, foresters, estheticians, laboratory technicians, doctors, nurses, veterinarians, water quality control technicians, and environmental technicians.
- Visit places where chemistry is used on a regular basis, such as water testing plants, analytical laboratories, and the quality control department in a refinery.
- Ask a local college or university whether they have a speakers' bureau.
- Before booking a field trip or asking a speaker to come in, make sure the topic is interesting and appropriate for students and that the speaker will cover material that students will find engaging.

Unit 1 Blackline Masters

CONTENT-RELATED BLACKLINE MASTERS	ASSESSMENT-RELATED BLACKLINE MASTERS
UNIT BLM 1-1, Unit 1 Summary BLM 1-2, Unit 1 Key Terms BLM 1-36, Unit 1 Review—Concept Map and Table BLM 1-37, Unit 1 Test	
CHAPTER 1 BLM 1-3, Safety Symbols BLM 1-4, Using Material Safety Data Sheets BLM 1-5, Safety Scavenger Hunt BLM 1-6, Using a Bunsen Burner BLM 1-7, Using a Hot Plate BLM 1-8, Using a Balance BLM 1-9, Science Equipment BLM 1-10, Physical and Chemical Properties of Matter BLM 1-11, A Chemical Family BLM 1-12, Parts of the Atom Concept Map BLM 1-13, Subatomic Particles BLM 1-14, Chapter 1 Quiz	• Assessment Checklist 1, Making Observations and Inferences • Assessment Checklist 9, Oral Presentation • Assessment Checklist 10, Computer Slide Show Presentation • Assessment Checklist 11, Poster • Assessment Checklist 12, Classification System • Assessment Checklist 14, Events Chain or Flowchart • Assessment Checklist 24, K-W-L Assessment Checklist • Assessment Checklist 25, Safety Checklist • Process Skills Rubric 2, Hypothesizing • Process Skills Rubric 4, Problem Solving • Process Skills Rubric 8, Interpreting Data • Assessment Rubric 5, Conduct an Investigation • Assessment Rubric 7, Scientific Research Planner Rubric • Assessment Rubric 8, Research Project Rubric • Assessment Rubric 9, Collecting Information Rubric • Assessment Rubric 10, Presentation Rubric • Assessment Rubric 11, Communication Rubric • Assessment Rubric 12, Using Tools, Equipment, and Materials Rubric
CHAPTER 2 BLM 1-15, Meet the Elements BLM 1-16, Symbols for Elements BLM 1-17, Common Elements BLM 1-18, Assessing Attitudes BLM 1-19, The Modern Periodic Table BLM 1-20, Groups in the Periodic Table BLM 1-21, Simplified Periodic Table BLM 1-22, Bohr-Rutherford Diagram Template BLM 1-23, Looking for Patterns in Atoms BLM 1-24, Bohr-Rutherford Diagrams BLM 1-25, Bohr-Rutherford Diagrams of the First 18 Elements BLM 1-26, Electron Arrangements in the First 20 Elements BLM 1-27, Chapter 2 Quiz	• Assessment Checklist 1, Making Observations and Inferences • Assessment Checklist 4, Laboratory Report • Assessment Checklist 9, Oral Presentation • Assessment Checklist 10, Computer Slide Show Presentation • Assessment Checklist 11, Poster • Assessment Checklist 12, Classification System • Assessment Checklist 13, Concept Map • Assessment Checklist 18, Data Table • Assessment Checklist 24, K-W-L Assessment Checklist • Assessment Checklist 25, Safety Checklist • Process Skills Rubric 1, Developing Models • Process Skills Rubric 7, Predicting • Process Skills Rubric 8, Interpreting Data • Process Skills Rubric 9 Questioning • Assessment Rubric 3, Co-operative Group Work Rubric • Assessment Rubric 5, Conduct an Investigation Rubric • Assessment Rubric 12, Using Tools, Equipment, and Materials Rubric
CHAPTER 3 BLM 1-28, Anatomy of a Chemical Formula BLM 1-29, Chemical Bonds Concept Map BLM 1-30, Researching a Compound BLM 1-31, Kitchen Chemistry BLM 1-32, Chemical Formulas BLM 1-33, Forming Ionic Bonds BLM 1-34, Ionic Bonding BLM 1-35, Chapter 3 Quiz	• Assessment Checklist 1, Making Observations and Inferences • Assessment Checklist 2, Asking Questions • Assessment Checklist 3, Designing an Experiment • Assessment Checklist 6, Developing Models • Assessment Checklist 11, Poster • Assessment Checklist 13, Concept Map • Assessment Checklist 24, K-W-L Assessment Checklist • Assessment Checklist 25, Safety Checklist • Process Skills Rubric 1, Developing Models • Process Skills Rubric 3, Controlling Variables • Process Skills Rubric 6, Designing Experiments • Process Skills Rubric 10, Measuring and Reporting • Assessment Rubric 1, Concept Rubric • Assessment Rubric 3, Co-operative Group Work Rubric • Assessment Rubric 5, Conduct an Investigation Rubric • Assessment Rubric 6, Design Your Own Investigation Rubric • Assessment Rubric 11, Communication Rubric • Assessment Rubric 12, Using Tools, Equipment, and Materials Rubric

Teaching Notes
for
Pages 2 to 105 of the Student Textbook