Observatory: The Environment, Second Year of Secondary Cycle Two
Teacher's Guide B

SCIENCE LABS

Overview chart

This overview of the science labs provides a variety of information. The first column in the chart contains the lab number and, in parentheses, the number of the relevant student-book chapter. The second column contains the title of the lab and, in parentheses, the lab type (technique, observation or experiment). Concepts related to the lab appear in the third column. The fourth column indicates the source program or programs for the lab content: ST for Science and Technology, EST for Environmental Science and Technology, AST for Applied Science and Technology and SE for Science and the Environment. Finally, the last column contains a list of the materials for each lab.

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 1 (Chapter 1)	Metals and nonmetals (Observation)	Groups and periods of the periodic table	ST EST SE	• strip of copper • piece of emery paper • electrical conductivity detector • dropper bottle of acid • universal clamp • retort stand • crucible tongs • a few pieces of paraffin (small shavings) • alcohol burner • piece of sulphur • strip of iron • piece of carbon • strip of zinc • strip of aluminum • strip of nickel

NOTE TO TEACHERS OR LAB TECHNICIANS

– You could ask students to write their protocols themselves.

– Remind students that they must not heat the sulphur.

– Warning: The burner plates become very hot when the alcohol burner is lit. Please take the following precautions:
  • Instead of a universal clamp, you can use a clamp without a rubber covering or a thermometer clamp.
  • The countertop must be heat-resistant. Provide a container of water to cool the burner plates.

– The acid test could be done with powder or granules (magnesium, iron, etc.).

You will need the following materials:
• powder or granules (magnesium, iron, etc.)
• 7 test tubes (18 mm × 150 mm)
• test-tube rack
• spatula
• non-permanent marker
• dropper bottle of acid

Proceed as follows:
1. Using the spatula, place a small amount of powder (or granules) in a previously identified test tube.
2. Add a small amount of acid and observe the result.
3. Record any sign of reaction.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 2 (Chapter 1)	The concept of mole (Experiment)	Concept of mole	EST SE	• 25-mL graduated cylinder • balance (accurate to 0.01 g) • rubber stopper (No. 2) • tape for labelling • marker • solid in the form of powder or filings

NOTE TO TEACHERS OR LAB TECHNICIANS

– Divide the class into as many teams as there are elements available (C, S, Si, Cu, Al, Fe, Sn, etc.). For an enrichment activity, you can ask each team to find the origin of the name of their element, the year it was discovered, common uses for it, etc.

– If you are using toxic elements such as mercury, prepare the graduated cylinders in advance and seal them.

– You can also ask students to work with gases like nitrogen (N) or carbon dioxide (CO_2) and measure the volume with a balloon. Whatever the gas, its volume will be 22.4 L (22 400 cm^3). A balloon inflated to the right size will have a circumference of approximately 110 cm.

– The table opposite contains the values relevant to this lab for some common elements.

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Element	Atomic number (g/mol)	Molar mass	Density (g/cm^3)	Volume (cm^3)
Carbon (C)	6	12.01	1.8–3.5	6.67–3.43
Magnesium (Mg)	12	24.31	1.74	13.97
Aluminum (Al)	13	26.98	2.70	9.99
Silicon (Si)	14	28.09	2.33	12.06
Sulphur (S)	16	32.07	2.07	15.49
Manganese (Mn)	25	54.94	7.30	7.53
Iron (Fe)	26	55.85	7.89	7.08
Nickel (Ni)	28	58.69	8.90	6.59
Copper (Cu)	29	63.55	8.96	7.09
Zinc (Zn)	30	65.38	7.11	9.19
Tin (Sn)	50	118.71	7.29	16.28
Antimony (Sb)	51	121.76	6.61	18.42
Tungsten (W)	74	183.84	19.30	9.52
Lead (Pb)	82	207.20	11.35	18.26
Bismuth (Bi)	83	208.98	9.75	21.43

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 3 (Chapter 2)	Identifying ions by precipitation (Observation)	Ions	ST EST SE	• dropper bottle of a solution containing Ca^{2+} ions • spot plate • dropper bottle of 1 mol/L sodium hydroxide (NaOH) solution • dropper bottle of 1 mol/L sodium sulphate (Na_2SO_4) solution • glass stirring rod *or* toothpick • wash bottle of distilled water • dropper bottle of 0.5 mol/L solution containing Cu^{2+} ions • dropper bottle of 0.5 mol/L solution containing Fe^{2+} ions • dropper bottle of 0.5 mol/L solution containing Fe^{3+} ions • dropper bottle of 0.5 mol/L solution containing Mg^{2+} ions • dropper bottle of an unknown solution • disposal container

NOTE TO TEACHERS OR LAB TECHNICIANS

– You can give students a variety of unknown solutions.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 4 (Chapter 2)	Types of bonds (Observation)	Ionic bonds	EST SE	• balance • weighing pan • spatula • 2 100-mL beakers • 50-mL graduated cylinder • wash bottle of distilled water • dropper *or* graduated pipette • glass stirring rod • electrical conductivity detector • paper towels • 10 g sugar ($C_{12}H_{22}O_{11}$) • about 5 g table salt (NaCl) • about 5 g copper sulphate ($CuSO_4$)

NOTE TO TEACHERS OR LAB TECHNICIANS

– You could look at the table in Appendix 2 of the student book with students and point out that the melting point of ionic solids is higher than that of covalent solids.

– Make sure students understand that they must collect the $CuSO_4$ in disposal containers and not pour it down the classroom sink.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 5 (Chapter 2)	Measuring solubility (Technique)	Solubility	ST EST SE	• test tube (16 mm × 150 mm) with stopper (No. 0) • test-tube rack • balance (accurate to 0.01 g) • wash bottle of distilled water • 10-mL graduated cylinder • water-soluble solid (such as sugar or table salt) • spatula

NOTE TO TEACHERS OR LAB TECHNICIANS

– You could ask students to write their protocols themselves.

– Ideally, students should be given the opportunity to calculate the solubility of other solids than the test solid for this lab.

– Students could work in teams and compare their results. Each student would thus measure the solubility of some, but not all, of the solids you provided for this lab.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 6 (Chapter 2)	Preparing a solution by dissolving a solid in a solvent (Technique)	Dissolution	ST EST SE	• balance (accurate to 0.01 g) • weighing pan • 10 g of a coloured, water-soluble solid • 25-mL graduated cylinder • spatula • wash bottle of distilled water • glass stirring rod • test tube (18 mm × 150 mm) with stopper (No. 1) • test tube (18 mm × 150 mm) containing a control solution • test-tube rack

NOTE TO TEACHERS OR LAB TECHNICIANS

– You could ask students to write their protocols themselves.

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Lab number (Srudent book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 7 (Chapter 2)	Preparing a solution by dilution (Technique)	Dilution	ST EST SE	• test-tube rack • 2 test tubes (18 mm × 150 mm) with stoppers (No. 1) • solution with a concentration of 10 g/L • 25-mL graduated cylinder • 50-mL graduated cylinder • 100-mL beaker • wash bottle of distilled water • glass stirring rod

NOTE TO TEACHERS OR LAB TECHNICIANS

– You could have students work in teams and compare their results.

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Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 8 (Chapter 2)	Concentration in ppm (Experiment)	Concentration (ppm)	ST EST SE	• balance (accurate to 0.01 g) • weighing pan • spatula • 1 g of a coloured, water-soluble solid • 100-mL graduated cylinder • dropper *or* graduated pipette • wash bottle of distilled water • glass stirring rod • 4 test tubes (18 mm × 150 mm) with stoppers (No. 1) • tape for labelling • marker • test-tube rack

NOTE TO TEACHERS OR LAB TECHNICIANS

– Solutions can be prepared with fruit drink crystals, which are inexpensive and easy to find. They smell good, however, so some students cannot resist tasting them! You can also use NaCl coloured with food colouring. Prepare a large enough amount so that the solution for all the lab experiments is the same shade.

– Remove the glass stirring rod from the graduated cylinder before adjusting the volume of the solution.

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Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 9 (Chapter 2)	Preparing a solution (Technique)	Concentration (mol/L)	EST SE	• balance • beaker • weighing pan • spatula • 10 g copper sulphate • 25-mL graduated cylinder • wash bottle of distilled water • dropper *or* graduated pipette • glass stirring rod • test tube (18 mm × 150 mm) with stopper (No. 1) • test tube (18 mm × 150 mm) containing a control solution with stopper (No. 1) • test-tube rack

NOTE TO TEACHERS OR LAB TECHNICIANS

– Since this lab focuses on preparing a solution by dissolving a solute in a solvent, you may prefer not to use copper sulphate because its disposal is regulated. An alternative solute is NaCl coloured with food colouring. Prepare a large enough amount so that the solute for all the lab experiments is the same shade.

– You do not need one test tube of control solution per student or team. A single test tube, in a rack on your desk, is sufficient and will give you the opportunity to check students' calculations and procedure.

– Remove the glass stirring rod from the graduated cylinder before adjusting the volume of the solution.

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Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 10 (Chapter 2)	Electrical conductivity (Observation)	Electrical conductivity	ST EST SE	• spot plate • paper towels • dropper bottle of milk • electrical conductivity detector • wash bottle of distilled water • dropper bottle of apple juice • dropper bottle of shampoo • dropper bottle of coffee • dropper bottle of window cleaner • dropper bottle of all-purpose cleaner • dropper bottle of tap water • dropper bottle of rubbing alcohol • dropper bottle of sugar water • dropper bottle of distilled water

NOTE TO TEACHERS OR LAB TECHNICIANS

– You could look at the table in Appendix 2 of the student book with students and point out that ionic solids have a high melting point.

– You can buy distilled water in many superstores.

– Provide a disposal container for the products, a basin of soapy water and a basin of clear water. This will make it easier to wash the spot plates.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 11 (Chapter 2)	The strength of electrolytes (Experiment)	Strength of electrolytes	EST	• spot plate • pH meter *or* 4 strips of universal indicator paper • apparatus for determining electrical conductivity • nonpermanent marker • dropper bottle of 0.1 mol/L hydrochloric acid (HCl) solution • dropper bottle of 0.1 mol/L acetic acid (CH_3COOH) solution • dropper bottle of 0.1 mol/L citric acid ($C_6H_8O_7$) solution • dropper bottle of boric acid (H_3BO_3) solution • disposal container

NOTE TO TEACHERS OR LAB TECHNICIANS

– To determine the electrical conductivity of the solutions, use an experimental apparatus with a 100-W light bulb. Its light intensity will vary with the strength of the test acid.

– You can use other acids than those suggested in the list of materials.

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Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 12 (Chapter 2)	The pH of common substances (Observation)	pH scale	ST EST SE	• 9 strips of universal indicator paper (with pH colour scale) • dropper bottle of milk • dropper bottle of apple juice • dropper bottle of shampoo • dropper bottle of coffee • dropper bottle of window cleaner • dropper bottle of all-purpose cleaner • dropper bottle of tap water • dropper bottle of rubbing alcohol • dropper bottle of sugar water • dropper bottle of distilled water

NOTE TO TEACHERS OR LAB TECHNICIANS

– You could ask students to write their protocols themselves.

– You can use a spot plate for the pH tests.

Suggested procedure:

1. Label each well with a nonpermanent marker.
2. Place one or two drops of each product in its designated well.
3. Dip a strip of universal indicator paper in the milk.
4. Record the pH.
5. Repeat steps 3 and 4 with the other products.
6. Clean up and put away the materials.

Provide a disposal container for products, a basin of soapy water and a basin of clear water. This will make it easier to wash the spot plates.

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Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 13 (Chapter 3)	Energy efficiency (Experiment)	Energy efficiency	ST EST AST	• support ring • retort stand • wire-mesh screen • 100-mL graduated cylinder • wash bottle of distilled water • 3 100-mL beakers • beaker tongs • thermometer • burner containing alcohol • beam balance • matches • burner containing mineral oil • candle attached to a piece of cardboard

NOTE TO TEACHERS OR LAB TECHNICIANS

– You can use other fuels than those suggested in the list of materials—for example, fondue fuel.

– Keep the water as still as possible; stirring or shaking will alter the results.

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Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 14 (Chapter 3)	The distinction between heat and temperature (Experiment)	Distinction between heat and temperature	ST EST AST	**PART A** • balance • 2 100-mL beakers • wash bottle of distilled water • hot plate • 2 thermometer clamps • 2 thermometers • retort stand • stopwatch *or* watch • plastic pipette **PART B** • balance • 2 100-mL beakers • wash bottle of distilled water • 50 mL vegetable oil • hot plate • 2 thermometer clamps • 2 thermometers • retort stand • stopwatch *or* watch • 2 plastic pipettes **PART C** • balance • 2 100-mL beakers • wash bottle of distilled water • about 16 g ice cubes • hot plate • 2 thermometer clamps • 2 thermometers • retort stand • stopwatch *or* watch • 2 glass stirring rods • plastic pipette

NOTE TO TEACHERS OR LAB TECHNICIANS

– Choose between Labs 14 and 15 for EST students.

– Make sure students do not overheat the vegetable oil.

– To obtain comparable results, it is important to turn off the hot plate between experiments and let it cool completely.

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Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 15 (Chapter 3)	Factors influencing temperature variations (Experiment)	Relationship between heat energy, specific heat capacity, mass and temperature variations	EST SE	**PART A** • balance • 2 100-mL beakers • wash bottle of distilled water • hot plate • 2 thermometer clamps • 2 thermometers • retort stand • stopwatch *or* watch • plastic pipette **PART B** • balance • 2 100-mL beakers • wash bottle of distilled water • 50 mL vegetable oil • hot plate • 2 thermometer clamps • 2 thermometers • retort stand • stopwatch *or* watch • 2 plastic pipettes **PART C** • balance • 2 100-mL beakers • wash bottle of distilled water • about 16 g ice cubes • hot plate • 2 thermometer clamps • 2 thermometers • retort stand • stopwatch *or* watch • 2 glass stirring rods • plastic pipette

NOTE TO TEACHERS OR LAB TECHNICIANS

– Choose between Labs 14 and 15 for EST students.
– Make sure students do not overheat the vegetable oil.
– To obtain comparable results, it is important to turn off the hot plate between experiments and let it cool completely.
– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 16 (Chapter 3)	Thermal energy transfer in mixtures (Experiment)	Relationship between heat energy, specific heat capacity, mass and temperature variations	EST SE	• calorimeter • balance (accurate to 0.01 g) • 75 mL denatured alcohol • wash bottle of distilled water • 600-mL beaker • hot plate • beaker tongs • 50-mL graduated cylinder • thermometer • glass stirring rod • disposal container • paper towels • 75 mL vegetable oil • plastic pipette

NOTE TO TEACHERS OR LAB TECHNICIANS

– Students could work in teams, preparing only one mixture per team, and then share their results with other teams.
– You can use other substances than those suggested in the list of materials—for example, sand or antifreeze.
– The final temperature of a mixture can be calculated using the following formula:
$m_1c_1(T_f - T_{i1}) = -m_2c_2(T_f - T_{i2})$
– You can set up a hot plate at one or more workstations to ensure a constant supply of water at the right temperature, or you could use a coffeemaker.
– You can do the procedure with vegetable oil as a demonstration only, to prevent oil spatter on the lab counters.
– You can use a polystyrene foam cup instead of a calorimeter, but note that this material is not recyclable in Québec.
– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

SCIENCE LABS – Overview chart (*continued*)

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 17 (Chapter 3)	Potential energy (Experiment)	Relationship between potential energy, mass, acceleration and travel	EST SE	• about 450 g modelling clay • 4-L plastic container • 6 sheets of aluminum foil (8 cm × 8 cm) • 1-m ruler • 3 metal balls of different masses • balance

NOTE TO TEACHERS OR LAB TECHNICIANS

– Students could make their own modelling clay. By entering the words "modelling clay recipe"in a search engine, you will find many helpful links.

– Aluminum foil is used because it makes the impression of a ball in the modelling clay clearly visible.

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Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 18 (Chapter 3)	The relationship between constant speed, distance and time (Experiment)	Relationship between constant speed, distance and time	AST	• recording stopwatch • 2 C-clamps • bumper • cart • recording tape • adhesive tape • ruler

NOTE TO TEACHERS OR LAB TECHNICIANS

– If a constant speed is difficult to obtain manually, you can use a slow-moving battery- or spring-operated toy on wheels.

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Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 19 (Chapter 3)	Mass and weight (Observation)	Mass and weight	EST AST	• balance (beam, platform or electronic) • string (if necessary) • copper cylinder with hook • aluminum cylinder with hook • lead block with hook • object of your choosing: eraser, piece of metal, beaker, etc. • dynamometer

NOTE TO TEACHERS OR LAB TECHNICIANS

– You could ask students to write their protocols themselves.

– To help validate results, have students work with objects of known mass and weight.

– It is helpful to use samples for measuring specific gravity because they are equipped with hooks. This makes using the dynamometer easier.

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Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 20 (Chapter 3)	The effect of friction (Experiment)	Types of forces	AST	• pulley with attachments • string • block of wood (35 mm × 35 mm × 200 mm), fitted with a hook, its four sides covered with rubber, plastic, felt and sandpaper, respectively, and its mass written on one end (in kg) • ruler • set of weights with hooks • sheet of aluminum foil (150 mm × 200 mm) • a piece of stiff cardboard (250 mm × 400 mm) covered with aluminum foil

NOTE TO TEACHERS OR LAB TECHNICIANS

– To increase the mass of the wooden block, you can drill four or five holes (1 cm wide × 2 cm deep) in the block and fill them with metal pellets (lead, steel, etc.). Plug the holes with glue and cover the surface with one of the test materials for the lab (rubber, sandpaper, etc.).

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Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 21 (Chapter 3)	The equilibrium of two forces (Observation)	Equilibrium of two forces	AST	• 50-cm cord • 1-kg weight • 2 20-N dynamometers • dynamic cart

NOTE TO TEACHERS OR LAB TECHNICIANS

– Use a cart with a mass of about 1 kg for the best results.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 22 (Chapter 3)	Effective force (Experiment)	Effective force	EST SE	• balance • cart • inclined plane • modified protractor (with the part below the 0°–180° line removed) • dynamometer

NOTE TO TEACHERS OR LAB TECHNICIANS

– Inclined planes can be purchased. If a hook for the dynamometer is not provided with the inclined plane, you can use a C-clamp.

– You could also use a board at least 450 mm long, with a hook at one end.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 23 (Chapter 3)	Pascal's principle (Experiment)	Pascal's principle	AST	• 10-mL syringe • 2 30-mL syringes • 140-mL syringe • ruler • vernier caliper (optional) • 250-mL beaker • flexible tubing (about 2 mm internal diameter and 20 mm length)

NOTE TO TEACHERS OR LAB TECHNICIANS

– The presence of a small amount of air in the experimental apparatus is normal and will not affect results. However, you can remove the air from the system by doing the following: Expel the air by holding the first (30-mL) syringe vertically, with the flexible tubing pointing upward. In this way, the air will rise to the mouth of the tubing and escape when the plunger is pressed. Then, connect the second syringe, keeping the air in the system to a minimum.

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Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 24 (Chapter 3)	Buoyant force (Observation)	Archimedes' principle	AST	• 250-mL beaker • platform balance • 2-N dynamometer • universal clamp • retort stand • overflow can • 200-g weight fitted with a hook

NOTE TO TEACHERS OR LAB TECHNICIANS

– You can use a 250-mL graduated cylinder instead of a beaker to measure the volume of water displaced by the object.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 25 (Chapter 3)	Archimedes' principle (Observation)	Archimedes' principle	AST	• cork stopper (No. 6) • balance • 100-mL graduated cylinder • wash bottle of distilled water • rubber stopper (No. 2)

NOTE TO TEACHERS OR LAB TECHNICIANS

– Make sure that you choose stoppers of similar sizes.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 26 (Chapter 3)	The Cartesian diver (Observation)	Archimedes' principle	AST	• 2-L plastic bottle • dropper • 400-mL beaker
NOTE TO TEACHERS OR LAB TECHNICIANS Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw				

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 27 (Chapter 3)	Pressure in a liquid (Experiment)	Archimedes' principle	AST	• balance (accurate to 0.01 g) • 50-mL graduated cylinder • 3 containers of more than 1 L, each filled with a different liquid (water, methanol, ethylene glycol, saltwater solution, etc.) • 2 30-cm rulers • 1000-mL graduated cylinder *or* container more than 40 cm high • U-tube manometer • insulating tape • 40-cm glass stirring rod
NOTE TO TEACHERS OR LAB TECHNICIANS – You could ask students to write their protocols themselves. – You can build your own U-tube manometer; step-by-step instructions are easily found on the Internet. – Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw				

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 28 (Chapter 3)	Bernoulli's principle (Observation)	Bernoulli's principle	AST	• sheet of paper • ruler • pencil • adhesive tape • scissors • drinking straw
NOTE TO TEACHERS OR LAB TECHNICIANS Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw				

SCIENCE LABS – Overview chart (*continued*)

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 29 (Chapter 4)	The law of conservation of mass (Observation)	Law of conservation of mass	ST EST SE	• balance (accurate to 0.01 g) • balloon • sodium bicarbonate ($NaHCO_3$) • 2 25-mL graduated cylinders • 0.5 mol/L acetic acid (CH_3COOH) solution • 125-mL Erlenmeyer flask • disposal container • 2 100-mL beakers • 60 mL of 0.1 mol/L calcium chloride ($CaCl_2$) solution • 60 mL of 0.1 mol/L sodium carbonate (Na_2CO_3) solution • 60 mL of 0.1 mol/L hydrochloric acid (HCl) solution • dropper of phenolphthalein • 0.1 mol/L sodium hydroxide ($NaOH$) solution

NOTE TO TEACHERS OR LAB TECHNICIANS

– In addition to the reactions described in this lab, you could demonstrate an oxidation–reduction reaction with copper wire and 0.1 mol/L silver nitrate ($AgNO_3$) solution.

– If time permits, ask students to improve the experiment involving the emission of a gas by creating a truly closed system.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 30 (Chapter 4)	Stoichiometry (Observation)	Stoichiometry	EST SE	• balance (accurate to 0.01 g) • filter paper • 2 25-mL graduated cylinders • 0.5 mol/L calcium chloride ($CaCl_2$) solution • 0.5 mol/L sodium carbonate (Na_2CO_3) solution • 100-mL beaker • glass stirring rod • funnel • 125-mL Erlenmeyer flask • wash bottle of distilled water

NOTE TO TEACHERS OR LAB TECHNICIANS

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Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 31 (Chapter 4)	Endothermic and exothermic reactions (Observation)	Endothermic and exothermic reactions	EST SE	• wash bottle of distilled water • 25-mL graduated cylinder • polystyrene foam cup • balance • weighing pan • anhydrous calcium chloride ($CaCl_2$) • spatula • thermometer • retort stand • thermometer clamp • glass stirring rod • disposal container • 1.0 mol/L citric acid ($C_6H_8O_7$) solution • sodium bicarbonate ($NaHCO_3$)

NOTE TO TEACHERS OR LAB TECHNICIANS

– You can do a demonstration to show that a given solid dissolved in water may cause an endothermic reaction, but that once the solution passes its saturation point, the crystallization of the solid may raise the temperature of the system—which is an exothermic reaction. A good solid to use is sodium acetate (CH_3COONa), a salt. You can use 25 mm × 150 mm test tubes for the demonstration. First, supersaturate a solution in a test tube by adding a large amount of salt to the water (46.5 g/100 mL) and then heating the solution until the salt is completely dissolved. Allow the solution to cool slowly in a dust-free environment to prevent crystallization before the actual demonstration.

– In class, dissolve a large amount of sodium acetate in water and measure the temperature from time to time as energy is being absorbed. This is the endothermic reaction. Have students touch the test tube of supersaturated solution to show them that the solution is at room temperature. Next, drop a few crystals of sodium acetate into the solution and observe the crystallization. Now have students touch the test tube again to feel the heat of the exothermic reaction: the temperature of the solution will have risen dramatically (by about 50°C).

– If necessary, the same solution can be reused by reheating it and adding a little water.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 32 (Chapter 4)	A precipitation reaction (Observation)	Precipitation	SE	• spot plate • 6 dropper bottles, labelled A to F, containing the following solutions: – A: lead nitrate ($Pb(NO_3)_2$) – B: sodium iodide (NaI) – C: copper sulphate ($CuSO_4$) – D: potassium carbonate (K_2CO_3) – E: nickel chloride ($NiCl_2$) – F: sodium hydroxide ($NaOH$) • glass stirring rod *or* toothpick • wash bottle of distilled water • disposal container

NOTE TO TEACHERS OR LAB TECHNICIANS

– For satisfactory results, all solutions should have a concentration of 0.1 mol/L.

– Let the drops fall from the dropper to prevent contact between droppers and solutions, which could contaminate the solutions.

– Glass stirring rods must be rinsed after each use to avoid contaminating the solutions.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 33 (Chapter 4)	Neutralizing an acid with a base (Observation)	Acid–base neutralization reaction	ST EST SE	• 2 50-mL beakers • buffer solution (pH = 7) • litmus paper • universal indicator paper • dropper of litmus solution • 0.1 mol/L hydrochloric acid (HCl) solution • 100-mL beaker • 0.1 mol/L sodium hydroxide (NaOH) solution • disposal container

NOTE TO TEACHERS OR LAB TECHNICIANS

– This lab can be paired with the lab on titration so that students can relate the two concepts by realizing that a neutralization reaction can be used to determine the unknown concentration of one of the two substances involved.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 34 (Chapter 4)	Titration (Technique)	Acid–base neutralization reaction	ST EST SE	• 2 50-mL beakers, labelled *HCl* and *NaOH* • 25-mL burette • disposal container • burette clamp • retort stand • hydrochloric acid (HCl) solution of unknown concentration • 50-mL burette • 0.1 mol/L sodium hydroxide (NaOH) solution • 125-mL Erlenmeyer flask • dropper of bromothymol blue • sheet of white paper • wash bottle of distilled water

NOTE TO TEACHERS OR LAB TECHNICIANS

– It is best to repeat the titration to validate the results.

– Bromothymol blue is also a useful indicator because its endpoint is 7, but you must pay attention because it changes in colour from yellow (acidic) to green (neutral) and then to blue (basic).

– Placing a sheet of white paper under the Erlenmeyer flask will help students see colour changes in the solution more clearly.

– To make the titration easier, make sure that it can be done with the contents of just one burette of basic solution.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 35 (Chapter 4)	Copper oxidation (Observation)	Oxidation	AST	**PART A** • porcelain crucible • balance (accurate to 0.01 g) • spatula • powdered copper (Cu) • electrical conductivity detector • hot plate • crucible tongs • 30-cm glass stirring rod • stopwatch *or* watch (optional) • temperature-resistant gloves • heat-resistant plate (e.g. ceramic plate) **PART B** • test tube (25 mm × 150 mm) with one-hole stopper (No. 4) • balance (accurate to 0.01 g) • test-tube rack • porcelain crucible and its contents from Part A • carbon (C) (activated charcoal) • weighing pan • spatula • 30-cm glass stirring rod • retort stand • test-tube clamp • Bunsen burner • glass elbow tube • gas collection apparatus • 3 test tubes (18 mm × 150 mm) with stoppers (No. 1) • flexible tubing • stopwatch *or* watch (optional) • 50-mL beaker • wash bottle of distilled water • limewater • lighter *or* matches • wooden splints

NOTE TO TEACHERS OR LAB TECHNICIANS

– Students must be meticulous to do this experiment successfully:
- One difficulty is the risk of losing metal during heating.
- Wearing temperature-resistant gloves prevents injury but makes handling the glass stirring rod more difficult.
- Temperature-resistant gloves should not be worn when using crucible tongs because they make it difficult to hold the tongs.
- Once the three test tubes are filled, it is very important to remove the flexible tubing from the water before turning off the Bunsen burner.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 36 (Chapter 4)	Comparing combustion and cellular respiration (Observation)	Photosynthesis and respiration	ST EST SE	• candle • matches • Petri dish • wash bottle of distilled water • dropper bottle of phenol red • 600-mL beaker • disposal container • 100 mL limewater • 25-mL graduated cylinder • 2 100-mL beakers • 2 drinking straws

NOTE TO TEACHERS OR LAB TECHNICIANS

– It is important to remind students not to aspirate the limewater or phenol red solution. You could choose to do this part of the lab as a demonstration.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 37 (Chapter 4)	Gas from photosynthesis (Experiment)	Photosynthesis and respiration	ST EST SE	• 3 1000-mL beakers • 2700 mL of 0.1 mol/L sodium bicarbonate ($NaHCO_3$) solution • 3 bunches of fresh waterweed (*Elodea*) • 3 cutoff plastic funnels • 3 test tubes (15 mm × 125 mm) with stoppers (No. 0) • test-tube rack • lamp with 100-W bulb • dropper bottle of limewater • wooden splints • matches *or* lighter

NOTE TO TEACHERS OR LAB TECHNICIANS

– You can prepare limewater by adding calcium hydroxide ($Ca(OH)_2$) powder to distilled water (about 45 mL for 4 L of water) until the solution is saturated. Stir gently to prevent carbon dioxide (CO_2) from entering the solution. Remove the excess powder by decanting the solution.

– Prepare funnels 8 cm in diameter by cutting the stems 3 cm below the cone-shaped parts.

– If water plants other than waterweed are available, some teams might use them instead, to add variety to the lab and demonstrate that waterweed is not the only plant that releases oxygen.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 38 (Chapter 5)	Detecting static electricity (Observation)	Static electricity	ST EST AST	• leaf electroscope • glass stirring rod • scrap of wool *or* fur • ebonite rod

NOTE TO TEACHERS OR LAB TECHNICIANS

– Before using the instruments, make sure they are not charged. Touch the knob (or the plate, depending on the model) of the electrocope. Rinse the rods and air-dry them; do not wipe them with a paper towel or they may become charged again.

– Make sure students understand that a substance is charged by an excess of electrons (negative charge) or a shortage of electrons (positive charge).

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 39 (Chapter 5)	Charging an object (Observation)	Static electricity	ST EST AST	• strip of polyethylene • scrap of wool • retort stand • universal clamp • pith ball covered with metallic paint and suspended from a silk thread

NOTE TO TEACHERS OR LAB TECHNICIANS

– You can use strips of polypropylene instead of strips of polyethylene. Strips 260 mm × 26 mm in size work well.

– For cotton scraps (instead of wool), you can use old facecloths. Scraps 100 mm × 100 mm in size work well.

– Make sure the fabric is completely dry. Dry it before use and keep it in a desiccator.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 40 (Chapter 5)	Ohm's law (Experiment)	Ohm's law	ST EST AST	• variable power supply • ammeter • voltmeter • switch • 6 wires with alligator clips • 2 resistors (colour-coded or with the resistance value hidden)

NOTE TO TEACHERS OR LAB TECHNICIANS

– Resistors of less than 15 Ω may become hot, placing students at risk of burns.

– Note that when resistors heat up, their resistance values are affected, altering results. Students should therefore use the switch between readings to prevent the resistors from overheating and keep the current flowing continuously through the circuit.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 41 (Chapter 5)	Current intensity (Technique)	Electrical circuits	ST EST AST	• small light bulb with base • 6 wires with alligator clips • variable-intensity direct-current power supply • ammeter • switch

NOTE TO TEACHERS OR LAB TECHNICIANS

– Test the materials so that you can tell students how to adjust the power supply for the desired current intensity. If the amperage is too high, the light bulb will burn out.

– Ammeters are fragile instruments, and a power surge can easily damage them. It is very important to specify the maximum intensity of the direct-current power supply.

– Pay particular attention to the range levels because the units of measurement may vary.

– On some devices, if the needle points toward the 0 mark or indicates a negative reading, it means that the ammeter connections are reversed.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 42 (Chapter 5)	Electrical potential difference (Technique)	Electrical circuits	ST EST AST	• small light bulb with base • switch • 6 wires with alligator clips • variable-intensity direct-current power supply • voltmeter

NOTE TO TEACHERS OR LAB TECHNICIANS

– Test the materials so that you can tell students how to adjust the power supply for the desired power level. If the level is too high, the light bulb will burn out and the resistor will heat up. Some resistors may even explode.

– It is very important to specify the maximum intensity of the direct-current power supply.

– Pay particular attention to the range levels because the units of measurement may vary.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 43 (Chapter 5)	Kirchhoff's laws (Observation)	Kirchhoff's laws	EST	• variable-intensity direct-current power supply • 2 small light bulbs with bases • 20-Ω resistor • 10 wires with alligator clips • ammeter • voltmeter • switch

NOTE TO TEACHERS OR LAB TECHNICIANS

– A resistor can become very hot. For this reason, it is important to open the switch after each reading.

– The 20-Ω resistor can be replaced by a carbon electrode or other similar element to show students that resistors can be made of various materials.

– Alligator clips and enamelled copper wires sometimes oxidize, causing variations in equipment readings. Note that points of contact between different circuit elements may also be sources of error.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 44 (Chapter 5)	Magnets (Observation)	Forces of attraction and repulsion	ST EST AST	• 2 bar magnets • piece of cardboard (300 mm × 300 mm) • iron filings • compass • horseshoe magnet

NOTE TO TEACHERS OR LAB TECHNICIANS

– You can use a commercial kit to do this lab as a demonstration.

– Sometimes you have to tap the cardboard gently so that the iron filings align themselves with the magnetic field lines.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 45 (Chapter 5)	The magnetic field of a live wire (Observation)	Magnetic field of a live wire	ST EST AST	• electrical wire (200 mm long) • piece of stiff cardboard (about 200 mm × 200 mm) with a hole in the middle • 2 retort stands • 2 or 3 universal clamps • direct-current power supply • iron filings • 2 wires with alligator clips • compass

NOTE TO TEACHERS OR LAB TECHNICIANS

– You can use a piece of plexiglass instead of cardboard.

– The live wire can become very hot.

– You can use a commercial kit to do this lab as a demonstration.

– It is strongly recommended that you use very stiff cardboard to prevent it from bending under the weight of the compass or because of handling during the procedure.

– Two experimental setups were used to test this lab, and both worked well at all current intensities. In the first setup, we used No. 16 enamelled copper wire, and in the second setup, we used No. 22 plastic-coated aluminum wire. The second setup required a third universal clamp to hold the wires in the correct position.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 46 (Chapter 5)	The magnetic field of a solenoid (Observation)	Magnetic field of a solenoid	EST AST	• electrical wire (500 mm long) • piece of stiff cardboard (about 300 mm × 200 mm) with 8 holes in it • 2 retort stands • 2 universal clamps • direct-current power supply • iron filings • compass • 2 wires with alligator clips

NOTE TO TEACHERS OR LAB TECHNICIANS

– You can use a commercial kit to do this lab as a demonstration.

– The live wire can become very hot.

– You can use a piece of plexiglass instead of cardboard.

– Leave enough space between the two rows of four holes to insert the compass.

– It is strongly recommended that you use very stiff cardboard to prevent it from bending under the weight of the compass or because of handling during the procedure.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 47 (Chapter 5)	The effect of solenoid coils in an electric motor (Experiment)	Magnetic field of a solenoid	EST AST	• wide elastic band • 2 large metal paper clips (modified for the experiment) • D battery • 7-coil solenoid (solenoid with 7 turns) • permanent magnet • 14-coil solenoid • 21-coil solenoid

NOTE TO TEACHERS OR LAB TECHNICIANS

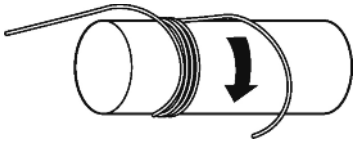
– Rectangular permanent magnets work best for this lab.

– For each team of students, prepare two paper clips by bending them into the shape below.

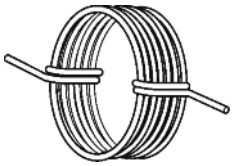
– When preparing the solenoids, the best wire to use is large-gauge enamelled copper wire.

– Follow these instructions to build the solenoids:

1. Starting about 10 cm from one end of the wire, wrap it around a cardboard toilet paper roll.
2. Make seven turns around the roll, taking care to place each new coil right beside the previous one.



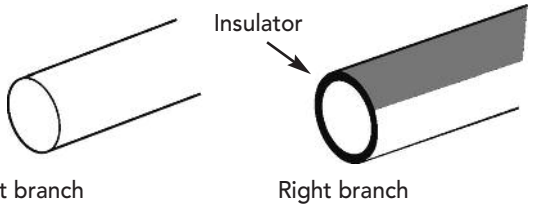
3. Remove the roll, leaving another 10-cm length of wire at the opposite end from your starting point. Cut the wire. The two branches at the ends of the solenoid should be equal in length.
4. Roll each branch once or twice around all seven coils as shown, forming two knots. Make sure the branches are perpendicular to the solenoid coils.



5. Repeat steps 1 to 4, making rotors of 14 and 21 coils for each team of students.

   Sanding the insulator on the solenoid branches:

   - For the **left** branch, leave about 1 cm of insulator at the end of the wire.
   - Remove the insulator from the rest of the branch by sanding.
   - For the **right** branch, leave about 1 cm of insulator at the end of the wire. On the rest of the wire, remove the insulator from only half of the branch.



– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 48 (Chapter 5)	Electromagnetic induction (Observation)	Electromagnetic induction	AST	• 2 wires with alligator clips • galvanometer • solenoid • bar magnet

NOTE TO TEACHERS OR LAB TECHNICIANS

– You can use a commercial kit to do this lab as a demonstration.

– You can use a multimeter instead of the galvanometer, but a galvanometer gives a more accurate reading.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 49 (Chapter 6)	Identifying minerals (Observation)	Minerals	ST EST AST	• 5 unidentified mineral samples • one-cent coin • steel knife *or* jackknife • streak plate (piece of unglazed porcelain)

NOTE TO TEACHERS OR LAB TECHNICIANS

– For each team of students, choose five minerals among those described in this lab. It would be interesting for each team to have a different set of minerals. Ideally, each team should have at least one allochromatic mineral (such as quartz, calcite or talc).

– Streak plates measuring 5 cm × 5 cm are suitable for this lab.

– Instead of providing students with the table of mineral properties, you can ask them to find this information on their own on the Internet or in books on mineralogy.

– Regarding magnetite and magnetic fields: you can show students that magnetite has magnetic properties because it attracts or repels a magnet.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 50 (Chapter 6)	Water retention in soil horizons (Observation)	Soil profile (horizons)	ST EST SE	• 4 filter papers • 4 250-mL Erlenmeyer flasks • scissors • 250-mL beaker • fine sand • distilled water • 100-mL graduated cylinder • stopwatch • 4 funnels • grass sod • black soil • spatula • gravel

NOTE TO TEACHERS OR LAB TECHNICIANS

– The pieces of grass sod you give students must cover the mouths of the funnels completely.

– Make sure the grass sod, black soil, fine sand and gravel are all dry.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 51 (Chapter 6)	Variations in soil pH (Experiment)	Buffering capacity of the soil	EST SE	• 3 400-mL beakers • garden soil • balance • sand • wash bottle of distilled water • 25-mL graduated cylinder • 3 glass stirring rods • forceps • 6 strips of universal indicator paper (with colour scale) • dropper bottle of 0.1 mol/L hydrochloric acid (HCl) • plastic pipette • disposal container

NOTE TO TEACHERS OR LAB TECHNICIANS

– You can use this lab to have students test various types of soil.

– Before disposing of the students' mixtures, it is best to neutralize them with lime or caustic soda (NaOH).

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 52 (Chapter 6)	Soil depletion (Experiment)	Soil depletion	EST	• 2 small empty plastic bottles • permanent marker • 2 funnels • fine sand • liquid fertilizer (Knop's solution) • distilled water • 2 bean seeds that have been soaked in water for a day • 2 cork stoppers, damp and perforated

NOTE TO TEACHERS OR LAB TECHNICIANS

– To make liquid fertilizer (Knop's solution): In 1 L of distilled water, dissolve 1 g of calcium nitrate, 0.25 g of potassium nitrate, 0.25 g of potassium phosphate and 0.25 g of magnesium sulphate.

– You can use 125-mL Erlenmeyer flasks instead of plastic bottles.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 53 (Chapter 6)	Sanitary landfills (Observation)	Contamination (lithosphere)	EST SE	• scissors • sturdy plastic bag • 30-cm ruler • 3 600-mL beakers • clear tap water • gravel • black soil • marker • forceps • piece of cheesecloth (200 mm × 200 mm) • 5 wide elastic bands • 250-mL beaker • graduated cylinder • dropper bottle of red food colouring • 12 pieces of sponge (25 mm × 25 mm × 25 mm)

NOTE TO TEACHERS OR LAB TECHNICIANS

– Sturdy plastic bags work very well for this experiment. Do not use ordinary plastic shopping bags.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 54 (Chapter 6)	A watershed (Observation)	Watershed	ST EST AST	• spot plate • dropper bottle of liquid fertilizer • dropper bottle of bromothymol blue • glass stirring rod • wet sand • 2 rectangular plastic containers • ruler • metal spatula • wash bottle of distilled water • glass dropper • 10-mL graduated cylinder • wooden stick, about 254 mm long and 15 mm high • marker

NOTE TO TEACHERS OR LAB TECHNICIANS

– It is important that the sand for this lab be already saturated with water at the beginning of the experiment.

– The containers used to test this lab were rectangular weighing pans measuring about 140 mm × 130 mm × 60 mm.

– Depending on the size of the plastic containers you use, you may have to adjust the amounts of water and fertilizer to add.

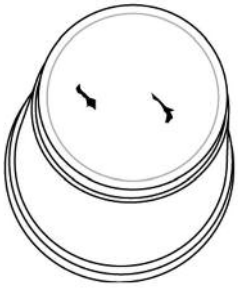
– The liquid fertilizer used to test this lab was a 20-20-20 solution diluted to a concentration of 4 mL/L.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 55 (Chapter 6)	Ocean circulation (Observation)	Ocean circulation	ST EST	• small plastic tub • tap water • polystyrene foam cup with 2 holes punched in the bottom • 25-cm length of adhesive tape • 10-cm length of adhesive tape • about 250 mL of a saltwater solution with food colouring added

NOTE TO TEACHERS OR LAB TECHNICIANS

– With scissors or another sharp object, prepare the polystyrene foam cup by punching two holes in the bottom as shown.



– To test this lab, we used a 35 g/L aqueous solution of table salt, to which we added a few drops of food coloring.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 56 (Chapter 6)	Eutrophication (Observation)	Eutrophication	EST SE	• spot plate • dropper bottle of a solution containing phosphate ions • dropper bottle of molybdate reagent solution • glass stirring rod • wash bottle of distilled water • 3 liquid test substances • 3 plastic pipettes

NOTE TO TEACHERS OR LAB TECHNICIANS

– To prepare 100 mL of molybdate reagent, dissolve 15 g of ammonium molybdate in 50 mL of distilled water. Add 40 mL of concentrated nitric acid. Add distilled water to obtain 100 mL of solution.

– One way of preparing a phosphate-ion solution is to dissolve 2 grams of $NaHPO_4$ in 100 mL of water.

– For the test solutions, you can ask students to bring in solutions of their own choice. It is important, however, to tell them not to choose foaming solutions, such as laundry detergent, or solutions that are yellow in colour, because their precipitate is yellowish.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

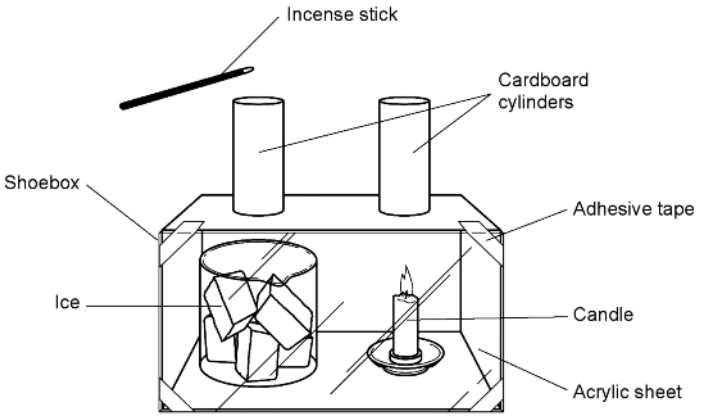
Lab number (Student book chapter)	Lab title (Type of lab)	Concepts	Programs	Materials
LAB 57 (Chapter 7)	Atmospheric circulation (Observation)	Atmospheric circulation, air mass	ST EST AST SE	• modified shoebox • ice • small candle • adhesive tape • lighter *or* matches • 2 cardboard cylinders • 250-mL beaker • sheet of acrylic • 2 incense sticks • ashtray

NOTE TO TEACHERS OR LAB TECHNICIANS

– This lab may be done as a demonstration to avert the risk of students' setting fire to a shoebox.

– Use shoeboxes without the lids.

– You will need to make two holes in each shoebox, at the points where the cardboard cylinders will be placed. See the experimental setup below.



– For this lab, you can use cardboard cylinders from toilet paper rolls.

– The acrylic sheet must be long enough and wide enough to cover the front opening of the shoebox completely. You can replace the acrylic sheet with plastic wrap, which must also cover the shoebox opening completely.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 58 (Chapter 7)	Relative humidity (Technique)	Air mass	ST EST AST	• 2 thermometer clamps • retort stand • 2 thermometers • piece of gauze • wash bottle of water • thin elastic band

NOTE TO TEACHERS OR LAB TECHNICIANS

– It would be helpful to have a digital psychrometer in the classroom. Students could then compare the relative humidity value they obtained experimentally with the value on the psychrometer.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 59 (Chapter 7)	The greenhouse effect (Experiment)	Greenhouse effect	ST EST SE	• 2 thermometer clamps • retort stand • 2 thermometers • 710-mL green plastic bottle with its cap, perforated • 250-W infrared lamp • stopwatch

NOTE TO TEACHERS OR LAB TECHNICIANS

– It is not absolutely necessary to keep the cap on the bottle in this lab, but it helps create greater variations in temperature.

– The results suggested in the answer key were obtained with a green plastic bottle.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 60 (Chapter 7)	Air pollution (Observation)	Contamination (atmosphere)	EST SE	• stibnite (Sb_2S_3) *or* another metallic sulphide (FeS_2, ZnS, PbS, etc.) • test tube (25 mm × 150 mm) • retort stand • universal clamp • two-hole stopper (No. 4) fitted with 2 glass elbow tubes • wash bottle of distilled water • 250-mL beaker • dropper of litmus solution • 2 strips of universal indicator paper • 60-cm flexible tubing • 15-cm flexible tubing • syringe • adhesive tape • Bunsen burner • lighter

NOTE TO TEACHERS OR LAB TECHNICIANS

Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 61 (Chapter 7)	Energy from the sun (Experiment)	Solar energy flow	ST EST AST	• 3 pieces of black cardboard (12 cm × 6 cm) • stapler • 250-W infrared lamp • universal clamp • 3 thermometers • retort stand • stopwatch

NOTE TO TEACHERS OR LAB TECHNICIANS

– Thermometer clamps can be used to hold thermometers in the different positions.
– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 62 (Chapter 8)	Terrestrial biomes (Observation)	Terrestrial biomes	ST EST	• 2-L milk carton • 30-cm ruler • 10 impatiens seeds • watering can • elastic bands • switch with an automatic timer • spray bottle of tap water • stapler • black soil • 5 bean seeds • tap water • lamp • scissors • dry sand • 30 grass seeds • plastic wrap

NOTE TO TEACHERS OR LAB TECHNICIANS

– If it is difficult for you to give your students daily access to their cartons, you could let them take their boxes home, or you could do this experiment as a demonstration only.
– Seeds for all three types of plants grown in this lab are usually available at garden centres.
– You can assign setups to students so that the same number of teams explores each set of growing conditions.
– You can limit the need for lamps and switches by grouping together cartons that need the same light conditions.
– Because this lab involves living matter, results can vary dramatically. The goal is not to grow a miniature garden, however, but to recreate certain conditions in terrestrial biomes so that students can understand the concept of a biome.
– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 63 (Chapter 8)	An artificial aquatic biome (Technique)	Aquatic biome	ST EST	• large plastic container • liquid antibacterial soap • strainer • aquatic plants • decorative items for an aquarium (optional) • long wooden spoon • functional aquarium • 2 or 3 pond snails (*Lymnaeidae*) • thermometer • pH scale • Siamese fighting fish • fish net • 250-mL graduated cylinder • brush • sand *or* gravel • dropper • universal indicator paper • goldfish • guppies

NOTE TO TEACHERS OR LAB TECHNICIANS

– You can buy aquatic plants, snails and freshwater fish for aquariums at pet shops or from biological supply companies.
– Aquatic plants such as *Elodea, Myriophyllum* and *Bacopa* are good choices for the artificial biomes students build in this lab.
– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 64 (Chapter 9)	Methods for measuring the size of a population (Technique)	Study of populations (density, biological cycles)	ST EST	• 50 or more marbles in a plastic container with lid • marker • damp cloth

NOTE TO TEACHERS OR LAB TECHNICIANS

– Use marbles that are all the same size.

– To test this lab, we used a 700-mL plastic spaghetti-sauce container (with its cover).

– You may wish to vary the number of marbles given to each team. Following the suggested protocol, each team would still have at least 50 marbles.

– Marbles are available in many stores, at reasonable cost.

– You can modify the protocol by omitting to specify the number of marbles to mark and draw (recapture). In this case, students must complete the entire table of results on their own.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 65 (Chapter 9)	Population density (Technique)	Study of populations (density, biological cycles)	ST EST	• tape measure • aquarium containing goldfish • 600-mL beaker containing soil and earthworms • plastic bin • spatula • students of the class

NOTE TO TEACHERS OR LAB TECHNICIANS

– To save time in this lab, you can write the volume of water in the aquarium and the area of the classroom on the board.

– You have to prepare one 600-mL beaker containing a total volume of 500 mL of soil and earthworms for each team. You may wish to vary the number of earthworms in the beakers so that the teams' results will be different.

– Because some soil may be lost during each lab session, remember to top up the soil volume in each beaker to 500 mL between classes.

– If you have access to more than one aquarium, you may wish to compare their population densities. For example, two aquariums of different sizes but with the same number of fish will help students understand variations in density.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 66 (Chapter 9)	Ecological factors (Observation)	Study of populations (density, biological cycles)	ST EST	• cardboard box *or* opaque, rectangular plastic container • black soil • light source • sandpaper • spray bottle of water • piece of cardboard • 4 earthworms • dry sand

NOTE TO TEACHERS OR LAB TECHNICIANS

– If students are reluctant to handle earthworms, you can do this lab as a demonstration.
– To test this lab, we used an empty 3.3-kg laundry detergent box.
– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 67 (Chapter 10)	Vermicomposting (Technique)	Dynamics of ecosystems (material and energy flow)	ST EST AST	• soldering iron • 2 2-L plastic containers with lids • geomembrane • 4 wooden blocks (254 mm × 254 mm) • newspaper (black ink only) • potting soil • balance • metal spatula • polystyrene foam cup • sand • wash bottle of tap water • redworms • ruler

NOTE TO TEACHERS OR LAB TECHNICIANS

– To test this lab, we used 2-L ice cream containers.
– Redworms (*Eisenia foetida*) can be purchased from suppliers of vermicomposting products or biological supply companies.
– You need bagged soil without additives for this lab. Avoid peat moss because it is too acidic.
– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 68 (Chapter 10)	Primary productivity (Experiment)	Dynamics of ecosystems (primary productivity)	ST EST AST	• 5 1000-mL beakers • 4 equally sized bunches of fresh waterweed • 5 funnels • 5 test tubes (15 mm × 125 mm) with stoppers (No. 00) • test-tube rack • opaque box • refrigerator with 100-W light bulb that stays on at all times • tap water • 100-W lamp • refrigerator without a light bulb

NOTE TO TEACHERS OR LAB TECHNICIANS

– You can do Lab 37 to demonstrate experimentally that the gas released by waterweed is oxygen.
– If other plants than waterweed are available, you could vary teams' plants to show that temperature and light affect the primary productivity of ecosystems containing plants other than waterweed.
– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Programs	Materials
LAB 69 (Chapter 10)	The toxicity threshold (Observation)	Ecotoxicology (contaminants)	EST SE	• plastic pipette • 3 daphnia • 3 cavity slides • 3 microscopes • dropper bottle of distilled water • dropper bottle of 10% alcohol solution • dropper bottle of 50% alcohol solution

NOTE TO TEACHERS OR LAB TECHNICIANS

– To avoid using too many microscopes, it is best to have students work in teams of three.

– To test this lab, we used denatured alcohol.

– Daphnia are available from biological supply companies.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw

Lab number (Student book chapter)	Lab title (Type of lab)	Concept	Program	Materials
LAB 70 (Chapter 11)	Character traits (Observation)	Character traits	EST	• 3 sealed test tubes, numbered 1 to 3, each containing a different pure line of fruit flies • test-tube rack • magnifying glass • light source

NOTE TO TEACHERS OR LAB TECHNICIANS

– Different strains of fruit flies can be procured from biological supply companies. Wild-type strains have red eyes and normal wings. Usually, when you purchase fruit flies, the supplier will provide you with instructions on how to transfer them into test tubes.

– White eyes are a character trait linked to the sex chromosome. For teachers who wish to cover this concept, this lab can provide an introduction to the topic.

– Rather than preparing three test tubes per team, you can simply prepare several workstations and have teams work in rotation.

– Adaptable versions of the reproducibles in Guides A and B are available on the Companion Website at the following address: www.erpi.com/observatory.cw