Science & Technology Concepts

STC/MS™

for Middle Schools™

Properties of Matter
Changes to the Teacher's Guide
and
Properties of Matter
Changes to the Student Guide and Source Book

Since publication of the *Properties of Matter* Teacher's Guide and Student Guide, the solder pieces used in the *Properties of Matter* unit have changed in composition, affecting the melting points of the solders. These changes to the unit require revisions in the unit's printed materials, both for the teacher and the student. Please replace the pages in your texts with the revised pages provided.

The pages in this errata set for solder pieces include the following:

- For the *Properties of Matter* Teacher's Guide – revised pages xxxv–xli (Materials List), xliv, 195–196, 198–200, and 206.
- For the *Properties of Matter* Teacher's Guide – revised pages 383–388 from Appendix D-Material Safety Data Sheets for Blue Solder, Green Solder, and Red Solder. Photocopy and distribute these MSDS as needed, especially if you keep the sheets on file in other locations.
- For the *Properties of Matte*r Student Guide and Source Book – revised pages 151, 155, and 156.

In addition, some school systems have expressed concerns with students using potassium permanganate in elementary and middle school classrooms or labs. If you reside in an area or a state with these concerns, limit the use of potassium permanganate to teacher demonstration only. If you are in a state that bans the use of potassium permanganate by teachers and students, you will omit part of Inquiry 1.5 in Lesson 1, substitute sucrose (confectioners' sugar) for potassium permanganate as indicated for Inquiry 6, and omit Lesson 12. Please replace the pages in your text with the revised pages provided.

The pages in this errata set for potassium permanganate include the following:

- For the *Properties of Matter* Teacher's Guide – revised pages xxxii, 5–6, 67–69, 71–73, and 137–138.

If you have questions about these changes or about the module in general, call Carolina's product information staff at 800-227-1150 (8 am–5 pm ET, M–F), or email ***stcms@carolina.com***

CAROLINA

Carolina Biological Supply Company

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Materials List

There are four materials options available for the Properties of Matter module to accommodate your classroom and laboratory needs:

- One-Class Kit (no burners supplied)
- One-Class Kit with an Alcohol Burner Set
- One-Class Kit with a Natural Gas Burner Set
- One-Class Kit with an Artificial (Propane) Gas Burner Set

Many of the items that the teacher and students will need during this module are supplied in the one-class unit (designed for a class of up to 32 students) from Carolina Biological Supply Company. The one-class kit is divided into two subsets of items based on how each item is used in the module:

- a Base Set (equipment and supplies that can be shared by more than one class of students if the unit is taught to multiple classes)
- a Refurbishment Set (items that will be used up during instruction or will need to be replenished if taught to multiple classes)

The following chart provides information about all kit materials, including: a description of the item as it appears in the Teacher's Guide, a description of the item as it is listed on the unit's packing list, item type (B=Base Set, R=Refurbishment Set), total quantity of the item needed during the unit, and in which lesson(s) the item is used and the quantity used per lesson.

Those items that are not supplied in the unit are listed in a separate "Needed, but not supplied" list following the Materials List chart and are clearly identified in each lesson's materials list by an asterisk (*).

If you plan to purchase any additional individual items or equipment for the units, it is recommended that you purchase these items from the official distributor of authentic STC/MS science unit materials, Carolina Biological Supply Company. Materials available for purchase through Carolina have been reviewed, tested, and approved by Carolina and the National Science Resource Center. Lab results and lesson outcomes cannot be guaranteed if materials and equipment other than those specified for the unit are used.

Item Description in Teacher's Guide	Item Description on Packing List	Item Type	Total Quantity Used	Lesson Number (Quantity Used)
2-propanol (isopropyl alcohol), 70%	Alcohol, isopropyl, 16oz	R	1	16 (1)
Aluminum pan	Aluminum pans, small, round	B	13	1 (4), 18 (9)
Ammonium chloride	Ammonium chloride, 31g	R	1	6 (1)
Baking soda	Baking soda, 16oz	R	1	23 (1)
Balloon	Balloons, 9in., round	R	2	1 (2)
Battery, 6 V	Battery, 6V, lantern	R	8	20 (8), 21 (8)
Battery, AA (for electronic balance)	Battery, AA alkaline	R	12	1 (3), 2 (12), 3 (12), 4 (12), 8 (12), 9 (12), 13 (12), 14 (12), 25 (12), 26 (12)

Item Description in Teacher's Guide	Item Description on Packing List	Item Type	Total Quantity Used	Lesson Number (Quantity Used)
Beaker, 250 mL	Beaker, 250mL	B	32	1 (4), 3 (16), 5 (16), 6 (9), 7 (8), 8 (16), 9 (32), 12 (10), 14 (16), 15 (16), 17 (16), 18 (16), 19 (32), 22 (16), 25 (16), 26 (32)
Bimetal strip	Bimetallic strips	B	1	5 (1)
Black marker	Pens, marker, black	B	8	17 (8), 18 (8), 21 (8), 23 (8), 24 (8)
Black pen with roller ball	Pens, roller ball, black	B	8	17 (8)
Black permanent marker	Pens, marker, black, permanent	B	16	1 (8), 5 (16), 16 (8), 17 (8), 26 (16)
Block Set:	Block Set	B	1	2 (1), 3 (1)
aluminum block		B	8	2 (8), 3 (8)
transparent plastic block		B	8	2 (8), 3 (8)
wax block		B	8	2 (8), 3 (8)
white plastic block		B	8	2 (8), 3 (8)
Bottle of immiscible liquid mixture	Immiscible liquid mixture, 2-oz bottle	B	2	1 (2), 3 (1)
Bottle of lime water (calcium hydroxide solution)	Lime water (calcium hydroxide), 500mL	R	1	26 (1)
Bottle of red food coloring	Food coloring, red, 1oz	R	1	3 (1), 4 (1), 5 (1), 11 (1)
Bottle with cap, 125 mL	Bottles with caps, 125mL	B	24	3 (16), 11 (16), 14 (16), 23 (24), 26 (16)
Box of safety matches	Safety matches	R	2	1 (2)
Brown marker	Pens, marker, brown	B	8	17 (8)
Bulb holder with 6-V bulb	Bulb holder	B	9	21 (9)
Burner Set:		B	1	
For 97-4406A Base Set:				
Alcohol Burner Set includes:	Alcohol Burner Set	B	1	
alcohol burner		B	9	5 (1), 6 (9), 7 (8), 18 (9), 20 (1), 23 (1)
bottle of ethanol (95%)		B	9	5 (1), 6 (9), 7 (8), 18 (9), 20 (1), 23 (1)
burner stand		B	9	5 (1), 6 (9), 7 (8), 18 (9), 20 (1), 23 (1)
For 97-4406B Base Set:				
Natural Gas Burner Set includes:	Natural Gas Burner Set	B	1	
burner stand (tripod)		B	9	5 (1), 6 (9), 7 (8), 18 (9), 20 (1), 23 (1)

Item Description in Teacher's Guide	Item Description on Packing List	Item Type	Total Quantity Used	Lesson Number (Quantity Used)
natural gas Bunsen burner		B	9	5 (1), 6 (9), 7 (8), 18 (9), 20 (1), 23 (1)
piece of tubing		B	9	5 (1), 6 (9), 7 (8), 18 (9), 20 (1), 23 (1)
piece of wire gauze		B	9	5 (1), 6 (9), 7 (8), 18 (9), 20 (1), 23 (1)
For 97-4406C Base Set:		B	1	
Artificial (Propane) Gas Burner Set includes:	Artificial Gas Burner Set	B	1	
artificial gas Bunsen burner		B	9	5 (1), 6 (9), 7 (8), 18 (9), 20 (1), 23 (1)
burner stand (tripod)		B	9	5 (1), 6 (9), 7 (8), 18 (9), 20 (1), 23 (1)
piece of tubing		B	9	5 (1), 6 (9), 7 (8), 18 (9), 20 (1), 23 (1)
piece of wire gauze		B	9	5 (1), 6 (9), 7 (8), 18 (9), 20 (1), 23 (1)
Butane lighter	Lighter, gas	B	1	5 (1), 6 (1), 7 (1), 18 (1)
Calcium chloride, anhydrous (drying agent)	Calcium chloride anhydrous pellets, 500g	R	1	23 (1)
Can of shaving foam	Shaving foam, can	B	1	1 (1), 11 (1)
Chocolate syrup	Chocolate syrup, 24-oz bottle	R	1	16 (1)
Confectioners' sugar	Confectionery sugar, 1lb	R	1	11 (1), 12 (1)
Copper (II) carbonate (cupric carbonate)	Cupric carbonate, 100g	R	1	6 (1)
Copper (II) sulfate, pentahydrate (cupric sulfate, pentahydrate)	Cupric sulfate pentahydrate, 75g	R	1	6 (1), 12 (1), 26 (1)
Copper filings	Copper granules, 150g	R	1	23 (1)
Cotton ball	Cotton balls	B	16	23 (16)
Cotton swab	Cotton swabs	B	80	16 (80)
Dropper bottle	Bottles, drop-dispensing, plastic, 60mL	B	24	16 (24)
Effervescent tablet	Effervescent tablets	R	24	1 (8), 25 (16)
Electrode stand	Electrode stands	B	9	20 (9)
Electronic balance (with an accuracy of 0.1 g)	Balance, digital	B	4	1 (1), 2 (4), 3 (4), 4 (4), 8 (4), 9 (4), 13 (4), 14 (4), 25 (4), 26 (4)

Item Description in Teacher's Guide	Item Description on Packing List	Item Type	Total Quantity Used	Lesson Number (Quantity Used)
Element Card Set	Element Cards, set	B	1	21 (1)
Element Set:	Element Set	B	1	21 (1)
aluminum sample		B	1	21 (1)
argon sample (110-V clear lightbulb)		B	1	21 (1)
carbon sample (graphite rod)		B	1	21 (1)
copper sample		B	1	21 (1)
iron sample		B	1	21 (1)
magnesium sample		B	1	21 (1)
silicon sample		B	1	21 (1)
sulfur sample (lump)		B	1	21 (1), 22 (1)
tin sample		B	1	21 (1)
zinc sample		B	1	21 (1)
Ethanol, 95% (ethyl alcohol)	Ethanol, 95%, 1liter	R	1	14 (1)
Filter paper	Filter paper disks	R	49	15 (49)
Funnel and test tube apparatus:	Funnel and test tube apparatus	B	1	4 (1)
funnel	Funnels	B	16	4 (2), 15 (16)
rubber stopper with single hole	Rubber stopper, single hole #2	B	1	4 (1)
test tube, 20 × 150 mm	Test tubes, 20×150mm	B	2	4 (2)
Graduated cylinder, 100 mL	Graduated cylinders, PMP®, 100mL	B	33	1 (2), 2 (16), 3 (33), 4 (8), 9 (32), 13 (16), 14 (32), 15 (16)
Green marker	Pens, marker, green	B	8	17 (8)
Hot pot	Hot pot	B	2	1 (2), 5 (2)
Hydrochloric acid, 1 M	Hydrochloric acid, 1.0M, 500mL	R	1	23 (1)
Index card, 3 × 5-inch	Index cards, 3×5in.	R	16	22 (16)
Inquiry Card Set	Inquiry Cards, set	B	2	1 (2)
Insulated connector wire with alligator clips	Connector wires with alligator clips	B	27	20 (5), 21 (27)
Iron filings	Iron filings, 625g	R	1	11 (1), 19 (1), 23 (1)
Irregular Objects Set:	Irregular Objects Set	B	1	2 (1)
copper cylinder		B	16	2 (8), 3 (16), 22 (8)
nylon spacer		B	16	2 (8), 3 (16)
steel bolt		B	8	2 (8), 22 (8)

Item Description in Teacher's Guide	Item Description on Packing List	Item Type	Total Quantity Used	Lesson Number (Quantity Used)
Jar of petroleum jelly	Petroleum jelly	R	1	24 (1)
Jar with lid (for reagent distribution), 60 mL	Jars with lids, 2oz	B	40	1 (4), 6 (40), 11 (24), 12 (17), 13 (24), 15 (8), 20 (9), 23 (32), 26 (16)
Kerosene	Kerosene, 250mL	R	1	16 (1)
Ketchup	Ketchup, 14oz bottle	R	1	16 (1)
Lab scoop	Lab scoops	B	32	1 (2), 6 (9), 11 (16), 12 (16), 13 (16), 14 (16), 15 (16), 19 (32), 20 (9), 23 (16), 26 (16)
Label	Labels, small, blank, white	R	405	1 (4), 3 (16), 6 (40), 11 (64), 12 (24), 13 (24), 14 (16), 15 (8), 16 (24), 17 (24), 20 (9), 23 (96), 24 (16), 26 (80)
Light corn syrup	Corn syrup, light, pint	R	2	3 (2)
Loupe (double-eye magnifier)	Magnifying loupes	B	32	1 (4), 9 (32), 11 (32), 15 (16), 19 (32)
Magnesium ribbon, 30 cm	Magnesium ribbon, 30g	B	1	23 (1), 24 (1)
Magnet	Magnets	B	32	11 (8), 19 (32), 21 (9)
Masking tape	Tape, masking, ½-in. wide	R	1	16 (1), 21 (1), 22 (1)
Metric ruler	Rulers	B	32	2 (8), 5 (16), 9 (32), 12 (16), 17 (16), 19 (32), 22 (16), 23 (16), 26 (16)
Modeling clay (to make set of balls and blocks)	Clay, modeling, 2-oz block	R	1	1 (1)
Mystery Objects Set:	Mystery Object Set	B	1	9 (1)
painted aluminum nail		B	8	9 (8)
painted copper rod		B	8	9 (8)
painted nylon bolt		B	8	9 (8)
painted steel nail		B	8	9 (8)
Nail, galvanized steel	Nails, galvanized, 1in.	R	8	24 (8)
Nail, stainless steel	Nails, stainless steel, 1in.	R	8	24 (8)
Nail, ungalvanized painted steel	Nails, ungalvanized painted steel, 1in.	R	8	24 (8)
Nail, ungalvanized steel	Nails, ungalvanized steel, 1in.	R	24	24 (24)
Pair of forceps	Forceps	B	2	1 (2), 12 (1)
Paper clip, large	Paper clips, jumbo	R	9	21 (9)

Item Description in Teacher's Guide	Item Description on Packing List	Item Type	Total Quantity Used	Lesson Number (Quantity Used)
Petri dish with lid	Petri dishes with lids, 100×15mm	B	40	1 (20), 11 (40), 12 (2), 19 (32), 24 (16)
Piece of chromatography paper	Chromatography paper	R	52	17 (52)
Piece of granite	Granite specimens	B	8	1 (2), 11 (8)
Piece of slate	Slate specimen	B	8	11 (8)
Piece of solder with 210 °C melting point (color-coded red)	Solder pieces, M.P. 210 °C	R	9	18 (9)
Piece of solder with 227 °C melting point (color-coded green)	Solder pieces, M.P. 227 °C	R	9	18 (9)
Piece of solder with 235 °C melting point (color-coded blue)	Solder pieces, M.P. 235 °C	R	9	18 (9)
Piece of steel wool	Steel wool pads	R	16	22 (16)
Pipette	Pipettes, 3mL	B	67	1 (2), 11 (16), 12 (1), 14 (16), 19 (32)
Plastic 1-gallon tank	Tanks, plastic, 1gal.	B	2	1 (2), 3 (1), 5 (2)
Plastic box with lid	Box w/lid, plastic, clear, 16×11×6in.	B	8	1 (2), 2 (8), 3 (8), 4 (8), 5 (8), 6 (8), 7 (8), 8 (8), 11 (8), 12 (8), 13 (8), 14 (8), 15 (8), 16 (8), 17 (8), 18 (8), 20 (8), 22 (8), 23 (8), 24 (8), 25 (8)
Plastic container	Plastic container, 16oz	R	18	19 (1), 20 (9), 23 (8)
Plastic cup, 30 mL	Plastic cups, small, 1oz	R	24	16 (24)
Plastic cup, 105 mL	Plastic cups, 3.5oz	R	16	12 (8), 15 (8)
Plastic spoon	Teaspoons, plastic	B	33	15 (16), 18 (8), 20 (9)
Potassium permanganate	Potassium permanganate, 25g	R	1	1 (1), 6 (1), 12 (1)
Powdered drink mix	Powdered drink mix, 500g	R	1	19 (1)
Red marker	Pens, marker, red	B	8	17 (8)
Rock salt	Salt, rock, 160g	R	1	15 (1)
Rubber stopper (no hole)	Rubber stoppers, solid #00	B	32	12 (32), 13 (32), 23 (1)
Sand	Marine sand, 1lb	R	3	1 (1), 11 (1), 12 (1), 19 (1)
Sheet of black construction paper	Paper, construction, black, 9×12in.	R	32	11 (32)
Sodium chloride	Sodium chloride (salt), 1lb	R	3	6 (1), 12 (1), 13 (1), 14 (1), 18 (1)
Sodium nitrate	Sodium nitrate, 500g	R	1	13 (1)
Sodium sulfate	Sodium sulfate, 50g	R	1	20 (1)

Item Description in Teacher's Guide	Item Description on Packing List	Item Type	Total Quantity Used	Lesson Number (Quantity Used)
Sulfur (powder)	Sulfur sublimed powder, 50g	R	1	6 (1), 11 (1), 12 (1)
Syringe apparatus (two syringes connected by tubing, assembled):	Syringe apparatus	B	1	4 (1)
piece of plastic tubing	Tubing, Tygon®, ¼B, per/ft	B	1	4 (1)
syringe	Disp., syringe w/cath.tip, 60cc	B	2	4 (2)
Tea candle	Tea candle	R	2	1 (2)
Test tube brush	Test tube brushes	B	16	3 (16), 6 (9), 11 (8), 12 (16)
Test tube clamp	Test tube clamp	B	9	6 (9)
Test tube rack, rectangular	Test tube rack, 6-hole, 25mm	B	17	1 (2), 4 (1), 11 (8), 12 (17), 13 (17), 15 (16), 19 (16), 23 (17)
Test tube rack, round	Test tube rack, round	B	4	5 (4)
Test tube, 10 × 75 mm	Test tubes, 10×75mm	B	18	20 (18)
Test tube, 16 × 125 mm	Test tubes, 16×125mm	B	250	6 (49), 11 (32), 12 (88), 13 (41), 14 (32), 19 (64), 22 (32), 23 (65), 26 (48)
Test tube, 20 × 150 mm	Test tubes, 20×150mm	B	32	1 (2), 4 (2), 5 (32)
Thermometer	Thermometer, alcohol	B	20	1 (4), 5 (20), 7 (8), 18 (16), 23 (16)
Thermometer assembly:	Thermometer assembly	B	16	5 (16)
piece of plastic tubing mounted in a stopper		B	16	5 (16)
rubber stopper with single hole	Rubber stopper, single hole #2	B	16	5 (16)
test tube, 20 × 150 mm	Test tubes, 20×150mm	B	16	5 (16)
Vacuum pump apparatus:		B	9	4 (9)
plastic bottle, thick-walled	Plastic bottle, thick-walled	B	9	4 (9)
rubber washer	Rubber washers	B	9	4 (9)
vacuum pump with vacuum stopper	Vacuum pump with rubber stopper	B	9	4 (9)
Vegetable oil	Vegetable oil, 32oz	R	2	3 (1), 11 (1), 16 (1), 23 (1)
Vinegar	Vinegar, pint	R	1	22 (1)
Wax beads	Wax crystals, 12oz	R	1	19 (1)
White cotton cloth square	Cloth squares, white cotton	R	40	16 (40)
Wooden splint	Splints, wooden	R	13	20 (11), 23 (2)
Zinc oxide	Zinc oxide, 125g	R	1	6 (1), 11 (1), 12 (1), 15 (1)
Zinc, granular	Zinc, granular, 75g	R	1	23 (1)

- **Lesson 17**
  - 1 copy of Student Sheet 17.1, Student Sheet 17.2, Student Sheet 17.3, and Student Sheet 17: Assessment Review for each student
  - 16 pencils

- **Lesson 18**
  - Crushed ice (minimum of 24 cubes)
  - 1 copy of Student Sheet 18.1, Student Sheet 18.2, and Student Sheet 18.3 for each student
  - Safety goggles for each student and the teacher

- **Lesson 19**
  - 1 copy of Student Sheet 19.1: Performance Assessment and Student Sheet 19.2: Written Assessment for each student
  - Safety goggles for each student and the teacher
  - 2 containers for waste disposal

- **Lesson 20**
  - Safety goggles for each student and the teacher
  - 1 transparency of TG Figure 20.1
  - Overhead projector
  - 1 copy of Student Sheet 20.1 for each student

- **Lesson 21**
  - Transparency of the first page of Table 1 from Student Sheet 21.1a
  - Transparency of Student Sheet 21.1b
  - Transparency markers
  - Overhead projector
  - 10 sheets of newsprint
  - 1 copy of Student Sheet 21.1a and Student Sheet 21.1b for each student
  - 1 plain charcoal briquette (for additional carbon sample), with no lighter fluid added
  - Table lamp with a standard screw socket for a 110-V bulb, *or* a 110-V bulb holder

- **Lesson 22**
  - Transparency of the periodic table from Lesson 21 (Student Sheet 21.1b)
  - Transparency markers
  - Overhead projector
  - 1 copy of Student Sheet 22.1 and Student Sheet 22.2 for each student
  - Safety goggles for each student and the teacher
  - 8 plain charcoal briquettes, with no lighter fluid added
  - 1 pair of scissors for each pair of students

- **Lesson 23**
  - Transparency of TG Figure 23.1
  - Transparency of Table 1 from Student Sheet 23.2
  - Transparency of Table 2 from Student Sheet 23.2
  - Transparency markers
  - Overhead projector
  - 1 copy of Student Sheet 23.1 and Student Sheet 23.2 for each student
  - Safety goggles for each student and the teacher
  - 2 2-L clear plastic soda bottles
  - 1 L of cooled, boiled water
  - 1 plastic bucket containing baking soda for collecting waste materials
  - 1 additional container of baking soda (to neutralize any acid spills)

The alloys used in Inquiry 18.3 are solders (used to join together metal materials); they were selected on the basis of their low melting points and ready availability. The use of a particular solder depends, in part, on its melting point. Table 18.2 lists the composition, melting points, and uses of the three solders investigated in this experiment.

The properties of mixtures other than solutions and alloys will probably come up during class discussions. Many of these mixtures are composite materials that consist of at least two discrete substances bound together. Examples of how composites are used are given in "Perfect Teamwork" (Lesson 11, SG page 102).

Table 18.1 Some Examples of Alloys

Alloy	Constituent Metals	Common Uses
Bronze	Copper and tin	Cast bronze sculptures (most contain about 10% tin)
Brass	Copper and zinc	Household objects, jewelry, and musical instruments
Nickel silver	Copper and nickel	Coins, model railway tracks, and the base for silver plate
Pewter	Tin and lead	Once used for utensils but now considered too toxic
Shape-memory alloy	Nickel and titanium	Heat-sensitive switches, springs, eyeglass frames, and antennae for mobile phones
Gold alloy	Gold, silver, and copper	Jewelry (composition varies; 22-carat gold is 91.7% gold)
Steel	Iron and carbon (less than 4% carbon)	Buildings, ships, and armaments
Cast iron	Iron and carbon (more than 4% carbon)	Cast objects that require less ductility than steel (such as garden furniture)
Stainless steel	Iron, carbon, chromium, and nickel	Cutlery

Table 18.2 Composition, Melting Points, and Uses of Solders Investigated in Inquiry 18.3

Color Code	Composition	Melting Point	Uses
Red	95% tin, 4.8% copper, 0.2% selenium	210 °C	Electrical repairs
Green	95.6% tin, 4% copper, 0.4% silver	227 °C	Nonelectrical applications (such as plumbing and jewelry)
Blue	95% tin, 5% antimony	235 °C	Automotive repairs (such as radiators), sheet metal work

MATERIALS FOR LESSON 18

For the teacher

1 pair of safety goggles*
1 aluminum pan
1 piece of solder, color-coded blue
1 piece of solder, color-coded green
1 piece of solder, color-coded red
1 burner
1 burner stand with gauze (wire gauze is used with natural and propane gas burner stands only, not with alcohol burner stands)
Access to a clock or watch with a second hand*
Crushed ice*
Butane lighter
Aluminum foil*

For each student

1 copy of Student Sheet 18.1: Adding Salt to Ice*
1 copy of Student Sheet 18.2: Adding Salt to Boiling Water*
1 copy of Student Sheet 18.3: Investigating Solid Solutions*
1 pair of safety goggles*

For each group of 4 students

1 plastic box with lid
1 plastic spoon
1 black marker
2 beakers, 250 mL
2 thermometers
1 aluminum pan
1 jar (2 oz) of sodium chloride (common salt)
1 piece of solder, color-coded blue
1 piece of solder, color-coded green
1 piece of solder, color-coded red
1 burner
1 burner stand with gauze
Access to a clock or watch with a second hand*

*Needed, but not supplied

For the class

Access to hot pots containing water at 60 °C-70 °C

PREPARATION

1. Make one copy of each of the three student sheets for each student.
2. Refill jars with sodium chloride if needed, and make sure they are labeled.
3. Ensure that the ice is crushed and kept cold before students begin Inquiry 18.1.
4. Make sure the burners are in good working condition.

NOTE You may need to adjust the burner flame size recommendations suggested in the procedure for Inquiry 18.3. It might be useful to run through the experiment to determine the optimal flame size and times for the type of burner you have.

5. Set up the hot pots or ensure that other sources of hot water at 60 °C–70 °C are available.

Getting Started

1. Have students discuss with other members of their group the questions in Step 1 of "Getting Started" in the Student Guide. They should record their answers in their science notebooks.
2. Ask students for their examples. On a transparency or on the board, list each example under the category covered by each question (mixtures with properties of both of the substances from which they are composed, mixtures that have the properties of only one of the substances from which they are composed, and mixtures that have completely different properties from those of the substances from which they are composed). You may wish to con-

4. Conduct a class discussion of students' results. These should include the observation that the ice melted and that the temperature of the ice dropped when salt was added. The amount of salt added affected the temperature; as more salt was added, the melting point decreased further and the ice melted faster. Ask students to relate this to the melting point of the ice (the melting point of the ice was lowered).

Inquiry 18.2
Adding Salt to Boiling Water

PROCEDURE

1. Explain that the objective of the inquiry is to determine what happens when salt is added to boiling water.

2. Briefly outline the procedure (see Steps 1 through 8 in the Student Guide).

SAFETY TIPS

Emphasize the correct use of the burners and safety procedures.

Students should tie back long hair.

Remind students to be careful when handling hot objects.

3. Have students conduct Steps 1 through 8 in the Student Guide.

4. Discuss students' results. They should have observed that the boiling point was raised.

5. Ask one student to read "Changing Melting and Boiling Points" (SG page 154) to the rest of the class. Discuss the questions in the reader and relate the answers to the results of Inquiries 18.1 and 18.2.

NOTE Students will be reading "Ice Cream in the Old Days" (SG page 160) for homework. Make sure they recognize that the antifreeze (ethylene glycol) mentioned in "Changing Melting and Boiling Points" (SG page 154) is toxic and cannot be used in making ice cream.

6. Point out that a relatively small amount of an impurity added to a substance will often affect the melting and boiling points of the substance.

7. Ask students how they could use this effect to determine the purity of a sample. (If they knew the melting and boiling points for a pure substance, they could measure these for their sample. Any difference between the known melting and boiling points for a substance and those obtained for their sample would be an indication that impurities were present.)

Inquiry 18.3
Investigating Solid Solutions

PROCEDURE

1. Bring students to the front of the class or to the demonstration table.

2. Set up the apparatus for the inquiry as shown in Figure 18.1. (The illustration for Figure 18.1 shows an alcohol burner in use. Your burners may differ from this one.) Explain that the substances students will investigate are mixtures of metals called solders.

3. Show students the pieces of solder. Explain that the color coding relates to the

composition of the solders: red: 95% tin, 4.8% copper, 0.2% selenium; green: 95.6% tin, 4% copper, 0.4% silver; and blue: 95% tin, 5% antimony.

4. Show students how they should arrange the solders on the aluminum pan to ready them for heating (see Figure 18.2).

5. Explain to students that they will do the following, but do not demonstrate these directions:

A. Ignite the burner. (If necessary, review the procedure used in earlier lessons for igniting burners.)

B. Heat the aluminum pan at its *center* with the flame. (If a Bunsen burner is used, its air vent should be halfway open, and the flame should be no higher than 4–5 cm.)

C. Start timing and then start heating.

SAFETY TIPS

The solders do not contain lead, but students should still handle them with care because most metals are toxic if ingested.

Students should wash their hands before leaving the lab.

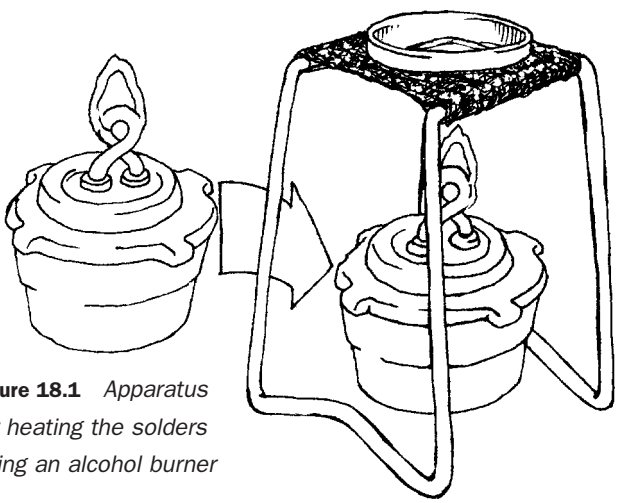
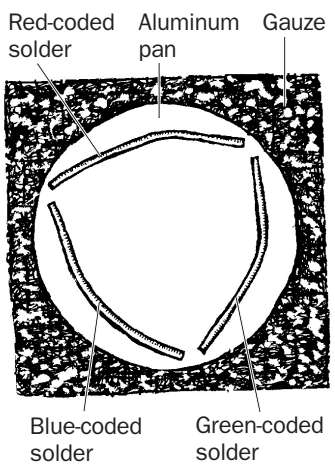


Figure 18.1 *Apparatus for heating the solders using an alcohol burner*



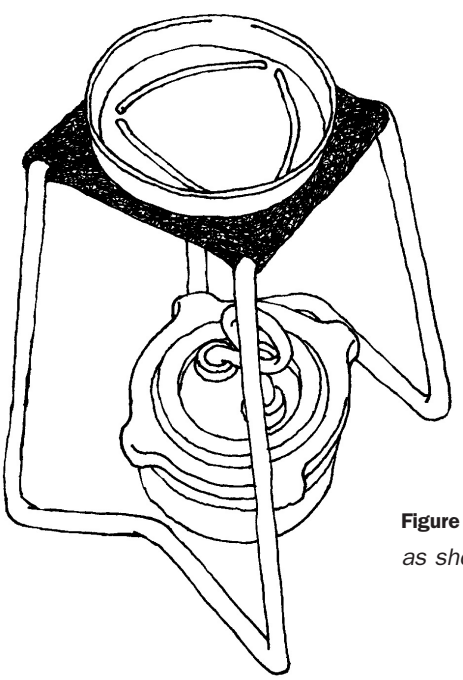


Figure 18.2 *Position the solder as shown on the aluminum pan.*

D. Record the exact time each piece of solder begins to show signs of melting (such as changes in shape.)

E. Extinguish the burners and allow the apparatus to cool for at least 5 minutes before touching it and returning it to the plastic box.

SAFETY TIPS

Students should not lean over the apparatus during heating.

They should observe the solders from a distance of 2–3 feet.

Students should not move the aluminum pan until it has cooled and the metals have solidified.

NOTE Make sure students have access to a clock or watch with a second hand.

6. Students should return to their places and read the instructions (Steps 2 through 8) in the Student Guide before continuing with the inquiry.

7. Have students conduct the inquiry and then discuss the questions in Step 9 of the Student Guide. Provide students with the melting points of the solder (see Table 18.2) when they reach the question in Step 7. Once they have agreed on their answers, they should record them on Student Sheet 18.3.

8. Collect used solder pieces and aluminum pans and dispose of them in the trash.

REFLECTIONS

1. Discuss students' answers to the questions on Student Sheet 18.3 and their results from Table 1 on the student sheet. Most students will have obtained the same order of melting for the solders. Discuss reasons for possible discrepancies in results (for example, errors in timing and positioning of the solder and the burner).

2. Explain the different uses of these solders. Discuss the properties of other alloys (you may want to ask students for some examples) such as steel, stainless steel, brass, bronze, tin/lead solders, shape-memory alloys (nickel/titanium), and gold alloys (see Background for further information).

3. Have students read "About Alloys" (SG page 157). Discuss other alloys and their uses.

4. You may wish to briefly discuss how other mixtures are used as materials for making useful items (for example, composites such as fiberglass, used in fishing rods and kayaks, and concrete and reinforced concrete, used for highway surfaces and in buildings).

5. Revisit the brainstorming list from "Getting Started." Include the mixtures encountered during the lesson.

HOMEWORK

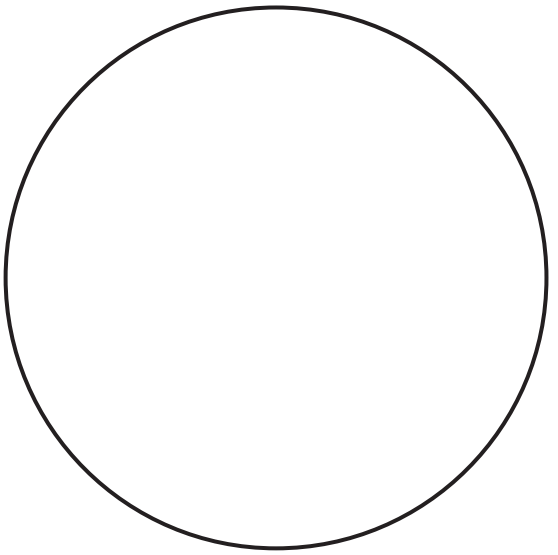
Have students read "The Samurai's Sword" (SG pages 158–159) and answer the accompanying question, and read "Ice Cream in the Old Days" (SG pages 160–161).

Name:_____

Class:_____ Date:_____

Student Sheet 18.3
Investigating Solid Solutions

1. Draw the location of the solders on this circle that represents the aluminum pan.



2. Enter your results in Table 1.

Table 1 Amount of Time for Solder To Melt

Color Code	Composition of the Mixture	Time at Which Solder Finished Melting	Melting Point
Red	95% tin, 4.8% copper, 0.2% selenium		
Green	95.6% tin, 4% copper, 0.4% silver		
Blue	95% tin, 5% antimony		
Tin	100% tin	Will melt at temperatures provided by your flame	232 °C
Silver	100% silver	Will not melt at temperatures provided by your flame	962 °C
Antimony	100% antimony	Will not melt at temperatures provided by your flame	630 °C
Copper	100% copper	Will not melt at temperatures provided by your flame	1083 °C

(continued)

Material Safety Data Sheet

SOLDER, BLUE

1. Product Description

Product Name: Solder, 95% Tin/5% Antimony
Product Code (s): Various
Size: Various
Chemical Name: Product is a mixture
CAS Number See section 2
Formula: Product is a mixture
Synonyms: Dutch Boy® 95% SN/5% SB
Distributor: Carolina Biological Supply Company
2700 York Road
Burlington, NC 27215
Chemical Emergency Information:
800-227-1150 (8am–5pm [ET] M–F)
Chemtrec (Transportation Spill Response 24 hours):
800-424-9300

2. Composition/Information on Ingredients

Principal Hazardous Components:

Tin (CAS# 7440-31-5)		95%
Antimony (CAS# 7440-36-0)		5%

TLV and PEL units:

Tin	ACGIH-TLV	2 mg/m3 (TWA)
	OSHA-PEL	2 mg/m3 (TWA)
Antimony	ACGIH-TLV	0.5 mg/m3 (TWA)
	OSHA-PEL	0.5 mg/m3 (TWA)

3. Hazardous identification

Emergency Overview: May cause irritation. During use minimize contact with skin. Avoid contact with eyes. Wash thoroughly after handling. When not in use, keep in tightly closed container.

4. First Aid Measures

Emergency and First Aid Procedures:

Eyes - Flush well with running water to remove particulate matter. Get medical attention if irritation persists.

Skin - Wash with soap and water. Get medical attention if irritation develops.

Ingestion - If swallowed, if conscious, give plenty of water. Get medical attention. Never give anything by mouth to an unconscious person.

Inhalation - Remove to fresh air. Get medical attention. Give artificial respiration if breathing has stopped.

5. Firefighting Procedures

Flash Point (Method Used): Not flammable
NFPA Rating: Health: 1
Fire: 0
Reactivity: 0

Extinguisher Media: Use media suitable to extinguish surrounding fire

Flammable Limits in Air % by Volume: Not applicable

Autoignition Temperature: Not applicable

Special Firefighting Procedures: Firefighters should wear full protective equipment and NIOSH approved self-contained breathing apparatus.

Unusual Fire and Explosion Hazards: Not a hazard in solid form. If dust is generated, it may present a moderate fire or explosion hazard.

6. Spill or Leak Procedures

Steps to be Taken in Case Material is Released or Spilled: Material may be scraped or picked up once cooled. Containerize material for disposal.

7. Special Precautions

Precautions to be Taken in Handling or Storing: Keep container tightly closed. Do not place in aluminum or galvanized container.

Other Precautions: Suitable for general chemical storage area. Store away from incompatibles.

8. Special Protection Information

Respiratory Protection (Specify Type): None needed under normal conditions of use with adequate ventilation. NIOSH approved equipment should be worn if PELs are exceeded.

Ventilation: Local Exhaust: Not necessary
Mechanical (General): Yes
Special: No
Other: No

Protective Gloves: Per manufacturer, gloves should be worn if skin contact is appreciable. Rubber, neoprene, PVC, or equivalent

Eye Protection: Splash proof chemical safety goggles should be worn at all times

Other Protective Clothing or Equipment: Lab coat, eye wash, and safety shower

Material Safety Data Sheet

SOLDER, BLUE *(cont.)*

9. Physical Data

Molecular Weight: Product is a mixture
Melting Point: 235 °C
Boiling Point: N/A
Vapor Pressure: N/A
Vapor Density (Air-1): N/A
Specific Gravity (H_2O=1): 5.8
Percent Volatile by Volume: N/A
Evaporation Rate (Ether=1): N/A
Solubility in Water: Insoluble
Appearance and Odor: Odorless, silvery-white metal

10. Reactivity Data

Stability: Stable
Conditions to Avoid: None
Incompatibility (Materials to Avoid): Turpentine, strong acids and bases, sulfur, halogens, nascent hydrogen, reducing agents. Never mix molten metal with water as it will exlpode. Do not place in galvanized or aluminum container. Antimony reacts with nascent hydrogen or certain concentrated acids or bases to evolve highly toxic stibine gas.
Hazardous Decomposition Products: Metal oxide fumes at temperatures above the melting point.
Hazardous Polymerization: Will not occur

11. Toxicity Data

Toxicity Data:
For antimony: orl-rat LD50: 7 g/kg
Effects of Overexposure:
Acute: See section 3
Chronic: Chronic (long term) exposure to tin can result in benign pneumoconiosis. Chronic (long term) exposure to antimony can result in liver and kidney abnormalities and central nervous system disorders.
Conditions Aggravated by Overexposure: Preexisting diseases of the lung, kidney, liver, and nervous system. Irritation of upper respiratory tract. Irritation or burns to the skin or eyes.
Primary Route(s) of Entry: Inhalation of dust or fumes, eye and skin contact

12. Ecological Data

EPA Waste Numbers: None

13. Disposal Information

Waste Disposal Methods: Dispose in accordance with all applicable federal, state and local regulations.
Always contact a permitted waste disposer (TSD) to assure compliance.

14. Transport Information

Non-regulated

15. Regulatory Information

EPA TSCA Status: On TSCA Inventory
Hazard Category for SARA Section 311/312 Reporting: Acute

	SARA Sec. 313				
Product or Components	SARA EHS Sec. 302 TPQ	Chemicals Name List	Chemical Category	CERCLA Sec. 103 RQ lbs.	RCRA Sec. 261.33
Tin	No	No	No	No	No
Antimony	No	Yes	No	5000*	No

*when in form with diamter less than .004 inches

16. Additional Information

The information provided in this Material Safety Data Sheet represents a compilation of data drawn directly from various sources available to us. Carolina Biological Supply makes no representation or guarantee as to the suitability of this information to a particular application of the substance covered in the Material Safety Data Sheet. Any employer must carefully assess the applicability of any information contained herein in regards to the particular use to which the employer puts the material.

Glossary

ACGIH American Conference of Governmental Industrial Hygienists
CAS Number Chemical Abstracts Service Number
CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
DOT U.S. Department of Transportation
IARC International Agency of Research on Cancer
mppcf million particles per cubic foot
N/A Not Available
NTP National Toxicology Program
OSHA Occupational Safety and Health Administration
PEL Permissible Exposure Limit
ppm parts per million
RCRA Resource Conservation and Recovery Act
SARA Superfund Amendments and Reauthorization Act
TLV Threshold Limit Value
TSCA Toxic Substances Control Act

Material Safety Data Sheet

SOLDER, GREEN

1. Product Description

Product Name: Solder, 95.6% Tin/4% Copper/0.4% Silver
Product Code (s): Various
Size: Various
Chemical Name: Product is a mixture
CAS Number See section 2
Formula: Product is a mixture
Synonyms: Dutch Boy® Silver
Distributor: Carolina Biological Supply Company
2700 York Road
Burlington, NC 27215
Chemical Emergency Information:
800-227-1150 (8am–5pm [ET] M–F)
Chemtrec (Transportation Spill Response 24 hours):
800-424-9300

2. Composition/Information on Ingredients

Principal Hazardous Components:

Tin (CAS# 7440-31-5)	95.6%
Copper (CAS# 7440-50-8)	4%
Silver (CAS# 7440-22-4	0.4%

TLV and PEL units:

Tin	ACGIH-TLV	2 mg/m^3 (TWA)
	OSHA-PEL	2 mg/m^3 (TWA)
Copper	ACGIH-TLV	1 mg/m^3 (TWA) (Dust) 0.2 mg/m^3 (TWA) (Fume)
	OSHA-PEL	1 mg/m^3 (TWA) (Dust) 0.1 mg/m^3 (TWA) (Fume)
Silver	ACGIH-TLV	0.1 mg/m^3 (TWA)
	OSHA-PEL	0.01 mg/m^3 (TWA)

3. Hazardous Identification

Emergency Overview: May cause irritation. During use minimize contact with skin. Avoid contact with eyes. Wash thoroughly after handling. When not in use keep in tightly closed container.

4. First Aid Measures

Emergency and First Aid Procedures:

Eyes - Flush well with running water to remove particulate matter. Get medical attention if irritation persists.

Skin - Wash with soap and water. Get medical attention if irritation develops.

Ingestion - If swallowed, if conscious, give plenty of water. Get medical attention. Never give anything by mouth to an unconscious person.

Inhalation - Remove to fresh air. Get medical attention. Give artificial respiration if breathing has stopped.

5. Firefighting Procedures

Flash Point (Method Used): Not flammable
NFPA Rating: Health: 1
Fire: 0
Reactivity: 0
Extinguisher Media: Use media suitable to extinguish surrounding fire
Flammable Limits in Air % by Volume: Not applicable
Autoignition Temperature: Not applicable
Special Firefighting Procedures: Firefighters should wear full protective equipment and NIOSH approved self-contained breathing apparatus
Unusual Fire and Explosion Hazards: Not a hazard in solid form. If dust is generated, it may present moderate fire or explosion hazard.

6. Spill or Leak Procedures

Steps to be Taken in Case Material is Released or Spilled: Material may be scraped or picked up once cooled. Containerize material for disposal.

7. Special Precautions

Precautions to be Taken in Handling or Storing: Keep container tightly closed
Other Precautions: Suitable for general chemical storage area. Store away from incompatibles.

8. Special Protection Information

Respiratory Protection (Specify Type): None needed under normal conditions of use with adequate ventilation. NIOSH approved equipment should be worn if PELs are exceeded.
Ventilation: Local Exhaust: Not necessary
Mechanical (General): Yes
Special: No
Other: No
Protective Gloves: Per manufacturer, gloves should be worn if skin contact is appreciable. Rubber, neoprene, PVC, or equivalent
Eye Protection: Splash proof chemical safety goggles should be worn at all times
Other Protective Clothing or Equipment: Lab coat, eye wash, and safety shower

Material Safety Data Sheet

SOLDER, GREEN *(CONT.)*

9. PHYSICAL DATA

Molecular Weight: Product is a mixture
Melting Point: 227 °C
Boiling Point: N/A
Vapor Pressure: N/A
Vapor Density (Air-1): N/A
Specific Gravity (H_2O=1): 7.38
Percent Volatile by Volume: N/A
Evaporation Rate (Ether=1): N/A
Solubility in Water: Insoluble
Appearance and Odor: Odorless, silvery-white metal

10. REACTIVITY DATA

Stability: Stable
Conditions to Avoid: None
Incompatibility (Materials to Avoid): Chlorine, turpentine, magnesium, acetylene gas
Hazardous Decomposition Products: Metal oxide fumes at temperatures above the melting point.
Hazardous Polymerization: Will not occur

11. TOXICITY DATA

Toxicity Data: For silver: orl-rat LD50: >2000 mg/kg
Effects of Overexposure:
Acute: See section 3
Chronic: Chronic (long term) exposure to tin can result in benign pneumoconiosis.
Conditions Aggravated by Overexposure: Preexisting diseases of the lungs; Wilson's Disease (genetic trait).
Primary Route(s) of Entry: Inhalation of dust or fumes, eye and skin contact

12. ECOLOGICAL DATA

EPA Waste Numbers: None

13. DISPOSAL INFORMATION

Waste Disposal Methods: Dispose in accordance with all applicable federal, state and local regulations.
Always contact a permitted waste disposer (TSD) to assure compliance.

14. TRANSPORT INFORMATION

Non-regulated

15. REGULATORY INFORMATION

EPA TSCA Status: On TSCA Inventory
Hazard Category for SARA Section 311/312 Reporting: Acute

	SARA Sec. 313				
Product or Components	SARA EHS Sec. 302 TPQ	Chemicals Name List	Chemical Category	CERCLA Sec. 103 RQ lbs.	RCRA Sec. 261.33
Tin	No	No	No	No	No
Copper	No	Yes	No	5000*	No
Silver	No	Yes	No	1000*	No

*when in form with diamter less than .004 inches

16. ADDITIONAL INFORMATION

The information provided in this Material Safety Data Sheet represents a compilation of data drawn directly from various sources available to us. Carolina Biological Supply makes no representation or guarantee as to the suitability of this information to a particular application of the substance covered in the Material Safety Data Sheet. Any employer must carefully assess the applicability of any information contained herein in regards to the particular use to which the employer puts the material.

Glossary

ACGIH American Conference of Governmental Industrial Hygienists
CAS Number Chemical Abstracts Service Number
CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
DOT U.S. Department of Transportation
IARC International Agency of Research on Cancer
mppcf million particles per cubic foot
N/A Not Available
NTP National Toxicology Program
OSHA Occupational Safety and Health Administration
PEL Permissible Exposure Limit
ppm parts per million
RCRA Resource Conservation and Recovery Act
SARA Superfund Amendments and Reauthorization Act
TLV Threshold Limit Value
TSCA Toxic Substances Control Act

Material Safety Data Sheet

SOLDER, RED

1. Product Description

Product Name: Solder, 95% Tin/4.8% Copper/ 0.2% Selenium
Product Code (s): Various
Size: Various
Chemical Name: Product is a mixture
CAS Number See section 2
Formula: Product is a mixture
Synonyms: Taramet Sterling® Lead Free Solder
Distributor: Carolina Biological Supply Company
2700 York Road
Burlington, NC 27215
Chemical Emergency Information:
800-227-1150 (8am–5pm [ET] M–F)
Chemtrec (Transportation Spill Response 24 hours):
800-424-9300

2. Composition/Information on Ingredients

Principal Hazardous Components:

Tin (CAS# 7440-31-5)	95%
Copper (CAS# 7440-50-8)	4.8%
Selenium (CAS# 7782-49-2)	0.2%

TLV and PEL units:

Tin	ACGIH-TLV	2 mg/m^3 (TWA)
	OSHA-PEL	2 mg/m^3 (TWA)
Copper	ACGIH-TLV	1 mg/m^3 (TWA) (Dust) 0.2 mg/m^3 (TWA) (Fume)
	OSHA-PEL	1 mg/m^3 (TWA) (Dust) 0.1 mg/m^3 (TWA) (Fume)
Selenium	ACGIH-TLV	0.2 mg/m^3 (TWA)
	OSHA-PEL	0.2 mg/m^3 (TWA)

3. Hazardous Identification

Emergency Overview: May cause irritation. During use minimize contact with skin. Avoid contact with eyes. Wash thoroughly after handling. When not in use keep in tightly closed container.

4. First Aid Measures

Emergency and First Aid Procedures:

Eyes - Flush well with running water to remove particulate matter. Get medical attention if irritation persists.

Skin - Wash with soap and water. Get medical attention if irritation develops.

Ingestion - If swallowed, if conscious, give plenty of water. Get immediate medical attention. Never give anything by mouth to an unconscious person.

Inhalation - Remove to fresh air. Get medical attention. Give artificial respiration if breathing has stopped.

5. Firefighting Procedures

Flash Point (Method Used): Not flammable
NFPA Rating: Health: 1
Fire: 0
Reactivity: 0
Extinguisher Media: Use media suitable to extinguish surrounding fire
Flammable Limits in Air % by Volume: Not applicable
Autoignition Temperature: Not applicable
Special Firefighting Procedures: Firefighters should wear full protective equipment and NIOSH approved self-contained breathing apparatus.
Unusual Fire and Explosion Hazards: Not a hazard in solid form. If dust is generated, it may present moderate fire or explosion hazard.

6. Spill or Leak Procedures

Steps to be Taken in Case Material is Released or Spilled: Material may be scraped or picked up once cooled. Containerize material for disposal.

7. Special Precautions

Precautions to be Taken in Handling or Storing: Keep container tightly closed
Other Precautions: Suitable for general chemical storage area. Store away from incompatibles.

8. Special Protection Information

Respiratory Protection (Specify Type): None needed under normal conditions of use with adequate ventilation. NIOSH approved equipment should be worn if PELs are exceeded.
Ventilation: Local Exhaust: Not necessary
Mechanical (General): Yes
Special: No
Other: No
Protective Gloves: Per manufacturer, gloves should be worn if skin contact is appreciable. Rubber, neoprene, PVC, or equivalent
Eye Protection: Splash proof chemical safety goggles should be worn at all times
Other Protective Clothing or Equipment: Lab coat, eye wash, and safety shower

Material Safety Data Sheet

SOLDER, RED *(CONT.)*

9. PHYSICAL DATA

Molecular Weight: Product is a mixture
Melting Point: 210 °C
Boiling Point: N/A
Vapor Pressure: N/A
Vapor Density (Air-1): N/A
Specific Gravity (H_2O=1): 7.38
Percent Volatile by Volume: N/A
Evaporation Rate (Ether=1): N/A
Solubility in Water: Insoluble
Appearance and Odor: Odorless, silvery-white metal

10. REACTIVITY DATA

Stability: Stable
Conditions to Avoid: None
Incompatibility (Materials to Avoid): Chlorine, turpentine, magnesium, acetylene gas
Hazardous Decomposition Products: Metal oxide fumes at temperatures above the melting point.
Hazardous Polymerization: Will not occur

11. TOXICITY DATA

Toxicity Data: For selenium: orl-rat LD50: 6700 mg/kg
Effects of Overexposure:
Acute: See section 3
Chronic: Chronic (long term) overexposure to tin can result in benign pneumoconiosis.
Conditions Aggravated by Overexposure: Preexisting diseases of the lungs; Wilson's Disease (genetic trait).
Primary Route(s) of Entry: Inhalation of dust or fumes, eye and skin contact.

12. ECOLOGICAL DATA

EPA Waste Numbers: None

13. DISPOSAL INFORMATION

Waste Disposal Methods: Dispose in accordance with all applicable federal, state and local regulations.
Always contact a permitted waste disposer (TSD) to assure compliance.

14. TRANSPORT INFORMATION

Description: Non-regulated

15. REGULATORY INFORMATION

EPA TSCA Status: On TSCA Inventory
Hazard Category for SARA Section 311/312 Reporting: Acute

	SARA Sec. 313				
Product or Components	SARA EHS Sec. 302 TPQ	Chemicals Name List	Chemical Category	CERCLA Sec. 103 RQ lbs.	RCRA Sec. 261.33
Tin	No	No	No	No	No
Copper	No	Yes	No	5000*	No
Selenium	No	Yes	No	100*	No

*when in form with diamter less than .004 inches

16. ADDITIONAL INFORMATION

The information provided in this Material Safety Data Sheet represents a compilation of data drawn directly from various sources available to us. Carolina Biological Supply makes no representation or guarantee as to the suitability of this information to a particular application of the substance covered in the Material Safety Data Sheet. Any employer must carefully assess the applicability of any information contained herein in regards to the particular use to which the employer puts the material.

Glossary

ACGIH American Conference of Governmental Industrial Hygienists
CAS Number Chemical Abstracts Service Number
CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
DOT U.S. Department of Transportation
IARC International Agency of Research on Cancer
mppcf million particles per cubic foot
N/A Not Available
NTP National Toxicology Program
OSHA Occupational Safety and Health Administration
PEL Permissible Exposure Limit
ppm parts per million
RCRA Resource Conservation and Recovery Act
SARA Superfund Amendments and Reauthorization Act
TLV Threshold Limit Value
TSCA Toxic Substances Control Act

Getting Started

1. During this lesson, you will work in a group of four. Discuss the following questions with the members of your group:

A. Can you think of at least one mixture that has the properties of both of the substances from which it is composed?

B. Can you think of at least one mixture that has the properties of only one of the substances from which it is composed?

C. Can you think of at least one mixture that has properties completely different from the properties of the substances from which it is composed?

Record your answers in your science notebook.

2. Your teacher will conduct a brainstorming session on your answers. Be prepared to contribute to the discussion.

MATERIALS FOR LESSON 18

For you

- 1 copy of Student Sheet 18.1: Adding Salt to Ice
- 1 copy of Student Sheet 18.2: Adding Salt to Boiling Water
- 1 copy of Student Sheet 18.3: Investigating Solid Solutions
- 1 pair of safety goggles

For your group

- 1 plastic spoon
- 1 black marker
- 2 250-mL beakers
- 2 thermometers
- 1 aluminum pan
- 1 jar of sodium chloride (common salt)
- 1 piece of solder, color-coded blue
- 1 piece of solder, color-coded green
- 1 piece of solder, color-coded red
- 1 burner
- 1 burner stand with gauze

Crushed ice
Access to hot water
Access to a clock or watch with a second hand

Inquiry 18.3
Investigating Solid Solutions

PROCEDURE

1. In this inquiry, you will investigate how impurities affect the melting point of three metal mixtures called solders. Because these solders melt at temperatures above the range of the thermometers you will use, you will measure the amount of time it takes for each of the solders to melt. You will then compare these measurements to determine the melting points of the solders. Your teacher will demonstrate how the apparatus in this inquiry should be used. Watch carefully and then read the instructions and Safety Tips before you start.

2. Assemble the apparatus as shown in Figure 18.1, but *do not place the burner into position under the stand until Step 6.*

SAFETY TIP

Solder is toxic if ingested. Do not put solder in your mouth.

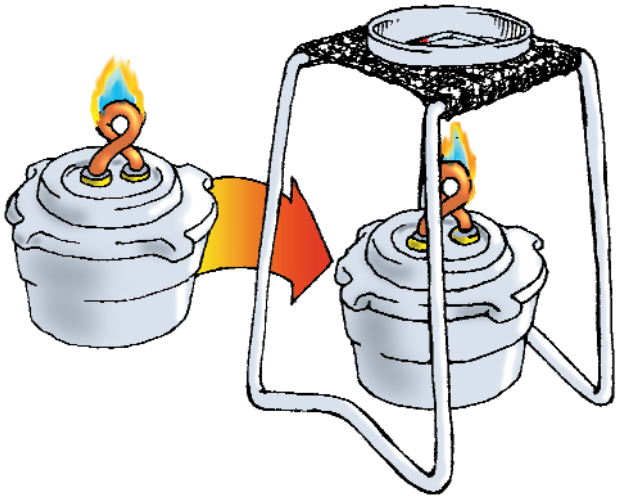


Figure 18.1 *How to assemble the alcohol burner apparatus for Inquiry 18.2. (Your burner may differ from this one.) Do not place the burner into position under the stand until Step 6.*

3. Place the pieces of solder on the aluminum pan in the same positions as those shown in Figure 18.2.

4. Make sure the aluminum pan is positioned in the center of the gauze. Make sure you know where each color-coded piece of solder is by completing the diagram in Step 1 on Student Sheet 18.3. **Warning:** As the solder gets hot, the color codes may disappear.

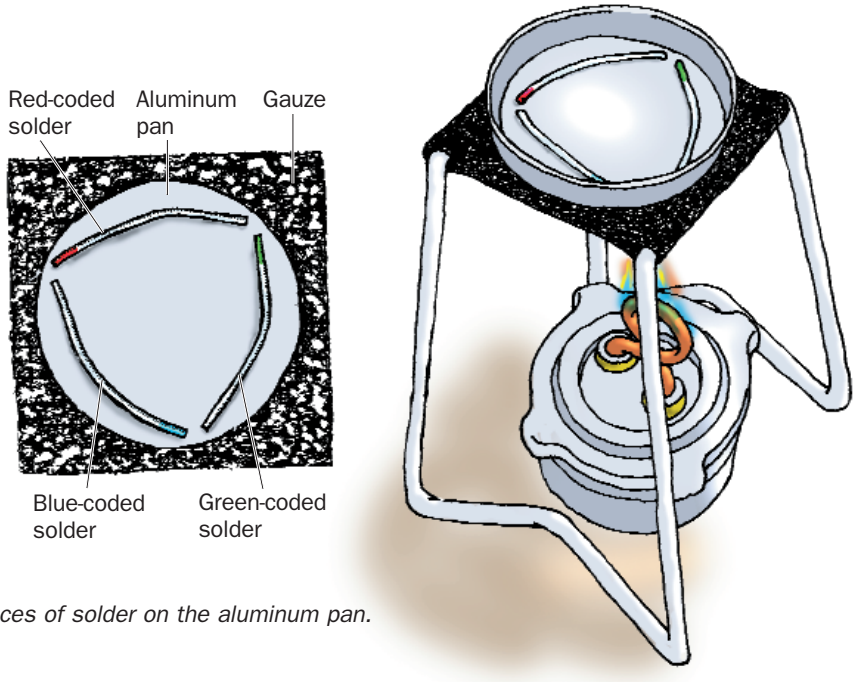


Figure 18.2 *Place the pieces of solder on the aluminum pan.*

SAFETY TIPS

Do not lean over the apparatus during heating.

Observe the solders from a distance of 2–3 feet.

5. Follow the procedure outlined by your teacher for igniting the burner. (If you are using a Bunsen burner, use the gas tap to make a flame about 4 cm high, and open the air hole about halfway.)

6. Using a clock or watch with a second hand, start recording the time at time 0. Move the burner so that the top of the flame is *exactly* in the center of the aluminum pan. Stand 2–3 feet (0.6–1 m) away from the apparatus.

7. Watch the pieces of solder very carefully, because changes may happen very quickly. Record in Table 1 on Student Sheet 18.3 when each piece of solder begins to show signs of melting (change in shape, seems more liquid than solid, etc.). Stop heating when all the pieces have melted or after 5 minutes (whichever comes first). If any of the pieces remains unmelted, record this information in Table 1.

8. Extinguish your burner.

9. Discuss the following questions with your group members. Once your group has agreed on the answers, write them under Steps 3 through 8 on Student Sheet 18.3.

A. How do you think the length of time to melt relates to the melting points of these solders? (Obtain the melting points from your teacher and add them to Table 1.)

B. Did all of the solders melt at the same temperature?

C. What effect do other metals have on the melting point of tin? (Use the information in Table 1 on the student sheet to help you answer this question.)

D. What effect does a greater amount of silver have on the melting points of the mixtures?

E. Look at the melting points of the pure metals in Table 1. Three of these metals are very difficult or impossible to melt with a lab burner. On the basis of this information, do you think that mixtures of metals always show a combination of the properties of their components?

F. Why are the low melting points of these alloys a useful property for solder?

10. Make sure your apparatus is cool. Return the materials to the plastic box and give any unused pieces of solder to your teacher.

SAFETY TIPS

Do not touch your apparatus for at least 5 minutes. It is still very hot.

Wash your hands before leaving the lab.

• Encourage students to report breakage and accidents as soon as they occur. Do not penalize students for breakage, because this may encourage secrecy.
• Have separate receptacles available for the disposal of broken glass.
• Fully train all students in the use of hot pots and burners before beginning inquiries that require their use.
• Never allow *students* to open or refill alcohol burners. Teachers should always refill alcohol burners away from any possible source of ignition and use small plastic bottles for refilling the burners.
• Emphasize the need for extra care when handling hot objects or liquids. Allow adequate cooling times. Warn students not to cool glass items with cold water.
• Make sure electrical cords are not draped across traffic areas or sinks.
• Show students how to immediately treat mild burns with cold water or ice. Refer injuries to the responsible authority in your school.
• Remind students to wash their hands before leaving the laboratory.
• Advise students that laboratory behavior that is disruptive or dangerous or that interferes with another student's right to learn may result in the disruptive student's being removed from the labs.

NOTE Some school systems have concerns with students using potassium permanganate in middle and elementary school labs. If you reside in an area or a state with these concerns, limit the use of potassium permanganate to teacher demonstration only. If you are in a state that *bans* the use of potassium permanganate by teachers and students you will omit part of Inquiry 1.5 in Lesson 1, substitute sucrose (confectioners' sugar) for potasssium permanganate as indicated for Inquiry 6, and omit Lesson 12.

CHEMICALS USED IN *PROPERTIES OF MATTER*

The following chemicals are used in this module:

- 2-propanol, 70% (isopropyl alcohol)
- Aluminum
- Ammonium chloride
- Calcium chloride, anhydrous
- Charcoal
- Copper
- Copper (II) carbonate (cupric carbonate)
- Copper (II) sulfate, pentahydrate (cupric sulfate)
- Ethanol, 95% (ethyl alcohol)
- Hydrochloric acid 1 M, 8%
- Iron filings
- Kerosene
- Lime water (calcium hydroxide solution)
- Magnesium
- Potassium permanganate
- Silicon
- Sodium chloride (table salt and rock salt)
- Sodium nitrate
- Sodium sulfate
- Solder
- Sulfur
- Tin
- Zinc, granular
- Zinc oxide

Each of these agents is regularly used in middle school science classrooms across the United States and is safe when appropriately handled. Each chemical is accompanied by an MSDS, which needs to be read thoroughly before the chemical is used in class.

2 test tube racks, rectangular
20 petri dish bases or lids
1 can of shaving foam
2 pieces of granite
4 loupes (double-eye magnifiers)
2 lab scoops
2 pairs of forceps
2 plastic boxes with lids
2 pipettes
2 jars (2 oz) containing sand
2 jars (2 oz) containing potassium permanganate (large crystals prepared by the teacher prior to the lesson)*
4 labels
2 bottles containing 2 immiscible liquids (blue and colorless)
4 aluminum pans
4 thermometers
8 effervescent tablets (cut in half)
8 black permanent markers (1 per group)
8 sheets of 11- × 14-inch paper*

PREPARATION

1. Start to prepare this lesson at least 3–4 days before you teach it. In the Setting Up section for Inquiry 1.2, instructions are given for making clay objects, which can be done in a day. In Setting Up for Inquiry 1.5, instructions are given for making potassium permanganate crystals, which will take about 2–3 days. If the use of potassium permanganate by teachers and students is banned in your school, set up Inquiry 1.5 using sand only.
2. Make one copy of Student Sheet 1.1: Our Ideas About Matter for each student.
3. At the top of each sheet of 11- × 14-inch paper, write one inquiry number and title. These sheets will be used after students complete all of the inquiries.
4. Students will work in pairs. The stations for each inquiry should be as widely separated as possible. Place one copy of each Inquiry Card (found in the kit) at the appropriate station.
5. Set up the apparatus for Inquiries 1.1–1.8, following the instructions for each inquiry below. (If you have more than 16 students in your class, set up a second circuit of inquiries and label them 1.1A–1.8A.)

*Needed, but not supplied

SAFETY TIP

Please be advised that the latex in the balloons may cause immediate or delayed allergic reactions in certain sensitive individuals.

Setting Up Inquiry 1.1: The Bottle and the Balloon

1. Inflate a balloon until it reaches a diameter of about 5 centimeters (cm) (see Figure 1.1A).

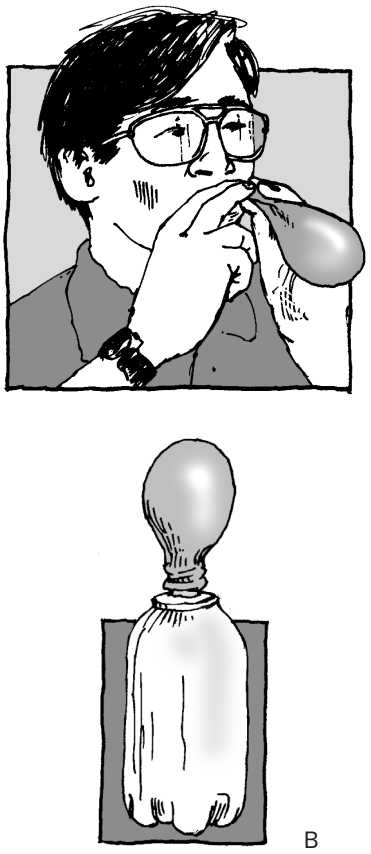


Figure 1.1 *(A) Inflate a balloon until it reaches a diameter of about 5 cm. (B) Put the balloon over the open neck of the 2-L plastic soda bottle.*

2. Attach the balloon to a 2-liter (L) plastic soda bottle (see Figure 1.1B).
3. Fill the hot pot half way with water. Set the thermostat to the midway position. Place a thermometer in the hot pot. Allow 5 minutes for the water to heat up to between 60 °C and 70 °C. Adjust the hot pot, if necessary, to keep the water at the correct temperature.
4. Fill half of the plastic tank with ice water (less than 10 °C). Additional ice will be required to maintain the temperature of the cold water bath throughout the lesson.
5. During the lesson check the temperature of both sets of water at regular intervals.

Setting Up Inquiry 1.2: Similar Objects

1. Make the clay balls and blocks by following these instructions:
   A. Unwrap the block of modeling clay provided with your kit.
   B. Cut it into four equal parts.
   C. Roll one of the parts into a ball. You may need to slightly reduce the quantity of clay in the ball so that it can fit into one of the 100-milliliter (mL) graduated cylinders provided in the kit.
   D. Use an electronic balance to measure the mass of the ball.
   E. Reduce the size of the remaining pieces of clay, if necessary, to make them about the same mass—within 0.2 gram (g)—as the ball you have made.
   F. From one of these pieces, make an additional ball. Use the remaining two parts to make two rectangular blocks. Make sure the blocks easily fit into a 100-mL graduated cylinder.
   G. Place the pieces you have made on a foil-lined tray in a kitchen oven.
   H. Bake at 275 °F for 15 minutes.
   I. Allow the objects to cool.
2. Place one ball, one block, and a bowl for water on a bench near a sink or other water source.
3. Place one 100-mL graduated cylinder on the bench.

Setting Up Inquiry 1.3: The Burning Candle

1. Place an unlit tea candle on the bench.
2. Provide matches and a 250-mL beaker.

Setting Up Inquiry 1.4: Describing Matter

1. Obtain two petri dishes (tops or bases). Use a permanent marker to label them A and B.
2. Place shaving foam (approximately 3 cm in height) in petri dish A. The shaving foam is easier to describe if it is left to stand for an hour, allowing the gas bubbles to expand and become easily visible with the loupe.
3. Place a piece of granite in petri dish B.
4. Provide two loupes.

Setting Up Inquiry 1.5: Adding Water

1. Set out the following apparatus:
   8 petri dish bases (or lids)
   1 plastic box (to collect dirty petri dishes)
   1 lab scoop
   1 pair of forceps
   1 pipette
   2 loupes (double-eye magnifiers)
   1 beaker, 250 mL, filled half way with water
   1 jar (2-oz) containing sand, labeled Substance A
   1 jar (2-oz) containing large crystals of potassium permanganate, labeled Substance B

NOTE When handling potassium permanganate, use a lab scoop or forceps because it can stain your clothes and hands. Also, wear safety goggles.

2. This inquiry works best if students use large crystals of potassium permanganate. You may wish to make these using the following instructions. Allow 2–3 days for this preparation.
   A. Warm about 25 mL of tap water in a 250-mL beaker (or evaporating dish if available) to approximately 70 °C.
   B. Slowly add potassium permanganate, stirring continuously until a saturated solution is formed.

Table 6.1 Changes That Occur Upon Heating

Substance	Appearance	Changes Observed When Heated	Notes	Appearance After Cooling
Potassium permanganate	Purple crystalline solid	Crackles and moves around the tube when heated; black powder produced	$2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$	Black powder
or	***or***	***or***	***or***	***or***
Sucrose (Confectioner's sugar)	White crystalline solid	Melts and turns brown; gives off steam; colorless liquid condenses near the top of the test tube; thickens and then turns black	$C_{12}H_{22}O_{11} \rightarrow 1H_2O + 12C$	Black solid
Ammonium chloride	White crystalline solid	Forms a ring of white solid farther up the test tube	$NH_4Cl \rightarrow NH_3 + HCl$ Dissociation reversed on cooling	White solid
Copper (II) carbonate	Blue/green powder	May move around in the test tube; turns brown and eventually black	$CuCO_3 \rightarrow CuO + CO_2$ Release of carbon dioxide causes the copper (II) carbonate to move around in the test tube	Black solid
Copper (II) sulfate	Blue crystalline solid	Turns white; a colorless liquid condenses higher up the test tube	$CuSO_4 \cdot 5H_2O \rightarrow CuSO_4 + 5H_2O$ Copper (II) sulfate loses water of crystallization	White but slowly turns blue
Sodium chloride	White crystalline solid	No observable change	—	White solid
Zinc oxide	White solid	Turns yellow when heated	—	Returns to original white form on cooling
Sulfur	Yellow crystalline solid	Melts to form a yellow/brown liquid; yellow solid may appear farther up the test tube	—	Yellow, needlelike crystals in the bottom of the tube; yellow powder may form on the wall of the test tube

All of the substances heated in this lesson are pure substances with specific chemical compositions. The changes that take place upon heating in a test tube are summarized in Table 6.1. Although the observations cited in the table may prove useful in discussion, all formulas and equations are given only as general information for you. You should rely on students' own observations for the completion of student data tables and will use these as the basis for the discussion during "Reflections."

Zinc oxide (ZnO) undergoes a phase change

when heated, turning from white to yellow. On cooling, the yellow form returns to its original white form. Phase changes are visible in sulfur (if dissociation is disregarded) and ammonium chloride. The sulfur used in this lesson is supplied in its rhombic crystalline form, and on heating, it melts. Students may notice that the hotter the liquid, the darker and more viscous it becomes. When this liquid is left to cool, it usually forms a hard mass of yellow, needlelike crystals. This substance is still sulfur, but it is the monoclinic crystalline form (or allotrope) of the element. Below 90 °C, monoclinic sulfur quickly turns back to the original, rhombic, form of the element. With the exception of sodium chloride, all the other chemicals undergo thermal decomposition.

Student Misconceptions

Students may have several misconceptions about chemical reactions and phase changes, including the following:

- Students may incorrectly think that matter is destroyed during chemical reactions. (This misconception may arise because combustion is used as a common means of disposal. As students discover in later lessons, matter is conserved in all chemical reactions.)
- Students may incorrectly believe that reactants disappear. (In fact, invisible products in the form of gases are often produced. The relationship between reactants and products may not always be an obvious one. Students' existing cognitive frameworks may allow for the "magical" disappearance of reactants and the unrelated appearance of new substances but may not allow for the formation of one new substance from another.)
- Students may incorrectly assume that the production of gases as products of a chemical reaction is a phase change (for example, in Inquiry 6.1, carbon dioxide is released in the thermal decomposition of copper carbonate).
- Students may incorrectly classify a phase change as a chemical reaction (for example, students may think that ice and water are two different substances and refer to their different properties to support this idea). (Changing phase is not a chemical reaction.)

These misconceptions are addressed more fully in later lessons.

MATERIALS FOR LESSON 6

For the teacher

1 transparency of Table 1 on Student Sheet 6.1*
Transparency markers*
Overhead projector*
1 burner
1 beaker, 250 mL
1 test tube clamp
1 test tube, 16 × 125 mm
1 test tube brush
1 lab scoop
Potassium permanganate *or* sucrose (confectioners' sugar)
1 pair of safety goggles*
1 butane lighter

For each student

1 copy of Student Sheet 6.1: Applying the Heat*
1 copy of Student Sheet 6: Review for Characteristic Properties*
1 pair of safety goggles*

For each group of 4 students

1 plastic box with lid
1 burner
1 beaker, 250 mL
1 test tube clamp
5 test tubes, 16 × 125 mm
1 lab scoop
1 test tube brush
1 test tube (16 × 125 mm) containing sulfur

*Needed, but not supplied

5 jars (2 oz), labeled, containing:
- Ammonium chloride
- Copper (II) carbonate
- Copper (II) sulfate
- Sodium chloride
- Zinc oxide

For the class

1 container for collecting waste materials*
Access to water for cleanup

PREPARATION

NOTE Some school systems have concerns with students using potassium permanganate in middle and elementary school labs. If you are in a state that bans the use of potassium permanganate by teachers and students, you may substitute sucrose (confectioners' sugar) for potassium permanganate in the teacher demonstration for Inquiry 6.1 (Table 6.1 Changes That Occur Upon Heating lists results for both potassium permanganate and sucrose.)

1. Make one copy of Student Sheet 6.1: Applying the Heat and Student Sheet 6: Review for Characteristic Properties for each student. Make a transparency of Table 1 on Student Sheet 6.1 (or copy it onto the board).
2. Students must be familiar with the use of burners. You may need to do a supplementary exercise to explain burner use to students. Instructions for using Bunsen and alcohol burners are included in the procedure.
3. Set out burner workstations, allowing for safe movement between stations. Do not include the burners in the plastic boxes. Make sure that the burners are functioning properly and that all alcohol burners are filled, with the lids securely fastened. Do not fill alcohol burners in class. Keep reserve ethanol fuel in a separate location where students cannot access it.
4. Put one to two lab scoops of sulfur into each of eight test tubes.

NOTE After the first lesson, reuse these test tubes with your other classes. Before each lesson, make sure the test tubes contain enough sulfur (one to two lab scoops).

5. Fill eight 2-ounce jars with ammonium chloride and label the jars. Using the same procedure, fill the remaining jars with the following substances and label them: copper (II) carbonate, copper (II) sulfate, sodium chloride, and zinc oxide.
6. Read the Material Safety Data Sheet (MSDS) information supplied with the chemicals you are using.
7. Provide a labeled container for the disposal of waste. All solid waste in this lesson can be disposed of in the trash.

Inquiry 6.1
Heating Substances

PROCEDURE

1. Tell students to come to the demonstration desk.

2. Explain that the purpose of the lesson is to observe the changes that occur when several different substances are heated. Ask students what they will need to observe and record. After obtaining their ideas, place the transparency of Table 1 on the overhead projector (or refer to the one on the board).

3. Explain and, where appropriate, demonstrate the safety procedures that all students should follow (see Safety Tips). You may also wish to add your own safety procedures.

NOTE If this lesson is done in two periods, students should be reminded of safety procedures at the start of the second period.

4. Use potassium permanganate as an example to demonstrate the procedure for heating the substances. (If you are in a state that bans the use of potassium permanganate, you may substitute confectioners' sugar for potassium permanganate in this demonstration.) Select one student to act as an observer and another to record the results in Table 1 on the transparency (or the board).

A. Use one lab scoop of potassium permanganate. Remind students to handle chemicals only with a lab scoop.

B. Ask the recorder to fill in the name of the substance on Table 1 on the transparency.

C. Ask the observer to describe the potassium permanganate before heating. You may need to help the student with words to describe the crystals. Emphasize the importance of describing all substances completely and accurately. A good description for potassium permanganate would be "solid, shiny, purple crystals." A good description for confectioners' sugar would be "solid, powdery, white crystals."

D. Correctly hold the test tube with the test tube clamp at the mouth of the tube.

E. Hold the tube at an angle of about 45°.

F. Point the mouth of the tube away from the students and yourself.

SAFETY TIPS

Use safety goggles at all times.

Tie back long hair and restrict loose clothing.

Never smell or taste the chemicals.

Handle chemicals only with the lab scoop.

Use only a test tube holder to pick up test tubes.

Never move around with a lit burner.

Never refill the alcohol burners.

Do not walk around while the substances are being heated; remain at the workstations at all times.

Follow classroom procedures for disposing of broken glassware and cleaning up spills.

Wash hands at the end of the lesson.

G. Heat the base of the tube. Move the tube gently in the flame to ensure even distribution of heat.

H. Heat the substance for 1–2 minutes.

I. Ask the observer to comment on any changes. Solicit additional comments from the rest of the class. The recorder should record all observations in Table 1.

J. Allow the tube to cool for a minute before standing it in the beaker.

K. Ask the observer to carefully describe the substance after it has cooled for at least 1 minute. The recorder should record these observations in Table 1.

5. Have students return to their seats and complete the first row of Table 1 on Student Sheet 6.1 by copying the information from the table on the transparency (or the board).

6. Use these results as the basis of a short discussion (1–2 minutes) on what students should look for when heating the remaining substances, including changes in appearance (for example, phase, texture, and color), movement in the tube, and new substances produced.

7. Re-emphasize the need for careful observation and recording at all stages of this inquiry.

8. Have students get into groups of four, collect plastic boxes, and check the materials against the materials list.

9. Have students read Steps 7 through 20 in the Student Guide.

10. Allocate a workstation to each group.

11. Have students follow the procedures below for igniting and using the burners.

NOTE These procedures are not in the Student Guide. The procedures outlined here are also provided in the Teacher's Guide as Appendix C. You may want to write the procedures on the board, or you may use Appendix C to make an overhead transparency to use with your classes.

A. The procedure for using the Bunsen burner is as follows:

- Check the gas tubing and make sure it is firmly connected to the gas tap.
- Close the air hole on the burner.
- Ask your teacher to light the burner.
- Adjust the flame using the gas tap so that it is approximately 5 cm high.
- Use the ring to adjust the air hole so that it is half open.
- To extinguish the burner, turn off the gas at the gas tap.

B. The procedure for using the alcohol burner is as follows:

- Remove the cap from the burner's coil.
- Make sure the lid of the burner is "dry" (free of excess fuel).
- Ask your teacher to light the burner. (To light the burner, hold the gas lighter under the coil for a few seconds.)
- To extinguish the burner, place the cap over the flame.

12. Have students proceed with Steps 7 through 17 in the Student Guide.

NOTE Allow about 20 minutes for students to heat all of the substances.

13. You may ask students to clean up (Steps 18 and 19 in the Student Guide) before proceeding to "Reflections." Alternatively,

you may want students to retain the substances in the test tubes so that they can refer to them during "Reflections." Have students dispose of all waste products in a waste container.

14. Give students time to answer the questions in Steps 2 and 3 on Student Sheet 6.1 before you proceed to "Reflections." Have all students dispose of all waste products in a waste container.

REFLECTIONS

1. Bring the lesson to a close with a class discussion. Use the diagram produced during the brainstorming session to relate the types of changes students observed in the inquiry to those discussed during the session.

2. Discuss in detail the nature of the change that occurred when each substance was heated. Students should use the information in Table 1 on the student sheet to contribute to the discussion but should not modify their tables.

3. Ask students how they could classify these changes. Groups *could include* no changes, changes that were reversed on cooling (reversible), and changes that were permanent (irreversible).

4. Ask students to speculate about what is happening in each of the groups.

5. Have students read "Heat and Changing Matter," on page 60 in the Student Guide.

6. Discuss the idea that heating a substance may result in the formation of new substances that have very different characteristic properties compared with the properties of the original substance. This is called a **chemical reaction.**

7. Relate student observations to the concept of a chemical reaction. What evidence is there that a new substance(s) is produced? Do not name the compounds produced.

8. Introduce the idea of a simple chemical equation (reactant → products), using examples from student observations, such as bluish green powder → brownish black solid + gas (that is, copper carbonate → copper oxide + carbon dioxide).

NOTE The concept of simple chemical equations is more fully developed later in the module.

9. Emphasize that different substances behave differently when heated; therefore, the behavior of a substance on heating can be used to help identify a substance. The behavior is a characteristic property of a substance.

10. Have students answer question 4 on Student Sheet 6.1.

HOMEWORK

Tell students that Lesson 9 is an assessment. Provide them with the review sheet (Student Sheet 6) for Lessons 1 through 8. Have them review the first four rows of the table. (Students will review the last three rows as a homework assignment for Lesson 8.)

- Students may incorrectly think that solutes disappear when added to water. (This misconception is more common when the process involves the formation of a colorless solution. It is addressed in Step 3 of "Reflections" and in Lesson 14 when students investigate the conservation of mass in relation to dissolving.)
- Students may incorrectly think that the solute becomes water or that the dissolved solute and solvent constitute a single substance.
- Students may incorrectly equate the process of a solid dissolving with the process of melting, because in both processes the solids undergo an observable phase change.
- Students may incorrectly believe that solute particles can be removed by filtration or that over time, they will settle out of solution. (Solutions cannot be separated by filtration and are stable at a specific temperature.)
- Students may incorrectly think that the addition of solute does not add any volume to the solution. (The addition of solute does produce an increase in volume, although the volume is less than the sum of the volume of the separate solute and solvent.)

NOTE Some school systems prohibit the use of potassium permanganate by students in middle and elementary school labs. If you are in a state that bans the use of potassium permanganate by students, you will omit Lesson 12 and proceed to Lesson 13.

MATERIALS FOR LESSON 12

For the teacher

1 pair of safety goggles*
Overhead projector*
2 petri dish lids or bases
1 large potassium permanganate crystal
1 jar (2 oz) containing sand
1 pipette
1 pair of forceps
1 test tube rack, rectangular
8 test tubes (16 × 125 mm) containing food coloring solution
10 beakers, 250 mL
1 container labeled "Zinc Oxide Waste"*

*Needed, but not supplied

For each student

1 copy of Student Sheet 12.1: Mixing Substances With Water*
1 pair of safety goggles*

For each group of 4 students

1 plastic box with lid
Jars (2 oz), labeled, containing the following substances:
Copper (II) sulfate
Sodium chloride
Zinc oxide
Sulfur
Confectioners' sugar
1 plastic cup, 105 mL (3.5 oz)
1 label

For each pair of students

1 test tube rack, rectangular
5 test tubes, 16 × 125 mm
2 rubber stoppers (no hole)
1 lab scoop
1 metric ruler
1 test tube brush
Access to water

PREPARATION

1. Make one copy of Student Sheet 12.1: Mixing Substances With Water for each student.
2. Put 5 mL of food coloring solution into each of eight test tubes. Stand each tube in one 250-mL beaker.
3. Reuse the eight jars of copper (II) sulfate, sodium chloride, and zinc oxide prepared for Lesson 6. Make sure all of the jars are labeled and full. Also fill and label eight jars with sulfur and eight jars with confectioners' sugar.

4. Make sure that large crystals of potassium permanganate are available. See Preparation for Lesson 1, Inquiry 1.5, for information on how to prepare additional quantities of these crystals. If large crystals are unavailable, use half a lab scoop of fine crystals.

Getting Started

1. Explain to students that they are going to investigate a special type of mixture that they have already encountered in their everyday lives and in Lesson 11.

SAFETY TIPS

Students should wear safety goggles at all times.

If a student splashes a solution in his or her eyes, he or she should immediately flush them out with copious amounts of water and report the accident to you.

Students should not mix the contents of different test tubes.

Students should wash their hands at the end of the inquiry.

2. Ask one student to hand out the beakers and test tubes containing the food coloring solution. Ask students what they think the components of this mixture may be. Most students will identify water as the major component and say there is also a second substance (the food coloring). Ask students what a mixture like this is called. If they do not use the term "solution," introduce it.
3. Have students complete Step 1 of "Getting Started" in the Student Guide.
4. Ask several students what they observed about the solution. Look for the following properties:

   - It is a liquid (only one phase visible).
   - It has a uniform appearance (in this case, colored).
   - It is clear/transparent.

5. Because some students may equate transparency with colorlessness or translucence, have them define the term "transparent."
6. Emphasize that transparency and uniformity of color are properties of solutions with liquid solvents such as water. Discuss the properties of solutions with the class. Students should use these properties to determine whether a substance can form a solution in water.

NOTE All of the water-soluble substances used in this lesson will dissolve completely (if the specified quantities are used). Discussion of saturated solutions is reserved for Lesson 13.

7. Explain that substances in solution are the most finely divided and dispersed mixtures that exist.

NOTE If your students have done work on particulate theory, you may want to mention that solutions are mixtures in which the particles are either molecules or atoms (or ions). Extension 1 at the end of this lesson should help you illustrate this concept. Otherwise, it is not necessary to introduce the concepts of molecules, atoms, or ions here.

8. Have students return the test tubes containing the food coloring solution. Groups should retain the beakers for use in the inquiry. Use the two remaining beakers to store the tubes containing the food coloring solution for the next class.