Elements, Compounds, & Mixtures Wet Lab

Note: This lab is advanced and requires extra supplies not included

Standards:

7.PS1.2 Compare and contrast elemental molecules and compound molecules.
7.PS1.3 Classify matter as pure substances or mixtures based on composition
7.PS1.5 Use the periodic table as a model to analyze and interpret evidence relating to physical and chemical properties to identify a sample of matter

This lab requires some lab equipment that is not included in the kit. If there is not access to these supplies, the class cannot do this lab. This lab assumes 6 groups to a class. There can be more groups if there are more supplies. This lab is along the lines of a high school chemistry class procedure. It is not recommended for classes younger than 7th grade or with poor classroom management.

Supplies Needed but **Not** Included:

- 6 electric balances
- 6 400 ml beakers
- 6 250 ml beakers
- 6 funnels
- 6 hot plates
- 6 ring stands with rings
- 6 Stirrers
- Weighing Paper

Supplies Needed and Included:

- Carboy with DI water
- Iron Filings Fe, 5g for each group
- Sand SiO2, 5g each group
- Sodium Chloride NaCl, 5g for each group
- Zinc, mossy Zn, 5g each group
- 1 Box of 100 filter paper squares (for filtering and weighing)
- 6 Magnetic Wands
- 15 Screen Pieces
- Aluminum Foil Al, 3’ x 3’ piece for each group
- Copper(II) Chloride Dehydrate CuCl2 2H2O, 3g per group

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Elements, Compounds, and Mixtures

Super Value Laboratory Kit

Introduction

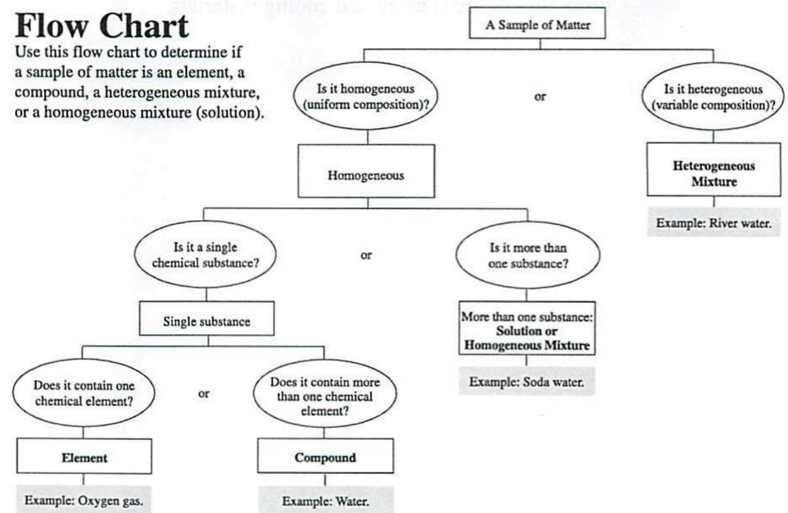
Engage in two dry-lab, classroom activities to review element names and symbols and to learn to classify matter. Then perform two laboratory activities—one involves the separation of a mixture of four substances using physical separation techniques and the other allows the analysis of a chemical reaction between an element and a compound.

Background

Matter is the material of the universe and can be defined as anything that has mass and takes up space. Most of the matter around us consists of mixtures of many substances. Soil, air, lemonade, and wood are all mixtures—the main characteristic of a mixture is that it has a variable composition. For example, soil is a mixture of many substances with varying proportions, depending on the type of soil and where it is found.

Mixtures can be classified as either heterogeneous or homogeneous. A *heterogeneous mixture* is a mixture that is not uniform in composition. If one portion of the mixture were to be sampled, its composition would be different from the composition of another portion. Soil, containing bits of decayed material along with sand, silt, and/or clay, is a heterogeneous mixture. Other examples of heterogeneous mixtures are sand in water and vinegar-and-oil dressing.

A *homogeneous mixture,* also called a *solution,* is a mixture that has a completely uniform composition. The components of the mixture are evenly distributed throughout the sample. Air, salt water, and brass are examples of homogeneous mixtures, or solutions. Air is a gaseous solution consisting of a mixture of gases, salt water is a liquid solution, and brass is a solid solution of copper and zinc.



Flow Chart
Use this flow chart to determine if a sample of matter is an element, a compound, a heterogeneous mixture, or a homogeneous mixture (solution).

Mixtures, both homogeneous and heterogeneous, can be separated into pure substances by physical methods. A *pure substance* is one with a uniform and definite composition. Pure substances can be divided into two groups—elements and compounds. *Elements* are the simplest forms of matter which cannot be decomposed into simpler substances by any chemical or physical means. Elements are the building blocks for all other substances. Some examples of elements include hydrogen, oxygen, carbon, and sulfur. Elements can combine with one another to form compounds. *Compounds* are substances composed of two or more elements chemically combined that can be separated into simpler substances only by chemical means. Water, for example, is a compound because pure water is composed of only H_2O molecules. Each molecule of water is a chemical combination of two hydrogen atoms and one oxygen atom. Water can be decomposed into its elements only by chemical means. A process called *electrolysis,* where an electric current is passed through the water, is used to break it down into its component elements, hydrogen and oxygen.

Characteristics that allow you to distinguish one kind of matter from another are called *properties*. A *physical property* is a quality or condition of a substance that can be observed or measured without changing the identity of the substance. Physical

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properties can help to identify a substance. Some examples of physical properties of matter are color, solubility, mass, odor, magnetism, density, melting point, and hardness. A *chemical property* is the ability of a substance to undergo chemical reactions and to form new substances. Chemical properties can also help to identify a substance. Some examples of chemical properties of matter are the ability to rust, corrode, decompose, or react.

Mixtures are simply a heterogeneous or homogeneous physical blend of two or more substances. They can be separated based solely on physical properties, or by undergoing physical changes. A *physical change* alters a substance without changing its composition. For example, the melting of ice, the freezing of water, the evaporation of water, or the bending of a piece of metal are all physical changes which do not change the identity of the substance. Physical separation techniques—such as filtration, evaporation, or distillation—are ways to separate a mixture into its component parts. The properties of each component part before mixing and after separation will not be altered by undergoing the physical separation. For example, imagine making a mixture of sugar in water. The sugar can be recovered by evaporation of the water; the water can be recovered by condensation. The sugar has the same properties before mixing and after separation. The same is true of the water.

Compounds, on the other hand, can be made or separated based on chemical properties, or by undergoing chemical changes. A *chemical change,* sometimes called a chemical reaction, is one in which a given substance becomes a new substance or substances with different properties and different composition. For example, the burning of leaves, the baking of bread, and the rusting of iron are all chemical changes in which the original substance has changed to a completely different substance with different properties and a different chemical composition. The original substance cannot be recovered easily (except perhaps by another chemical change). For example, imagine burning sugar, which is combining it with oxygen. The resulting product is very different than the starting material and the original sugar cannot be recovered.

Overview of Activities

- Activity 1: Learning the Elements—Become familiar with common element names and their corresponding symbols with this introductory activity.
- Activity 2: Classifying Matter—Classify various materials as either elements, compounds, heterogeneous or homogeneous mixtures following the flow chart provided to you.
- Activity 3: Laboratory Activity—Make and then separate a mixture of elements and compounds using physical separation techniques. Observe and record properties of the materials before mixing and after separation.
- Activity 4: Laboratory Activity—Perform a chemical reaction between an element and a compound. Observe and record properties of the starting and ending materials.

Name: ______________________________

Activity #1. Learning the Elements

Locate each element name or symbol on the periodic table and complete the following table. The first one has been done for you. Use the periodic table on page 13.

	Symbol	Element Name
1.	C	Carbon
2.	P	
3.	Si	
4.		Nitrogen
5.	Zn	
6.		Iron
7.	Cu	
8.	O	
9.		Hydrogen
10.	K	
11.		Sodium
12.		Chlorine
13.	Ne	
14.		Mercury
15.	Au	

	Symbol	Element Name
16.		Sulfur
17.	Al	
18.	Ca	
19.		Uranium
20.	I	
21.		Helium
22.		Cobalt
23.	Ag	
24.	Be	
25.		Magnesium
26.	Mn	
27.		Platinum
28.	W	
29.	Ti	
30.		Lead

Name: ______________________________

Activity #2. Classifying Matter

Classify each material below as an element, a compound, a heterogeneous mixture, or a homogeneous mixture (solution). Follow the flow chart provided on page 12 and read the information provided in the background section as a guideline. The first one has been done for you.

Material	Classification
1. Table salt	**Compound**
2. Block of iron	
3. Glass of cola	
4. Mercury in a thermometer	
5. Ice	
6. Vinegar and oil	
7. Copper wire	
8. Earth's atmosphere, when dusty	
9. Earth's atmosphere, when dust-free	
10. Rust	
11. Brass	
12. Aluminum foil	
13. Homogenized milk	
14. Sugar	
15. Sugar water	
16. Sandy water	
17. Neon gas in a neon sign	
18. Blood	

Activity #3. Lab Activity — Separating a Mixture of Elements and Compounds

Introduction

In this lab, a mixture of elements and compounds will be separated using physical separation techniques.

Concepts

- Elements
- Compounds
- Physical properties
- Physical separations
- Heterogeneous mixtures

Materials (for each student group)

Iron filings, Fe, 5 g
Sand, SiO_2, 5 g
Sodium chloride, NaCl, 5 g
Zinc, mossy, Zn, 5 g
Water, distilled or deionized, H_2O, 50 mL
Balance, 0.1-g sensitivity
Beaker, Pyrex®, 400-mL
Beaker, Pyrex®, 250-mL
Conductivity apparatus (optional)
Filter paper, 1 piece
Funnel
Hot plate
Iron ring
Magnetic wand or magnet
Ring stand
Screen
Sheet of notebook paper
Stirring rod
Weighing paper or squares of paper

Safety Precautions

Handle boiling water and the hot beaker with care. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron.

Procedure

1. Weigh approximately 5 g of iron filings, 5 g of mossy zinc, 5 g of sand, and 5 g of sodium chloride. Use a separate piece of weighing paper or a small square piece of paper for each. Record the exact mass of each material to the nearest tenth of a gram in Table 1.
2. Carefully observe each of the four pure substances. Record observations of physical properties in Table 2. *Note:* Be very descriptive!
3. Test each substance with a magnet by running a magnet underneath each piece of paper. Record these observations in Table 2.
4. Combine the four substances together in the 400-mL beaker. Record observations of the newly-formed mixture in Table 3 (step 4).
5. Pour the prepared mixture onto one half of a sheet of notebook paper. Pass a magnet underneath the paper moving the magnetic materials to the clean half of the paper. Completely separate the magnetic material, collect it on a piece of weighing paper, re-mass it on the balance, and identify it. Record the mass in Table 1 and record observations of the separated material in Table 3 (step 5).
6. Place a screen on top of a 400-mL beaker. Pour the remaining mixture (non-magnetic materials) onto the screen. Sift the mixture over the beaker so that the smaller particles fall through the screen and the larger particles remain on the screen. Separate and collect the material retained by the screen on a piece of weighing paper. Re-mass it on the balance and identify the material. Record the mass in Table 1 and record observations of the separated material in Table 3 (step 6).

7. Add about 50 mL of distilled or deionized water to the beaker containing the remaining mixture and swirl the beaker gently. If a conductivity apparatus is available, test the conductivity of pure distilled water and then test the conductivity of the mixture that you prepared. Record observations in Table 3 (step 7).
8. Weigh a piece of filter paper and record this mass in Table 4. Set up a filtering apparatus as shown in Figure 1.
9. Weigh an empty 250-mL beaker and record the mass in Table 4. Place the empty beaker underneath the funnel. Pour the contents of the 400-mL beaker into the funnel. Take care that no material is poured over the edges of the filter paper. Rinse this beaker and any solid it contains with about 10 mL of distilled or deionized water. Pour this rinse into the funnel.
10. Observe the contents of the beaker and of the filter paper. Record observations in Table 3 (step 10). Remove the filter paper from the funnel, unfold it and allow it to dry overnight or under a heat lamp. Identify the material. When dry, weigh the separated material (material #3) on the filter paper. Record this mass in Table 4. Calculate the mass of the dry separated material and transfer this mass to Table 1.

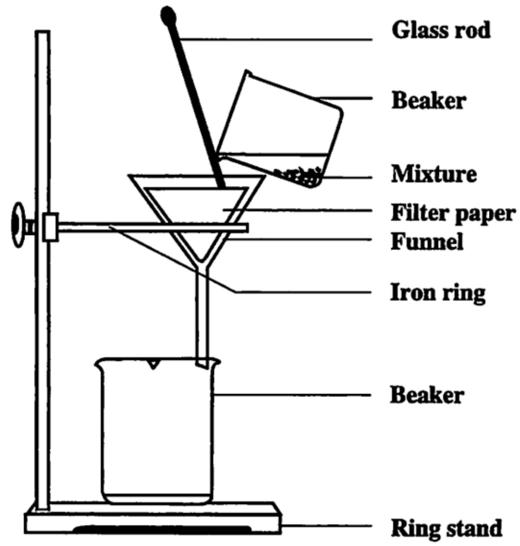


Figure 1. Filtering Apparatus

11. Place the 250-mL beaker on a hot plate set at medium heat. Allow most of the liquid to evaporate. Turn the heat down if spattering occurs. When only a small bit of liquid remains, turn off the heat and allow the remaining liquid to evaporate.
12. When the beaker is cool and dry, examine the contents, identify the material, and record observations in Table 3 (step 12). Weigh the beaker plus the separated material (material #4) and record the mass in Table 4. Calculate the mass of the dry separated material and transfer this mass to Table 1.
13. Answer questions 1–8 in the Questions and Calculations section.

Name: ______________________________

Separating a Mixture of Elements and Compounds Data Tables

Data Table 1. Yield

Substance	Initial Mass in Grams (Before Mixing)	Final Mass in Grams (After Separating)	Percent Yield
Iron			
Zinc			
Sand			
Sodium chloride			

Data Table 2. Observations Before Mixing

Substance	Observations of Physical Properties
Iron	
Zinc	
Sand	
Sodium chloride	

Data Table 3. Observations After Mixing

Step Number	Observations
Step 4	
Step 5	
Step 6	
Step 7	
Step 10	
Step 12	

Name: ______________________

Separating a Mixture of Elements and Compounds, continued

Data Table 4. Mass

Material	Mass in Grams
Filter paper	
Filter paper plus material #3	
Material #3	
Empty 250-mL beaker	
Beaker plus material #4	
Material #4	

Questions and Calculations

1. Calculate the percent yield for the iron, zinc, sand, and sodium chloride. Show all work in the space provided below. Fill in your answers in Table 1.

   Iron:

   Zinc:

   Sand:

   Sodium chloride:

2. What errors may have occurred that would cause the yield of the materials to be less than 100%?

3. How is it possible that some of the percent yields are actually greater than 100%?

Name: ______________________________

Separating a Mixture of Elements and Compounds, continued

4. Using a periodic table, label each of the four starting substances as either an element or as a compound.

Substance	Element or Compound?
Iron	
Zinc	
Sand	
Sodium chloride	

5. How did you determine which substances were elements and which were compounds?

6. When the four pure starting substances were combined to form a mixture, how did their properties before mixing compare to after separation?

7. After mixing the four substances together, is it possible to recover the original materials? Why or why not?

8. What properties of the four starting substances did you use to separate out each material?

Activity #4. Lab Activity — Observing a Chemical Reaction

Introduction

In this lab, an element will be combined with a compound and a single replacement chemical reaction will be observed.

Concepts

- Chemical reactions
- Chemical properties

Materials (for each student group)

Aluminum foil, Al, 3″ × 3″ piece

Copper(II) chloride dihydrate, $CuCl_2 \cdot 2H_2O$, 3 g

Water, distilled or deionized, H_2O, 20 mL

Balance, 0.1-g sensitivity

Beaker, Pyrex®, 250-mL

Graduated cylinder, 50-mL or 100-mL

Stirring rod

Safety Precautions

Copper(II) chloride is highly toxic by ingestion and is a body tissue irritant; avoid contact with body tissues; LD_{50} is 140 mg/kg. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron.

Procedure

1. Obtain a square of aluminum foil approximately 3″ × 3″. Record observations about the aluminum foil in Table 5.
2. Weigh approximately 3 grams of copper(II) chloride. Record the mass to the nearest tenth of a gram in Table 5.
3. Transfer the copper(II) chloride to a 250-mL beaker. Record observations about the copper(II) chloride in Table 5.
4. Use a graduated cylinder to measure approximately 20 mL of distilled or deionized water. Record observations of the water in Table 5.
5. Add the water to the beaker containing the copper(II) chloride. Stir and record observations in Table 5.
6. Loosely crumple the square of aluminum foil. Add the foil to the beaker containing the copper(II) chloride and water. Take care not to wad up the foil too tightly or else there will be less exposed surface to react. Observe the reaction and record immediate observations in Table 5.
7. Stir and continue observing until the reaction is complete. Record observations of the final product(s) in Table 5.
8. Answer questions 1–4 in the Questions/Results section.

Name: ____________________

Observing a Chemical Reaction

Data Table 5. Observations

Step Number	Material	Observations (Include mass where appropriate)	Element, Compound, Heterogeneous Mixture, or Solution
Step 1	Aluminum foil		
Step 2 and 3	Copper(II) chloride		
Step 4	Water		
Step 5	Copper(II) chloride and water		
Step 6	Copper(II) chloride, water, and aluminum foil (immediately)		
Step 7	Copper(II) chloride, water, and aluminum foil (after reacting)		

Questions/Results

1. Write the balanced chemical equation for the reaction between aluminum foil and copper(II) chloride.

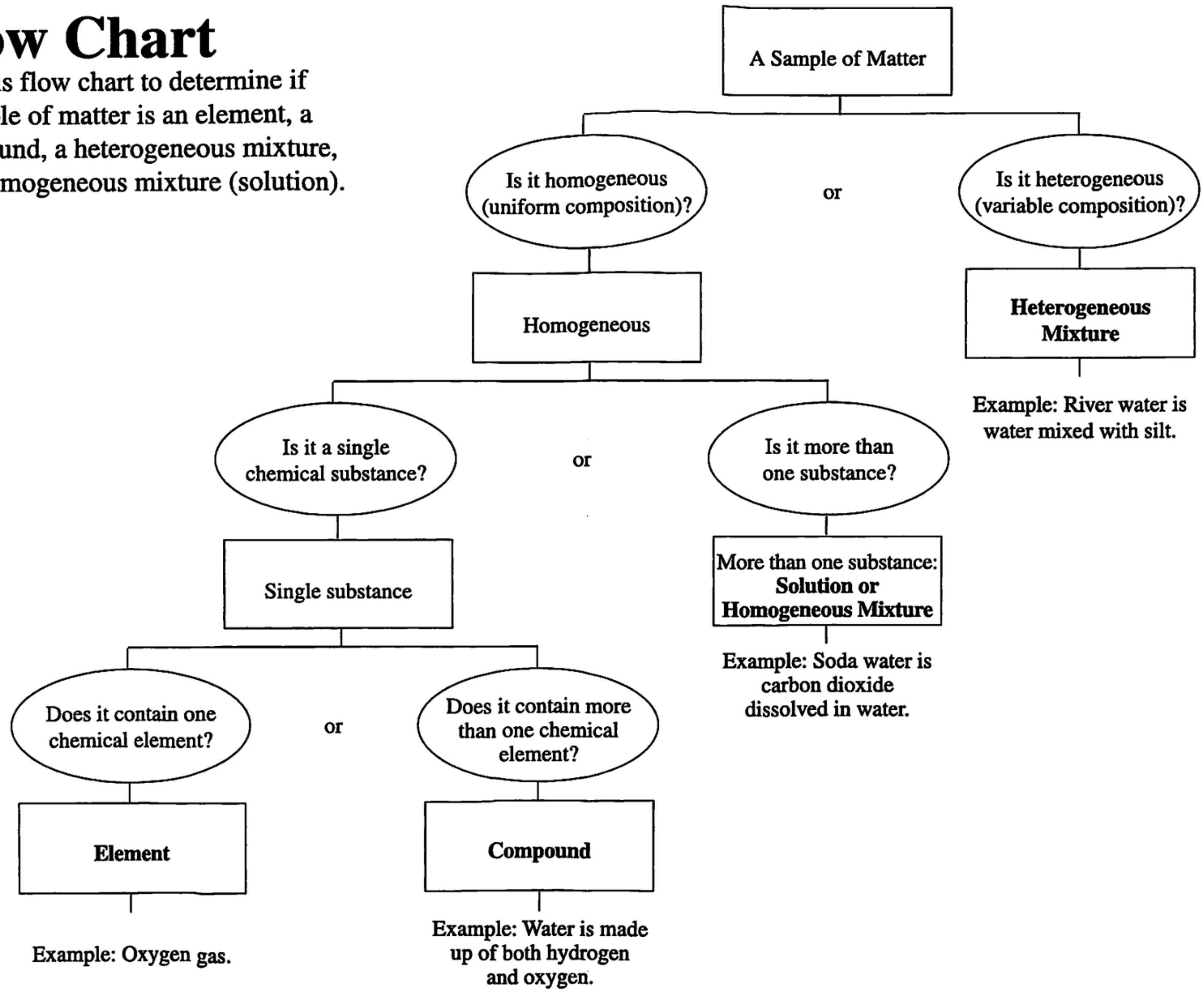
2. What evidence do you have that a chemical reaction did indeed occur? Be specific.

3. After mixing, is it possible to recover the original reactants (aluminum foil and copper(II) chloride) by physical means? Why or why not?

4. How might it be possible to separate a chemical compound into its component parts? Explain.

Flow Chart

Use this flow chart to determine if a sample of matter is an element, a compound, a heterogeneous mixture, or a homogeneous mixture (solution).



Name: ______________________________

The Periodic Table of the Elements

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 **H** 1.008																	2 **He** 4.003
2	3 **Li** 6.941	4 **Be** 9.012											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
3	11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
4	19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.87	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.38	31 **Ga** 69.72	32 **Ge** 72.64	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
5	37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.96	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
6	55 **Cs** 132.9	56 **Ba** 137.3	57–71 **La–Lu** ★	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.8	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
7	87 **Fr** (223)	88 **Ra** (226)	89–103 **Ac–Lr** #	104 **Rf** (267)	105 **Db** (268)	106 **Sg** (271)	107 **Bh** (272)	108 **Hs** (270)	109 **Mt** (276)	110 **Ds** (281)	111 **Rg** (280)	112 **Cn** (285)	113 **Uut** (284)	114 **Fl** (289)	115 **Uup** (288)	116 **Lv** (293)	117 **Uus** (294)	118 **Uuo** (294)

★	57 **La** 138.9	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
#	89 **Ac** (227)	90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

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Teacher's Notes

Elements, Compounds, and Mixtures Kit

Answers for Activity #1. Learning the Elements

Symbol	Element Name	Symbol	Element Name
1. **C**	Carbon	16. ***S***	Sulfur
2. P	***Phosphorus***	17. Al	***Aluminum***
3. Si	***Silicon***	18. Ca	***Calcium***
4. ***N***	Nitrogen	19. ***U***	Uranium
5. Zn	***Zinc***	20. I	***Iodine***
6. ***Fe***	Iron	21. ***He***	Helium
7. Cu	***Copper***	22. ***Co***	Cobalt
8. O	***Oxygen***	23. Ag	***Silver***
9. ***H***	Hydrogen	24. Be	***Beryllium***
10. K	***Potassium***	25. ***Mg***	Magnesium
11. ***Na***	Sodium	26. Mn	***Manganese***
12. ***Cl***	Chlorine	27. ***Pt***	Platinum
13. Ne	***Neon***	28. W	***Tungsten***
14. ***Hg***	Mercury	29. Ti	***Titanium***
15. Au	***Gold***	30. ***Pb***	Lead

Answers for Activity #2. Classifying Matter

Classify each material below as an element, a compound, a heterogeneous mixture, or a homogeneous mixture (solution). Follow the flow chart provided and read the information provided in the background section as a guideline.

Material	Classification
1. Table salt	**Compound**
2. Block of iron	*Element*
3. Glass of cola	*Homogeneous mixture (soluton)*
4. Mercury in a thermometer	*Element*
5. Ice	*Compound*
6. Vinegar and oil	*Heterogeneous mixture*
7. Copper wire	*Element*
8. Earth's atmosphere, when dusty	*Heterogeneous mixture*
9. Earth's atmosphere, when dust-free	*Homogeneous mixture (soluton)*
10. Rust	*Compound*
11. Brass	*Homogeneous mixture (soluton)*
12. Aluminum foil	*Element*
13. Homogenized milk	*Homogeneous mixture (soluton)*
14. Sugar	*Compound*
15. Sugar water	*Homogeneous mixture (soluton)*
16. Sandy water	*Heterogeneous mixture*
17. Neon gas in a neon sign	*Element*
18. Blood	*Homogeneous mixture (soluton)*

Activity #3. Lab Activity — Separating a Mixture of Elements and Compounds

Materials Included in Kit (for 5 classes of 30 students each, working in pairs)

Iron filings, Fe, 500 g

Sand, SiO_2, 500 g

Sodium chloride, NaCl, 500 g

Zinc mossy, Zn, 500 g

Filter paper, 4 boxes of 100

Magnetic wand

Screen squares, 9″ × 9″, 15

Additional Materials Needed (for each group)

Water, distilled or deionized, H_2O, 50 mL

Balance, 0.1-g sensitivity

Beaker, Pyrex®, 400-mL

Beaker, Pyrex®, 250-mL

Conductivity apparatus (optional)

Funnel

Hot plate

Iron ring

Ring stand

Sheet of notebook paper

Stirring rod

Weighing paper or squares of paper

Safety Precautions

Handle boiling water and the hot beaker with care. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Tips

- Enough materials are provided in this Super Value Kit for 5 classes of 30 students each, working in pairs (75 total student groups). One 50-minute lab period should be ample time to complete this lab activity.
- The "dry-lab" paper and pencil activities are an excellent introduction to elements, compounds, and mixtures. The activities may be done individually or as group pre-lab activities.
- As an introduction to this lab activity, consider showing students samples of elements that you have in your chemical stockroom or that they may find in the surrounding world. The Flinn Chemical Element Set (Catalog Number AP1128) contains samples of 25 elements and is a great option for displaying elements.
- One magnetic wand is included with the laboratory kit. Students can share or you might consider purchasing additional magnetic wands or simple bar magnets.
- This lab activity has been designed as an introductory activity. This activity can be modified for a higher-level lab experience. Simply give students the materials to be separated without the step-by-step procedure. Have them design their own flow chart and from it, a lab procedure in which they isolate each of the four materials.
- The equation to calculate percent yield may be provided to the student. See the answer to question 1.

Sample Data Table 1. Yield

Substance	Initial Mass in Grams (Before Mixing)	Final Mass in Grams (After Separating)	Percent Yield
Iron	*5.0 g*	*4.3 g*	*86%*
Zinc	*5.1 g*	*4.9 g*	*96%*
Sand	*5.3 g*	*5.5 g*	*104%*
Sodium chloride	*5.0 g*	*4.5 g*	*90%*

Sample Data Table 2. Observations Before Mixing

Substance	Observations of Physical Properties
Iron	*Magnetic, shiny, silvery, metallic*
Zinc	*Metallic, grayish, chunks, rough surface*
Sand	*Tan color, crystalline, granular*
Sodium chloride	*White, solid, crystalline, granular*

Sample Data Table 3. Observations After Mixing

Step Number	Observations
Step 4	*No reaction when mixed; each substance still looks the same; physically combined*
Step 5	*Iron filings—separated with magnet; metallic; shiny*
Step 6	*Zinc pieces—separated with screen; large metal chunks; gray*
Step 7	*Pure distilled water—does not conduct electricity. Mixture in water—conducts electricity.*
Step 10	*Sand—separated by filtration; sand is in filter paper—crystalline, tan.* *Clear solution passed through into beaker; Solution conducts electricity*
Step 12	*Sodium chloride—left in beaker after boiling off water; white, chunky solid—not crystalline.*

Sample Data Table 4. Mass

Material	Mass in Grams
Filter paper	*1.2 g*
Filter paper plus material #3	*6.7 g*
Material #3	*5.5 g*
Empty 250-mL beaker	*113.3 g*
Beaker plus material #4	*117.8 g*
Material #4	*4.5 g*

Questions and Calculations

1. Calculate the percent yield for the iron, zinc, sand, and sodium chloride. Show all work in the space provided below. Fill in your answers in Table 1.

$$\text{Percent yield} = \frac{\text{Final mass}}{\text{Initial mass}} \times 100\% = \frac{4.3\text{ g}}{5.0\text{ g}} \times 100\% = 86\%$$

Note: The percent yield calculation is shown as a sample calculation. Student answers will vary. Students should show a calculation for each of the four materials.

2. What errors may have occurred that would cause the yield of the materials to be less than 100%?

Possible errors may include: loss of some material when transferring from one place to another; some iron may have been left on the magnet; some sand may have been left in the beaker when filtering; some sodium chloride may have spattered out of the beaker when heating to evaporate the water.

3. How is it possible that some of the percent yields are actually greater than 100%?

If the percent yield of any of the materials is calculated to be greater than 100%, this may indicate an error such as: the sand or sodium chloride may not be dry—the water would add weight; or the samples may be contaminated either with impurities or with one of the other substances which would increase the final mass.

4. Using a periodic table, label each of the four starting substances as either an element or as a compound.

Substance	Element or Compound?
Iron	*Element*
Zinc	*Element*
Sand	*Compound*
Sodium chloride	*Compound*

5. How did you determine which substances were elements and which were compounds?

Iron (Fe) and zinc (Zn) can be found on the periodic table and are therefore elements. Sand (SiO2) and sodium chloride (NaCl) contain more than one element chemically combined; thus, they are compounds.

6. When the four pure starting substances were combined to form a mixture, how did their properties before mixing compare to after separation?

The properties of the four substances before mixing were the same as the properties of those substances after separation.

7. After mixing the four substances together, is it possible to recover the original materials? Why or why not?

   Yes the original materials can be recovered because they were physically combined to make a heterogeneous mixture but not chemically combined. A mixture can be separated using physical separation techniques such as sifting, filtering, and evaporation.

8. What properties of the four starting substances did you use to separate out each material?

   The iron was separated based on its magnetic properties. The zinc was separated by sifting based on its particle size. The sand was separated based on its lack of solubility in water and was therefore separated via filtration. The sodium chloride was separated based on its water solubility and then was recovered by the simple evaporation of water.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The iron, zinc, sand, and salt may be reused or disposed of in the solid waste disposal according to Flinn Suggested Disposal Method #26a.

Activity #4. Lab Activity — Observing a Chemical Reaction

Materials Included in Kit (for 5 classes of 30 students each, working in pairs)

Aluminum foil, Al, 18″ × 12″, 5 sheets

Copper(II) chloride dihydrate, $CuCl_2{\cdot}2H_2O$, 300 g

Additional Materials Needed (for each group)

Water, distilled or deionized, H_2O, 20 mL

Balance, 0.1 g sensitivity

Beaker, Pyrex®, 250-mL

Graduated cylinder, 50-mL or 100-mL

Stirring rod

Safety *Precautions*

Copper(II) chloride is highly toxic by ingestion and is a body tissue irritant; avoid contact with body tissues; LD50 is 140 mg/kg. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Teaching Tip

- Enough materials are provided in this Super Value Kit for 5 classes of 30 students each, working in pairs (75 total student groups). One 50-minute lab period should be ample time to complete this lab activity.

Sample Data Table 5. Observations

Step Number	Material	Observations (Include mass where appropriate)	Element, Compound, Heterogeneous Mixture, or Solution
Step 1	Aluminum foil	*Silver, 3″ × 3″ piece, shiny*	*Element*
Step 2 and 3	Copper(II) chloride	*Blue–green crystals, 3.0 g*	*Compound*
Step 4	Water	*Colorless liquid, 20 mL*	*Compound*
Step 5	Copper(II) chloride and water	*Blue–green solution*	*Homogeneous mixture (solution)*
Step 6	Copper(II) chloride, water, and aluminum foil (immediately)	*Sizzles, silvery foil becomes dark, blue solution turns colorless*	*Heterogeneous mixture*
Step 7	Copper(II) chloride, water, and aluminum foil (after reacting)	*Colorless or gray solution* *Copper colored solid formed in solution*	*Homogeneous mixture (solution)*

Answers to Questions

1. Write the balanced chemical equation for the reaction between aluminum foil and copper(II) chloride.

   $2Al(s) + 3CuCl_2(aq) \rightarrow 2AlCl_3(aq) + 3Cu(s)$

2. What evidence do you have that a chemical reaction did indeed occur? Be specific.

   A chemical reaction was indicated by the following evidence: the solution changed color from blue–green to colorless; a new material was produced (Cu); the original aluminum and copper(II) chloride are gone and cannot be recovered.

3. After mixing, is it possible to recover the original reactants (aluminum foil and copper(II) chloride) by physical means? Why or why not?

   No, the original reactants cannot be recovered by simple physical means because they have undergone a chemical change to new substances. Whenever a chemical reaction occurs, the original substances have reacted. The reaction cannot be reversed except by, in some cases, chemical means.

4. How might it be possible to separate a chemical compound into its component parts? Explain.

   A chemical compound may, in some cases, be separated into its component elements through chemical means such as electrolysis or by chemical reaction. For example, water can be separated into hydrogen and oxygen by electrolysis.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The final solution may be washed down the drain with plenty of water according to Flinn Suggested Disposal Method #26b. The copper may be disposed of in the solid waste disposal according to Flinn Suggested Disposal Method #26a.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions

Materials for *Elements, Compounds, and Mixtures—Super Value Laboratory Kit* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP7586	Elements, Compounds, and Mixtures—Super Value Laboratory Kit
AP4584	Magnetic Wand
AP1123	Weighing Paper, 500 sheets
AP1128	Element Set

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.