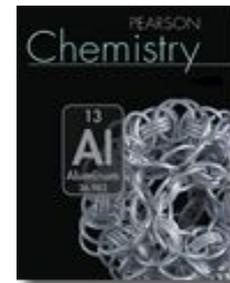




PEARSON CHEMISTRY

Wilbraham | Staley | Motta | Waterman



Chapter 2

Matter and Change

2.1 Properties of Matter

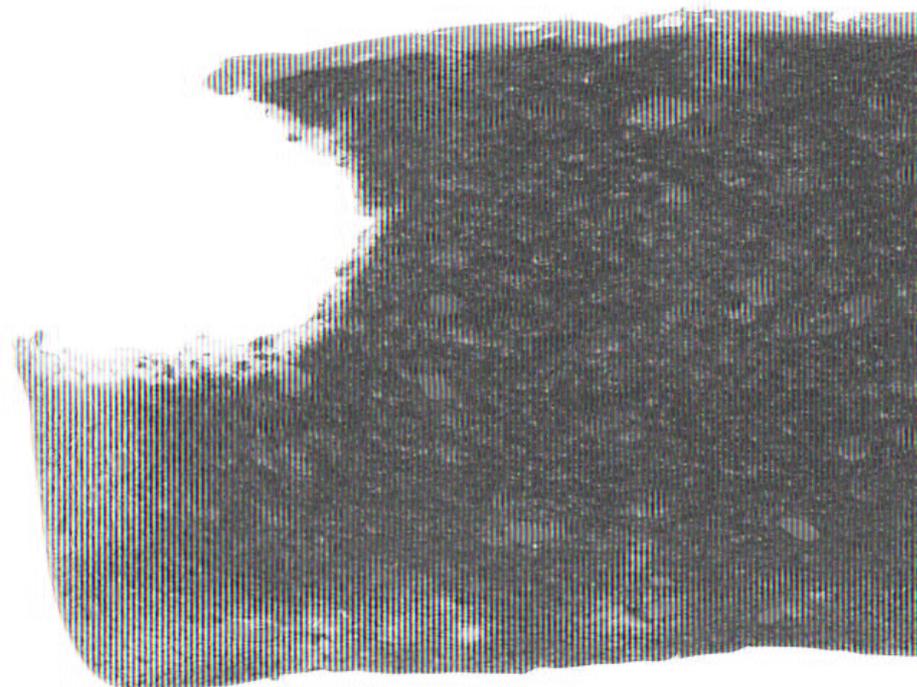
2.2 Mixtures

2.3 Elements and Compounds

2.4 Chemical Reactions

Why does burned toast taste so bad?

Bread that is toasted to a nice golden brown makes for a tasty addition to breakfast.



Distinguishing Elements and Compounds



How are elements and compounds different?

Substances can be classified as elements or compounds.

- An **element** is the simplest form of matter that has a unique set of properties.
 - Oxygen and hydrogen are two of the more than 100 known elements.

Substances can be classified as elements or compounds.

- A **compound** is a substance that contains two or more elements chemically combined in a fixed proportion.

Carbon, oxygen, and hydrogen are chemically combined in the compound sucrose.

- In every sample of sucrose, there are twice as many hydrogen particles as oxygen particles.
- The proportion of hydrogen particles in sucrose is fixed.

There is a key difference between elements and compounds.



Compounds can be broken down into simpler substances by chemical means, but elements cannot.

Breaking Down Compounds

Physical methods that are used to separate mixtures cannot be used to break a compound into simpler substances.

- Boil liquid water and you get water vapor, not the oxygen and hydrogen that water contains.

Breaking Down Compounds

Physical methods that are used to separate mixtures cannot be used to break a compound into simpler substances.

- Dissolve a sugar cube in water and you still have sucrose, not oxygen, carbon, and hydrogen.
 - This does not mean that sucrose or water cannot be broken down into simpler substances.
 - But methods must involve a chemical change.

Breaking Down Compounds

A **chemical change** is a change that produces matter with a different composition than the original matter.

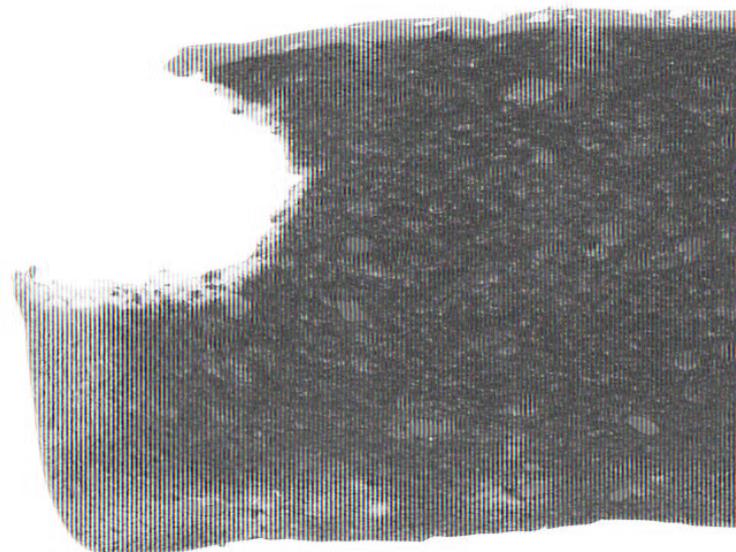
Breaking Down Compounds

Heating is one of the processes used to break down compounds into simpler substances.



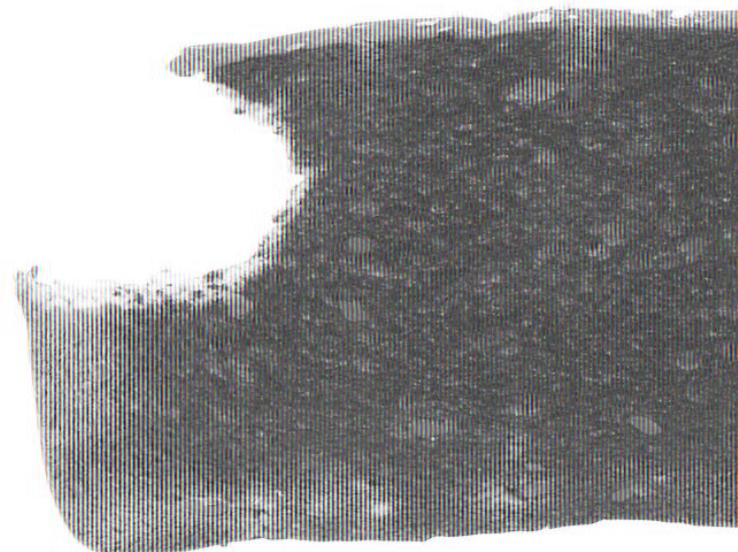
- The layer of sugar is heated until it breaks down into solid carbon and water vapor.

What happens to the compounds in bread when it is overcooked that causes the change in the taste of the bread?



What happens to the compounds in bread when it is overcooked that causes the change in the taste of the bread?

The compounds undergo a chemical change that changes the taste of the bread. They are broken down into solid carbon.



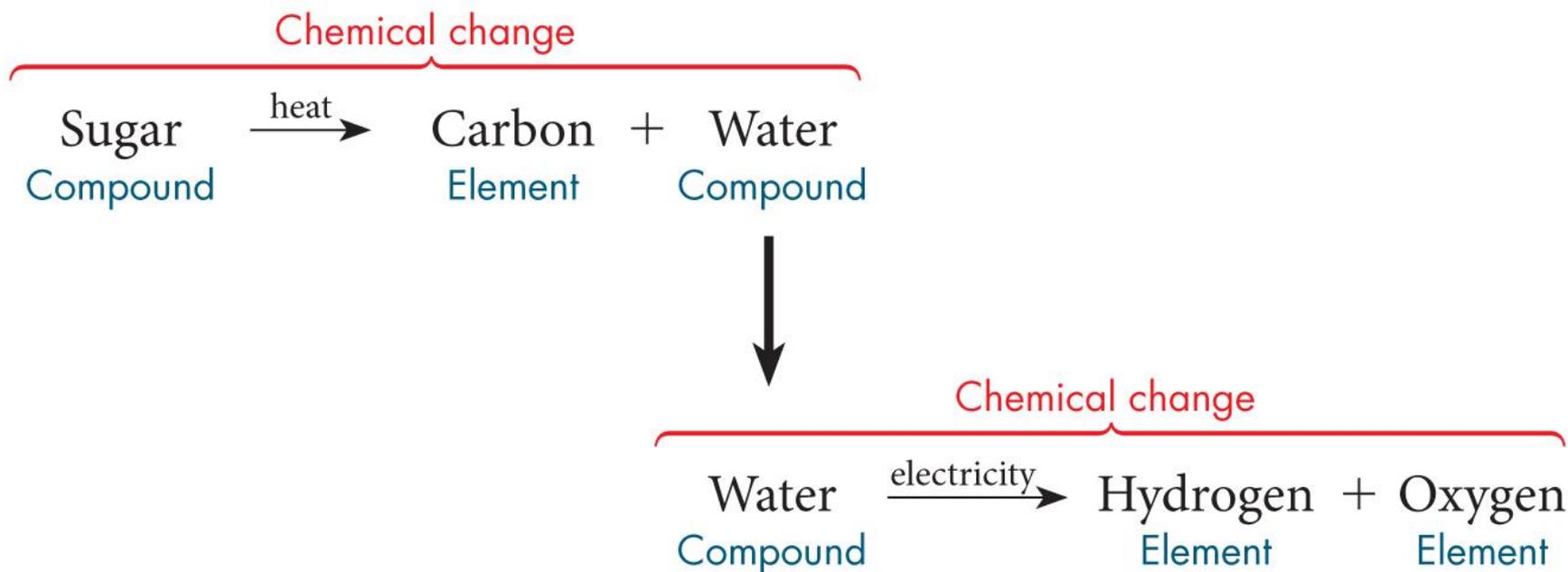
Breaking Down Compounds

Can the substances that are produced when sugar is broken down when heated also be broken down?

- There is no chemical process that will break down carbon into simpler substances because carbon is an element.

Breaking Down Compounds

When an electrical current passes through water, it is broken down into oxygen and hydrogen.



Properties of Compounds

In general, the properties of compounds are quite different from those of their component elements.

- Sugar is a sweet-tasting white solid, but carbon is a tasteless black solid.

Properties of Compounds

In general, the properties of compounds are quite different from those of their component elements.

- Hydrogen is a gas that burns in the presence of oxygen—a colorless gas that supports burning.
 - The product of this chemical change is water, a liquid that can stop materials from burning.

Properties of Compounds

When the elements sodium and chlorine combine chemically to form sodium chloride, there is a change in composition and a change in properties.

- Sodium is a soft gray metal.



Properties of Compounds

When the elements sodium and chlorine combine chemically to form sodium chloride, there is a change in composition and a change in properties.

- Chlorine is a pale yellow poisonous gas.

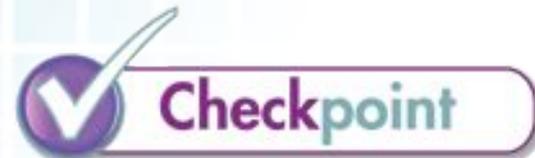


Properties of Compounds

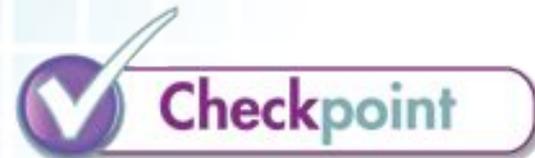
When the elements sodium and chlorine combine chemically to form sodium chloride, there is a change in composition and a change in properties.

- Sodium chloride (commonly known as table salt) is a white solid.





Can elements be broken down by chemical changes? Can compounds?



Can elements be broken down by chemical changes? Can compounds?

There are no chemical processes that can break down an element into simpler substances. Compounds can be broken down by chemical changes.

Distinguishing Substances and Mixtures



How can substances and mixtures be distinguished?

Deciding whether a sample of matter is a substance or a mixture based solely on appearances can be difficult.

- After all, homogeneous mixtures and substances will both appear to contain only one kind of matter.

Sometimes you can decide by considering whether there is more than one version of the material in question.

- You can buy whole milk, low-fat milk, no-fat milk, light cream, or heavy cream.
 - From this information, you can conclude that milk and cream are mixtures.
 - You might infer that these mixtures differ in the amount of fat they contain.

Sometimes you can decide by considering whether there is more than one version of the material in question.

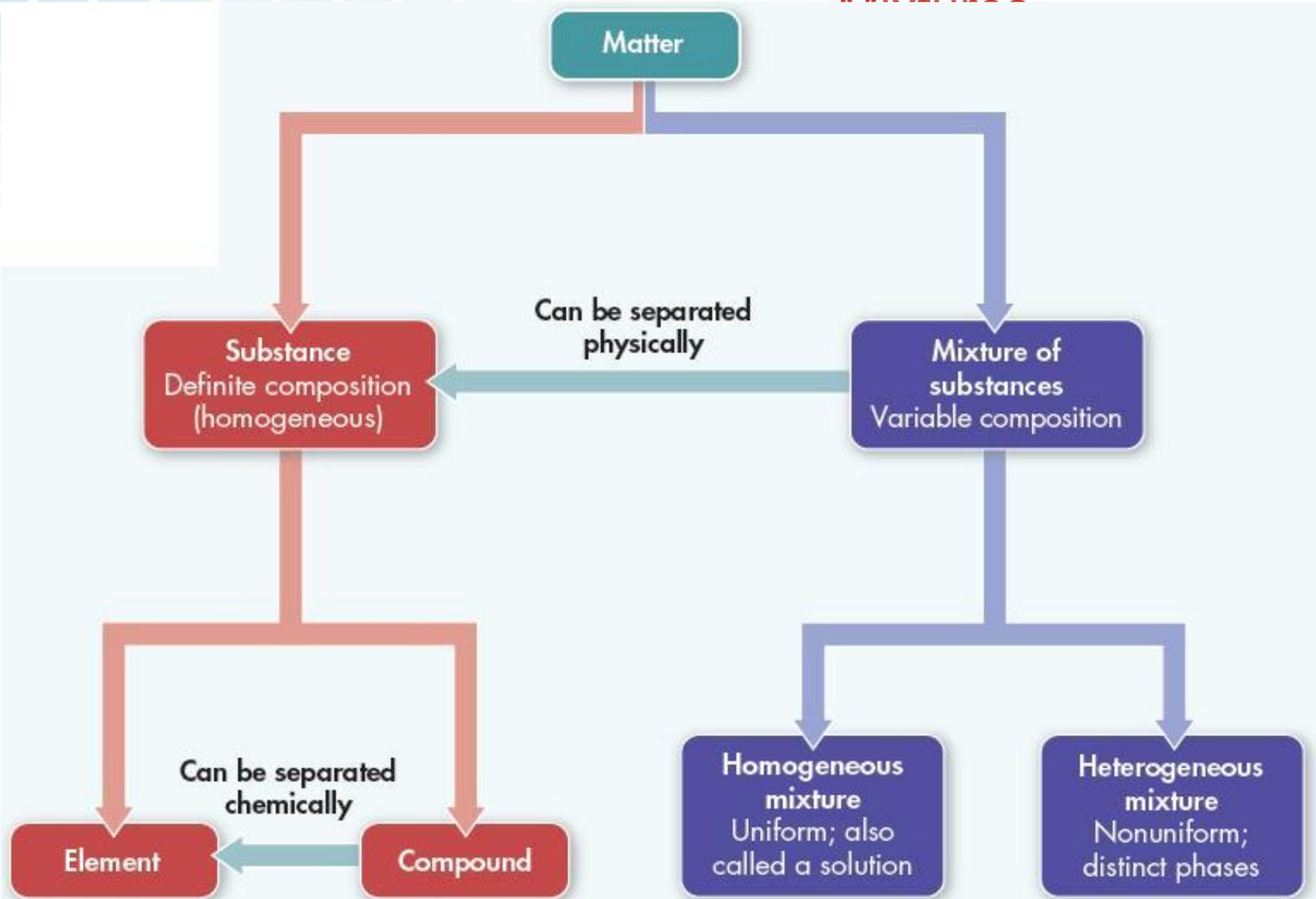
- Most gas stations offer at least two blends of gasoline.
 - The blends have different octane ratings and different costs per gallon.
 - So, gasoline must be a mixture.



If the composition of a material is fixed, the material is a substance. If the composition of a material may vary, the material is a mixture.

2.3 Elements and Compounds >

Distinguishing Substances and Mixtures



Classifying Materials

When a certain blue-green solid is heated, a colorless gas and a black solid form. All three materials are substances. Is it possible to classify these substances as elements or compounds?



1 Analyze Identify the relevant concepts.

A compound can be broken down into simpler substances by a chemical change, but an element cannot. Heating can cause a chemical change.

A compound is made of two or more elements that are chemically combined.

2 Solve Apply concepts to this situation.

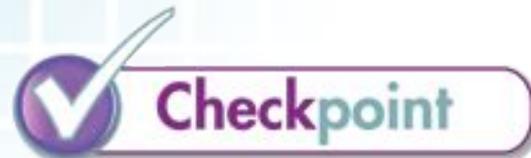
List the known facts and relevant concepts.

- A blue-green solid is heated.

2 Solve Apply concepts to this situation.

Determine if the substances are elements or compounds.

- A colorless gas and a black solid appear.
- Before heating, there was one substance.
- After heating, there were two substances.
- The blue-green solid must be a compound.
- Based on the information given, it isn't possible to know if the colorless gas and the black solid are elements or compounds.



No matter what you do to a silvery liquid, it doesn't seem to change. Is it more likely to be a substance or a mixture?



No matter what you do to a silvery liquid, it doesn't seem to change. Is it more likely to be a substance or a mixture?

It is most likely a substance. If it was a mixture, it would likely have separated when manipulated chemically or physically.

Symbols and Formulas

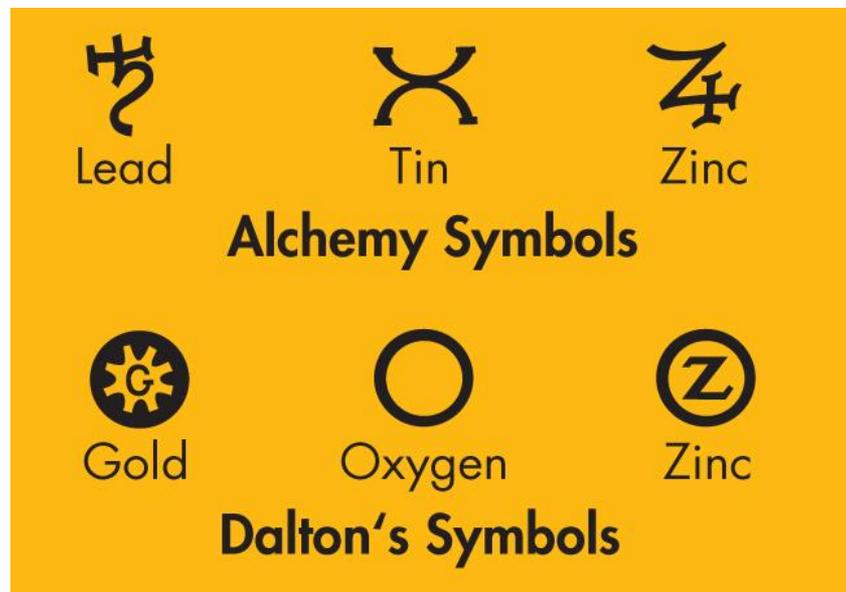
 What do chemists use to represent elements and compounds?



Chemists use chemical symbols to represent elements, and chemical formulas to represent compounds.

Using symbols to represent different kinds of matter is not a new idea.

- For thousands of years, alchemists used symbols, such as the ones below, to represent elements.
- Alchemists and the English chemist John Dalton (1766–1844) both used drawings to represent chemical elements.



The symbols used today for elements are based on a system developed by Swedish chemist Jöns Jacob Berzelius (1779–1848).

- He based his symbols on the Latin names of elements.
- Each element is represented by a one- or two-letter **chemical symbol**.
 - First letters of chemical symbols are capitalized.
 - When a second letter is used, it is lowercase.

If the English name and the Latin name of an element are similar, the symbol will appear to have been derived from the English name.

- Examples include Ca for calcium, N for nitrogen, and S for sulfur.

Symbols and Latin Names for Some Elements

Name	Symbol	Latin name
Sodium	Na	<i>natrium</i>
Potassium	K	<i>kalium</i>
Antimony	Sb	<i>stibium</i>
Copper	Cu	<i>cuprum</i>
Gold	Au	<i>aurum</i>
Silver	Ag	<i>argentum</i>
Iron	Fe	<i>ferrum</i>
Lead	Pb	<i>plumbum</i>
Tin	Sn	<i>stannum</i>

Chemical symbols provide a shorthand way to write the chemical formulas of compounds.

- The symbols for hydrogen, oxygen, and carbon are H, O, and C.
- The formula for water is H₂O.
- The formula for sucrose, or table sugar, is C₁₂H₂₂O₁₁.

Subscripts in the chemical formulas tell you how many of each type of element are in the compound.

- The subscript 2 in H_2O indicates that there are always two parts of hydrogen for each part of oxygen in water.
- Because a compound has a fixed composition, the formula for a compound is always the same.



Chemical symbols are abbreviations for the names of elements in what language?



Chemical symbols are abbreviations for the names of elements in what language?

Chemical symbols are abbreviations for the names of elements in Latin.

The Periodic Table—A Preview

 Why is a periodic table useful?

All the known elements are organized in a special table called the periodic table.

- A **periodic table** is an arrangement of elements in which the elements are separated into groups based on a set of repeating properties.



The periodic table allows you to easily compare the properties of one element (or a group of elements) to another element (or group of elements).

Each element is identified by its symbol placed in a square.

1A 1 H																	8A 2 He		
3A 3 Li	2A 4 Be											3A 5 B	4A 6 C	5A 7 N	6A 8 O	7A 9 F	10 Ne		
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar		
19 K	20 Ca	3B 21 Sc	4B 22 Ti	5B 23 V	6B 24 Cr	7B 25 Mn	8B 26 Fe			27 Co	28 Ni	1B 29 Cu	2B 30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe		
55 Cs	56 Ba	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn		
87 Fr	88 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Uuq	115 Uup	116 Uuh		118 Uuo		

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No

Each element is identified by its symbol placed in a square.

- The elements are listed in order from left to right and top to bottom by atomic number, a number that is unique to each element.
- The atomic number of the element is shown centered above the symbol.

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- The elements are listed in order from left to right and top to bottom by atomic number, a number that is unique to each element.
- The atomic number of the element is shown centered above the symbol.
 - Hydrogen (H), the lightest element, is in the top left corner.
 - Helium (He), atomic number 2, is at the top right.
 - Lithium, atomic number 3, is at the left end of the second row.

Each horizontal row of the periodic table is called a **period**.

- There are seven periods in the periodic table.
- The number of elements per period ranges from 2 (hydrogen and helium) in Period 1 to 32 in Period 6.

Within a period, the properties of the elements vary as you move across the period.

- This pattern of properties then repeats as you move to the next period.

Each vertical column of the periodic table is called a **group**, or family.

- Elements within a group have similar chemical and physical properties.
- Note that each group is identified by a number and the letter A or B.
 - Group 2A contains the elements beryllium (Be), magnesium (Mg), calcium (Ca), strontium (Sr), barium (Ba), and radium (Ra).



Which elements are included in the periodic table?



Which elements are included in the periodic table?

All known elements are included in the periodic table.

2.3 Elements and Compounds > Key Concepts



Compounds can be broken down into simpler substances by chemical means, but elements cannot.



If the composition of a material is fixed, the material is a substance. If the composition may vary, the material is a mixture.

2.3 Elements and Compounds > Key Concepts



Chemists use chemical symbols to represent elements, and chemical formulas to represent compounds.



The periodic table allows you to easily compare the properties of one element (or group of elements) to another element (or group of elements).

2.3 Elements and Compounds > Glossary Terms

- **element**: the simplest form of matter that has a unique set of properties; an element cannot be broken down into simpler substances by chemical means
- **compound**: a substance that contains two or more elements chemically combined in a fixed proportion
- **chemical change**: a change that produces matter with a different composition than the original matter

2.3 Elements and Compounds > Glossary Terms

- **chemical symbol**: a one- or two-letter representation of an element
- **periodic table**: an arrangement of elements in which the elements are separated into groups based on a set of repeating properties
- **period**: a horizontal row of elements in the periodic table
- **group**: a vertical column of elements in the periodic table; the constituent elements of a group have similar chemical and physical properties

Chemistry as the Central Science

- Matter may be made of elements or compounds.
- Elements and compounds are pure substances but can be physically combined to make heterogeneous or homogeneous mixtures.
- These different forms of matter may undergo physical or chemical changes.

2.3 Elements and Compounds >

END OF 2.3