

Classification of Matter

Classification of Matter

- How do we make sense of all the types of material in the world?
- Properties of Materials
 - Describe materials by listing their properties
 - Chemical properties vs Physical properties
 - Intensive vs. Extensive properties

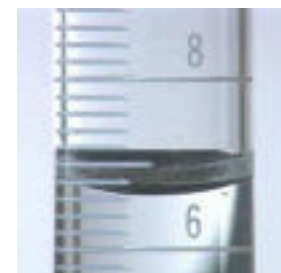
Properties of Matter

- Chemistry is the study of matter
- Matter is classified according to its properties. There are two types:
 - A physical property can be observed without changing the identity of the substance. Ex. Are color, temperature, density, etc.
 - A chemical property describes change of a substance to form other substances – flammability, biodegradability, etc.

Properties of Matter

There are two types of physical properties:

1. An extensive property depends on the amount of substance
2. An intensive property is independent of the amount



Extensive Properties	Volume	76.2 mL	6.64 mL
	Mass	76 g	6.5 g
Both Substances are water!!			
Intensive Properties	Density	0.999 g/mL	0.999 g/mL
	Temp	20 °C	20 °C

Intensive vs. Extensive Properties

- Intensive properties can be used to identify unknown substances

For Example:

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

A glass container weighs 48.462 g. A sample of 4.00 mL of a substance is added, and the container plus the substance weigh 54.51 g. Calculate the density of substance.

“The number of brain cells that refuse to learn
a new concept is a measure of your
density.”

Melinda Hutson

Geology, PCC

Physical & Chemical Changes

- In a physical process, the identity of a substance doesn't change.
- In a chemical process, a substance is transformed into a different substance.

If measuring a property changes the substance (i.e., flammability, etc), then it is a chemical property.

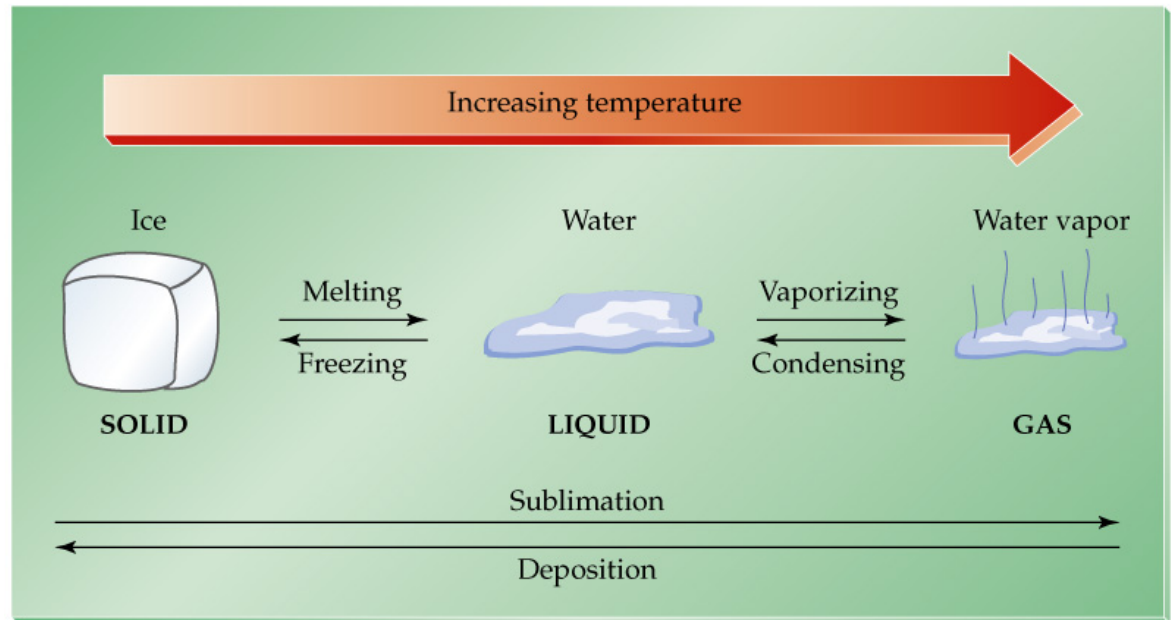
TABLE 1.2

Some Examples of Physical and Chemical Properties

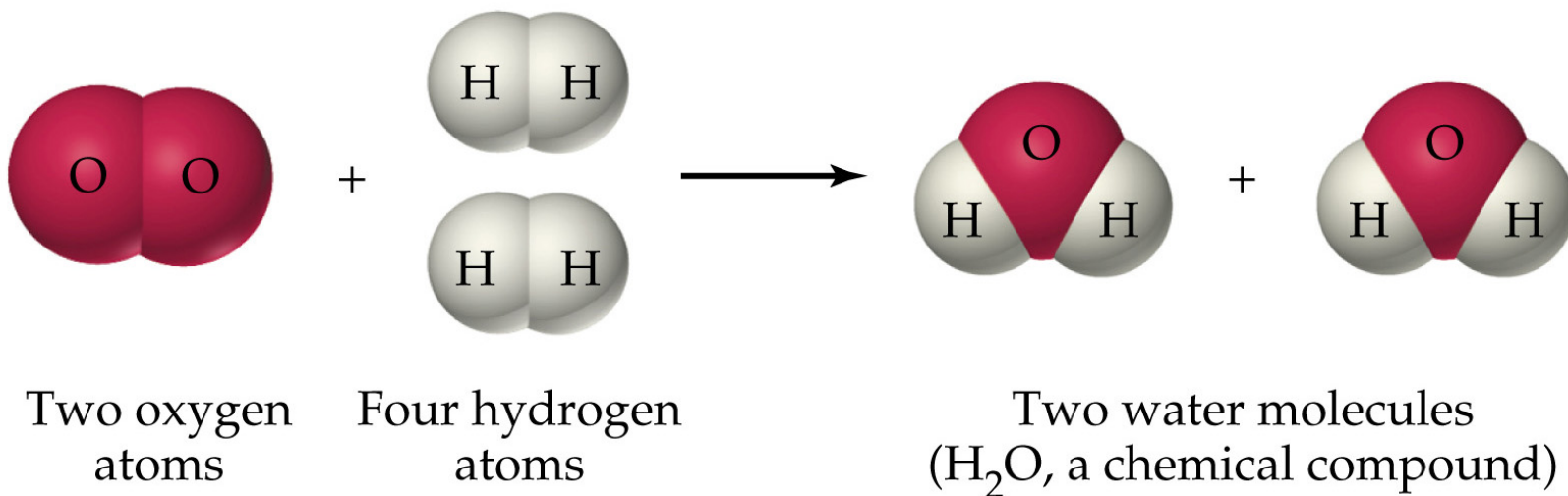
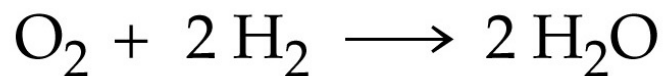
Physical Properties		Chemical Properties
Temperature	Amount	Rusting (of iron)
Color	Odor	Combustion (of gasoline)
Melting point	Solubility	Tarnishing (of silver)
Electrical conductivity	Hardness	Hardening (of cement)

Physical Change

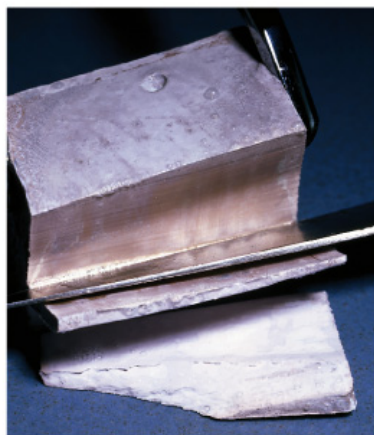
- Whether it is in solid form, liquid or gas...it is all still water!



Chemical Change



Chemical Change



(a)



(b)



(c)

Classifying Properties

- Which of the following is an extensive property?

volume melting point color hardness temp

- Which of the following is an intensive chemical property of a box of raisins?

grams per serving total grams total # of raisins
calories per serving total calories

- Which of the following is an extensive property of a bubble of air?

radius density % oxygen temp

Classifying Properties

- Which of the following is a physical property?

hardness

melting pt

color

volume

temp

- Which of the following is a chemical property of a slice of chocolate cake?

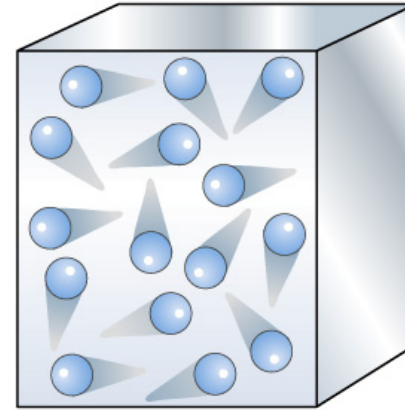
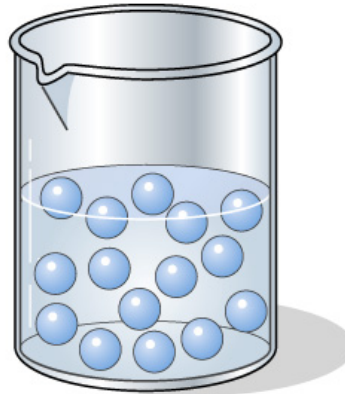
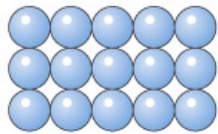
volume

temp

color

mass

dietary calories



SOLID

High density

Hard to expand/compress

Rigid shape

LIQUID

High density

Hard to expand/compress

Takes shape of container

GAS

Low density

Easy to expand/compress

Fills container

Phase Changes

- A phase is a region with homogeneous (uniform) properties
- Conversions between states are called “phase transitions” or “changes of state”
- Changes in temp, pressure or composition can result in changes of state.

Physical or Chemical Changes?

- Water is heated in a microwave
- Water freezes to ice
- Rust forms on an iron nail
- A gas is compressed with a pump
- A lump of coal burns
- Table salt is dissolved in water

Classification of Matter

All matter is either a pure substance or a mixture.

- A pure substance has a fixed composition and distinct properties
- A mixture consists of two or more pure substances which retain their chemical identities.

Classification of Matter

Pure substance: characteristics

- The percent of each component always the same from sample to sample

Example: water is always 11.2% hydrogen and 88.8% oxygen – no matter where you get it!

- Samples melt or boil at a characteristic temperature (is this intrinsic or extrinsic?)

Pure Substances

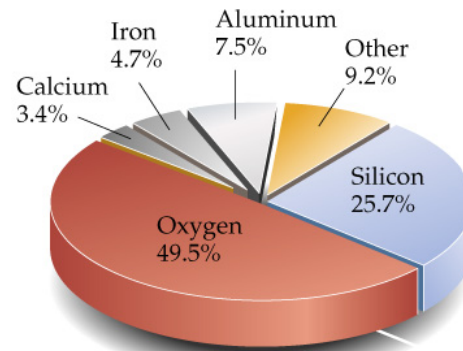
Pure substances are either elements or compounds.

- An element cannot be decomposed into simpler substances by physical or chemical means.
- A compound is composed of two or more elements always in the same proportion.

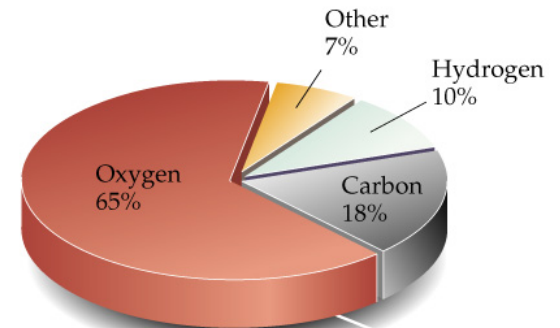
Elements

There are about
100 elements.
Their names and
symbols are
shown in the
Periodic Table.

Some common
elements →



Earth's crust



Human body

Elements

PERIODIC TABLE OF THE ELEMENTS

Atomic number
Symbol

1
H

	1 IA	2 IIA																	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
2	3 Li	4 Be																	5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIII	9 VIII	10 VIII	11 IB	12 IIB	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar						
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr						
5	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						
6	55 Cs	56 Ba	57 La	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						
7	87 Fr	88 Ra	89 Ac	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118						

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	71 Lu
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	103 Lr

Metals

Semimetals

Nonmetals

States of the Elements

1

IA

2

IIA

3

Li

4

Be

11

Na

12

Mg

19

K

20

Ca

37

Rb

38

Sr

55

Cs

56

Ba

87

Fr

88

Ra

3

IIIB

4

IVB

5

VB

6

VIB

7

VIIB

8

VIII

9

VIII

10

VIII

11

IB

12

IIB

21

Sc

22

Ti

23

V

24

Cr

25

Mn

26

Fe

27

Co

28

Ni

29

Cu

30

Zn

31

Ga

32

Ge

33

As

34

Se

35

Br

36

Kr

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

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

104

105

106

107

108

109

110

111

112

113

114

115

116

117

118

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

71

Lu

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

103

Lr

Solids

Liquids

Gases

Atomic number

Symbol

1

H

13

IIIA

14

IVA

15

VA

16

VIA

17

VIIA

18

VIIIA

5

B

6

C

7

N

8

O

9

F

10

Ne

13

Al

14

Si

15

P

16

S

17

Cl

18

Ar

31

Ga

32

Ge

33

As

34

Se

35

Br

36

Kr

49

In

50

Sn

51

Sb

52

Te

53

I

54

Xe

81

Tl

82

Pb

83

Bi

84

Po

85

At

86

Rn

113

114

115

116

117

118

Elements

Writing element symbols:

- First 1-2 distinguishing letters in name used for symbol
- Only the first letter is capitalized.

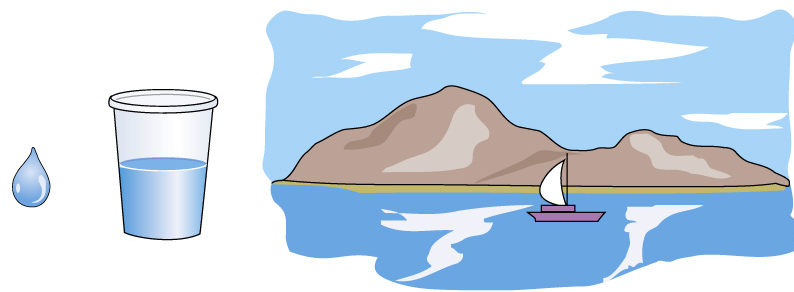
Element Symbols Derived from Ancient Names

English Name	Symbol	Ancient Name
Antimony	Sb	Stibium
Copper	Cu	Cuprum
Gold	Au	Aurum
Iron	Fe	Ferrum
Lead	Pb	Plumbum
Mercury	Hg	Hydragyrum
Potassium	K	Kallium
Silver	Ag	Argentum
Sodium	Na	Natrium
Tin	Sn	Stannum
Tungsten	W	wolfram

Compounds

- Compounds can be decomposed into their elements **ONLY** by a chemical means.

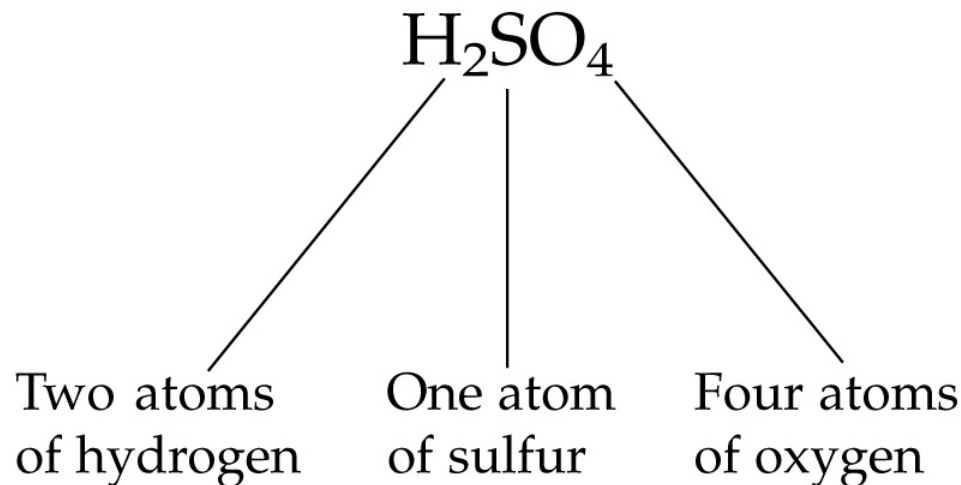
Example: the electrolysis of H_2O



- Compounds always give the same proportion of each element by mass.

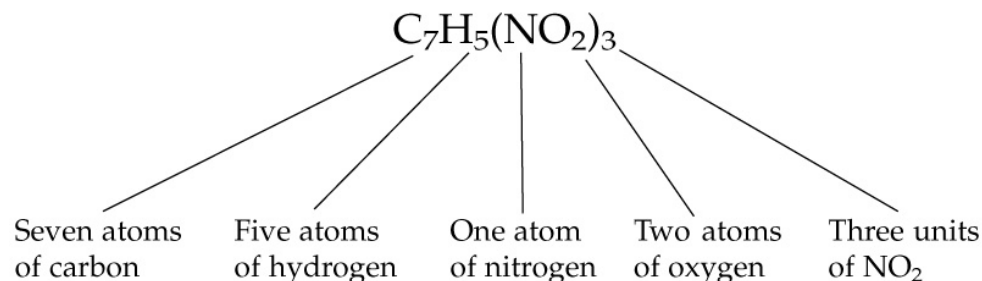
Compound Formulas

- A chemical formula expresses the number of atoms of each type of element in the compound. The number of atoms is indicated with a subscript.



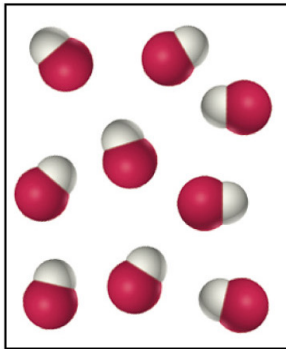
Compound Formulas

- Some formulas require parentheses for clarification. The subscript multiplies everything in the parenthesis by that number.

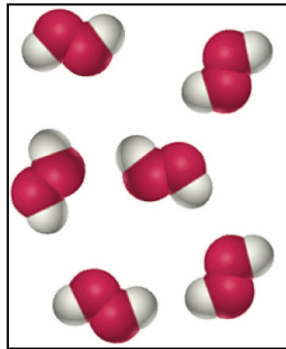


Your Turn

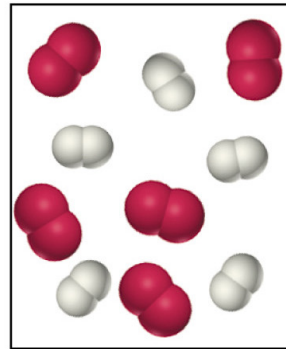
- Which of the following represents a collection of hydrogen peroxide (H_2O_2) molecules?
- H is white and O is red.



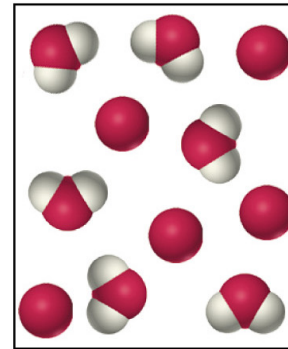
(a)



(b)



(c)



(d)

Mixtures

- A mixture has a variable composition
- If the properties of a mixture are not uniform throughout, the mixture is heterogeneous.



Mixtures

- If the properties are uniform, the mixture is homogeneous, or a solution.



- No ice in the Kool-Aid

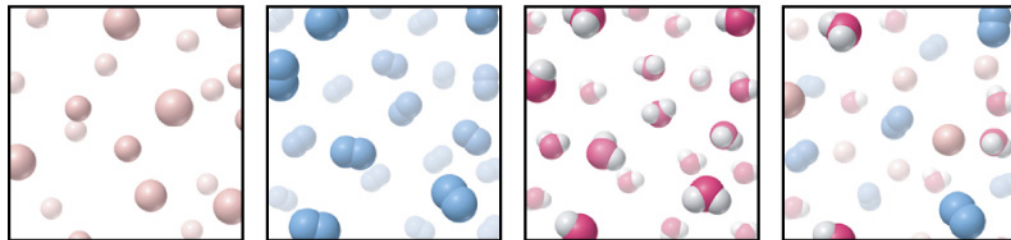


Mixtures

- The pure substances in a mixture can be separated through physical means.
 - Separation of salt from seawater.
 - Distillation of brandy, rum, etc.
 - Separation of fresh brewed coffee from coffee grounds (filtration)

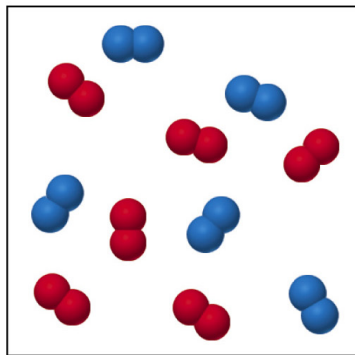
A Microscopic View

- Pure substances are composed of atoms or molecules with fixed numbers of atoms bonded together.
- Mixtures consist of variable numbers of atoms or molecules.

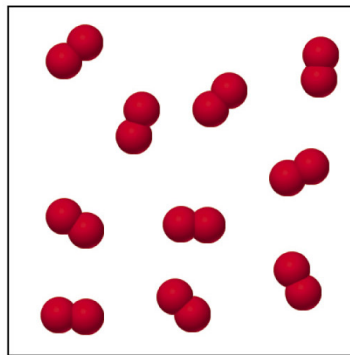


Your Turn

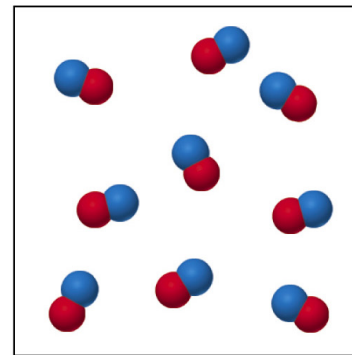
- Which of the following represents a mixture, which a compound, and which an element?



(a)

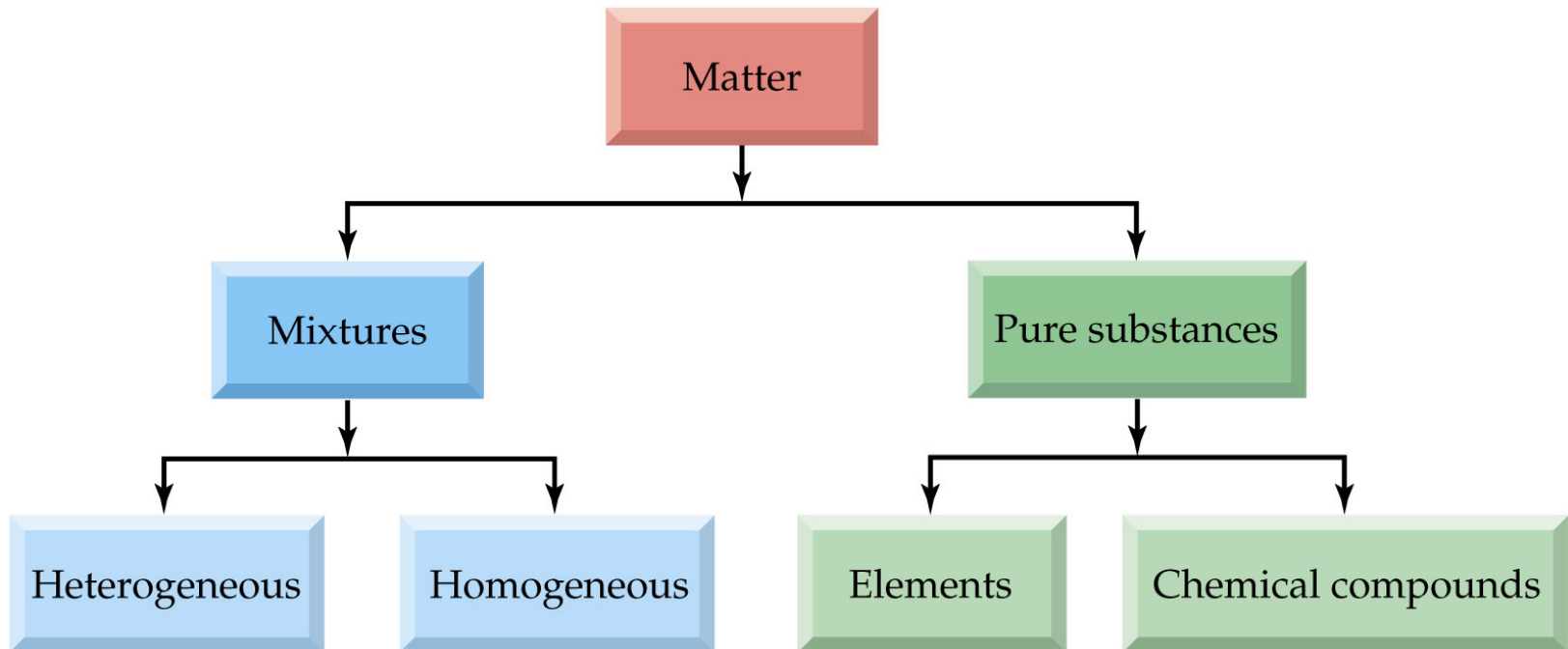


(b)



(c)

The Classification of Matter



Your Turn Again

- Are the following elements, mixtures or compounds?
 - seawater
 - steel
 - copper
 - marble
 - iron oxide
 - diamond
 - milk