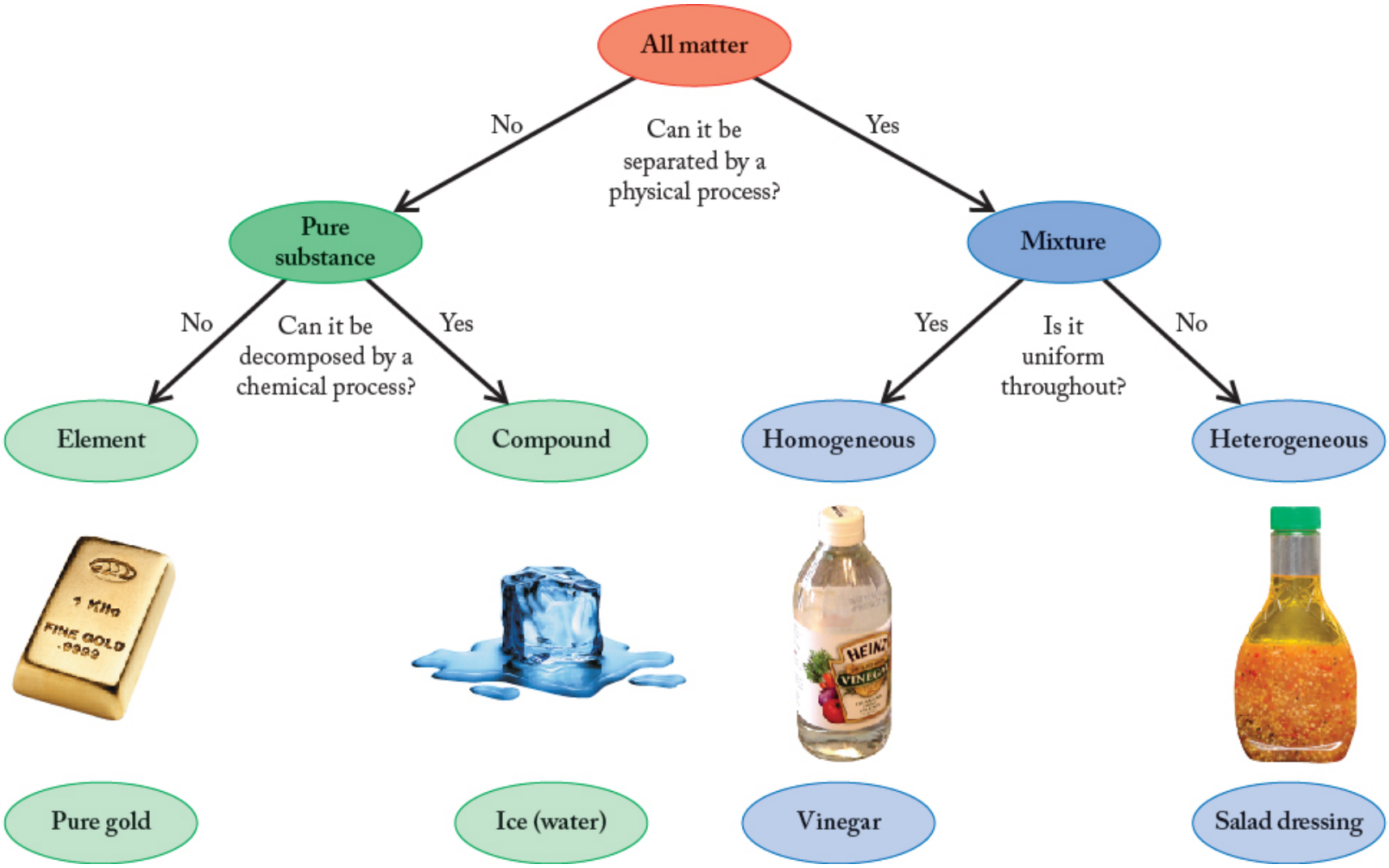
Chapter 1

Matter Measurement and Problem Solving

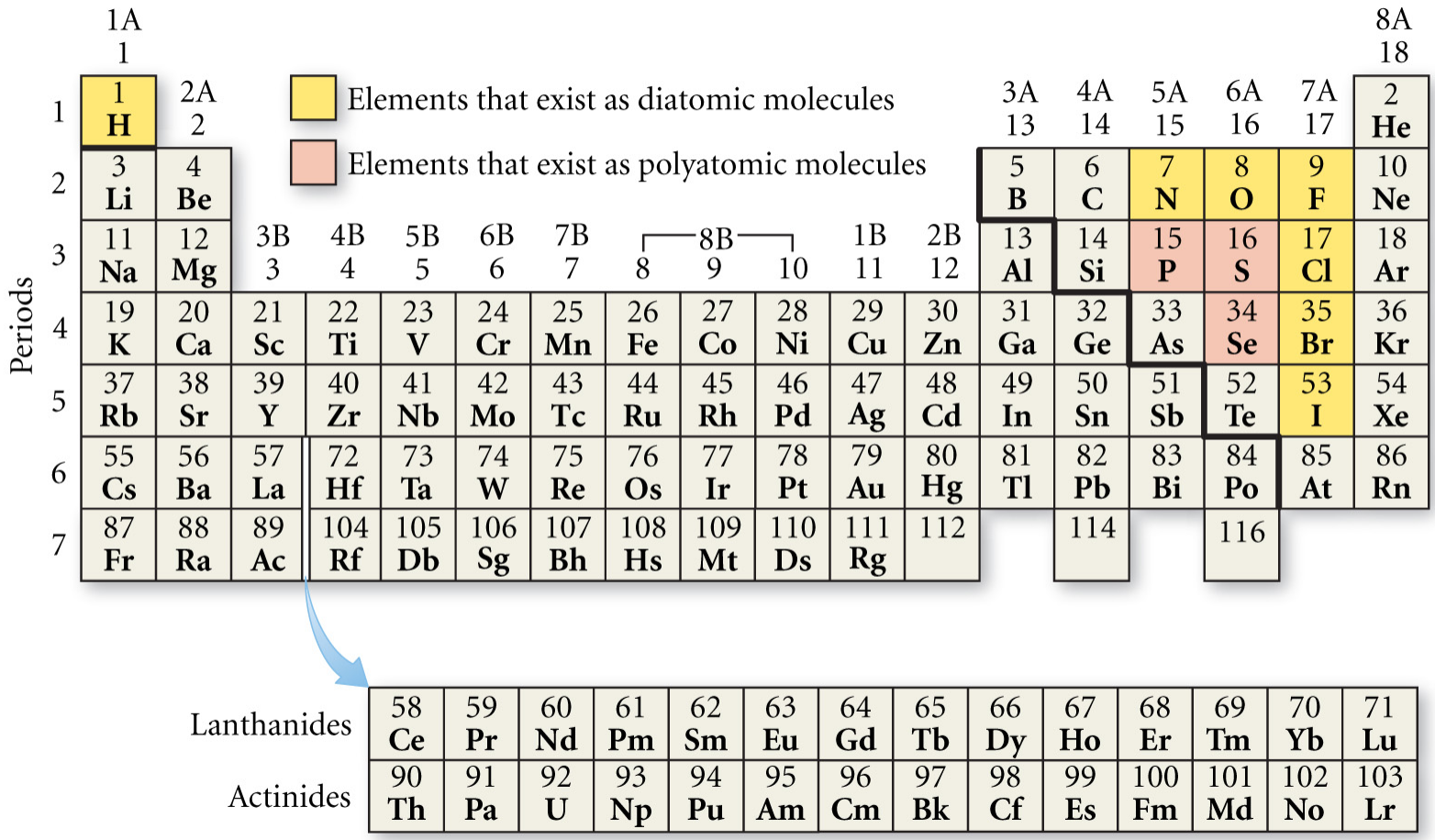
Matter

- Anything you can touch, taste, or smell
- Mass is a measure of the amount of matter in an object.



Practice problems Gilbert 1.13-1.18

Molecular Elements



P_4, S_8, and Se_8 are the polyatomic elements

Combining Elements to make Compounds

$$2\ H_2 + O_2 \rightarrow 2\ H_2O$$

- the properties of the compound are totally different from the constituent elements

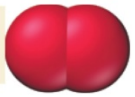
Selected Properties of Hydrogen

Boiling point, −253 °C

Gas at room temperature

Explosive

Selected Properties of Oxygen



Boiling point, −183 °C

Gas at room temperature

Supports combustion

Selected Properties of Water

Boiling point, 100 °C

Liquid at room temperature

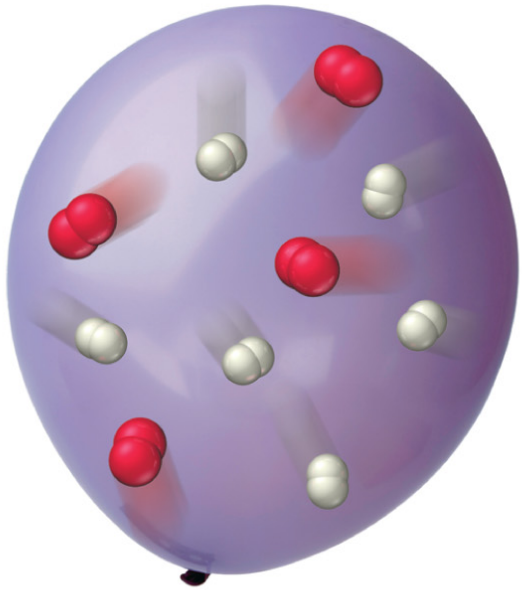
Used to extinguish flame

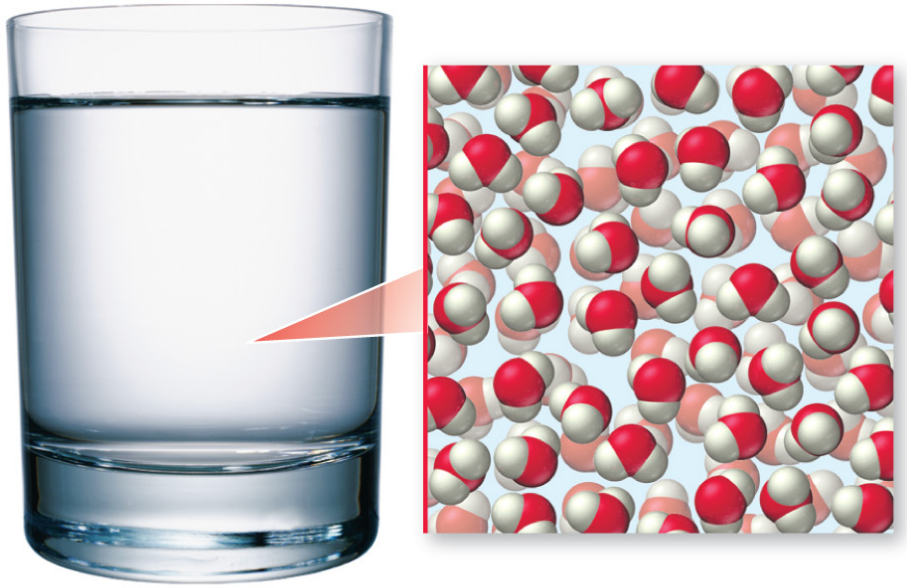
Formation of Water from Its Elements

Mixtures and Compounds

Hydrogen and Oxygen Mixture
Can have any ratio of hydrogen to oxygen.

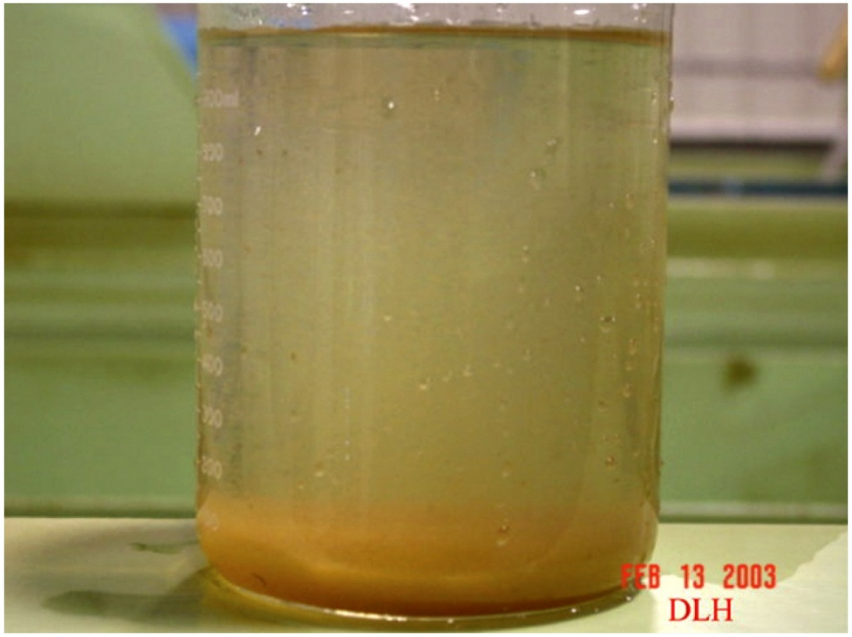
Water (A Compound)
Water molecules have a fixed ratio of hydrogen (2 atoms) to oxygen (1 atom).





Separation of Mixtures

- Filtration

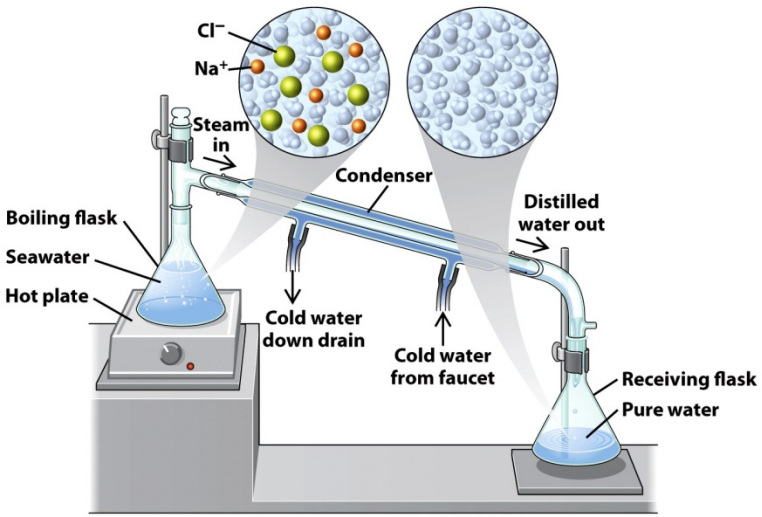


Chemistry: The Science in Context 2/e Figure 1.8b
Courtesy Wellsville, New York Water Treatment Plant

Chemistry: The Science in Context 2/e Figure 1.9

Practice problems Gilbert – 1.29-30

Separation of Mixtures



Chemistry: The Science in Context 2/e Figure 1.10
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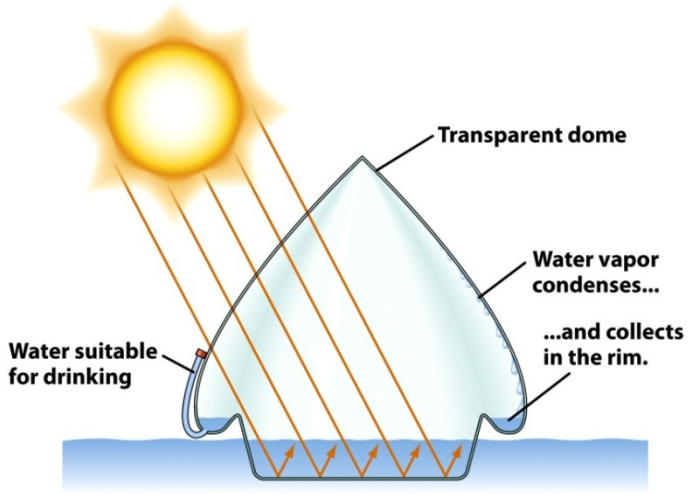

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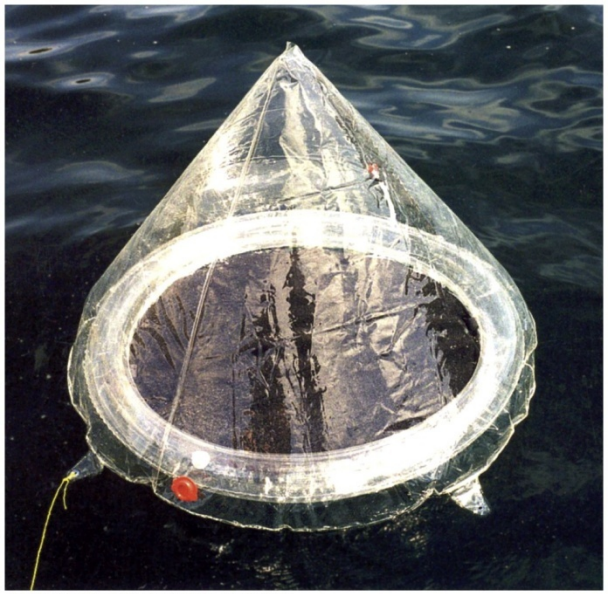

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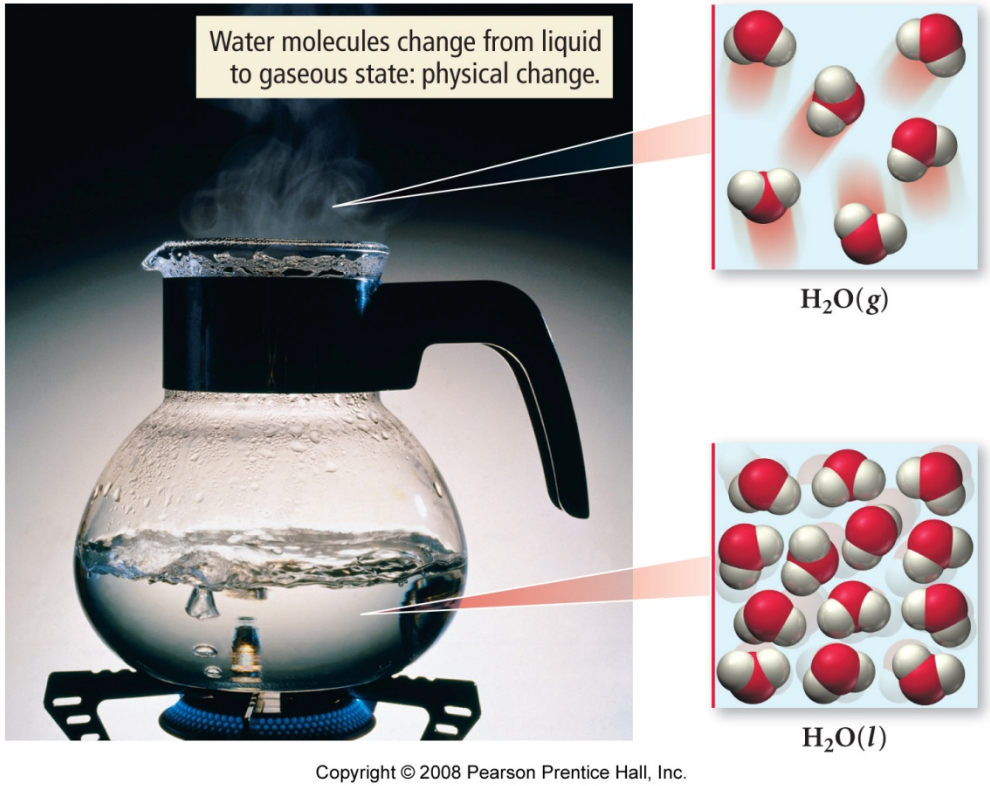
AquaCone Courtesy Solar Solutions, Inc.

Physical and Chemical Properties

A **physical property** is one that can be observed without changing the makeup of a substance.

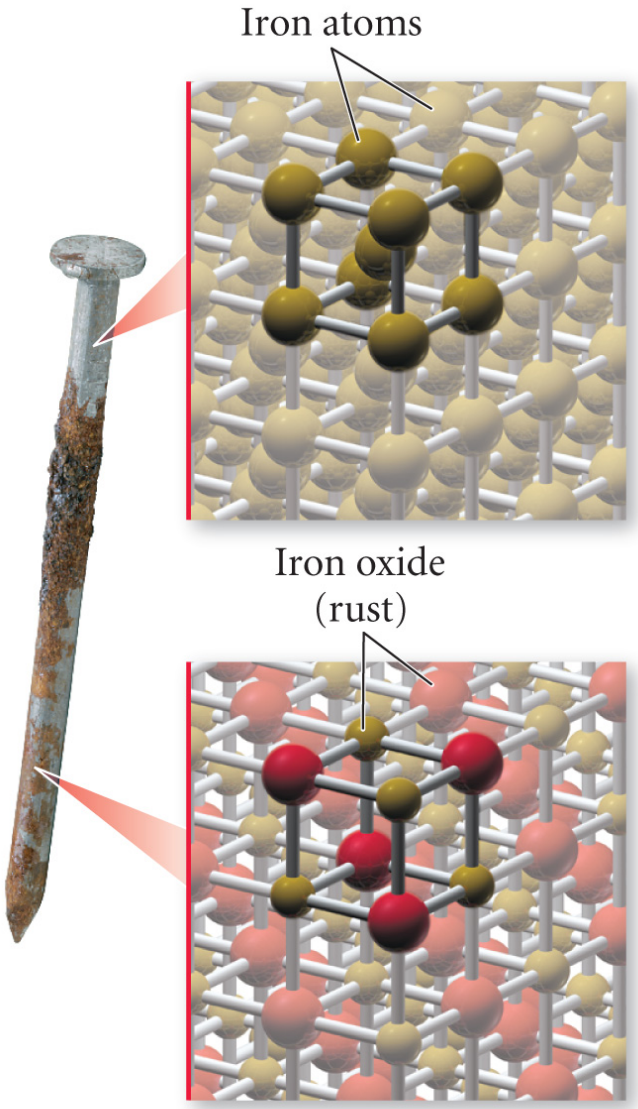
– Color, conductivity, density, melting point, boiling point, density, hardness, and solubility

- Changes that occur when observing physical properties are called **physical changes**.



Physical and Chemical Properties

- A **chemical property** describes a **chemical change** (chemical reaction) that a substance undergoes.
  - Rusting of iron and caramelization of sugar are chemical changes.



- A sample of calcium (an electrically conducting white metal that is shiny, relatively soft, melts at 850^{o}C, and boils at 1440^{o}C) was placed into liquid water that was at 25^{o}C. The calcium reacted slowly with the water to give bubbles of gaseous hydrogen and a solution of the substance calcium hydroxide.

- What are the physical and chemical properties described above?

Intensive Properties

- Do not depend on the amount of sample present.

Extensive Properties

- Depend on the amount of sample present.

TABLE 1.2 Seven SI Base Units

Quantity or Dimension	Unit Name	Unit Abbreviation
Mass	kilogram	kg
Length	meter	m
Temperature	kelvin	K
Time	second	s
Energy	joule	J
Electrical current	ampere	A
Amount of a substance	mole	mol

TABLE 1.1 Commonly Used Prefixes for SI Units

PREFIX		VALUE	
Name	**Symbol**	**Numerical**	**Exponential**
zetta	Z	1,000,000,000,000,000,000,000	10^{21}
exa	E	1,000,000,000,000,000,000	10^{18}
peta	P	1,000,000,000,000,000	10^{15}
tera	T	1,000,000,000,000	10^{12}
giga	G	1,000,000,000	10^{9}
mega	M	1,000,000	10^{6}
kilo	k	1000	10^{3}
hecto	h	100	10^{2}
deka	da	10	10^{1}
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	μ	0.000001	10^{-6}
nano	n	0.000000001	10^{-9}
pico	p	0.000000000001	10^{-12}
femto	f	0.000000000000001	10^{-15}
atto	a	0.000000000000000001	10^{-18}
zepto	z	0.000000000000000000001	10^{-21}

TABLE 1.3 Conversion Factors for SI and Other Commonly Used Units

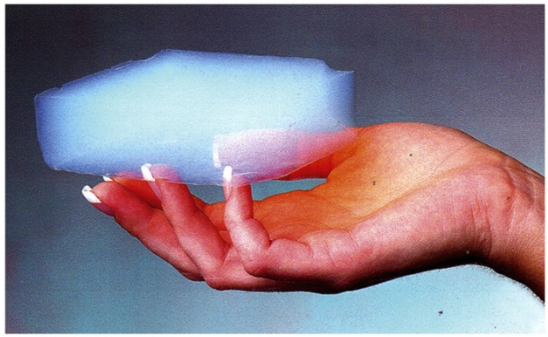
Quantity or Dimension	Equivalent Units
Mass	1 kg = 2.205 pounds (lb); 1 lb = 0.4536 kg = 453.6 g
	1 g = 0.03527 ounce (oz); 1 oz = 28.35 g
Length (distance)	1 m = 1.094 yards (yd); 1 yd = 0.9144 m (exactly)
	1 m = 39.37 inches (in); 1 foot (ft) = 0.3048 m (exactly)
	1 in = 2.54 cm (exactly)
	1 km = 0.6214 miles (mi); 1 mi = 1.609 km
Volume	$1\ m^3 = 35.31\ ft^3$; $1\ ft^3 = 0.02832\ m^3$
	$1\ m^3$ = 1000 liters (L) (exactly)
	1 L = 0.2642 gallon (gal); 1 gal = 3.785 L
	1 L = 1.057 quarts (qt); 1 qt = 0.9464 L

Practice problems Gilbert – 1.53-1.76

- Which will require greater stamina and endurance on your part, an utterly boring 1-hr lecture or an equally boring micro-century lecture?

- Aerogel or “solid smoke” is a novel material that is made of silicon dioxide, like glass, but is a thousand times less dense than glass because it is extremely porous. Material scientists at NASA’s Jet Propulsion Laboratory created the lightest aerogel ever in 2002, with a density of 0.00011 lb/in^3. The material was used for thermal insulation in the 2003 Mars Exploration Rover. If the maximum space for insulation in the spacecraft’s hull is 2510 cm^3, what mass (in grams) will the aerogel insulation add to the spacecraft?

Practice problems Gilbert – 1.92-1.93, 1.97-100



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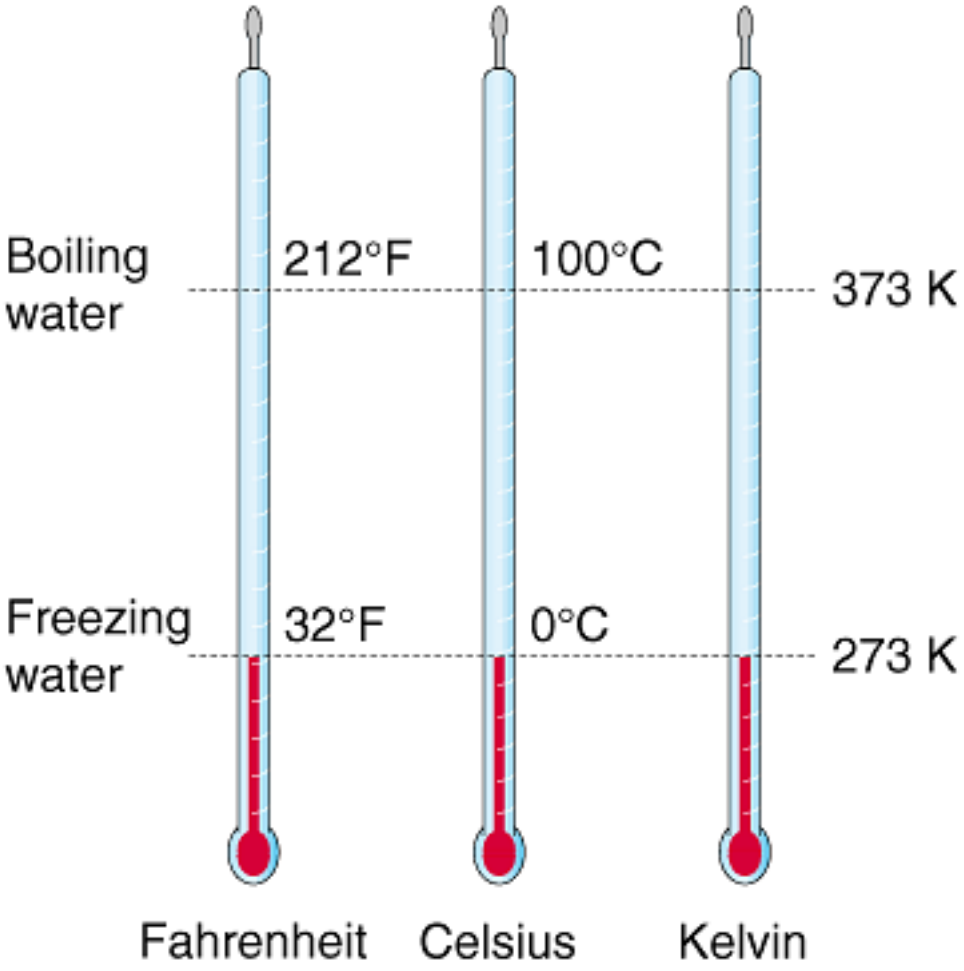
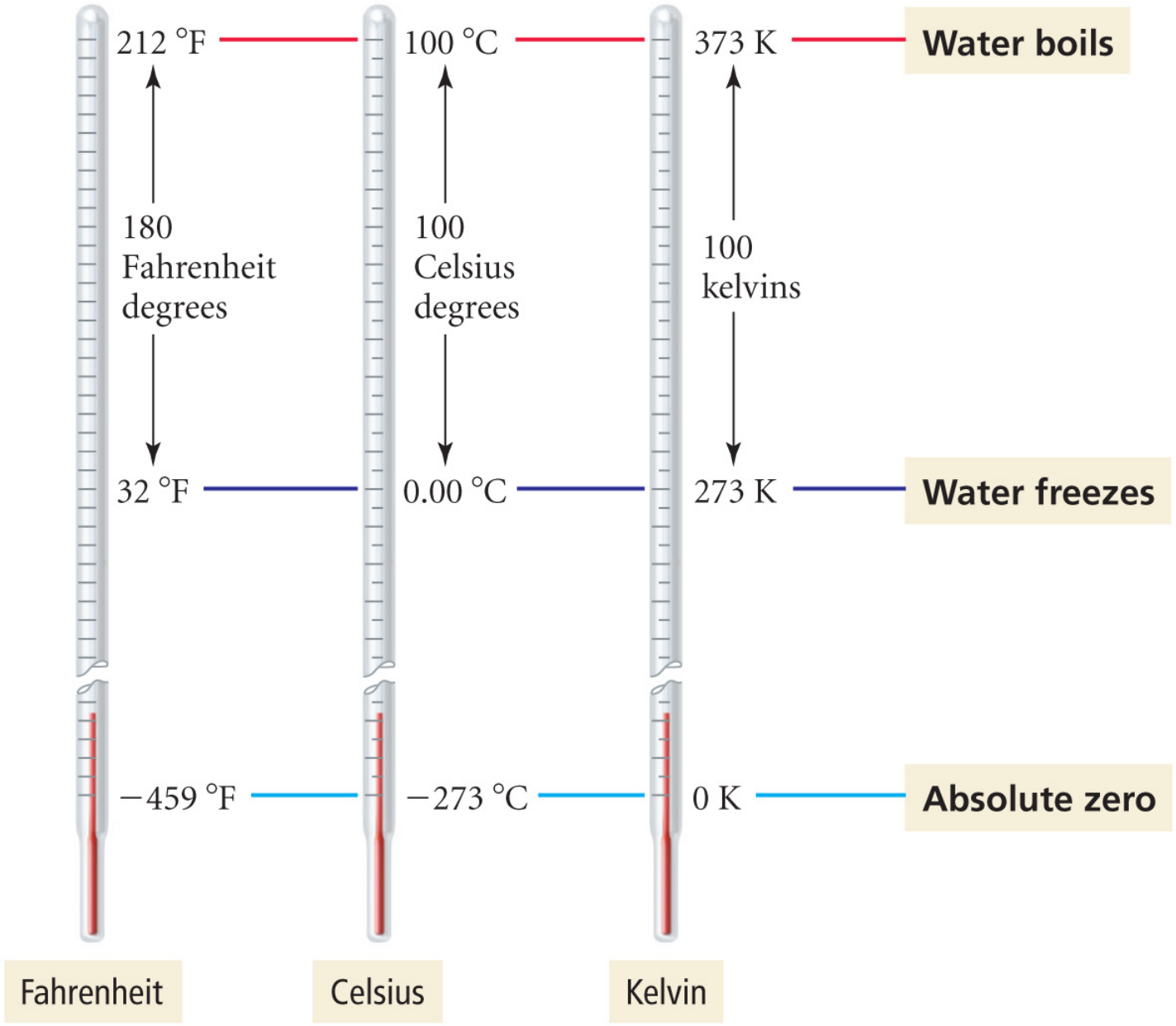
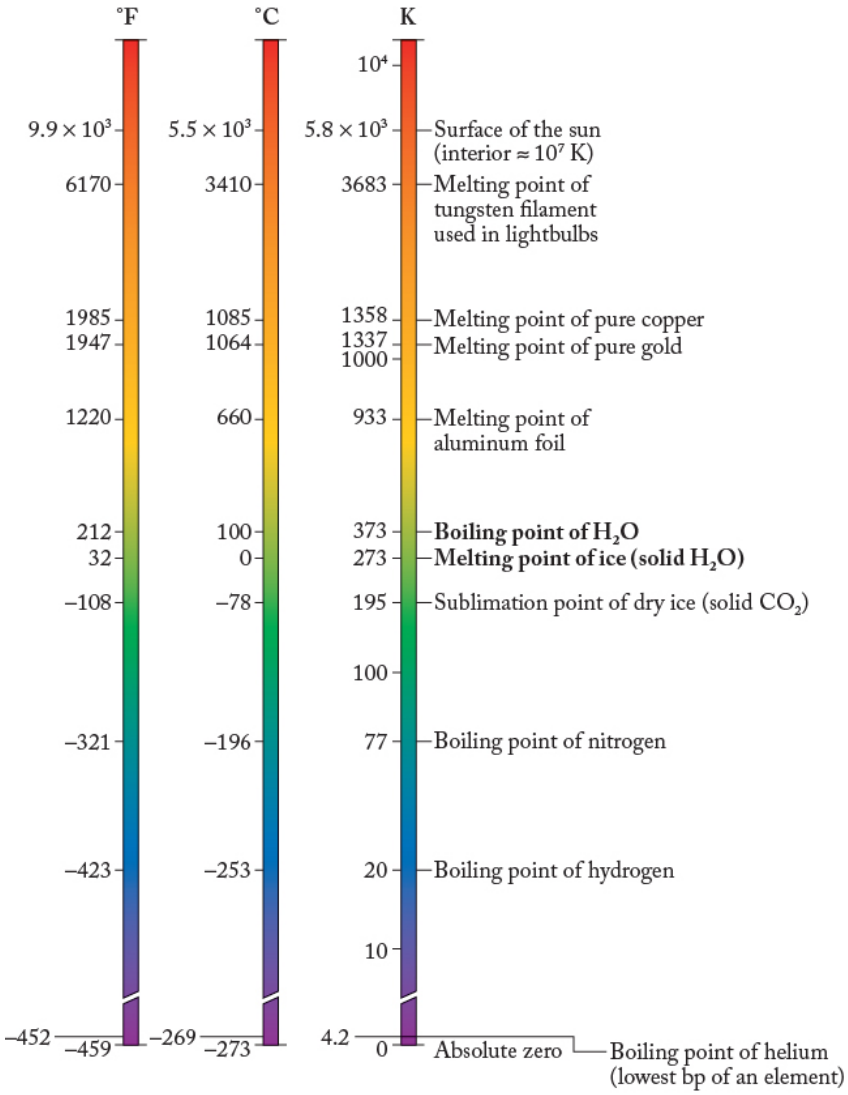
Courtesy NASA/JPL

Temperature



Temperature Scales




°F
°C
K
10^4
9.9×10^3
5.5×10^3
5.8×10^3
Surface of the sun (interior ≈ 10^7 K)
6170
3410
3683
Melting point of tungsten filament used in lightbulbs
1985
1947
1085
1064
1358
1337
Melting point of pure copper
Melting point of pure gold
1000
1220
660
933
Melting point of aluminum foil
212
32
100
0
373
273
Boiling point of H_2O
Melting point of ice (solid H_2O)
−108
−78
195
Sublimation point of dry ice (solid CO_2)
100
−321
−196
77
Boiling point of nitrogen
−423
−253
20
Boiling point of hydrogen
10
−452
−459
−269
−273
4.2
0
Absolute zero
Boiling point of helium (lowest bp of an element)

- Convert 25ºC to ºF

- Convert 25ºF to ºC.

Practice problems Gilbert – 1.79-1.86

New Temperature Scales

- In the Willard temperature scale, water freezes at 345ºW and boils at 745ºW. Convert 36ºC to ºW.

Practice problems Gilbert – 1.87

- The density of alcohol at 20^{o}C is 0.79 g/mL. The density of benzene at the same temperature is 0.88 g/mL. How many liters of alcohol would you get if you bought a pound of alcohol?

- An ore bed in an open pit gold mine yields 0.035 oz of gold per ton of ore. The mine operates 20 hr/day and shows an average profit of $135000 per day. It costs $860.00/oz to extract the gold from the ore and gold is selling for $1335.00/oz. If the ore trucks have a capacity of 85 tons, how many trips per hour must they make to achieve this level of productivity?

Tro Problem 1.109

- On a new Jekyll temperature scale, water freezes at 17^{o}J and boils at 97^{o}J. On another new temperature scale, the Hyde scale, water freezes at 0^{o}H and boils at 120^{o}H. If methyl alcohol boils at 84^{o}H, what is its boiling point on the Jekyll scale?

Tro Problem 1.140

- Nanotechnology, the field of trying to build ultrasmall structures one atom at a time, has progressed in recent years. One poteinial application of nanotechnology is the construction of artificial cells. The simplest cells would probably mimic red blood cells, the body's oxygen transporters. For example, nanocontainers, perhaps constructed of carbon, could be pumped full of oxygen and injected into a person's bloodstream. If the person needed additional oxygen – due to a heart attack perhaps, of for the purpose of space travel – these containers could slowly release oxygen into the blood, allowing tissues that would otherwise die to remain alive.

Tro Problem 1.140 cont.

Suppose that the nanocontainers were cubic and had an edge length of 25 nanometers.

a. What is the volume of one nanocontainer?

b. Suppose that each nanocontainer could contain pure oxygen pressurized to a density of 85 g/L. How many grams of oxygen could be contained by each nanocontainer?

c. Normal air contains about 0.28 g of oxygen per liter. An average human inhales about 0.50 L of air per breath and takes about 20 breaths per minute. How many grams of oxygen does a human inhale per hour?

Tro Problem 1.134 cont.

d. What is the minimum number of nanocontainers that a person would need in their bloodstream to provide 1 hour's worth of oxygen?

e. What is the minimum volume occupied by the number of nanocontainers computed in part d? Is such a volume feasible, given that total blood volume in an adult is about 5 liters?

Tro Problem 1.142

- A box contains a mixture of small copper spheres and small lead spheres. The total volume of both metals is measured by the displacement of water to be 427 mL and the total mass is 4.36 kg .
- What percentage of the spheres are copper?