CHAPTER 1 CHEMISTRY AND MEASUREMENT

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1. Chemistry and Measurement

- Chemistry: the science of the composition and structure of materials and of the changes that materials undergo

1.3 Law of Conservation of Mass

- Mass: the quantity of matter in a material
- Matter: the general term for the material things around us
- the total mass remains constant during a chemical change (chemical reaction)
- mass *vs* weight

1.4 Matter: Physical state and Chemical Constitution

Classification:

Physical State (*compressibility*)

solid

liquid

gas

Chemical constitution

element

compound

mixture

Physical change *vs.* chemical change

P34 Problem 1.43

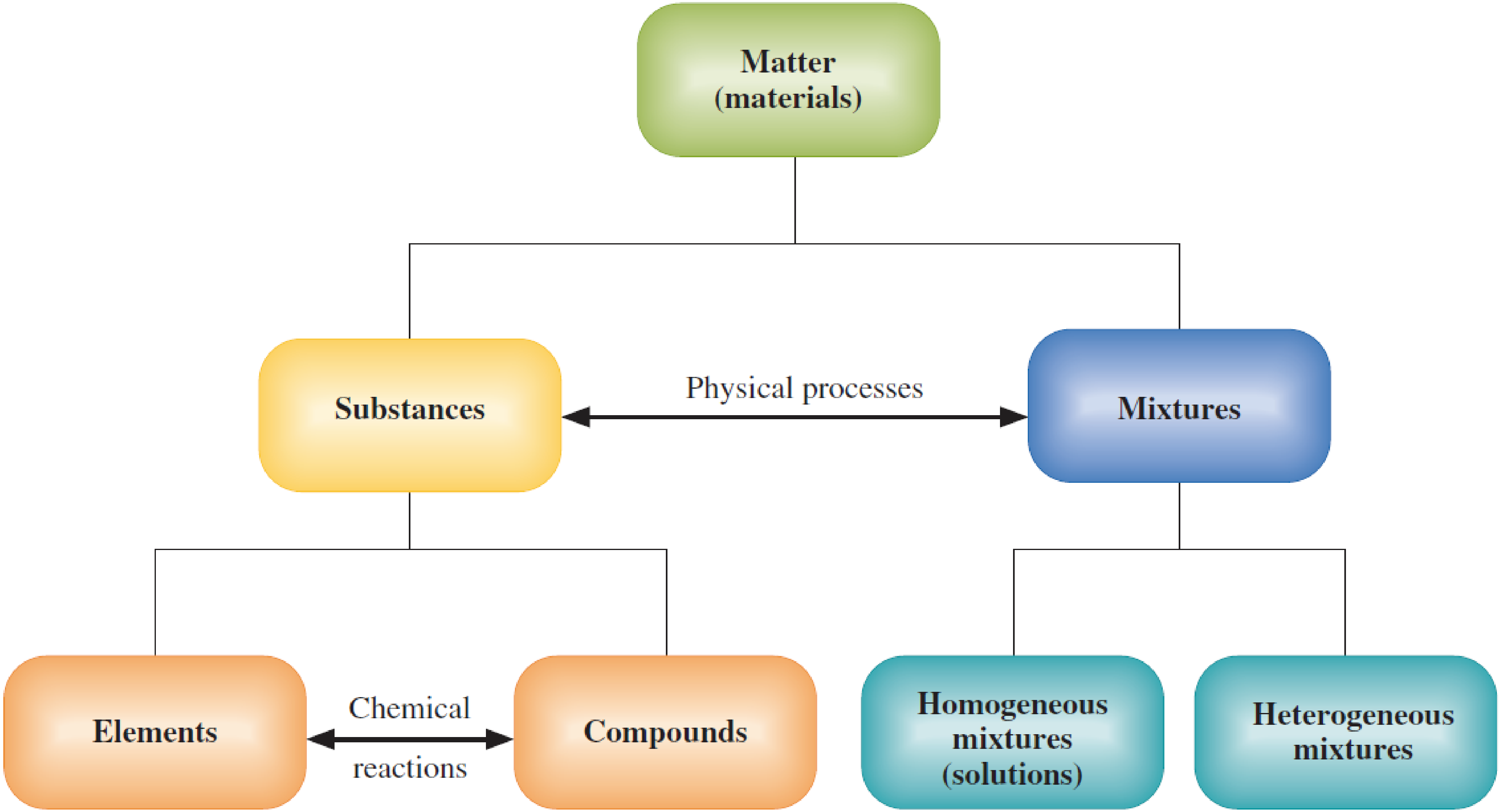
1.43 Which of the following are physical changes and which are chemical changes?

- **a.** melting of sodium chloride
- **b.** pulverizing of rock salt
- **c.** burning of sulfur
- **d.** dissolving of salt in water

1.4 Matter: Physical state and Chemical Constitution

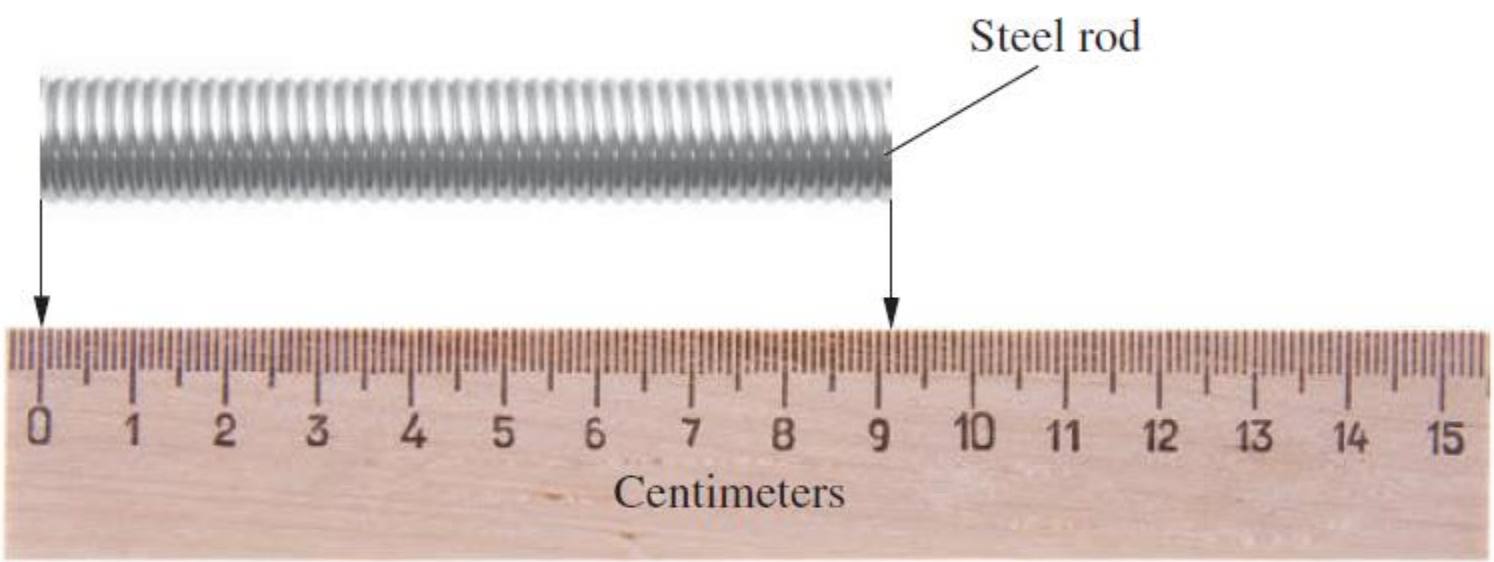
- Substance: a kind of matter that cannot be separated into other kinds of matter by any physical process. *e.g.*, NaCl
- Element: a substance that cannot be decomposed by any chemical reaction into simpler substances. *e.g.*, Na
- Compound: a substance composed of two or more elements chemically combined.
- Mixture: a material that can be separated by physical means into two or more substances.

1.4 Matter: Physical state and Chemical Constitution

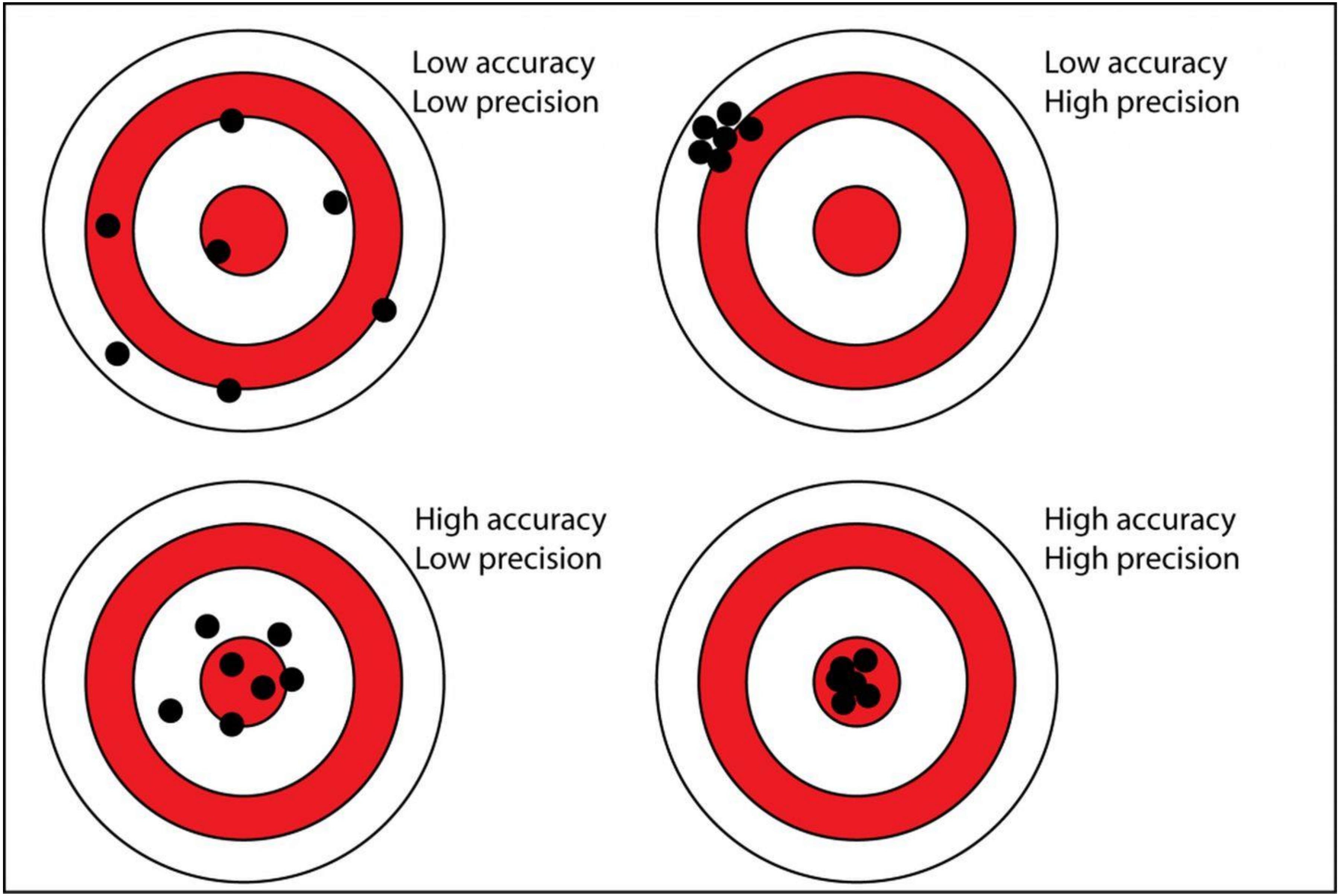


1.5 Measurement and Significant Figures

- the measured number + the unit
- Precision: the closeness of the set of values obtained from identical measurements of a quantity
- Accuracy: the closeness of a single measurement to its true value



Precision *vs* accuracy

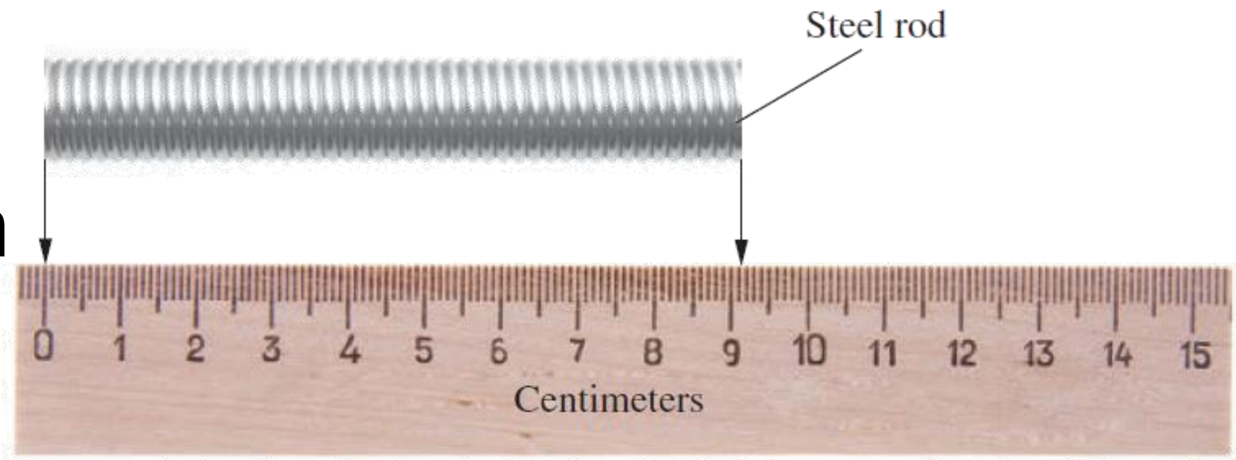


1.5 Measurement and Significant Figures

- **Significant figures:** those digits in a measured number (or in the result of a calculation with measured numbers) that include all certain digits plus a final digit having some uncertainty.

9.12 cm

certain uncertain



1.5 Measurement and Significant Figures

- Number of significant figures: the number of digits reported for the value of a measured or calculated quantity, indicating the precision of the

1. All digits are significant except zeros at the beginning of the number and possibly terminal zeros (one or more zeros at the end of a number). Thus, 9.12 cm, 0.912 cm, and 0.00912 cm all contain three significant figures.
2. Terminal zeros ending at the right of the decimal point are significant. Each of the following has three significant figures: 9.00 cm, 9.10 cm, 90.0 cm.
3. Terminal zeros in a number without an explicit decimal point may or may not be significant. If someone gives a measurement as 900 cm, you do not know whether one, two, or three significant figures are intended. If the person writes 900. cm (note the decimal point), the zeros are significant. More generally, you can remove any uncertainty in such cases by expressing the measurement in scientific notation.

1.5 Measurement and Significant Figures

- Scientific notation： $A \times 10^n$

- Significant figures in calculations:

1. **Multiplication and division.** When multiplying or dividing measured quantities, give as many significant figures in the answer as there are in the measurement with *the least number of significant figures.*
2. **Addition and subtraction.** When adding or subtracting measured quantities, give the same number of decimal places in the answer as there are in the measurement with *the least number of decimal places.*

单选题 1分

设置

The speed of light is 300,000,000 meters per second. If precise to three significant figures, it should be written as

A 300 m/s

B 0.03 m/s

C 3.0×10^8 m/s

D 3.00×10^8 m/s

提交

1.5 Measurement and Significant Figures

- Exact numbers: a number that arises when you count items or sometimes when you define a unit.
- They have an infinite number of significant figures.
- The number of significant figures in a calculation result depends only on the numbers of significant figures in quantities having uncertainties.

$$3.0 \text{ grams} \times 9 = 27 \text{ grams}$$

1.5 Measurement and Significant Figures

- Rounding: the procedure of dropping nonsignificant digits in a calculation result and adjusting the last digit reported

1. If this digit is 5 or greater, add 1 to the last digit to be retained and drop all digits farther to the right. Thus, rounding 1.2151 to three significant figures gives 1.22.
2. If this digit is less than 5, simply drop it and all digits farther to the right. Rounding 1.2143 to three significant figures gives 1.21.

1.5 Measurement and Significant Figures

Example 1.2 Using Significant Figures in Calculations

Perform the following calculations and round the answers to the correct number of significant figures (units of measurement have been omitted).

a. $\dfrac{2.568 \times 5.8}{4.186}$

b. $5.41 - 0.398$

c. $3.38 - 3.01$

d. $4.18 - 58.16 \times (3.38 - 3.01)$

Answer:

a. 3.6 b. 5.01 c. 0.37 d. -17

1.6 International System of Units (SI Units)

TABLE 1.1 SI Base Units		
Quantity	Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Amount of substance	mole	mol
Electric current	ampere	A
Luminous intensity	candela	cd

1.6 International System of Units (SI Units)

TABLE 1.2 Selected SI Prefixes

Prefix	Multiple	Symbol
mega	10^{6}	M
kilo	10^{3}	k
deci	10^{-1}	d
centi	10^{-2}	c
milli	10^{-3}	m
micro	10^{-6}	μ*
nano	10^{-9}	n
pico	10^{-12}	p

*Greek letter mu, pronounced "mew."

A non-SI unit of length

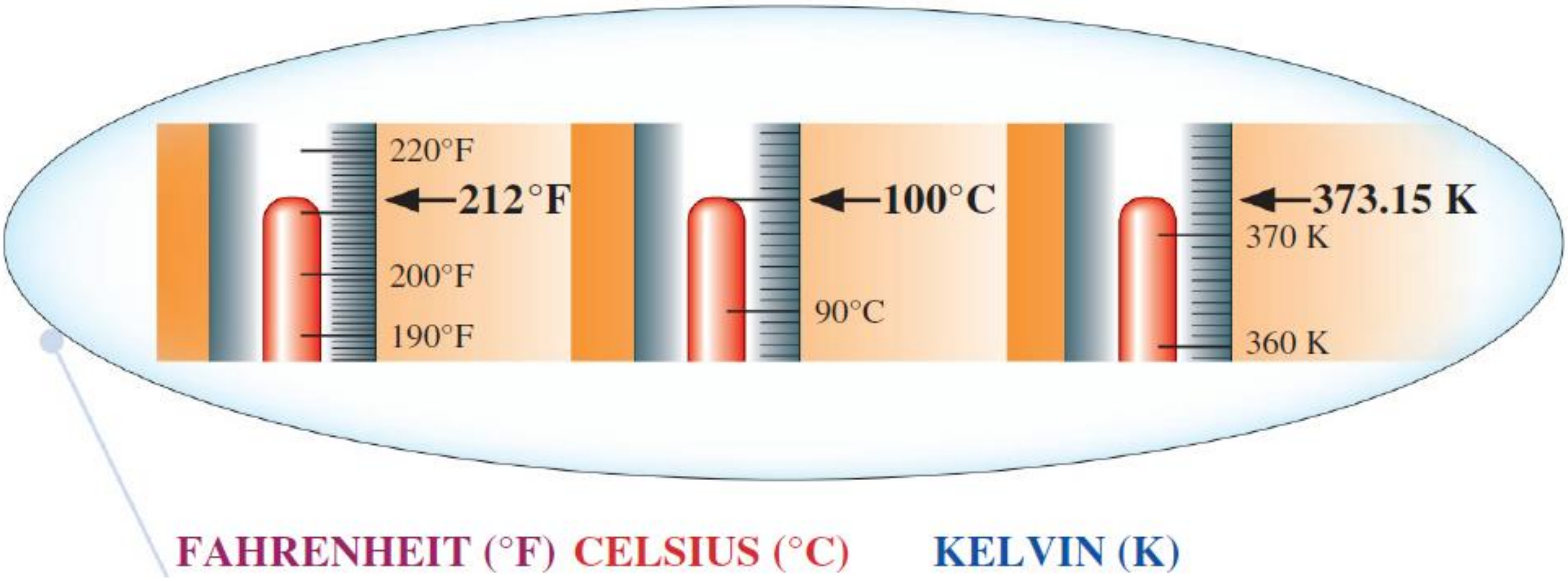
Å (**angstrom**) = 10^{-10} m

1.6 International System of Units (SI Units)

- Temperature: **kelvin (K)**

$$T_K = \left(t_C \times \frac{1\ \mathrm{K}}{1^\circ\mathrm{C}} \right) + 273.15\ \mathrm{K}$$

$$t_C = \frac{5^\circ\mathrm{C}}{9^\circ\mathrm{F}} \times (t_F - 32^\circ\mathrm{F})$$



单选题 1分

设置

What is this temperature of -78 ºC in kelvins?

A 351.15 K

B 195.15 K

C 78.15 K

提交

1.7 Derived Units

TABLE 1.3 Derived Units

Quantity	Definition of Quantity	SI Unit
Area	Length squared	m^2
Volume	Length cubed	m^3
Density	Mass per unit volume	kg/m^3
Speed	Distance traveled per unit time	m/s
Acceleration	Speed changed per unit time	m/s^2
Force	Mass times acceleration of object	$kg{\cdot}m/s^2$ (= newton, N)
Pressure	Force per unit area	$kg/(m{\cdot}s^2)$ (= pascal, Pa)
Energy	Force times distance traveled	$kg{\cdot}m^2/s^2$ (= joule, J)

P24 Example 1.4 & 1.5

$$d = \frac{m}{V} = \frac{30.5\ \text{g}}{35.1\ \text{mL}} = \mathbf{0.869\ g/mL}$$

Example 1.4 Calculating the Density of

A colorless liquid, used as a solvent (a liquid that dissolves other substances), is believed to be one of the following:

Substance	*Density (in g/mL)*
n-butyl alcohol	0.810
ethylene glycol	1.114
isopropyl alcohol	0.785
toluene	0.866

To identify the substance, a chemist determined its density. By pouring a sample of the liquid into a graduated cylinder, she found that the volume was 35.1 mL. She also found that the sample weighed 30.5 g. What was the density of the liquid? What was the substance?

P24 Example 1.4 & 1.5

Example 1.5 Using the Density to Relate

An experiment requires 43.7 g of isopropyl alcohol. Instead of measuring out the sample on a balance, a chemist dispenses the liquid into a graduated cylinder. The density of isopropyl alcohol is 0.785 g/mL. What volume of isopropyl alcohol should he use?

$$V = \frac{43.7\ \text{g}}{0.785\ \text{g/mL}} = \mathbf{55.7\ mL}$$

1.8 Units and Dimensional Analysis

Factor - Label Method

the method of calculation in which one carries along the units for quantities.

$$\frac{1\ \text{L}}{10^3\ \text{cm}^3} = \frac{\cancel{10^3\ \text{cm}^3}}{\cancel{10^3\ \text{cm}^3}} = 1$$

P26 Example 1.6 & 1.7

Example 1.6 Converting Units: Metric Unit to Metric Unit

Nitrogen gas is the major component of air. A sample of nitrogen gas in a glass bulb weighs 243 mg. What is this mass in SI base units of mass (kilograms)?

$$243\ \cancel{\text{mg}} \times \underbrace{\frac{10^{-3}\ \cancel{\text{g}}}{1\ \cancel{\text{mg}}}}_{\substack{\text{converts} \\ \text{mg to g}}} \times \underbrace{\frac{1\ \text{kg}}{10^{3}\ \cancel{\text{g}}}}_{\substack{\text{converts} \\ \text{g to kg}}} = 2.43 \times 10^{-4}\ \text{kg}$$

P26 Example 1.6 & 1.7

Example 1.7 Converting Units: Metric Volume to Metric Volume

The world's oceans contain approximately 1.35×10^9 km^3 of water. What is this volume in liters?

$$1.35 \times 10^9\ \cancel{\text{km}^3} \times \underbrace{\left(\frac{10^3\ \cancel{\text{m}}}{1\ \cancel{\text{km}}}\right)^3}_{\substack{\text{converts} \\ \text{km}^3 \text{ to m}^3}} \times \underbrace{\left(\frac{1\ \text{dm}}{10^{-1}\ \cancel{\text{m}}}\right)^3}_{\substack{\text{converts} \\ \text{m}^3 \text{ to dm}^3}} = 1.35 \times 10^{21}\ \text{dm}^3$$