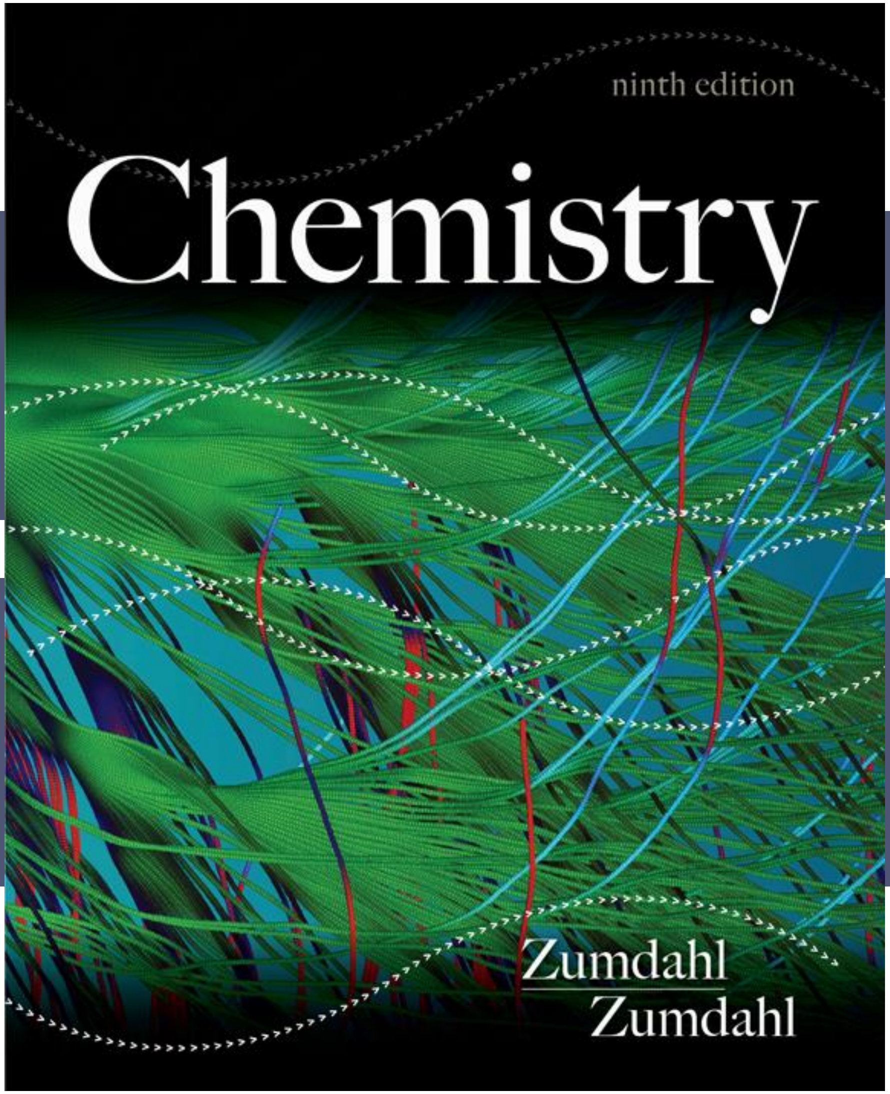
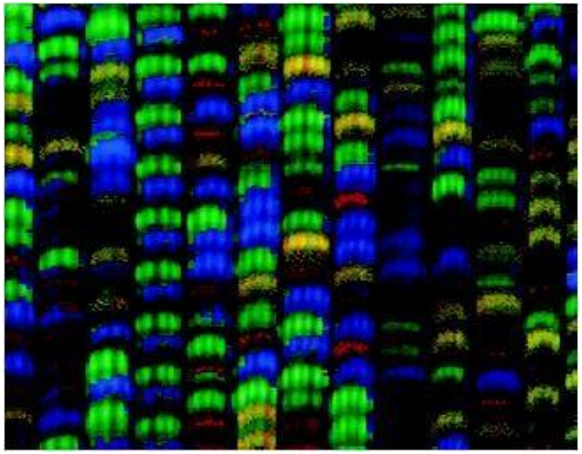


Chapter 1

Chemical Foundations

Modern Chemistry: A Brief Glimpse

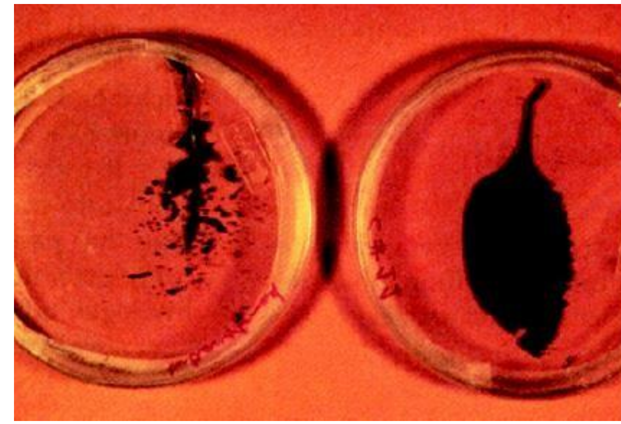
- Health and Medicine
  - Sanitation systems
  - Surgery with anesthesia
  - Vaccines and antibiotics
  - Gene therapy



- Energy and the Environment
  - Fossil fuels
  - Solar energy
  - Nuclear energy

Modern Chemistry: A Brief Glimpse

- Materials and Technology
  - Polymers, ceramics, liquid crystals
  - Room-temperature superconductors?
  - Molecular computing?

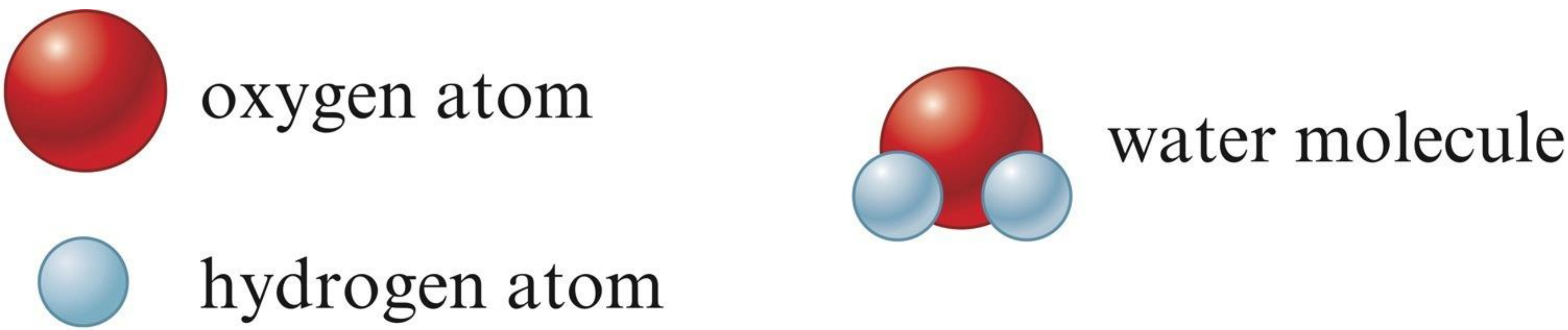


- Food and Agriculture
  - Genetically modified crops
  - “Natural” pesticides
  - Specialized fertilizers

- A main challenge of chemistry is to understand the connection between the macroscopic world that we experience and the microscopic world of atoms and molecules.
- You must learn to think on the atomic level.

Atoms vs. Molecules

- Matter is composed of tiny particles called atoms.
- Atom: smallest part of an element that is still that element.
- Molecule: Two or more atoms joined and acting as a unit.

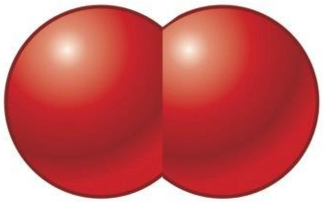


easy

Oxygen and Hydrogen Molecules

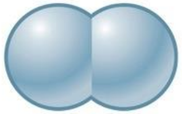
- Use subscripts when more than one atom is in the molecule.

oxygen molecule



written O_2

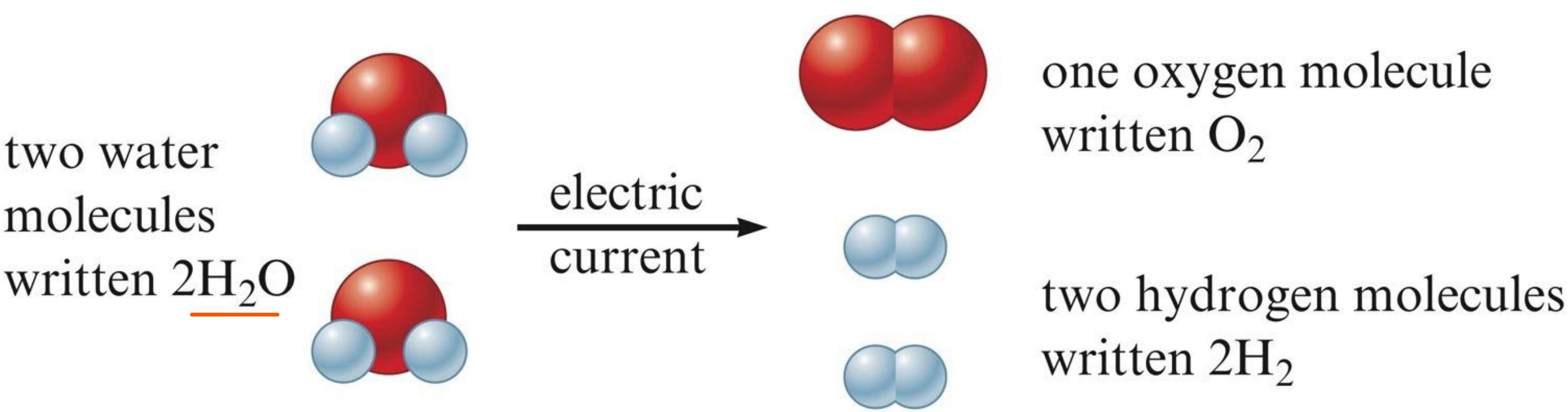
hydrogen molecule



written H_2

A Chemical Reaction

- One substance changes to another by reorganizing the way the atoms are attached to each other.



Science

Def

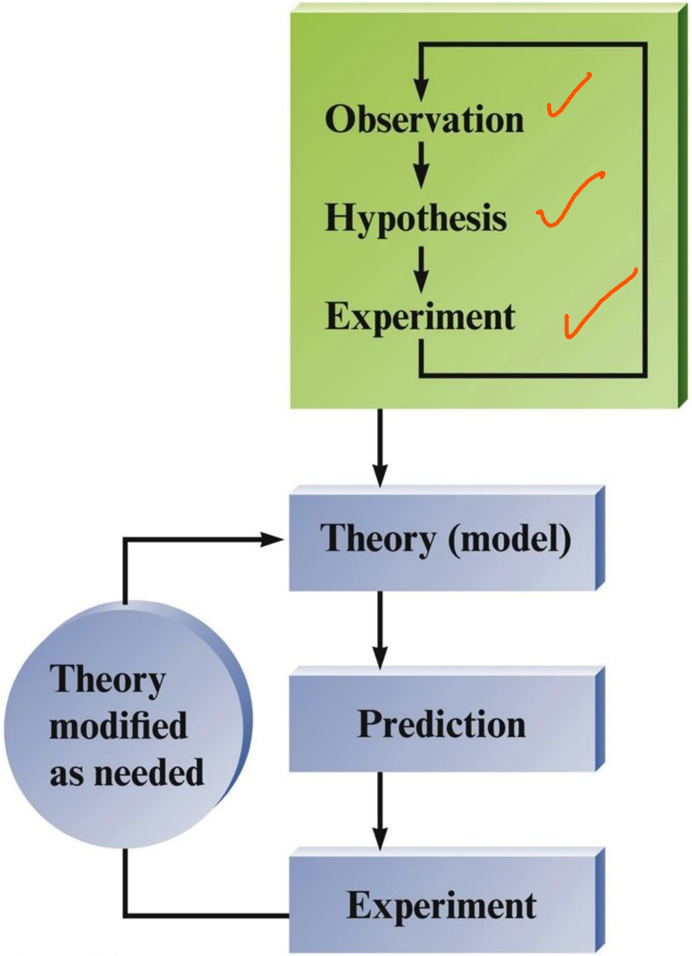
- Science is a framework for gaining and organizing knowledge.

fact

- Science is a plan of action — a procedure for processing and understanding certain types of information.
- Scientists are always challenging our current beliefs about science, asking questions, and experimenting to gain new knowledge.
- Scientific method is needed.

Fundamental Steps of the Scientific Method

- Process that lies at the center of scientific inquiry.



1.2 Experiment and Explanation

Def.

- An **experiment** is *an observation of natural phenomena carried out in a controlled manner so that the results can be duplicated and rational conclusions obtained*. ظواهر

موجزة

- A **law** is *a concise statement or mathematical equation about a fundamental relationship or regularity of nature.*

فرضية مؤقت

- A **hypothesis** is *a tentative explanation of some regularity of nature.*

نظرية مجربة

- A **theory** is *a tested explanation of basic natural phenomena.*

Example: molecular theory of gases.

Note: We cannot prove a theory absolutely.

It is always possible that further experiments will show the theory to be limited or that someone will develop a better theory

Section 1.2
The Scientific Method

Scientific Models

Law قانون

- A summary of repeatable observed (measurable) behavior.

Hypothesis فرضية

- A possible explanation for an observation.

Theory (Model) نظرية

- Set of tested hypotheses that gives an overall explanation of some natural phenomenon.

Done Here

Nature of Measurement

Measurement

- Quantitative observation consists of two parts.
  - number
  - scale (unit)

- Examples
  - 20 grams
  - 6.63×10^{-34} joule·second

The Fundamental SI Units

Physical Quantity		*Name of Unit*	*Abbreviation*
Mass	g	kilogram	kg
Length	m	meter	m
Time	s	second	s
Temperature	K	kelvin	K
Electric current	A	ampere	A
Amount of substance	mol	mole	mol
Luminous intensity	cd	candela	cd

Prefixes Used in the SI System

- Prefixes are used to change the size of the unit.

Table 1.2 Prefixes Used in the SI System (The most commonly encountered are shown in blue.)

Prefix	Symbol	Meaning	Exponential Notation*
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	1,000	10^{3}
hecto	h	100	10^{2}
deka	da	10	10^{1}
—	—	1	10^{0}

Prefixes Used in the SI System

imp

Table 1.2 | Prefixes Used in the SI System (The most commonly encountered are shown in blue.)

Prefix	Symbol	Meaning	Exponential Notation*
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}

cm

Tetra
Peta
exa

*See Appendix 1.1 if you need a review of exponential notation.

Mass ≠ Weight

- Mass is a measure of the resistance of an object to a change in its state of motion. Mass does not vary.

why

$= F_g = ma$

- Weight is the force that gravity exerts on an object. Weight varies with the strength of the gravitational field.

Uncertainty in Measurement

uncertain

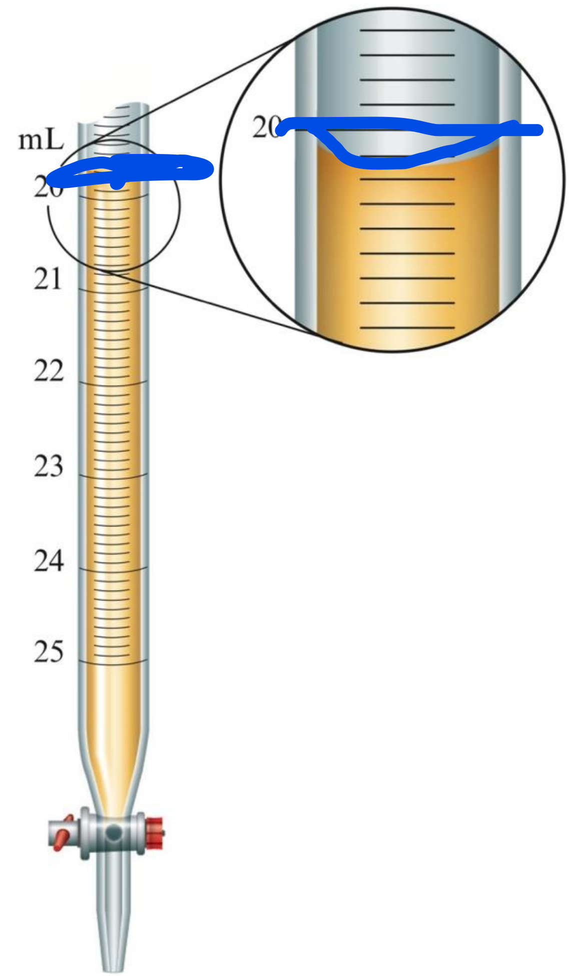
- A digit that must be estimated in a measurement is called uncertain.
- A measurement always has some degree of uncertainty. It is dependent on the precision of the measuring device.
- Record the certain digits and the first uncertain digit (the estimated number).

2.46 ⇒ 2.5

Measurement of Volume Using a Buret

- The volume is read at the bottom of the liquid curve (meniscus).
- Meniscus of the liquid occurs at about 20.15 mL.
  - Certain digits: 20.15
  - Uncertain digit: 20.15

uncer-
tain



Precision and Accuracy

Accuracy الدقة

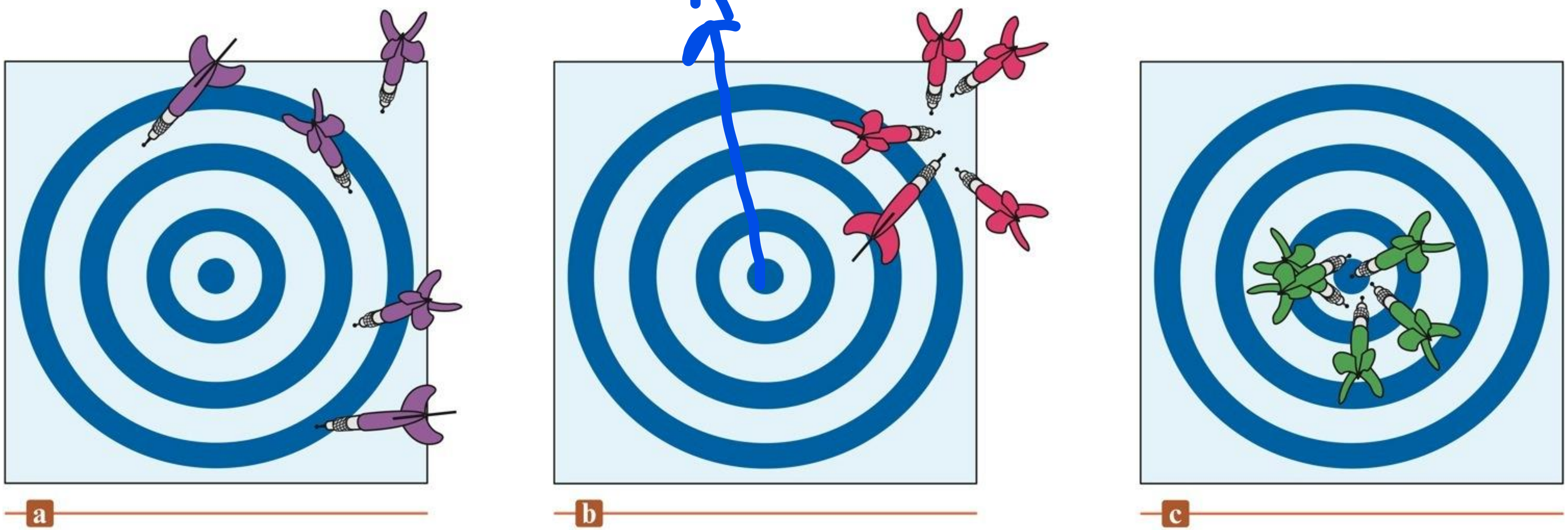
- Agreement of a particular value with the true value.

Precision الضبط

- Degree of agreement among several measurements of the same quantity.

Precision and Accuracy

true value



a Neither accurate nor precise.

b Precise but not accurate.

c Accurate and precise.

Rules for Counting Significant Figures

1. Nonzero integers always count as significant figures.
   - 3456 has 4 sig figs (significant figures).

1 → 1 S.F

1.0 → 2 S.F

0.01 → 1 S.F

Rules for Counting Significant Figures

2. There are three classes of zeros.

a. Leading zeros are zeros that precede all the nonzero digits. These do not count as significant figures.

- 0.048 has 2 sig figs.

zero

Doesn't Count

Rules for Counting Significant Figures

b. Captive zeros are zeros between nonzero digits. These always count as significant figures.

- 16.07 has 4 sig figs.

counts

Rules for Counting Significant Figures

c. Trailing zeros are zeros at the right end of the number. They are significant only if the number contains a decimal point.

- 9.300 has 4 sig figs.
- 150 has 2 sig figs.

مع فاصلة 4 S.F
بدون فاصلة 2 S.F

. → counts
~~.~~ → Doesn't

Section 1.5
Significant Figures and Calculations

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.

   3 3 3

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 3 3

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.

Exponential Notation

- Example
  - 300. written as 3.00×10^2
  - Contains three significant figures. أصفار بجوار كلها
- Two Advantages
  - Number of significant figures can be easily indicated.
  - Fewer zeros are needed to write a very large or very small number.

How many significant figures does each of the following numbers have?

	# of Sig. Figs.	Scientific Notation
1. 413.97	**5**	5 $10^2 \times 4.1397$
2. 0.0006	**1**	$^{4-}10 \times 6$
3. 5.120063	**7**	5.120063
4. 161,000	**3**	$10^5 \times 1.61$
5. 03600.	**4**	$10^3 \times 3.600$

Section 1.5
Significant Figures and Calculations

Q)Round each of the following to **three significant figures**.dedeen erehw noitaton cifitneics esU .

$3.7459 \rightarrow 3.75 \times 10$

1. 37.459 — **37.5 or 3.75 × 10^{1}**

$\rightarrow 5.431 \times 10^{6}$

2. 5431978 — **5.43 × 10^{6}**

3. 132.7789003 — **133 or 1.33 × 10^{2}**

4. 0.00087564 — **8.76 × 10^{-4}**

Q) Round 0.00564458 to four significant figures and express the answer using scientific notation.

5.645×10^{-3}

A. 5.64×10^{-2}

B. 5.000×10^{-3}

C. 5.645×10^{-4}

D. 0.56446

E. $\boxed{5.645 \times 10^{-3}}$

Significant Figures in Mathematical Operations

1. For multiplication or division, the number of significant figures in the result is the same as the number in the least precise measurement used in the calculation.

$$1.342 \times \underline{5.5} = 7.381 \rightarrow \underline{7.4}$$

e.g.,

$10.54 \times 31.4 \times 16.987$ **$5.62 \times = 5621.9 = 10^3$**

4 S.F. ×3 S.F. × 5 S.F. = 5 S.F. = 3 S.F.

e.g.

$5.896 \div 0.008 = 737 = 7 \times 10^2$

4 S. F. ÷ 1 S.F. = 3 S.F.= 1 S.F.

Give the value of the following calculation to the correct number of significant figures.

$$\left(\frac{635.4 \times 0.0045}{2.3589}\right) \qquad \frac{2\ \text{s.f}}{5\ \text{s.f}}$$

$$= 2\ \text{s.f}$$

A. 1.21213

B. 1.212

C. 1.212132774

$\boxed{\text{D. } 1.2}$

E. 1

Significant Figures in Mathematical Operations

2. For addition or subtraction, the result has the same number of decimal places as the least precise measurement used in the calculation.

$$
\begin{array}{rr}
 & 23.445 \\
+ & 7.8\underline{3} \\
\hline
 & 31.275
\end{array}
\xrightarrow{\text{Corrected}} 31.2\underline{8}
$$

Addition and Subtraction

- Answer has same number of decimal places as quantity with **fewest number** of decimal places.

e.g.,	12.9753	4 decimal places
	319.5+	1 decimal place
	4.398+	3 decimal places
	336.9	1 decimal place

e.g.,	397	0decimal places
	273.15–	2 decimal places
	124	0 decimal place

Q) For each calculation, give the answer to the **correct number of significant figures**.

1. $10.0\text{ g} + 1.03\text{ g} + 0.243\text{ g} =$

   11.3 g

   1.13×10^{1} g

2. $^\circ$ $19.556\text{ C} - 19.552\ ^\circ\text{ C} =$

   $0.004\text{C}\ ^\circ$

   $4 \times 10^{-3}\ \text{C}^\circ$

3. $327.5\text{ m} \times 4.52\text{ m} = 1480.3 = 1.48 \times 10^{3}\ \text{m}^2$

4. $15.985\text{ g} \div 24.12\text{ mL} =$

   0.6627 g/mL

   6.627×10^{-1} g/mL

Q) When the expression,

412.272 + 0.00031 – 1.00797 + 0.000024 +12.8

is evaluated, the result should be expressed as:

A. 424.06

B. 424.064364

C. 424.1

D. 424.064

E. 424

Q) For the following calculations, give the answer to the correct number of significant figures.

1. $$\frac{(71.359\text{m} - 71.357\text{m})}{(3.2\text{ s} \times 3.67\text{ s})} = \frac{0.00\underline{2}\text{m}}{11.744}$$

$$= (0.002/12) = (1.666 \times 10^{-4}) = 2 \times 10^{-4}\text{ m/s}^2$$

2. $$\frac{13.674\text{ cm} \times 4.35\text{ cm} \times 0.35\text{ cm}}{856\text{ s} + 1531.1\text{ s}}$$

$$\frac{2\underline{0}.818665\text{ cm}^3}{238\underline{7}.1\text{ s}}$$

$= (21/2387) = 0.0088\text{ cms/}^3$

Or $8.8 \times {}^{3}\text{-}10$

Rules for Counting Significant Figures

rule \ law

3. Exact numbers have an infinite number of significant figures.

- 1 inch = 2.54 cm, exactly.
- 9 pencils (obtained by counting).

Section 1.5

Significant Figures and Calculations

(1)Numbers that come from definitions S.F = ∞

12 in. = 1 ft

60 s = 1 min

(2)Numbers that come from direct count S.F = ∞

–Number of people in small room

•Have no uncertainty

•Assume they have 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

Q) If you have 9 coins in a jar. What is the total mass of the 9 coins when each coin has a mass of 3.0 grams?

3.0g x 9=27 g

- The number 9 is exact and does not determine the number of significant figures
- Q) How many feet are there in 36.00 inches? Express the answer with the correct number of significant figures: 1 ft.=12 in

A. 3 ft.

B. 3.0 ft

C. 3.00 ft.

D. 3.000 ft.

E. 3.00000 ft.

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

a = 3.6
b = 5.01
c = 0.37
d=-18

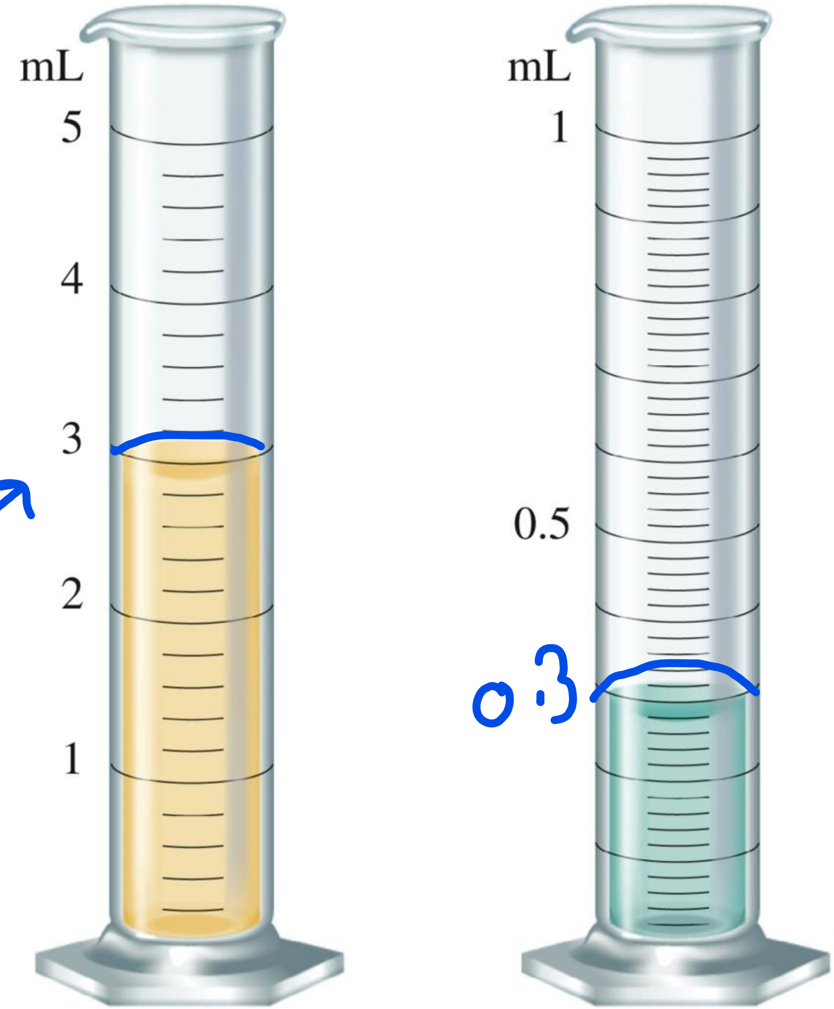
CONCEPT CHECK!

You have water in each graduated cylinder shown. You then add both samples to a beaker (assume that all of the liquid is transferred).

How would you write the number describing the total volume?

3.1 mL

What limits the precision of the total volume?



Questions to ask when approaching a problem

- What is my goal? 1
- What do I know? 2
- How do I get there? 3

my goal

Section 1.7
Dimensional Analysis

- Use when converting a given result from one system of units to another.
  - To convert from one unit to another, use the equivalence statement that relates the two units.
  - Derive the appropriate unit factor by looking at the direction of the required change (to cancel the unwanted units).
  - Multiply the quantity to be converted by the unit factor to give the quantity with the desired units.

Example #1

A golfer putted a golf ball 6.8 ft across a green. How many inches does this represent?

- To convert from one unit to another, use the equivalence statement that relates the two units.

1 ft = 12 in

12 in = 1 ft

The two unit factors are:

$$\frac{1\text{ ft}}{12\text{ in}} \text{ and } \frac{12\text{ in}}{1\text{ ft}}$$

Example #1

ft

in **A golfer putted a golf ball 6.8 ft across a green. How many inches does this represent?**

- Derive the appropriate unit factor by looking at the direction of the required change (to cancel the unwanted units).

12 in = 1 ft

$$6.8\ \cancel{\text{ft}} \times \frac{12\ \text{in}}{1\ \cancel{\text{ft}}} = 81.6\ \text{in}$$

Example #1

A golfer putted a golf ball 6.8 ft across a green. How many inches does this represent?

- Multiply the quantity to be converted by the unit factor to give the quantity with the desired units.

$81.6 \approx \underline{\underline{82}}$

$$6.8\ \cancel{\text{ft}} \times \frac{12\ \text{in}}{1\ \cancel{\text{ft}}} = 82\ \text{in}$$

$\boxed{2{,}100.0}$

Example #2

$4.50 \text{ lb} \times \frac{2.1(1000)}{\text{lb}} =$

An iron sample has a mass of 4.50 lb. What is the mass of this sample in grams?

(1 kg = 2.2046 lbs; 1 kg = 1000 g)

4.50

$$4.50 \cancel{\text{lbs}} \times \frac{1 \cancel{\text{kg}}}{2.2046 \cancel{\text{lbs}}} \times \frac{1000 \text{ g}}{1 \cancel{\text{kg}}} = 2.04 \times 10^3 \text{ g}$$

1 kg → 2.2046 lbs

x kg → 4.50 ?

$\Rightarrow \frac{4.50}{2.2046} = \frac{2.2046x}{2.2046}$

$\Rightarrow 2.2041178661$

Dimensional Analysis Method of Solving Problems

1. Determine which unit conversion factor(s) are needed
2. Carry units through calculation
3. If all units cancel except for the ***desired unit(s)***, then the problem was solved correctly.

given quantity x conversion factor = desired quantity given

$$\cancel{\text{given unit}} \times \frac{\text{desired unit}}{\cancel{\text{given unit}}} = \text{desired unit}$$

A person's average daily intake of glucose (a form of sugar) is 0.0833 pound (lb). What is this mass in milligrams (mg)?

(1 lb = 453.6 g.)

lb → g =

pounds ⟶ grams ⟶ milligrams

$$\begin{array}{r} 0.0833 \\ \times\ 453.6 \\ \hline 37.78488 \end{array} \approx 37.8$$

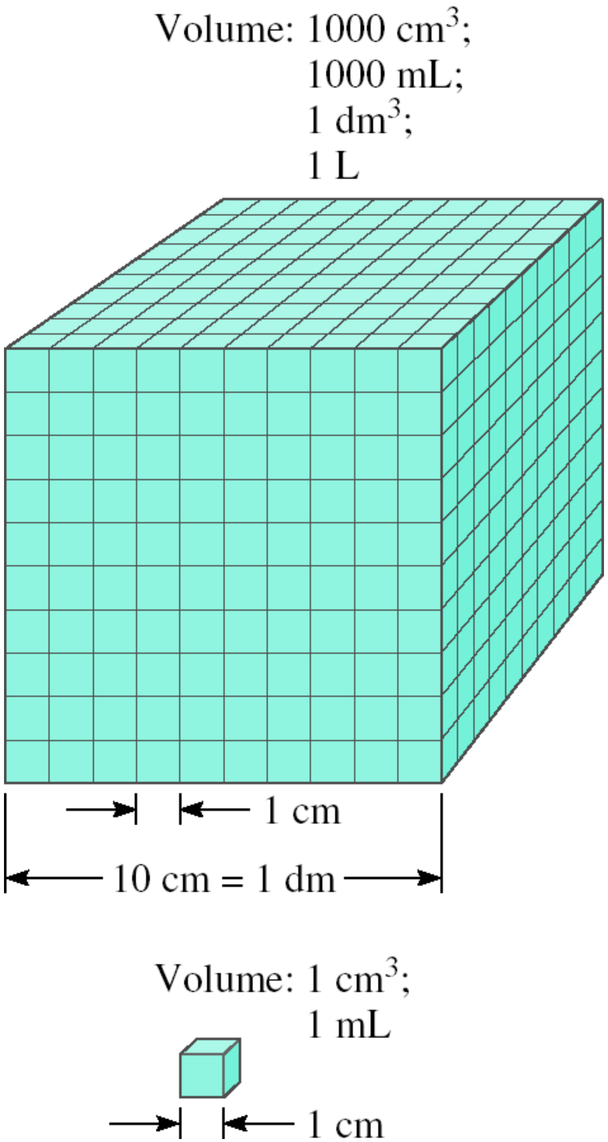
$$\frac{453.6\ \text{g}}{1\ \text{lb}} \quad \text{and} \quad \frac{1\ \text{mg}}{1 \times 10^{-3}\ \text{g}}$$

$$37.8\,g \times \frac{10^{3}}{g} =$$

$$?\ \text{mg} = 0.0833\ \cancel{\text{lb}} \times \frac{453.6\ \cancel{\text{g}}}{1\ \cancel{\text{lb}}} \times \frac{1\ \text{mg}}{1 \times 10^{-3}\ \cancel{\text{g}}} = 3.78 \times 10^{4}\ \text{mg}$$

$$37.8 \times 10^{3} \Rightarrow 378 \times 10^{4}$$

Volume – SI derived unit for volume is cubic meter (m^3)



$(1\ m)^3 = (100\ cm)^3$

$(1\ m)^3 = (10\ dm)^3$

$1\ L = 1000\ mL = 1000\ cm^3 = 1\ dm^3$

$\boxed{1\ mL = 1\ cm^3}$

$\boxed{1\ L = 1\ dm^3}$

$\boxed{10^3\ L = 1\ m^3}$

m^3

Volumetric flask

21

Q) A liquid helium storage tank has a volume of 275 L. What is the volume in m^3?

إجابة غلط

$0.275\ m^3$

$$275\ \cancel{L} \times \frac{1\ m^3}{10^3\ \cancel{L}} = \boxed{27.5\ m^3}$$

$\times 10^{-2}$

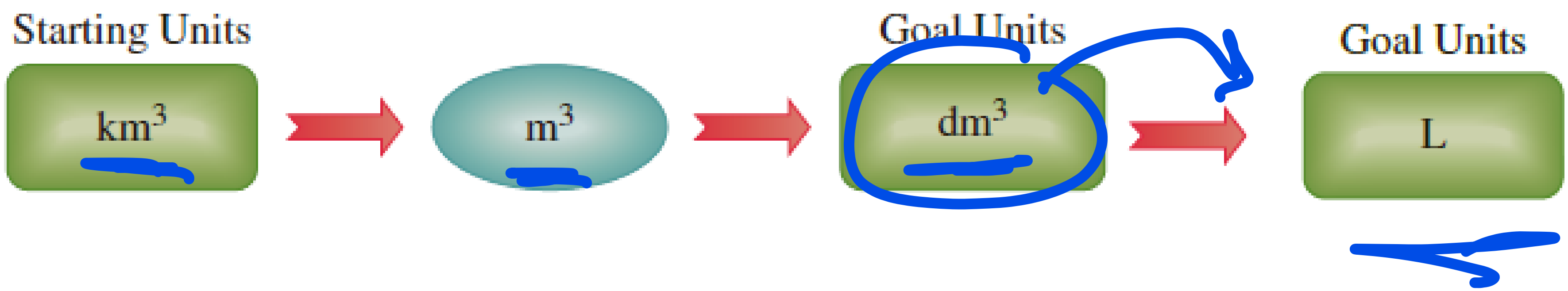
$g/m^3 \Rightarrow kg/m^3$

Q) The density of liquid nitrogen at its boiling point (−196° C or 77 K) is 0.808 g/cm³. Convert the density to units of kg/m³.

$$\frac{1\ kg}{1000\ g} \quad \text{and} \quad \frac{1\ cm^3}{1\times10^{-6}\ m^3}$$

$$?\ kg/m^3 = \frac{0.808\ \cancel{g}}{1\ \cancel{cm^3}} \times \frac{1\ kg}{1000\ \cancel{g}} \times \frac{1\ \cancel{cm^3}}{1\times10^{-6}\ m^3} = 808\ kg/m^3$$

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



$$1.35 \times 10^9 \text{km}^3 \times \frac{1000\text{m}^3}{1\ \text{km}^3} \times \frac{1000\ \text{dm}^3}{1\text{m}^3} \times \frac{1\ \text{L}}{1\ \text{dm}^3} = 1.35 \times 10^{21}\ \text{L}$$

$1\,in = 2.54\,cm$

Example: How to convert a person's height from 68.0 in to cm? if 2.54 cm = 1 in.

$68 \times 2.54 = 172.72$

Example: Convert 3.5 m³ to cm³.

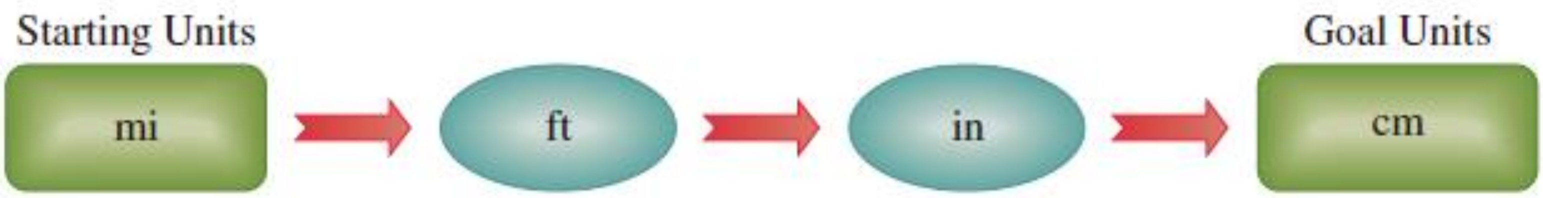
$3.5 \times 10^{-2} = 0.035$

Example: Convert 0.097 m to mm.

mi → cm

Q) How many centimetres are there in 6.51 miles?

1 mi = 5280 ft	1 ft = 12 in	1 in = 2.54 cm



$$6.51\,\cancel{\text{mi}} \times \underbrace{\frac{5280\,\cancel{\text{ft}}}{1\,\cancel{\text{mi}}}}_{\substack{\text{converts}\\ \text{mi to ft}}} \times \underbrace{\frac{12\,\cancel{\text{in.}}}{1\,\cancel{\text{ft}}}}_{\substack{\text{converts}\\ \text{fi to in.}}} \times \underbrace{\frac{2.54\text{ cm}}{1\,\cancel{\text{in.}}}}_{\substack{\text{converts}\\ \text{in. to cm}}} = \mathbf{1.05 \times 10^6\ cm}$$

$$6.51\,\cancel{\text{mi}} \; \frac{5280\,\cancel{\text{f}}}{1\,\cancel{\text{mi}}} \times \frac{12\,\cancel{\text{in}}}{1\,\cancel{\text{f}}} \times \frac{2.54\,\text{cm}}{1\,\cancel{\text{in}}}$$

Q) Convert speed of light from 3.00×10^8 m/s to mi/hr

(1 mi = 1.609 km)

$$3.00 \times 10^8\,\frac{\text{m}}{\cancel{\text{s}}} \times \frac{1\ \cancel{\text{km}}}{1000\ \text{m}} \times \frac{1\ \text{mi}}{1.609\ \cancel{\text{km}}} \times \frac{60\ \cancel{\text{s}}}{1\cancel{\text{m}}} \times \frac{60\ \text{m}}{1\text{h}\cancel{\text{r}}} = 671224363$$

$= 671 = 6.71 \times 10^2$

1 mi = 5280 ft	1 ft = 12 in	1 in = 2.54 cm

$$3.00 \times 10^8\,\frac{\text{m}}{\text{s}} \times \frac{100\ \text{cm}}{1\ \text{m}} \times \frac{1\ \text{in}}{2.54\ \text{cm}} \times \frac{1\ \text{ft}}{12\ \text{in}} \times \frac{1\text{mi}}{5281\ \text{ft}} \times \frac{60\ \text{s}}{1\text{m}} \times \frac{60\ \text{m}}{1\text{hr}}$$

$= 670953813 = 671 = 6.71 \times 10^2$

The Toyota Camry hybrid electric car has a gas mileage rating of 56 miles per gallon. What is this rating expressed in **units of kilometers per liter**?

1 gal = 3.784 L   1 mile = 1.609 km

$$56\frac{\cancel{\text{mi}}}{\cancel{\text{gal}}} \times \frac{1\,\cancel{\text{gal}}}{3.784\,\text{L}} \times \frac{1.609\,\text{km}}{1\,\cancel{\text{mi}}}$$

A. 2.38×10^{1} km L^{-1}

B. 24 km L^{-1}

C. 23.8 km L^{-1}

$\boxed{\text{D. } 2.4 \times 10^{1} \text{ km L}^{-1}}$

E. 9.2 km L^{-1}

27

The volume of a basketball is 433.5 in^3. Convert this to mm^3. (1 in. = 2.54 cm)

$$433.5\text{in}^3 \times \left(\frac{2.54\text{cm}}{1\text{ in}}\right)^3 \times \left(\frac{1\text{ m}}{100\text{ cm}}\right)^3 \times \left(\frac{1000\text{ mm}}{1\text{ m}}\right)^3 =$$

A. 1.101×10^{-2} mm^3

B. 7.104×10^{6} mm^3

C. 7.104×10^{4} mm^3

D. 1.101×10^{4} mm^3

E. 1.101×10^{6} mm^3

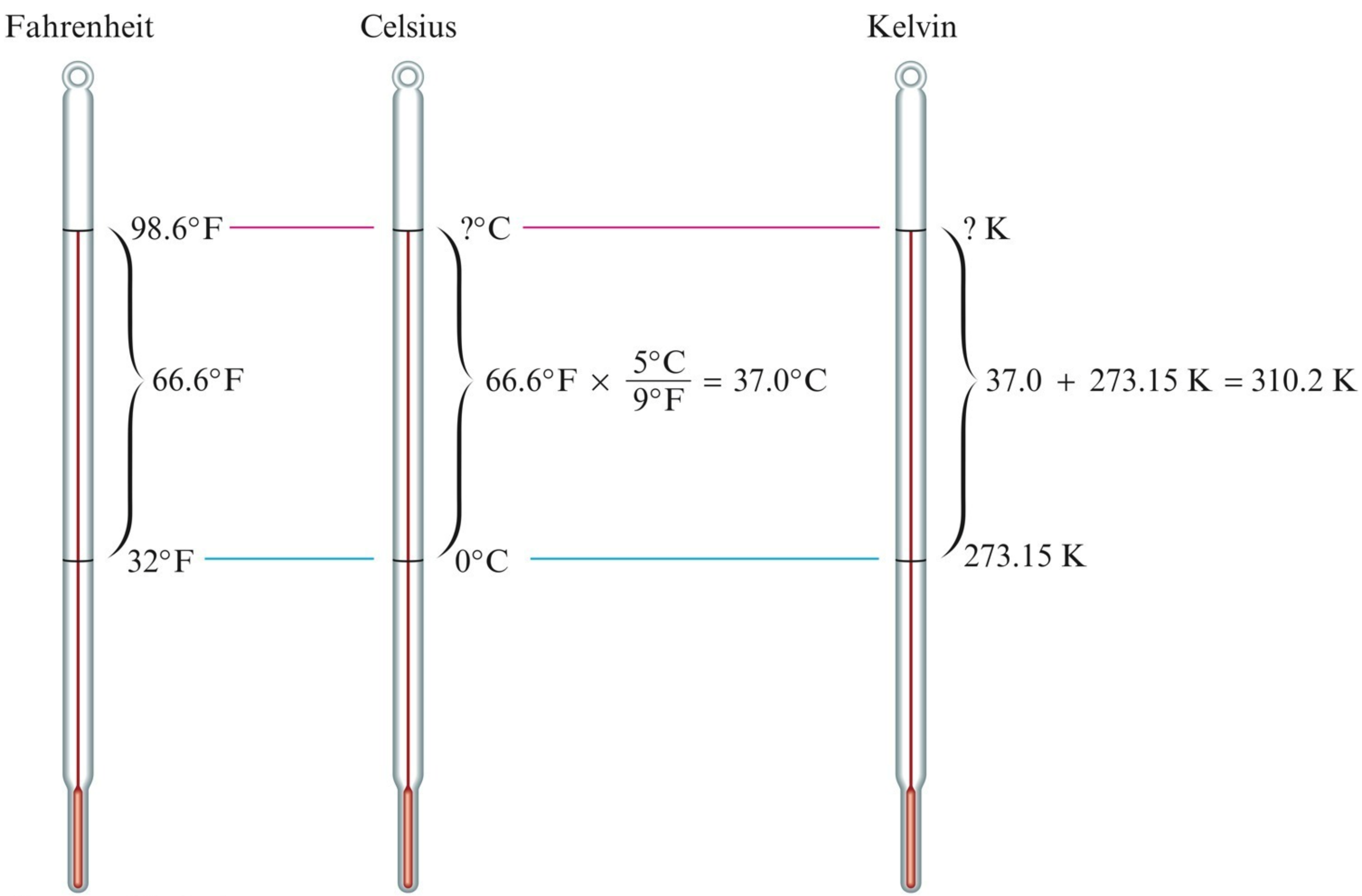
CONCEPT CHECK!

What data would you need to estimate the money you would spend on gasoline to drive your car from New York to Los Angeles? Provide estimates of values and a sample calculation.

Three Systems for Measuring Temperature

- Fahrenheit
- Celsius
- Kelvin

The Three Major Temperature Scales



Converting Between Scales

$$T_K = T_C + 273.15 \qquad T_C = T_K - 273.15$$

$$T_C = \left(T_F - 32^\circ\text{F}\right)\frac{5^\circ\text{C}}{9^\circ\text{F}} \qquad T_F = T_C \times \frac{9^\circ\text{F}}{5^\circ\text{C}} + 32^\circ\text{F}$$

Temperature conversions

- $T_K = T_C + 273.15$
- $T_C = (T_F - 32^\circ\text{F})\left(\frac{5^\circ\text{C}}{9^\circ\text{F}}\right)$
- $T_F = T_C\left(\frac{9^\circ\text{F}}{5^\circ\text{C}}\right) + 32^\circ\text{F}$

EXERCISE!

At what temperature does °C = °F?

- $T_F = T_C$
- Assume: $T_F = T_C = X$

$T_C = T_K = x$

EXERCISE!

- Since ° C equals ° F, they both should be the same value (designated as variable *x*).
- Use one of the conversion equations such as:

$$T_{\mathrm{C}} = \left(T_{\mathrm{F}} - 32^{\circ}\mathrm{F}\right)\frac{5^{\circ}\mathrm{C}}{9^{\circ}\mathrm{F}}$$

- Substitute in the value of *x* for both T_{C} and T_{F}. Solve for *x*.

EXERCISE!

$$T_C = (T_F - 32°F)\frac{5°C}{9°F}$$

$$x = (x - 32°F)\frac{5°C}{9°F}$$

$$\boxed{x = -40}$$

So $-40°C = -40°F$

1. Convert 121 °F to the Celsius scale.

$$T_F = \frac{9}{5} \times T_C + 32 \qquad T_C = (T_F - 32\ (^oF))\ \frac{5\ (^oC)}{9\ (^oF)}$$

$$T_c = \left(121\ ^oF - 32\ ^oF\right)\frac{5\ ^oC}{9\ ^oF} = \mathbf{49\ ^oC}$$

2. Convert 121 °F to the Kelvin scale.

– We already have in ° C so…

$$T_K = (T_c + 273.15^oC)\frac{1\,K}{1\ ^oC} = (49 + 273.15C)\frac{1K}{1\ ^oC}$$

$$\mathbf{T_K = 332\ K}$$

3. Convert 77 K to the Celsius scale.

$$T_K = (T_C + 273.15\ ^oC)\frac{1\ K}{1\ ^oC} \qquad T_C = (T_K - 273.15\ K)\frac{1\ ^oC}{1\ K}$$

$$T_C = (77\ K - 273.15\ K)\frac{1\ C}{1\ K}$$ **= –196 ºC**

4. Convert 77 K to the Fahrenheit scale.

– We already have in ° C so

$$T_F = \frac{9\ ^oF}{5\ ^oC}(-196\ ^oC) + 32\ ^oF$$ **= –321 ºF**

The melting point of UF_6 is 64.53 °C. What is the melting point of uranium UF_6 on the Fahrenheit scale?

$$T_F = \frac{9^{o}F}{5^{o}C} \times T_C + 32$$

A. 67.85 ° F

B. 96.53 ° F

C. 116.2 ° F

D. 337.5 ° F

E. 148.15 ° F

- Mass of substance per unit volume of the substance.
- Common units are g/cm^3 or g/mL.

g/mL

g/cm^3

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

Example #1

m

A certain mineral has a mass of 17.8 g and a volume of 2.35 cm^3. What is the density of this mineral?

V

$$\frac{17.8}{2.35} = 7.57$$

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

$$\text{Density} = \frac{17.8\text{ g}}{2.35\text{ cm}^3}$$

$$\text{Density} = 7.57\text{ g/cm}^3$$

Example #2

V

What is the mass of a 49.6-mL sample of a liquid, which has a density of 0.85 g/mL? D

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

$$0.85 = \frac{x}{49.6}$$

$$0.85\ \text{g/mL} = \frac{x}{49.6\ \text{mL}}$$

$$x = 0.85 \times 49.6$$

$$\text{mass} = x = 42\ \text{g}$$

$$5.6 \to = 42\ \text{g}$$

$$\boxed{42.16}$$

- A student weighs a piece of gold that has a volume of 11.02 cm³ of gold. She finds the mass to be 212 g. What is the density of gold?

$$d = \frac{m}{V}$$

$$\frac{212}{11.02} = 19.3\ \text{g/cm}^3$$

$$d = \frac{212\ \text{g}}{11.02\ \text{cm}^3} = \mathbf{19.3\ g/cm^3}$$

Another student has a piece of gold with a volume of 1.00 cm³. What does it weigh? **19.3 g**

19.3×2

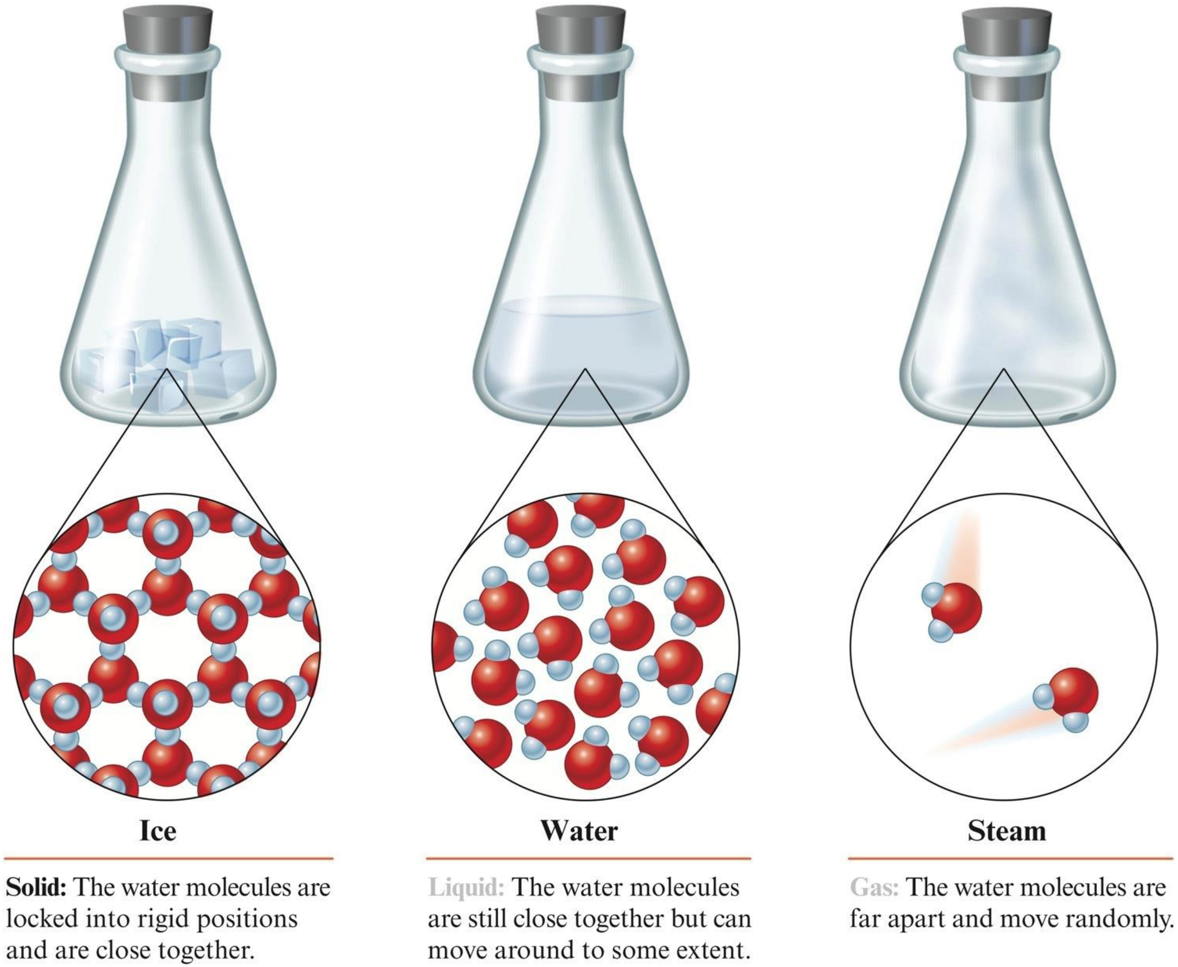
What if it were 2.00 cm³ in volume? **38.6 g**

(Q) If the density of an object is 2.87 x 10^{-4} lbs/cubic inch, what is its density in g/mL? (1 lb = 454 g, 1 inch = 2.54 cm)

Matter

- Anything occupying space and having mass.
- Matter exists in three states.
  - Solid
  - Liquid
  - Gas

The Three States of Water



Solid

- Rigid
- Has fixed volume and shape.
- relatively incompressible

Liquid

- Has definite volume but no specific shape.
- Assumes shape of container.
- relatively incompressible

Gas

- Has no fixed volume or shape.
- Takes on the shape and volume of its container.
- easily compressible

Section 1.10
Classification of Matter

- A **substance:** is a kind of matter that cannot be separated into other kinds of matter by any physical process.

- A mixture: is a kind of matter that can be separated by physical means into two or more substances.

- an Element: A substance that cannot be decomposed by any chemical reaction into simpler substances (Fe, Au, Na etc…)

- A compound: is a substance composed of two or more elements chemically combined. H_2O, NaCl, CO_2

Section 1.10
Classification of Matter

Mixtures

- Have variable composition.

Homogeneous Mixture متجانس

محلول

- Having visibly indistinguishable parts; solution.
- is a mixture that is uniform in its properties throughout given samples. Examples: NaCl solution, Soft drink, Air, Solder

Heterogeneous Mixture غير متجانس

- Having visibly distinguishable parts.
- a mixture that consists of physically distinct parts, each with different properties **Example**: Sand and iron filings

CONCEPT CHECK!

Which of the following is a homogeneous mixture?

- Pure water
- Gasoline
- Jar of jelly beans
- Soil
- Copper metal

متجانس
(مخلوط)

Physical Change

- Change in the form of a substance, not in its chemical composition.
    - Example: boiling or freezing water
- Can be used to separate a mixture into pure compounds, but it will not break compounds into elements.
    - Distillation
    - Filtration
    - Chromatography

مادة ، طوا

Chemical Change

- A given substance becomes a new substance or substances with different properties and different composition.
  - Example: Bunsen burner (methane reacts with oxygen to form carbon dioxide and water)

- A physical change is a change in the form of matter but not in its chemical identity. Examples: Ice melting, salt or sugar dissolved in water. (Physical property: Melting, boiling, electrical conductivity)

- A chemical change, or chemical reaction, is a change in which one or more kinds of matter are transformed into a new kind of matter or several new kinds of matter. Examples: rust formation, burning butane gas in oxygen (Chemical property: Describes how a substance undergoes a chemical reaction)

CONCEPT CHECK!

Which of the following are examples of a chemical change?

- Pulverizing (crushing) rock salt
- Burning of wood
- Dissolving of sugar in water
- Melting a popsicle on a warm summer day

	Chemical	Physical
Magnesium burns when heated	✓	
Magnesium metal tarnishes in air	✓	
Magnesium metal melts at 922 K		✓
Orange juice lightens when water is added		✓

The Organization of Matter