

Chemistry 151

- Professor James H. Geiger
- Office: Chemistry Building, Room 9
- Office Hours: 1:30-2:30 PM MWF, and other times by appointment (send me an email).
- You can also drop by, but I might be busy.
- Email: geigerj@msu.edu



Textbooks/other help

- Textbooks
- An on-line version can be purchased from the publisher. www.MasteringChemistry.com bundled with the on-line homework.
You can also get the e version at the book store
ISBN-10: 0321705122
- Brown, LeMay, and Bursten, Chemistry, the Central Science, 10th edition, Prentice-Hall, 2005. ISBN: 0-13-109686-9.
- The same text will be used for CEM 152 in the spring semester.
- The 9th edition (2003), 11th or 12th editions can also be used.
- The 10th edition is stocked by campus bookstores. Also, it can be ordered from Amazon.com, barnesandnoble.com, or directly from the publisher.
- Lecture notes will be available on the web.

On line homework

- Can be purchased masteringchemistry.com
- Will be required, is a big part of your grade
- Many of the problems are mini tutorials
- Make sure you do the introduction problem set, it is for credit as well.

Dear Student:

In this course you will be using MasteringChemistry®, an online tutorial and homework program that accompanies your textbook. *If you have joined a MasteringChemistry course before and can still log in:* Save time by following the guide for joining another course by following the guide for joining another course (available from www.masteringchemistry.com > Tours & Training > Getting Started) instead of this page.

What You Need:

II **A valid email address**

II **A student access code**

(Comes in the Student Access Code Card/Kit that may have been packaged with your new textbook or that may be available separately in your school's bookstore. Otherwise, you can purchase access online at www.masteringchemistry.com.)

II **The ZIP or other postal code for your school: 48901**

II **A Course ID: **GEIGER09036 (those are zeroes)****

1. Register

- Go to www.masteringchemistry.com and click **Students under Register**.
- To register using the student access code inside the MasteringChemistry Student Access Code Card/Kit, select **Yes, I have an access code. Click Continue**.
- OR– *Purchase access online:* Select **No, I need to purchase access online now. Select your textbook**, whether you want access to the eText, and click **Continue. Follow the on-screen instructions to purchase access using a credit card.** The purchase path includes registration, but the process is a bit different from the steps printed here.
- **License Agreement and Privacy Policy: Click I Accept to indicate that you have read and agree to the license agreement and privacy policy.**
- Select the appropriate option under “Do you have a Pearson Education account?” Continue to give the requested information until you complete the process. The **Confirmation & Summary page confirms your registration.** This information will also be emailed to you for your records. You can either click **Log In Now or** return to www.masteringchemistry.com later.



2. Log In

- Go to www.masteringchemistry.com.
- Enter your Login Name and Password that you specified during registration and click **Log In**.

3. Join Your Instructor's Online Course and/or Open Self-Study Resources

Upon first login, you'll be asked to do one or more of the following:

- **Join a Course by entering the MasteringChemistry Course ID provided by your instructor. If you don't have a Course ID now, you can return to join the MasteringChemistry course later. When you join a course, you may also be asked for a Student ID (follow on-screen instructions).**
- **Explore the Study Area or Launch Your eText, if these resources are available for your textbook.**

To Access MasteringChemistry Again Later

Simply go to www.masteringchemistry.com, enter your Login Name and Password, and click **Log In**.

*After you have joined a course: You can open any assignments from the **Assignments Due Soon area or from the***

Assignments page. For self-study, click eText or Study Area, if these options are available.

Support

Access Customer Support at <http://www.masteringchemistry.com/support>, where you will find:

- System Requirements
- Answers to Frequently Asked Questions
- Registration Tips & Tricks video
- Additional contact information for Customer Support, including Live Chat



Course organization

- Lectures MWF 12:40-1:30 pm (me)

Recitation once a week (check your schedule). Small class, more individual help from Teaching assistants. Each section = 1 recitation group.

No Recitation this week.

They start next week.

**This week only come to class WF
12:40-1:30 pm.**

Grades

- Four exams (130 points/exam)x4 = 520 points
- On-line homework (200 points) (Mastering Chemistry)
- Some quizzes (100 points total, in class/ recitation) (Total = 100).
- **There will be no makeups.**
 - quiz problems *will be directly copied from homework problems, except the numerical values will be changed such that the numerical answer is different.*

Final exam (180 points). Will be given on exam week.

How to succeed:

- Attend lecture and recitation
- Do homework problems
- Do extra problems if you think you need them
- ***Being able to do the problems is key***
- Understand the concepts from lecture.

Lectures

- Will follow the book closely
- Example problems will be a key part.

Topics to be covered

First 9 chapters, Chapter 24 and 25

- Chap 1 matter and measurement
- Chap 2, Atoms, molecules and Ions
- Chap 3 Stoichiometry, The Mole!
- Chap 4, reactions in water and solution stoichiometry
- Chap 5, Thermochemistry
- Chap 6, Electronic structure, atoms
- Chap 7, The periodic table
- Chap 8, Chemical bonding
- Chap 9, Molecular geometry
- Chap 24, Coordination chemistry
- Chap 25, Organic and biological chemistry



Chapter 1

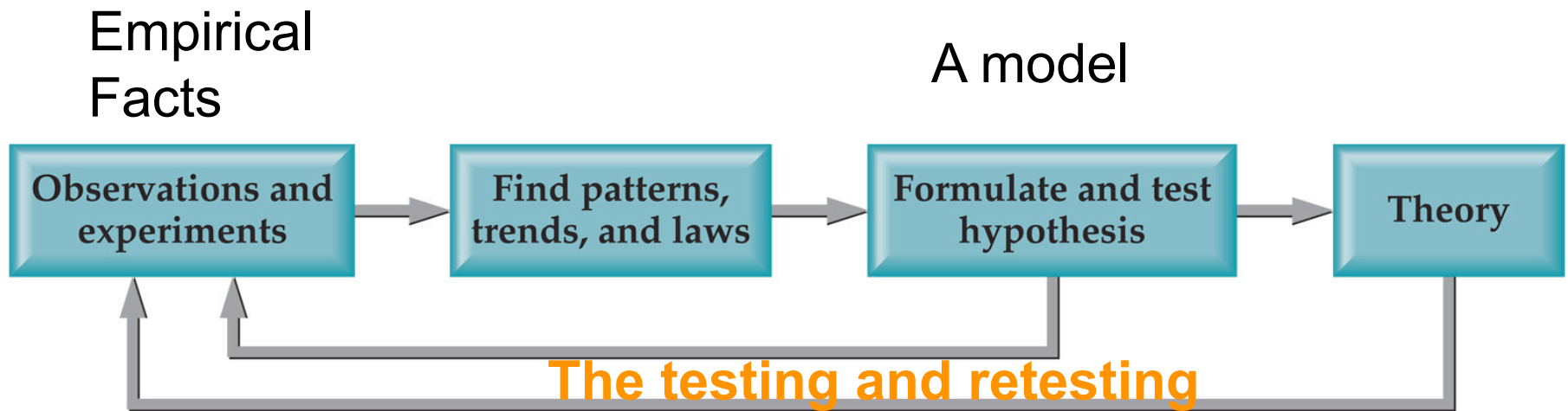
Introduction:

Matter and Measurement



Scientific Method:

A systematic approach to solving problems.



THIS IS WHAT MAKES IT SCIENCE!

Facts and theories

*Fact: on June 30, 1908 in Tunguska, Siberia, an explosion equivalent to about 15 million tons of TNT occurred.

* **Hypothesis** is that a comet or meteor collided with the Earth.



http://en.wikipedia.org/wiki/Tunguska_event

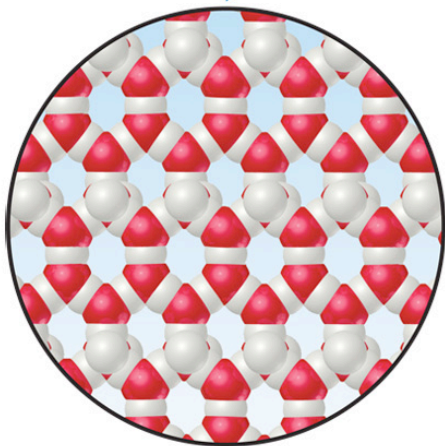
Testing: look for elements and substances characteristic of extraterrestrial objects, elements not found in the area. Such elements (Nickel, Iridium) were found.

However, there is no crater.

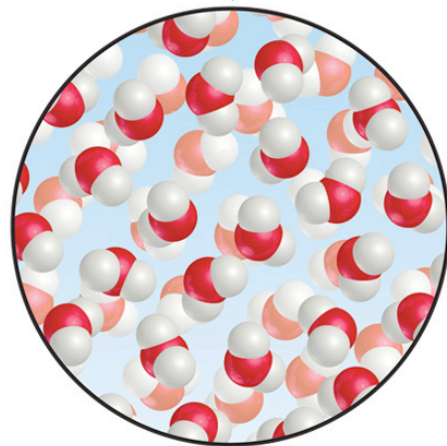
Theory: Meteor exploded above the ground.

Chemistry:

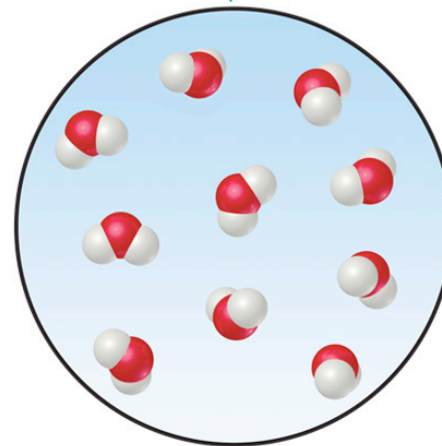
The study of matter and the changes it undergoes.



Solid



Liquid



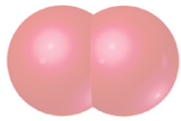
Gas

Matter:

Anything that has mass and takes up space.



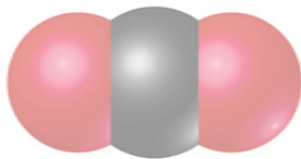
Matter



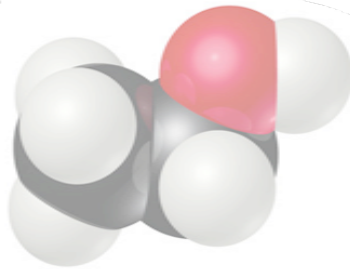
(a) Oxygen



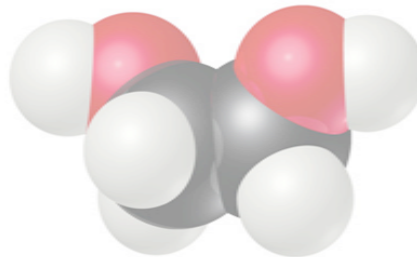
(b) Water



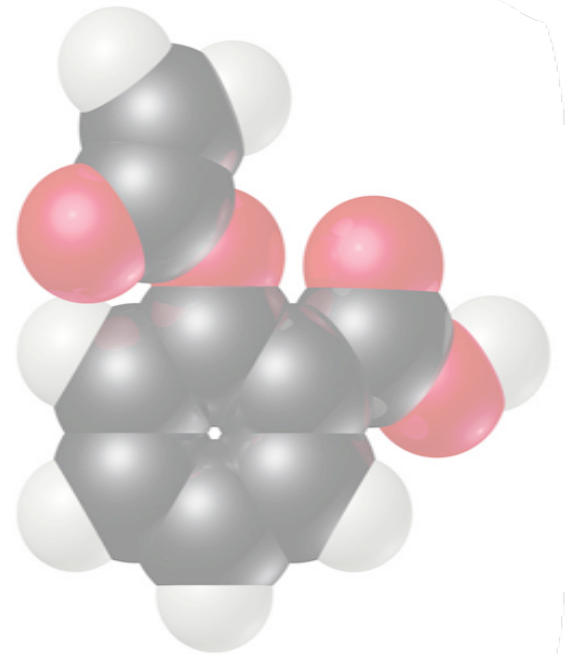
(c) Carbon dioxide



(d) Ethanol



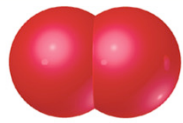
(e) Ethylene glycol



(f) Aspirin

- **Atoms** are the building blocks of matter.

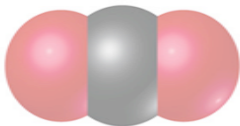
Matter



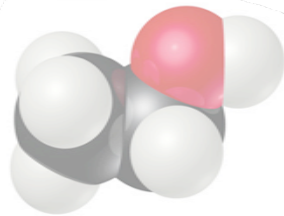
(a) Oxygen



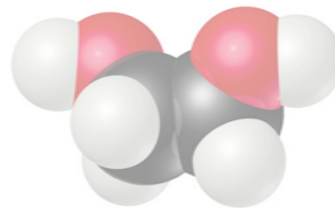
(b) Water



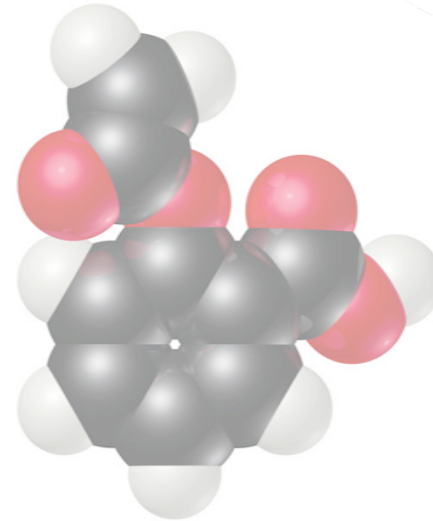
(c) Carbon dioxide



(d) Ethanol



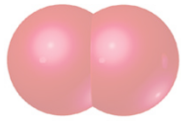
(e) Ethylene glycol



(f) Aspirin

- Each element is made of the same kind of atom.

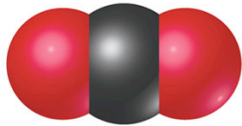
Matter



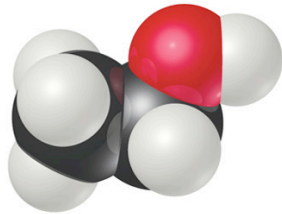
(a) Oxygen



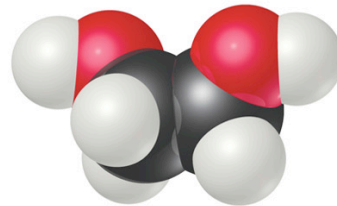
(b) Water



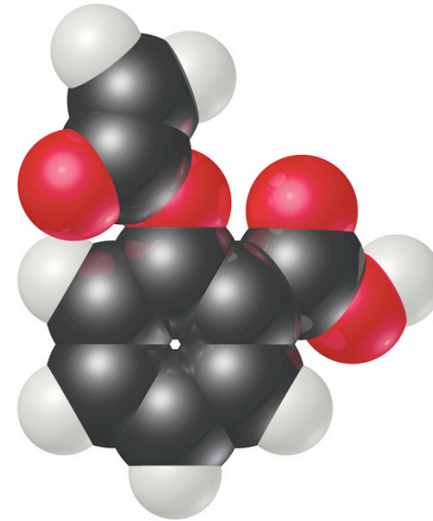
(c) Carbon dioxide



(d) Ethanol



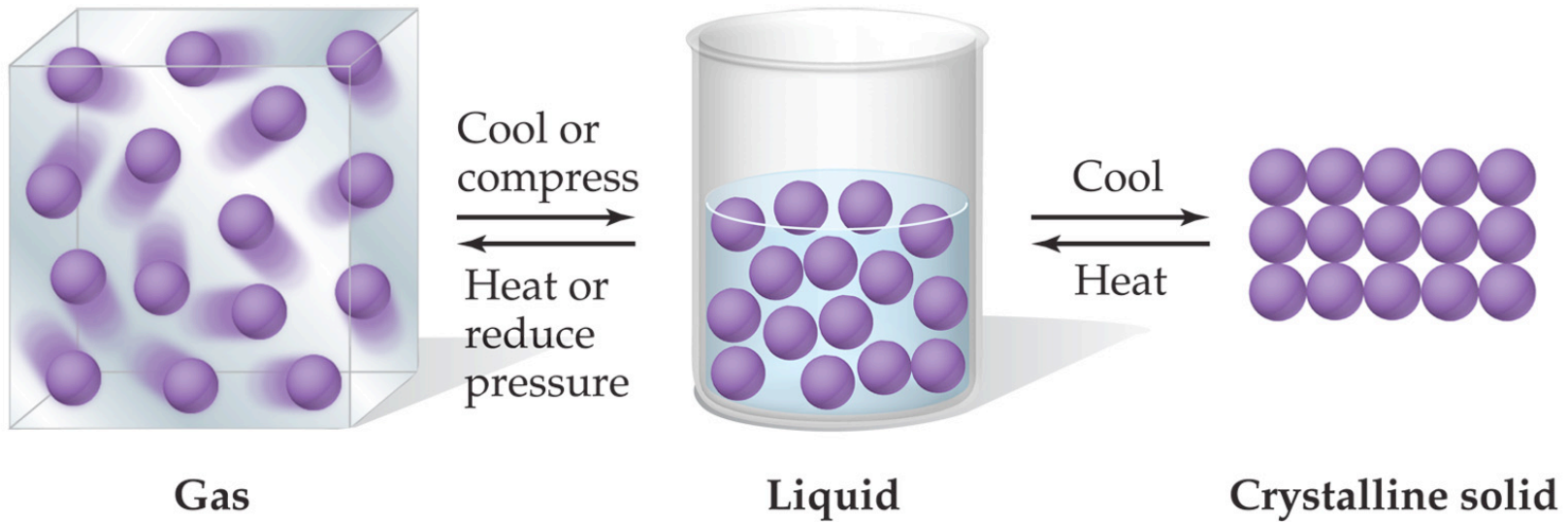
(e) Ethylene glycol



(f) Aspirin

- A **compound** is made of two or more different kinds of elements.

States of Matter

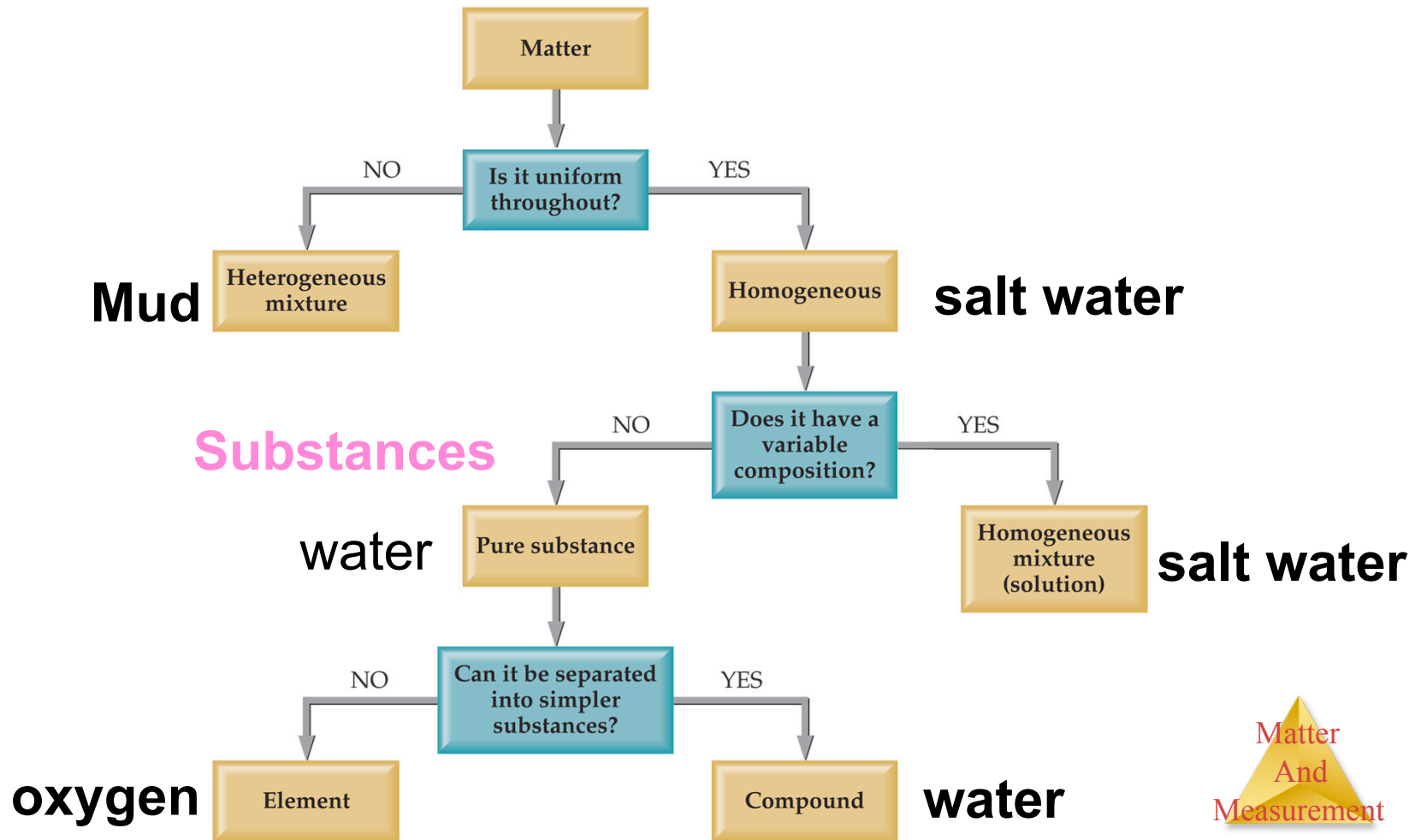


Mastering chemistry hell

- Their on-line help chat. This is supposed to be there 24 hours a day: http://247pearsoned.custhelp.com/app/chat/chat_launch
- [Or you can call them:](#)
- [STUDENT SUPPORTToll free \(800\) 677-6337Mon - Fri Noon - 8:00 pm EST.](#)
- [Either way, they should have no problem taking care of your problem. If this does not work, or they want to charge you money, email me and I'll give them much grief.](#)



Classification of Matter



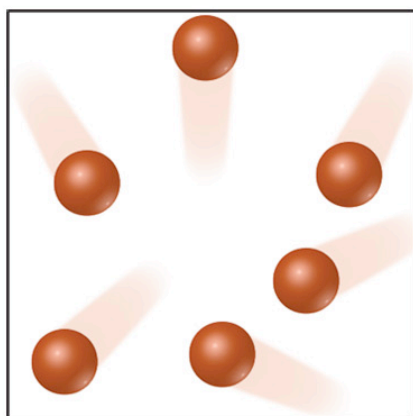
Mixtures and Compounds

Element
(atoms)

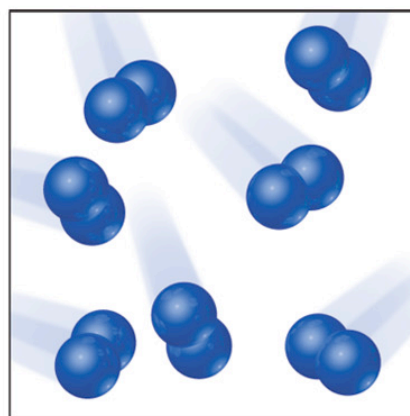
Element
(molecules)

Compound
(molecules)

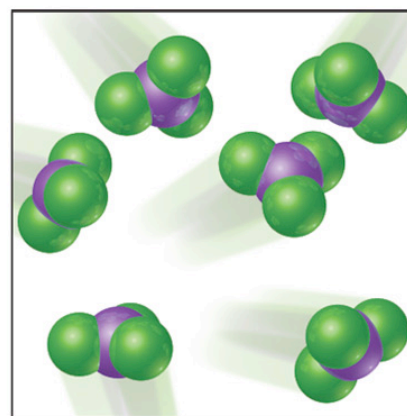
Mixture



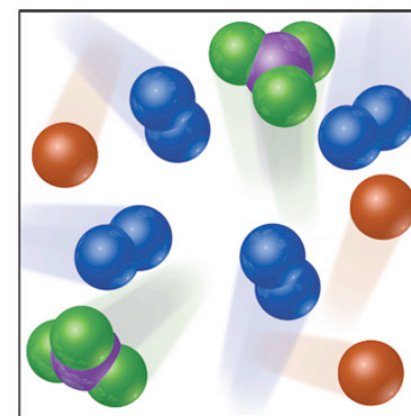
(a) Atoms of an element



(b) Molecules of an element



(c) Molecules of a compound



(d) Mixture of elements and a compound

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He, Ne

N_2 , O_2 , Cl_2

CO_2 , H_2O , NH_3

Mix

Properties and Changes of Matter



Properties of Matter

- Physical Properties:
 - Must be observed without changing a compound/element into another compound/element.
 - **Boiling point, density, mass, volume, etc.**
- Chemical Properties:
 - Can *only* be observed when a compound/element is changed into another compound/element.
 - **Flammability, corrosiveness, reactivity with acid, etc.**

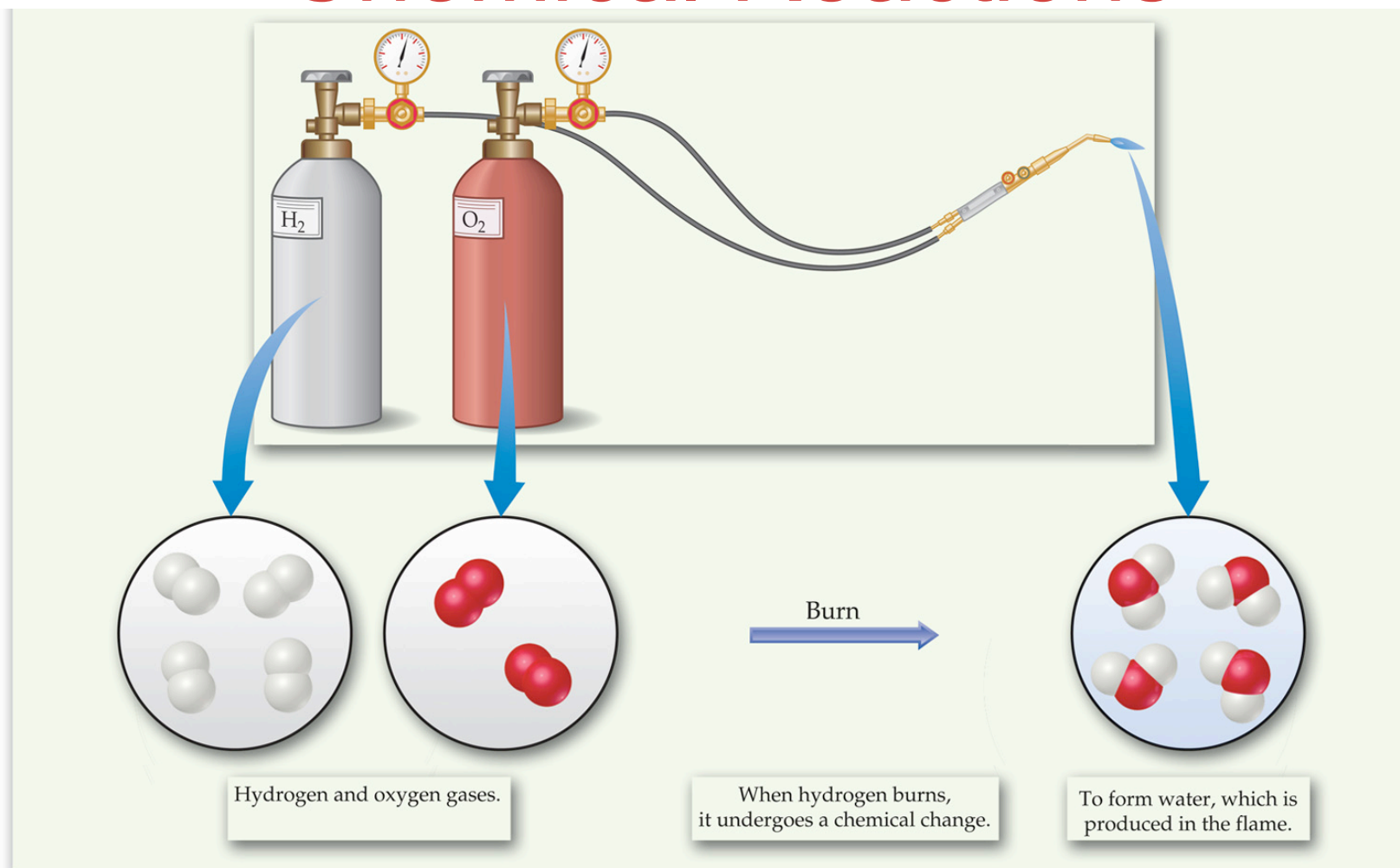
Properties of Matter

- Intensive Properties:
 - Independent of the amount of the matter that is present.
 - **Density, boiling point, color, etc.**
- Extensive Properties:
 - Dependent upon the amount of the matter present.
 - **Mass, volume, energy, etc.**

Changes of Matter

- Physical Changes:
 - Changes in matter that do not change the composition of a substance.
 - **Changes of state, temperature, volume, etc.**
- Chemical Changes:
 - Changes that result in new substances.
 - **Combustion, oxidation, decomposition, etc.**

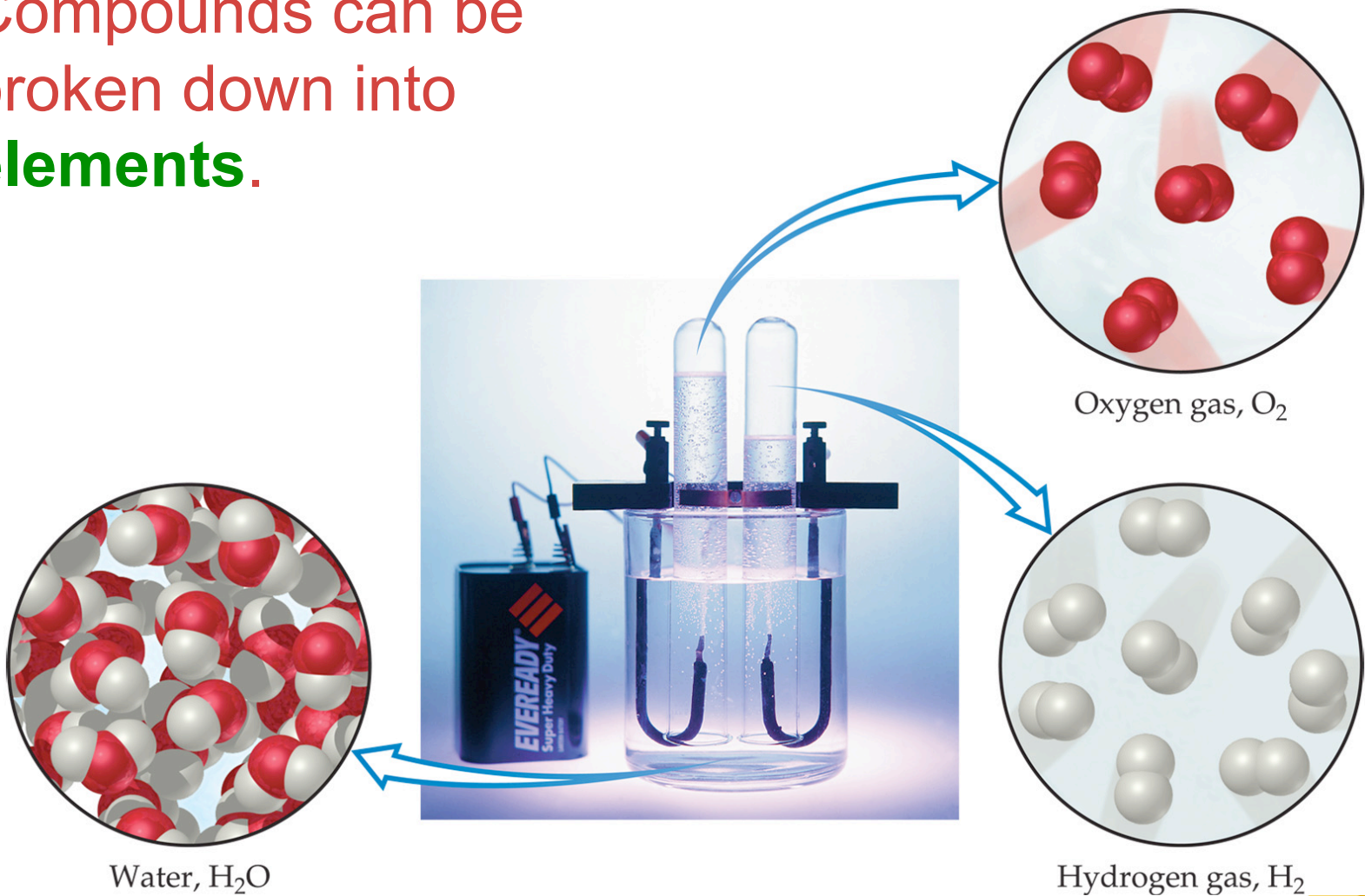
Chemical Reactions



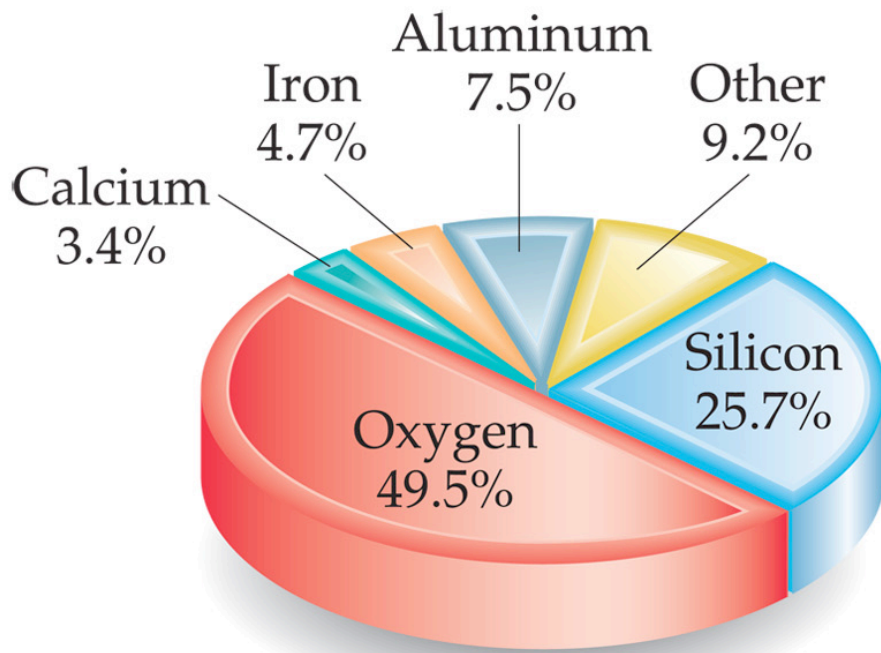
In the course of a chemical reaction, the reacting substances are converted to new substances.

Compounds

Compounds can be broken down into **elements**.

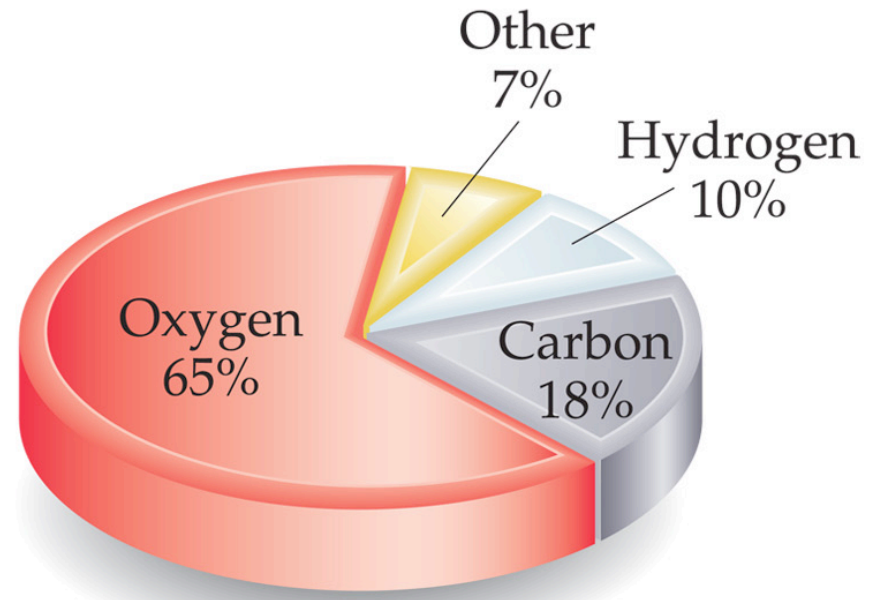


Relative abundance of elements



Earth's crust

(a)



Human body

(b)

TABLE 1.1 The Top Ten Chemicals Produced by the Chemical Industry in 2002^a

Rank	Chemical	Formula	2002 Production (billions of pounds)	Principal End Uses
1	Sulfuric acid	H ₂ SO ₄	81	Fertilizers, chemical manufacturing
2	Nitrogen	N ₂	73	Fertilizers
3	Oxygen	O ₂	53	Steel, welding
4	Ethylene	C ₂ H ₄	52	Plastics, antifreeze
5	Lime	CaO	38	Paper, cement, steel
6	Propylene	C ₃ H ₆	32	Plastics
7	Ammonia	NH ₃	29	Fertilizers
8	Chlorine	Cl ₂	25	Bleaches, plastics, water purification
9	Phosphoric acid	H ₃ PO ₄	24	Fertilizers
10	Sodium hydroxide	NaOH	20	Aluminum production, soap

^aMost data from *Chemical and Engineering News*, July 7, 2003, pp. 53, 56.

Acids

Bases

Pure elements

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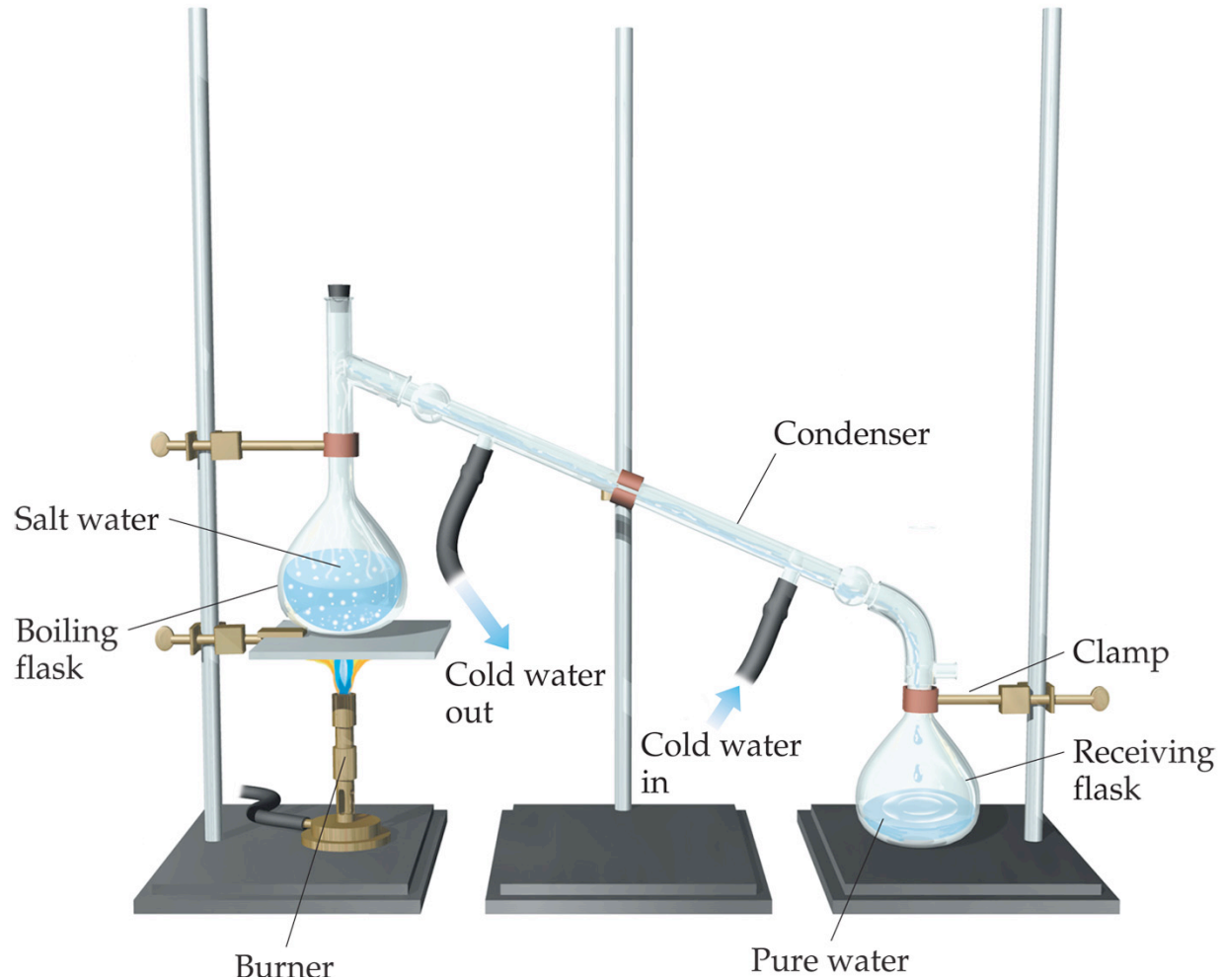
Separation of Mixtures

Filtration:



Separates
heterogeneous
mixture, solid
substances from
liquids and solutions.

Distillation:



Separates homogeneous mixture of liquids on the basis of differences in boiling point.

Chromatography:

Separates homogeneous mixtures on the basis of differences in solubility in a solvent, or in binding to a solid matrix.



Separation techniques were critical to the development of the basic theories of chemistry.

How do we know there are homogeneous mixtures?

We can separate them.

Units of Measurement

SI Units

Learn! symbols and all!

Physical Quantity	Name of Unit	Abbreviation
Mass	Kilogram	kg
Length	Meter	m
Time	Second	s ^a
Temperature	Kelvin	K
Amount of substance	Mole	mol
Electric current	Ampere	A
Luminous intensity	Candela	cd

^aThe abbreviation sec is frequently used.

- *Système International d'Unités*
- Uses a different base unit for each quantity

Metric System

Prefixes convert the base units into units that are appropriate for the item being measured.

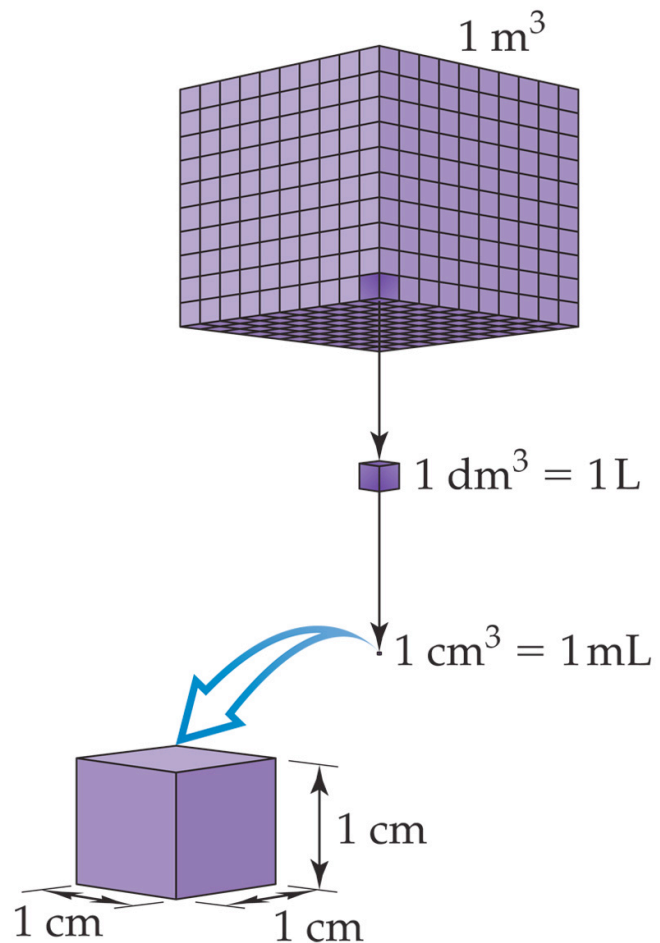
Learn! More important than it looks!!!

Prefix	Abbreviation	Meaning	Example
Giga	G	10^9	1 gigameter (Gm) = 1×10^9 m
Mega	M	10^6	1 megameter (Mm) = 1×10^6 m
Kilo	k	10^3	1 kilometer (km) = 1×10^3 m
Deci	d	10^{-1}	1 decimeter (dm) = 0.1 m
Centi	c	10^{-2}	1 centimeter (cm) = 0.01 m
Milli	m	10^{-3}	1 millimeter (mm) = 0.001 m
Micro	μ^a	10^{-6}	1 micrometer (μm) = 1×10^{-6} m
Nano	n	10^{-9}	1 nanometer (nm) = 1×10^{-9} m
Pico	p	10^{-12}	1 picometer (pm) = 1×10^{-12} m
Femto	f	10^{-15}	1 femtometer (fm) = 1×10^{-15} m

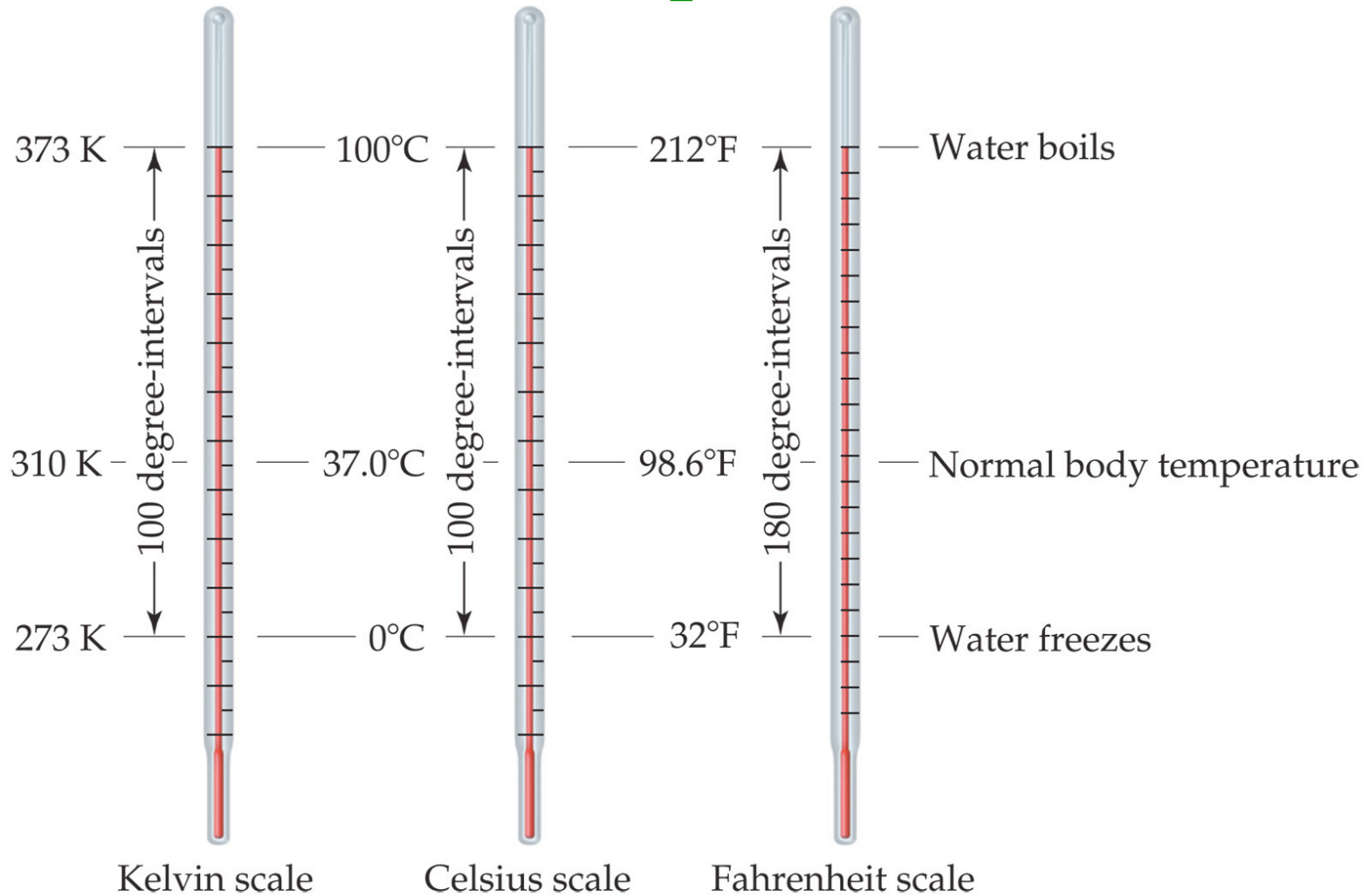
^aThis is the Greek letter mu (pronounced "mew").

Volume

- The most commonly used metric units for volume are the liter (L) and the milliliter (mL).
 - A liter is a cube 1 dm (10 cm) long on each side.
 - A milliliter is a cube 1 cm long on each side.



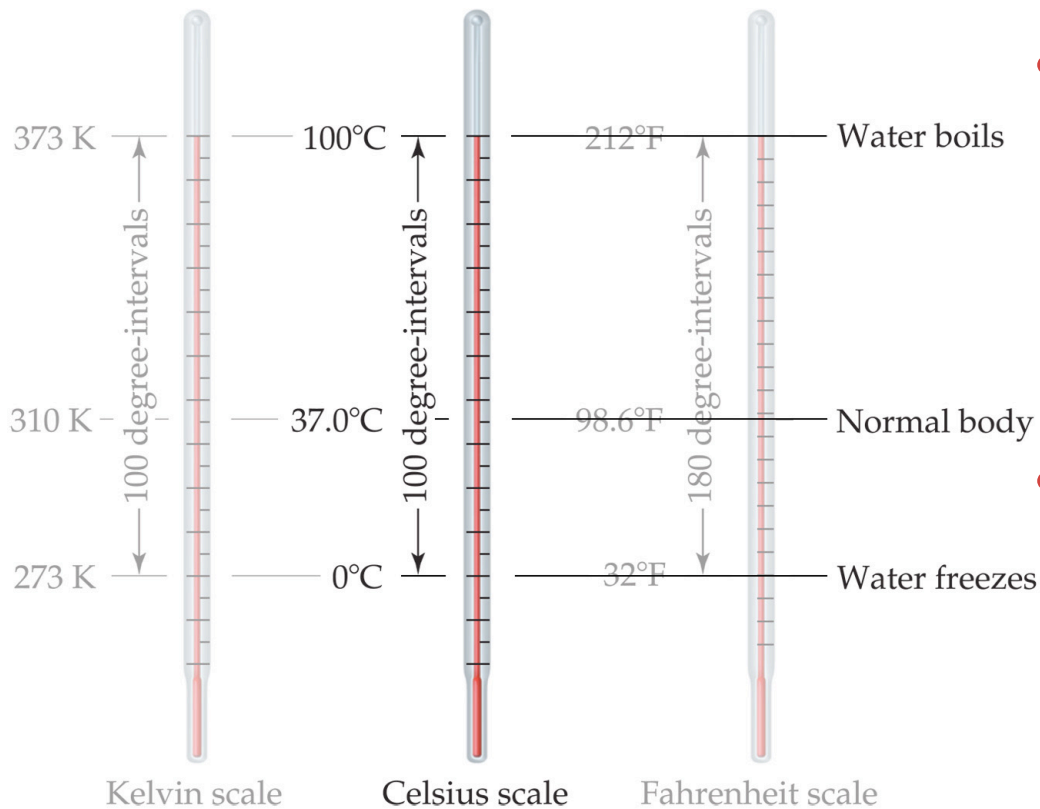
Temperature:



proportional to the average kinetic energy of the particles in a sample.

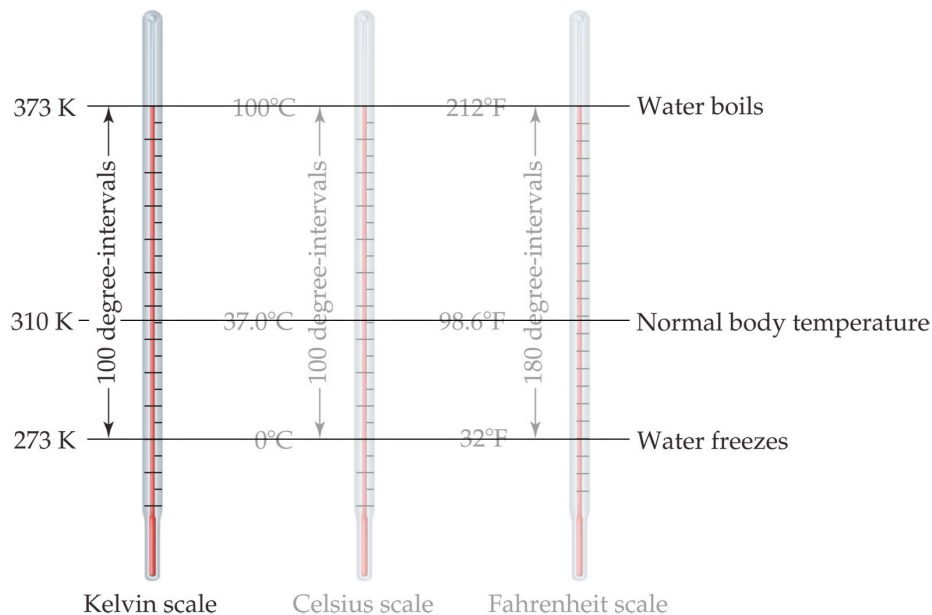
$$K.E. = \frac{1}{2}mv^2$$

Temperature



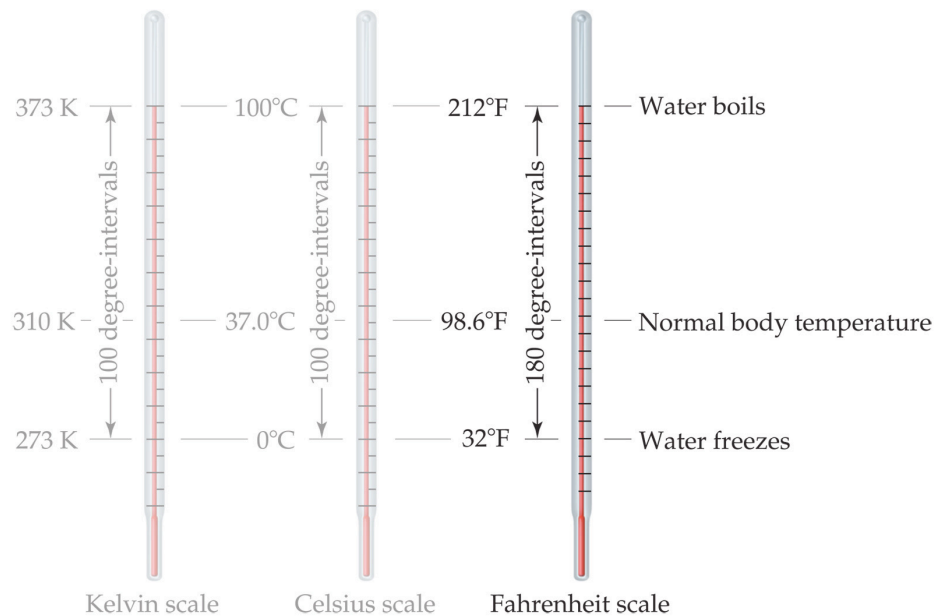
- In scientific measurements, the Celsius and Kelvin scales are most often used.
- The Celsius scale is based on the properties of water.
 - 0°C is the freezing point of water.
 - 100°C is the boiling point of water.

Temperature



- The Kelvin is the SI unit of temperature.
- It is based on the properties of gases.
- **0 K = 0 K.E.**
- There are no negative Kelvin temperatures.
- $K = ^\circ C + 273.15$

Temperature



- The Fahrenheit scale is not used in scientific measurements.
- $^{\circ}\text{F} = 9/5(^{\circ}\text{C}) + 32$
- $^{\circ}\text{C} = 5/9(^{\circ}\text{F}) - 32$

Density:

Physical property of a substance
Intensive.

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

Density of selected substances

TABLE 1.6 Densities of Some Selected Substances at 25°C

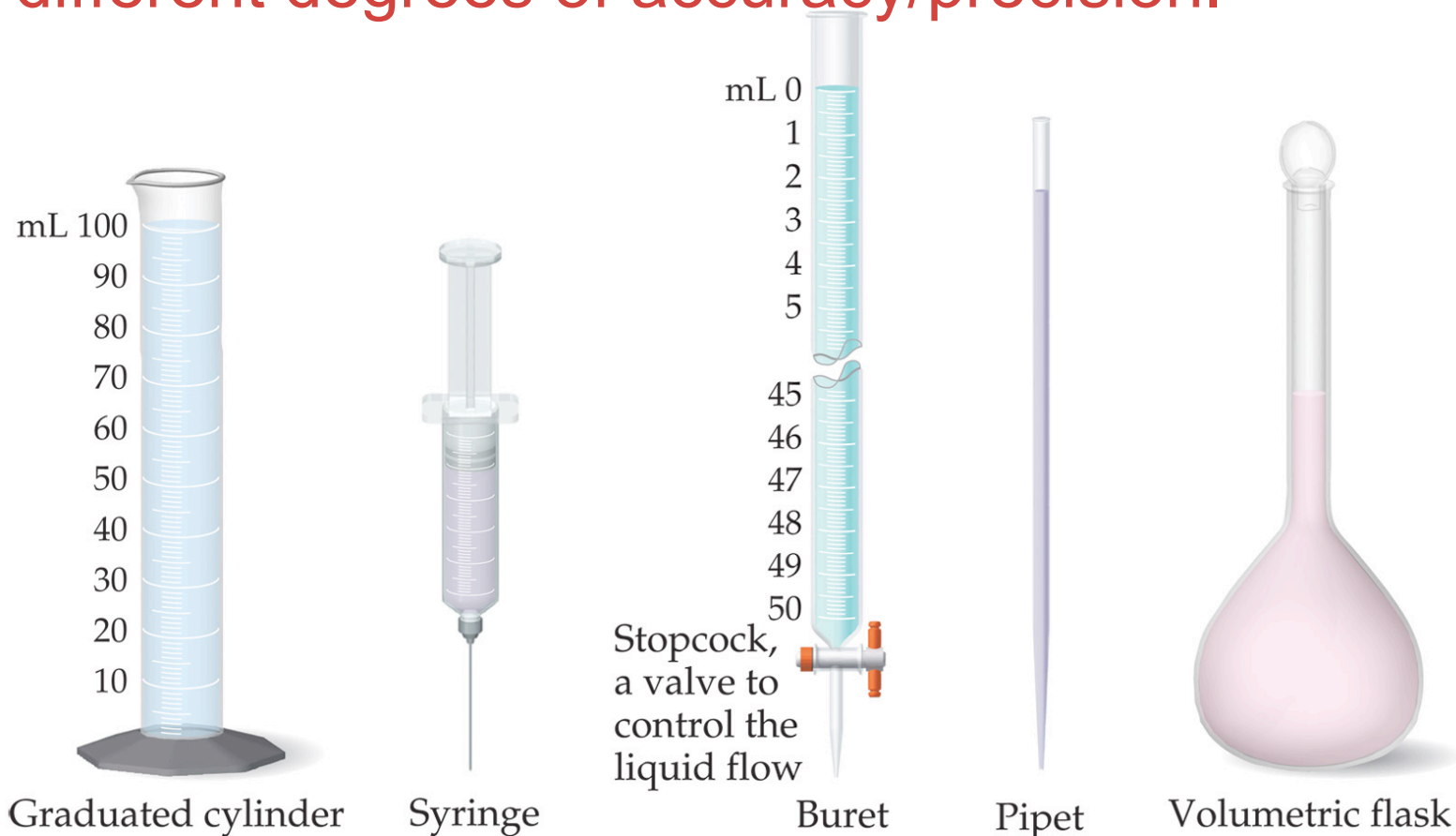
Substance	Density (g/cm ³)
Air	0.001
Balsa wood	0.16
Ethanol	0.79
Water	1.00
Ethylene glycol	1.09
Table sugar	1.59
Table salt	2.16
Iron	7.9
Gold	19.32

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Uncertainty in Measurement

Uncertainty in Measurements

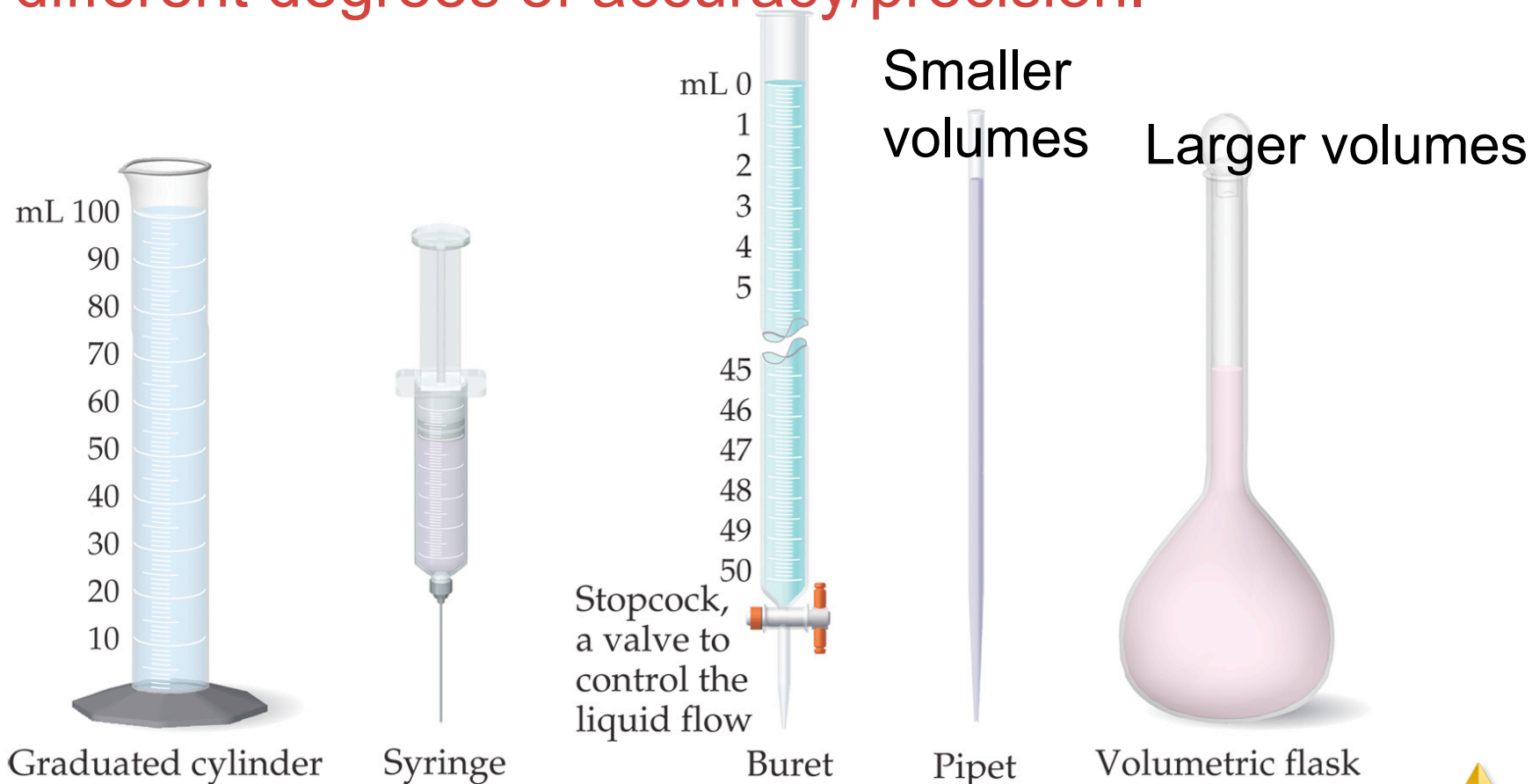
Different measuring devices have different uses and different degrees of accuracy/precision.



Which are more accurate?

Uncertainty in Measurements

Different measuring devices have different uses and different degrees of accuracy/precision.



It depends on amount

Exact versus inexact numbers

Exact

1000 g/kg

2.54 cm/in

12/dozen

any conversion

factor

Inexact

ruler measure

Temp. reading

volume or mass

etc.

Significant Figures

- The term **significant figures** refers to digits *that were measured*.
- When rounding calculated numbers, we pay attention to significant figures so we do not overstate the precision of our answers.

Significant Figures

1. All nonzero digits are significant. (sig figs in **red**)

423.444

2. Zeroes between two significant figures are themselves significant.

42,300045 42,340.0025

3. Zeroes at the beginning of a number are never significant.

00042345.0 0.00048

4. Zeroes at the end of a number are significant if a decimal point is written in the number.

423,000 versus: 423,000. or: 423,000.000

Significant Figures

- When addition or subtraction is performed, answers are rounded to the least significant decimal place.

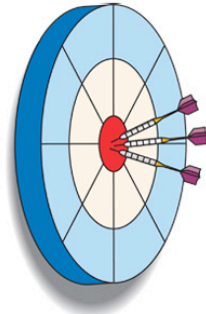
$$\begin{array}{r} 24.245 \\ +22.33488 \\ \hline 46.57988 = 46.580 \end{array}$$

- When multiplication or division is performed, answers are rounded to the number of digits that corresponds to the *least* number of significant figures in any of the numbers used in the calculation.

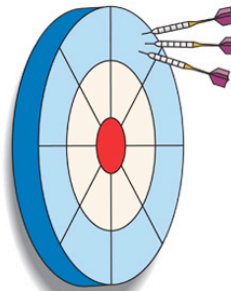
$$\begin{array}{r} 35.8750 \quad (6 \text{ sig figs}) \\ \times 40.006800 \quad (8 \text{ sig figs}) \\ \hline 1435.24395 = 1435.24 \quad (6 \text{ sig figs}) \end{array}$$

Accuracy versus Precision

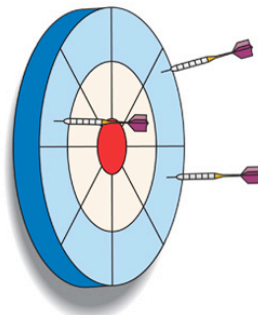
- **Accuracy** How close a measurement is to the true value. (How right you are)
- **Precision** How close measurements are to each other. (Reproducibility). Precise but incorrect data are often the result of systematic errors.



Good accuracy
Good precision



Poor accuracy
Good precision



Poor accuracy
Poor precision

Dimensional analysis

What do virtually all problems in chemistry have in common?

Dimensional analysis

Convert centimeters to feet: 1 cm = ? feet

Know: 2.54 cm = 1 in, 12 in = 1 foot.

$$\frac{1 \text{ in}}{2.54 \text{ cm}} \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 0.032 \frac{\text{ft}}{\text{cm}}$$

Dimensional Analysis

- What do I need on top?
- What do I need on the bottom?
- What do I know?
- How do I get there?
- Note: You will always be given the conversion factors you need, you don't have to memorize them.

Dimensional analysis, examples

The speed of light is 2.998×10^{10} cm/s. What is it in km/hr?

Know: 1 km = 1000m, 1m = 100cm 60 min = 1 hr, 60 sec = 1 min

What do I need on top? *kilometers*

What do I need on the bottom? *hours*

$$2.998 \times 10^{10} \frac{\cancel{cm}}{\cancel{s}} \left(\frac{1\cancel{m}}{100\cancel{cm}} \right) \left(\frac{1km}{1000\cancel{m}} \right) \left(\frac{60\cancel{sec}}{1\cancel{min}} \right) \left(\frac{60\cancel{min}}{1hr} \right) = 1.0892 \times 10^9 km/hr$$

Dimensional analysis, examples

The Vehicle Assembly Building (VAB) at the Kennedy Space Center has a volume of: $3,666,500\text{m}^3$. What is it in liters?

Know: $1\text{ L} = 1\text{ dm}^3$, $1\text{ dm} = 0.1\text{ m}$

What do I need on top? *Liters*

What do I need on the bottom? *nothing*

$$3,666,500\cancel{\text{m}^3} = \left(\frac{\cancel{\text{dm}}}{0.1\cancel{\text{m}}}\right)^3 \left(\frac{1\text{L}}{1\cancel{\text{dm}}^3}\right) = 3.6665 \times 10^9 \text{ L}$$

Dimensional analysis, examples

An individual suffering from high cholesterol has 232 mg cholesterol per 100.0 mL of blood. How many grams of cholesterol in the blood, assuming a blood volume of 5.2 L?

Know: 1 L = 1000 mL, 1g = 1000mg

What do I need on top? *grams*

What do I need on the bottom? *patient*

$$232 \frac{\cancel{\text{mg}}}{\cancel{100.0\text{mL}}} \left(\frac{\cancel{1000\text{mL}}}{\cancel{1\text{L}}} \right) \left(\frac{5.2\text{Lblood}}{\text{patient}} \right) \left(\frac{1\text{g}}{\cancel{1000\text{mg}}} \right) = 12. \frac{\text{g}}{\text{patient}}$$