Chem 103, Section F0F
Unit I - An Overview of Chemistry
Lecture 2

- Strategies for solving chemical problems
- Taking measurements
- Expressing uncertainties in measurements

Lecture 2 - Strategies for Problem Solving

Measured Quantities

- Measured quantities in chemistry most often have two components
  - A number
  - A unit
- Both of these are important in any calculation

Lecture 2 - Strategies for Problem Solving

All calculations are essentially done twice

- Once to solve for the unit
- Once to solve for the number

Examples:

Lecture 2 - Strategies for Problem Solving

Conversion Factors

- Conversion factors are used in calculations to convert from one type of unit to another.

Lecture 2 - Clicker Question 1

Mary was 13 minutes late for class today. How many **hours** was she late for class?

A) 0.25 hr
B) 0.090 days
C) 0.22 hr
D) 780 s
E) 0.0090 days

Lecture 2 - Strategies for Problem Solving

Conversion Factors

- Conversion factors are used in calculations to convert from one type of unit to another.

To → From $\left(\frac{\text{To}}{\text{From}}\right)$ *conversion factor*

Lecture 2 - Strategies for Problem Solving

Conversion Factors

- Conversion factors can strung together in longer calculations.

Lecture 2 - Clicker Question 2

Mary was 13 minutes late for class today. How many days was she late for class?

A) 0.25 hr
B) 0.090 days
C) 0.22 hrLecture 2
D) 780 s
E) 0.0090 days

Lecture 2 - Strategies for Problem Solving

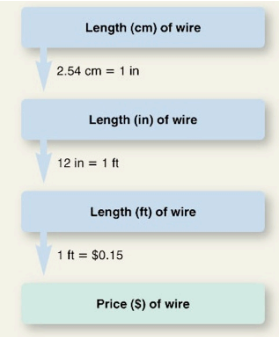
Problems should be solved systematically

- Problem
- Plan
- Solution
- Check
- Comment
- Follow-up Problem (Answers in back of chapter.)

SAMPLE PROBLEM 1.3 Converting Units of Length

PROBLEM To wire your stereo equipment, you need 325 centimeters (cm) of speaker wire that sells for $0.15/ft. What is the price of the wire?

PLAN We know the length of wire in centimeters and the cost in dollars per foot ($/ft). We can find the unknown price of the wire by converting the length from centimeters to inches (in) and from inches to feet. Then the cost (1 ft = $0.15) gives us the equivalent quantities to construct the factor that converts feet of wire to price in dollars. The roadmap starts with the known and moves through the calculation steps to the unknown.



SOLUTION Converting the known length from centimeters to inches: The equivalent quantities alongside the roadmap arrow are the ones needed to construct the conversion factor. We choose 1 in/2.54 cm, rather than the inverse, because it gives an answer in inches:

$$\text{Length (in)} = \text{length (cm)} \times \text{conversion factor} = 325 \text{ cm} \times \frac{1 \text{ in}}{2.54 \text{ cm}} = 128 \text{ in}$$

Converting the length from inches to feet:

$$\text{Length (ft)} = \text{length (in)} \times \text{conversion factor} = 128 \text{ in} \times \frac{1 \text{ ft}}{12 \text{ in}} = 10.7 \text{ ft}$$

Converting the length in feet to price in dollars:

$$\text{Price (\$)} = \text{length (ft)} \times \text{conversion factor} = 10.7 \text{ ft} \times \frac{\$0.15}{1 \text{ ft}} = \$1.60$$

CHECK The units are correct for each step. The conversion factors make sense in terms of the relative unit sizes: the number of inches is *smaller* than the number of centimeters (an inch is *larger* than a centimeter), and the number of feet is *smaller* than the number of inches. The total price seems reasonable: a little more than 10 ft of wire at \$0.15/ft should cost a little more than \$1.50.

COMMENT **1.** We could also have strung the three steps together:

$$\text{Price (\$)} = 325 \text{ cm} \times \frac{1 \text{ in}}{2.54 \text{ cm}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{\$0.15}{1 \text{ ft}} = \$1.60$$

2. There are usually alternative sequences in unit-conversion problems. Here, for example, we would get the same answer if we first converted the cost of wire from \$/ft to \$/cm and kept the wire length in cm. Try it yourself.

FOLLOW-UP PROBLEM 1.3 A furniture factory needs 31.5 ft^2 of fabric to upholster one chair. Its Dutch supplier sends the fabric in bolts of exactly 200 m^2. What is the maximum number of chairs that can be upholstered by 3 bolts of fabric (1 m = 3.281 ft)?

Lecture 2 - Measurements

We will be using the SI system of units:

- There are 7 fundamental units in this system:

Table 1.2 SI Base Units

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

Lecture 2 - Measurements

We will be using the SI system of units:

- Metric units are typically scale by factors of 1,000.

Table 1.3 Common Decimal Prefixes Used with SI Units

Prefix*	Prefix Symbol	Word	Conventional Notation	Exponential Notation
tera	T	trillion	1,000,000,000,000	1×10^{12}
giga	G	billion	1,000,000,000	1×10^{9}
mega	M	million	1,000,000	1×10^{6}
kilo	k	thousand	1,000	1×10^{3}
hecto	h	hundred	100	1×10^{2}
deka	da	ten	10	1×10^{1}
—	—	one	1	1×10^{0}
deci	d	tenth	0.1	1×10^{-1}
centi	c	hundredth	0.01	1×10^{-2}
milli	m	thousandth	0.001	1×10^{-3}
micro	μ	millionth	0.000001	1×10^{-6}
nano	n	billionth	0.000000001	1×10^{-9}
pico	p	trillionth	0.000000000001	1×10^{-12}
femto	f	quadrillionth	0.000000000000001	1×10^{-15}

*The prefixes most frequently used by chemists appear in bold type.

Lecture 2 - Measurements

We will be using the SI system of units:

- Conversions from English units

Table 1.4 Common SI-English Equivalent Quantities

Quantity	SI	SI Equivalents	English Equivalents	English to SI Equivalent
Length	1 kilometer (km)	1000 (10^3) meters	0.6214 mile (mi)	1 mile = 1.609 km
	1 meter (m)	100 (10^2) centimeters	1.094 yards (yd)	1 yard = 0.9144 m
		1000 millimeters (mm)	39.37 inches (in)	1 foot (ft) = 0.3048 m
	1 centimeter (cm)	0.01 (10^{-2}) meter	0.3937 inch	1 inch = 2.54 cm (exactly)
Volume	1 cubic meter (m^3)	1,000,000 (10^6) cubic centimeters	35.31 cubic feet (ft^3)	1 cubic foot = 0.02832 m^3
	1 cubic decimeter (dm^3)	1000 cubic centimeters	0.2642 gallon (gal)	1 gallon = 3.785 dm^3
			1.057 quarts (qt)	1 quart = 0.9464 dm^3
				1 quart = 946.4 cm^3
	1 cubic centimeter (cm^3)	0.001 dm^3	0.03381 fluid ounce	1 fluid ounce = 29.57 cm^3
Mass	1 kilogram (kg)	1000 grams	2.205 pounds (lb)	1 pound = 0.4536 kg
	1 gram (g)	1000 milligrams (mg)	0.03527 ounce (oz)	1 ounce = 28.35 g

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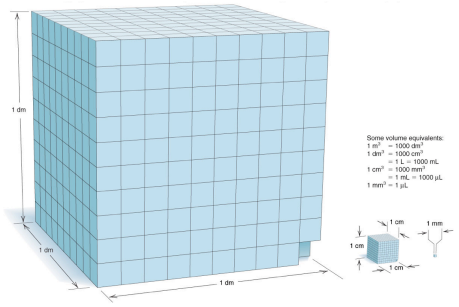
Lecture 2 - Measurements

Some units are derived from the fundamental units.

- Example, the liter



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Lecture 2 - Measurements

Some measurements or properties are *intensive* while others are *extensive*.

Intensive property

- *One that is independent of the amount of substance present*

Extensive property

- *One that is dependent on the amount of substance present*

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Lecture 2 - Clicker Question 3

Is the following property an intensive or extensive property?

Mass?

A) Intensive
B) Extensive

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Lecture 2 - Clicker Question 4

Is the following property an *intensive* or *extensive* property?

Density?

A) Intensive
B) Extensive

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Lecture 2 - Clicker Question 5

Is the following property an *intensive* or *extensive* property?

Volume?

A) Intensive
B) Extensive

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Lecture 2 - Clicker Question 6

Is the following property an *intensive* or *extensive* property?

Melting point?

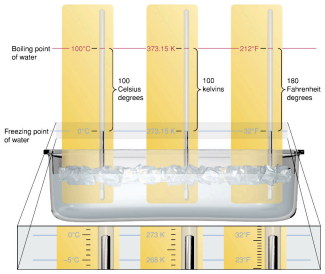
A) Intensive

B) Extensive

Lecture 2 - Measurements

Temperature:

- The Celsius (°C) and Fahrenheit (°F) scales are the ones commonly used.
- We will also be using the Kelvin (K) scale.
  - Used when discussing thermal energy.



Lecture 2 - Uncertainty

When communicating quantities to other, we need to also communicate our confidence in those quantities

- Example

$$3.12 \pm 0.05 \text{ g}$$

Lecture 2 - Uncertainty

Significant digits

- Express all digits that your are certain about, plus the first digit that you have some uncertainty about.

Lecture 2 - Uncertainty

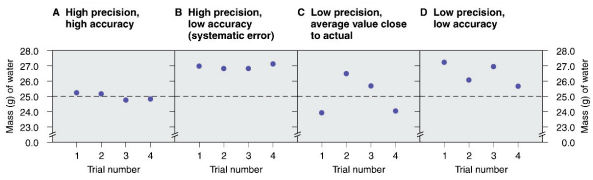
Significant digits in calculations

- Addition and subtraction
  - Look a decimal places
- Multiplication and division
  - Look at significant figures

Round off at the end of your calculations

Lecture 2 - Uncertainty

Precision *vs* Accuracy



Unit I - Up Next

- The chemist's view of matter: atoms, elements, compounds & mixtures.
- Some observations that led to the atomic view of matter
- Dalton's postulates for the atomic view of matter

The End