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 \rightarrow \text{From}
\begin{array}{c}
\frac{\text{To}}{
\text{From}}
\end{array}
conversion factor
Lecture 2 - Strategies for Problem Solving

Conversion Factors
- Conversion factors can be 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 hr  
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 ($/ft). We can find the unknown price of the wire by converting the length from centimeters to inches (in) and from inches to feet. Then the cost ($/ft) 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.
Lecture 2 - Measurements

We will be using the SI system of units:
• There are 7 fundamental units in this system:

<table>
<thead>
<tr>
<th>Physical Quantity (Dimension)</th>
<th>Unit Name</th>
<th>Unit Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>kilogram</td>
<td>kg</td>
</tr>
<tr>
<td>Length</td>
<td>meter</td>
<td>m</td>
</tr>
<tr>
<td>Time</td>
<td>second</td>
<td>s</td>
</tr>
<tr>
<td>Temperature</td>
<td>kelvin</td>
<td>K</td>
</tr>
<tr>
<td>Electric current</td>
<td>ampere</td>
<td>A</td>
</tr>
<tr>
<td>Amount of substance</td>
<td>mole</td>
<td>mol</td>
</tr>
<tr>
<td>Luminous intensity</td>
<td>candela</td>
<td>cd</td>
</tr>
</tbody>
</table>

Table 1.2 SI Base Units

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.

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:

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

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-converted problems. Here, for example, we would get the same answer if we first converted the cost of wire from $0/ft to $/cm and kept the wire length in cm. Try it yourself.

FOLLOW-UP PROBLEM 1.3 A furniture factory needs 31.5 ft² of fabric to upholster one chair. Its Dutch supplier sells the fabric in bolts of exactly 200 m². What is the maximum number of chairs that can be upholstered by 3 bolts of fabric (1 m² = 3.281 ft²)?

<table>
<thead>
<tr>
<th>Prefix*</th>
<th>Prefix Symbol</th>
<th>Word</th>
<th>Conventional Notation</th>
<th>Exponential Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>tera</td>
<td>T</td>
<td>trillion</td>
<td>1,000,000,000,000</td>
<td>$1 \times 10^{12}$</td>
</tr>
<tr>
<td>peta</td>
<td>P</td>
<td>petillion</td>
<td>1,000,000,000,000,000</td>
<td>$1 \times 10^{15}$</td>
</tr>
<tr>
<td>exa</td>
<td>E</td>
<td>exillion</td>
<td>1,000,000,000,000,000</td>
<td>$1 \times 10^{18}$</td>
</tr>
<tr>
<td>zetta</td>
<td>Z</td>
<td>zetillion</td>
<td>1,000,000,000,000,000</td>
<td>$1 \times 10^{21}$</td>
</tr>
<tr>
<td>yotta</td>
<td>Y</td>
<td>yottillion</td>
<td>1,000,000,000,000,000</td>
<td>$1 \times 10^{24}$</td>
</tr>
<tr>
<td>giga</td>
<td>G</td>
<td>billion</td>
<td>1,000,000,000</td>
<td>$1 \times 10^{9}$</td>
</tr>
<tr>
<td>mega</td>
<td>M</td>
<td>million</td>
<td>1,000,000</td>
<td>$1 \times 10^{6}$</td>
</tr>
<tr>
<td>kilo</td>
<td>k</td>
<td>thousand</td>
<td>1,000</td>
<td>$1 \times 10^{3}$</td>
</tr>
<tr>
<td>hecto</td>
<td>h</td>
<td>hundred</td>
<td>100</td>
<td>$1 \times 10^{2}$</td>
</tr>
<tr>
<td>deka</td>
<td>da</td>
<td>ten</td>
<td>10</td>
<td>$1 \times 10^{1}$</td>
</tr>
<tr>
<td>deci</td>
<td>d</td>
<td>tenth</td>
<td>0.1</td>
<td>$1 \times 10^{-1}$</td>
</tr>
<tr>
<td>centi</td>
<td>c</td>
<td>hundredth</td>
<td>0.01</td>
<td>$1 \times 10^{-2}$</td>
</tr>
<tr>
<td>milli</td>
<td>m</td>
<td>thousandth</td>
<td>0.0001</td>
<td>$1 \times 10^{-3}$</td>
</tr>
<tr>
<td>micro</td>
<td>µ</td>
<td>millionth</td>
<td>0.000001</td>
<td>$1 \times 10^{-6}$</td>
</tr>
<tr>
<td>nano</td>
<td>n</td>
<td>billionth</td>
<td>0.00000001</td>
<td>$1 \times 10^{-9}$</td>
</tr>
<tr>
<td>pico</td>
<td>p</td>
<td>trillionth</td>
<td>0.0000000001</td>
<td>$1 \times 10^{-12}$</td>
</tr>
<tr>
<td>femto</td>
<td>f</td>
<td>quadrillionth</td>
<td>0.000000000001</td>
<td>$1 \times 10^{-15}$</td>
</tr>
</tbody>
</table>

* 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>
<thead>
<tr>
<th>Quantity</th>
<th>SI</th>
<th>SI Equivalents</th>
<th>English Equivalents</th>
<th>English to SI Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>1 kilometer (km)</td>
<td>1,000,000 meters</td>
<td>0.0006 miles (mi)</td>
<td>1 mile = 1.6093 km</td>
</tr>
<tr>
<td></td>
<td>1 meter (m)</td>
<td>100 centimeters</td>
<td>3.28 feet (ft)</td>
<td>1 foot = 0.3048 m</td>
</tr>
<tr>
<td></td>
<td>1 centimeter (cm)</td>
<td>10 millimeters</td>
<td>0.39 inch (in)</td>
<td>1 inch = 2.54 cm</td>
</tr>
<tr>
<td>Volume</td>
<td>1 cubic meter (m³)</td>
<td>1,000,000,000 cubic centimeters</td>
<td>35.31 cubic feet (ft³)</td>
<td>1 cubic foot = 0.0283 m³</td>
</tr>
<tr>
<td></td>
<td>1 cubic decimeter (dm³)</td>
<td>100 cubic centimeters</td>
<td>0.2642 gallons (gal)</td>
<td>1 gallon = 3.7854 L</td>
</tr>
<tr>
<td></td>
<td>1 cubic centimeter (cm³)</td>
<td>0.001 dm³</td>
<td>0.00028 pounds (lbf)</td>
<td>1 pound = 0.4444 L</td>
</tr>
<tr>
<td></td>
<td>1 liter (L)</td>
<td>1 cubic decimeter (dm³)</td>
<td>1.057 quarts (qt)</td>
<td>1 quart = 0.9464 L</td>
</tr>
<tr>
<td></td>
<td>1 gram (g)</td>
<td>0.001 kg</td>
<td>0.03531 fluid ounce</td>
<td>1 fluid ounce = 29.57 mL</td>
</tr>
</tbody>
</table>

Some units are derived from the fundamental units.
• Example, the liter

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

Lecture 2 - Clicker Question 3
Is the following property an intensive or extensive property?
Mass?
A) Intensive
B) Extensive

Lecture 2 - Clicker Question 4
Is the following property an intensive or extensive property?
Density?
A) Intensive
B) Extensive

Lecture 2 - Clicker Question 5
Is the following property an intensive or extensive property?
Volume?
A) Intensive
B) Extensive
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

  \[3.12 \pm 0.05 \text{ g}\]

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

Significant digits

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

Lecture 2 - Uncertainty

**Precision vs Accuracy**

- A: High precision, high accuracy (no systematic error)
- B: High precision, low accuracy (systematic error)
- C: Low precision, average value close to actual
- D: Low precision, low 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