

Chemistry 221 - Lecture 3 – 9/30

Possible Haiku

Other Student Results

Results from the ping pong problem

Coke vs Diet Coke:

Review Metric Units

Metric system basis for SI units or
Système International d'Unités

SI base units:

length: meter (m)

mass: kilogram (kg)

temperature: kelvin (K)

chemical amount: mole (mol)

Indicate orders of magnitude - prefixes

Table 2.2 Common SI prefixes

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

You should memorize these.

How to do it

Techniques for unit conversion:
dimensional analysis

Convert 25 feet to meters

1 ft = 0.305 m \rightarrow conversion factor

Equivalent to: 0.305 m/ft or 1 ft / 0.305 m
(25 ft)(0.305 m/ft) = 7.63 m

Practice

The diameter of a silicon atom is

2.3×10^{-8} cm. What is this distance in nanometers?

Using unit conversions:

1 cm = 1×10^{-2} m 1 nm = 1×10^{-9} m

$(2.3 \times 10^{-8} \text{ cm})(1 \times 10^{-2} \text{ m / 1cm})(1 \text{ nm} / 1 \times 10^{-9} \text{ m})$
= 0.23 nm

Or: $(2.3 \times 10^{-8} \text{ cm})(1 \text{ m} / 100 \text{ cm})(1 \times 10^9 \text{ nm} / 1 \text{ m})$

Measurement Uncertainty

Length of pen?

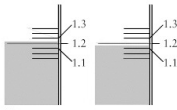
- Where is the uncertainty?
- What happens if I measure 5 times?
- How do we characterize uncertainty?

Precision

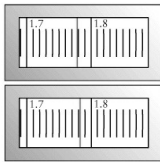
- how close the 5 measurements are

Accuracy

- how close to correct answer



(a)



(b)

Measurement

What is volume reading?

What is mass reading?

Characterize uncertainty by Significant Figures

DEFINITION: Those digits in a measured number (or result of calculation) that include all certain digits plus a final one with some uncertainty.

Example:

- 0.997 : between 0.995 - 0.999
- 0.9970 : between 0.9968 - 0.9972

Significant Figures - Help us interpret a number

Group answers from Ball problem

- 16,000,000 184,142,332 65,800,000
- How many of those digits do we know for certain?

Densities (rounded to whole #)

- Oil density = 0.8637 g/mL ~ 1 g/mL
- Water density = 0.997 g/mL ~ 1 g/mL

RULES: for counting

1. Express the number in scientific notation
2. Count the number of digits multiplying the factor of ten.

- 8.637×10^4 ----> 4 sig figs
- 8.6370×10^4 ----> 5 sig figs

Examples:

- 0.86370 --->
 8.6370×10^{-1} ----> 5 sig figs
- 0.008637 --->
 8.637×10^{-3} ----> 4 sig figs
- 400 --->
if 4×10^2 ----> 1 sig fig
if 4.00×10^2 ----> 3 sig figs

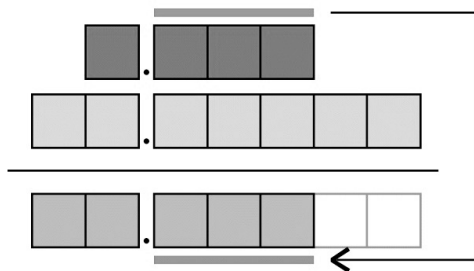
RULES: for calculation

When multiplying or dividing, report as many sig figs as those in the measurement with the least # of sig figs.

When adding or subtracting, give same # of decimal places in the answer as there are in the measurement with the least # of decimal places.

- Note: in subtraction you can lose # of sig figs but still know the number to the same units accuracy.

Addition / Subtraction



Example

The length of a table was measured to be 3.5 meters. A set of three tables were placed end to end. What length of space did they occupy?

$$3.5 + 3.5 + 3.5 = \underline{10.5} \quad 3 \text{ sig figs}$$

$$3.5 \times 3 = ? \quad 3 \text{ sig figs also (3 is exact \#)}$$

Ping Pong Balls

Rough measurement of room:

Assume rectangle:

$$25 \text{ ft high: } (25 \text{ ft})(0.305 \text{ m/ft}) = 7.63 \text{ m}$$

$$85 \text{ ft long: } (85 \text{ ft})(0.305 \text{ m/ft}) = 25.91 \text{ m}$$

$$70 \text{ ft high: } (70 \text{ ft})(0.305 \text{ m/ft}) = 21.34 \text{ m}$$

$$7.63 \times 25.91 \times 21.34 = 4.21 \times 10^3 \text{ m}^3$$

Problem - ping pong balls

Use conversion factors:

room $\sim 4.21 \times 10^3 \text{ m}^3$ ---> convert to cm^3

- Which unit is larger?
- What do we need to know?
- $10^2 = 100 \text{ cm} = 1 \text{ m}$

Write equivalence as a conversion factor:

- $100 \text{ cm} / 1 \text{ m}$

Conversion cont.

$$\begin{aligned} &4.21 \times 10^3 \text{ m}^3 (100 \text{ cm}/1\text{m})^3 \\ &= 4.21 \times 10^3 \text{ m}^3 (1 \times 10^6 \text{ cm}^3 / 1 \text{ m}^3) \\ &= 4.21 \times 10^9 \text{ cm}^3 \end{aligned}$$

To use conversion factors again:

$$1 \text{ ball} = 54.9 \text{ cm}^3$$

- $1 \text{ ball} / 54.9 \text{ cm}^3$ ($4.21 \times 10^9 \text{ cm}^3$)
- $= 7.67 \times 10^7 \text{ balls} = \underline{80,000,000}$

Approximations?

Rule of Thumb

- Conversion factor should not limit number of significant figures
- Use measured number to determine number of sig figs
- Carry at least one extra digit in sig figs to reduce round off error in calculation.

Shift Gears - measurement

Temperature Scale - Kelvin

- SI unit related to Celsius or Centigrade
- Celsius based on the physical properties of Water
- What physical properties of water are related to temp?

Remember: physical property

Property that can be measured without changing the identity of the substance.

Contrast with chemical properties:

- Describe the way substances change or "react" to form other substances.

For temperature:

- boiling
- melting

In the Celcius scale:

0 °C is assigned freezing temperature
100 °C is assigned boiling temperature
22-25 °C is room temperature

Relationships:

- Kelvin: $K = °C + 273.15$
- Fahrenheit: $F = (1.8 \times °C) + 32$

Example: Hottest day in Death Valley (1913): T= 330 K

Is this a mistake?

$$K = °C + 273.15$$

$$°C = 56.85$$

$$°F = (°C \times 1.8) + 32 = \underline{134.3} °F$$

- How should we report?
- Compare to measured number 330 K ---->
134 °F

Summary

Today we:

- introduced conversion factors
- introduced significant figures (sig figs)
- discussed uncertainty in measurement
- discussed accuracy vs precision
- Introduced celsius and Kelvin temperature scale
- Converted between temperature scales
