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 Systeme International d'Unites

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 -> 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

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

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

Measurement Uncertainty

Length of pen?

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

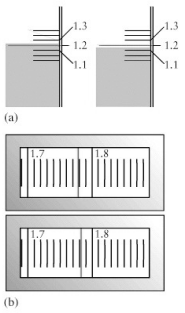
Precision

- how close the 5 measurements are

Accuracy

- how close to correct answer

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

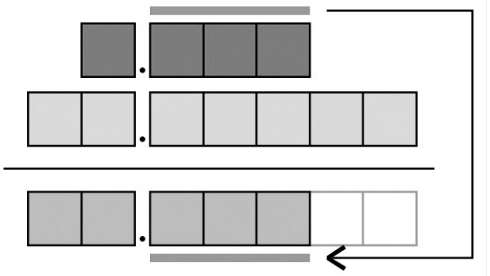
RULES: for calculation

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 = 10.5 3 sig figs

3.5 x 3 = ? 3 sig figs also (3 is exact #)

Ping Pong Balls

Rough measurement of room:

Assume rectangle:

25 ft high: (25 ft)(0.305 m/ft) = 7.63 m

85 ft long: (85 ft)(0.305 m/ft) = 25.91 m

70 ft high: (70 ft)(0.305 m/ft) = 21.34 m

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

Problem - ping pong balls

Use conversion factors:

room ~ $4.21 \times 10^3\ m^3$ ---> convert to cm^3

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

Write equivalence as a conversion factor:

- 100 cm / 1m

Conversion cont.

$4.21 \times 10^3\ m^3 (100\ cm/1m)^3$

$= 4.21 \times 10^3\ m^3 (1 \times 10^6\ cm^3 / 1\ m^3)$

$= 4.21 \times 10^9\ cm^3$

To use conversion factors again:

1 ball = $54.9\ cm^3$

- 1 ball / $54.9\ cm^3$ ($4.21 \times 10^9\ cm^3$)
- = 7.67×10^7 balls = 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 ºC is assigned freezing temperature
100 ºC is assigned boiling temperature
22-25 ºC is room temperature

Relationships:

- Kelvin: K = ºC + 273.15
- Fahrenheit: F = (1.8 x ºC) + 32

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

Is this a mistake?

K = ºC + 273.15
ºC = 56.85
ºF = (ºC x 1.8) + 32 = 134.3 ºF

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

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