Welcome to Chemistry 115

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461 CRL

Prerequisite for Chem 115 is one of the following:

1. Passing grade in Chem 110 at WVU.
2. Score of 600 or better on SAT/Math or score of 26 or better on ACT/Math.
3. Score of 17 or better on Part I of chemistry placement exam.
4. Appropriate grade in Chem 111 or Chem 112 at WVU.
5. Transfer credit for Chem 110, 111, 112, or 115 from another institution. See Dr. Babb as soon as possible if this is your prerequisite. Proof of transfer credit (from Admissions and Records) must be shown.

Include information about your prerequisite on the white card. Such as:

a. Chem 110, 111, or 112 grade, instructor, and semester
b. Date and score of chemistry placement exam.
c. ACT/Math or SAT/Math score.
d. Transfer information

Any student without the proper prerequisite will be dropped from the roster!!
Homework for Chem 115:

1. Read syllabus.

2. Check out the Chem 115 website (www.as.wvu.edu/~mbabb). Handouts, answer keys, grades, etc. are posted on the website.

3. Go to website for online homework (http://edugen.wiley.com/edugen/class/cls21918). Register and begin working on the first online homework assignment.


5. Complete Appendices A (Significant Figures) & B (Exponential Numbers) in Chem 115 laboratory manual. Appendices are to be turned in as lab homework at the beginning of the first lab (Jan. 17).

6. Start working on the other homework as specified on the Homework Sheet for Exam I.

**Chemistry:** the study of matter and its changes

**Matter:** anything that has mass and occupies space
   - Ex. hot dogs, cat, sand, air, etc.

Three physical states of matter:

1. **Solid** - particles of matter very close and touching but stuck in place. Not free to move (can’t flow).
   - Definite volume and shape.
   - Not compressible.

2. **Liquid** - particles of matter close and may be touching. Particles can move past one another (flow).
   - Definite volume but no definite shape.
   - Not compressible.

3. **Gas** - particles of matter are far apart (lots of empty space between) and are not touching. Particles can move past one another (flow).
   - No definite volume or shape. Gases take shape/volume of the container.
   - Compressible.

**Changes:** physical or chemical
Physical vs. Chemical Changes of Matter

**Physical Change:**
- Change that occurs without modification of the chemical makeup of the substance.
- Any change of state is a physical change.
  - Ex. Solid $\rightarrow$ Liquid (Melting/Fusion)
  - Liquid $\rightarrow$ Gas (Vaporization)
  - Solid $\rightarrow$ Gas (Sublimation)
  - Liquid $\rightarrow$ Solid (Freezing)
  - Gas $\rightarrow$ Liquid (Condensation)
- Dissolving of one substance in another.
- **Physical properties:** BP, MP, density, color, conductivity, specific heat, etc.

**Chemical Change:**
- Change that occurs with modification of the chemical makeup of the substance. New substance(s) with different properties formed!!
- Any chemical reaction is a chemical change.
  - Ex. decomposition, dehydration, combustion, explosion, rusting, precipitation, neutralization
- **Chemical properties:** rusting of iron, burning of gasoline in air, etc.

Classification of Matter

**Pure Substances**
- Composed of two or more elements and has constant composition.
- In compound, elements cannot be separated by physical means.
- Ex. Iron disulfide (FeS$_2$)

**Elements**
- Substances that can't be decomposed into simpler materials.
- Simplest form of matter. **Elements** are shown on periodic table. Only 90 occur naturally.

**Compounds**

**Mixtures**
- Can be a mixture of two or more pure substances. Has a variable composition. In mixture, substances can be physically separated.
- Ex. Sand/salt/sugar or iron/sulfur

**Homogeneous Mixtures**
- Has the same properties throughout.
  - Ex. air, seawater, soda, 14 k gold

**Heterogeneous Mixtures**
- Has different properties throughout and 2 or more phases.
  - Ex. salad dressing, milk shake, paint
Types of Numbers Used in Chemistry

**Exact Numbers**
- Number with a value that is exactly known.
- No error or uncertainty in the value of an exact number.
- Numbers obtained by counting individual objects AND defined numbers within a given measurement system.
- Ex. 230 seats in this room
  1 ft = 12 in
  100 cm = 1 m

**Measured Numbers**
- Number with a value that is NOT exactly known due to the measuring process.
- Some error or uncertainty in the value of a measured number.
- Amount of error depends on the measuring device (increment between markings and distance between).
- Numbers obtained by measuring an object with a measuring device.
- Ex. 191 lb person weighed on a scale or 8.25 min mile as timed with stopwatch

Significant Figures

**Significant Figures:** digits used to represent a measured number such that only the digit farthest to the right is uncertain. The digit farthest to the right has some error in its value but is still significant.

**Rules for Counting Significant Figures**

1. Find the first nonzero digit. This first digit and all digits to right of this digit are significant if written.

<table>
<thead>
<tr>
<th># SF</th>
<th>Ex.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.200x10^3 ft</td>
<td>1.200 ft</td>
</tr>
</tbody>
</table>

2. Measured numbers greater than one that end in zero(s) are ambiguous in sig. figs. and MUST be written in standard exponential form.

<table>
<thead>
<tr>
<th># SF</th>
<th>Ex.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.200 ft</td>
<td>1.200x10^3 ft</td>
</tr>
<tr>
<td>1.2x10^3 ft</td>
<td>1.200 ft</td>
</tr>
<tr>
<td>1.20x10^2 ft</td>
<td>1200 ft</td>
</tr>
</tbody>
</table>

**Which measurement has less error?**

- Triple Beam Balance = 1.6 g (+/-0.1 g)
- Electronic Balance = 1.597 g (+/-0.001 g)
Multiplication and Division of Measured Numbers

**Rule:** The measured number with least # sig. figs. limits the sig. figs. on the answer.

**Examples:**

A. \((6.4 \times 3.159)/23.3 = ?\)

B. \((1285.5)/257.1 = ?\)

C. \(11.7 \times 110.99 = ?\)

Addition and Subtraction of Measured Numbers

**Rule:** The measured number with least # decimals limits the # decimals on the answer.

**Examples:**

A.  

\[
\begin{align*}
5.195 \\
23.42 \\
+ 130.2
\end{align*}
\]

B.  

\[
\begin{align*}
8.99 \\
+ 2.1
\end{align*}
\]

C. \((6.21 \times 10^{-7})+(6.2 \times 10^{-8})= ?\)

**Mixed Operations:**

D. \((301.7 - 32.00) = ?\)

\[
\begin{array}{c}
1.8000
\end{array}
\]

E. \(129.7/(129.7 + 0.75) = ?\)
Rounding and Exponential Number Review

**Rounding**

Round each of the following numbers to 2 sf.

<table>
<thead>
<tr>
<th>Number</th>
<th>Rounded to 2 sf</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.871</td>
<td>0.8750</td>
</tr>
<tr>
<td>0.878</td>
<td>0.865</td>
</tr>
<tr>
<td>0.8751</td>
<td>14,263</td>
</tr>
<tr>
<td>0.8759</td>
<td>599,862,125</td>
</tr>
</tbody>
</table>

**Standard Exponential Form (Scientific Notation)**

\[ \# \times 10^n \]

<table>
<thead>
<tr>
<th>Number</th>
<th>Exponent</th>
</tr>
</thead>
<tbody>
<tr>
<td>14,000,000 (2 sf)</td>
<td>1</td>
</tr>
<tr>
<td>0.000065</td>
<td></td>
</tr>
<tr>
<td>7500 (3 sf)</td>
<td>1</td>
</tr>
<tr>
<td>0.0005</td>
<td></td>
</tr>
<tr>
<td>1380 (4 sf)</td>
<td>2</td>
</tr>
<tr>
<td>0.0100</td>
<td></td>
</tr>
<tr>
<td>120.0 \times 10^{-3}</td>
<td>-3</td>
</tr>
<tr>
<td>0.00071 \times 10^{3}</td>
<td></td>
</tr>
</tbody>
</table>

* Add one to exponent of 10 each time move decimal to left.
* Subtract one from exponent of 10 each time move decimal to right.

Units and Measurements

**SI System**

An international system of units used by the scientific community. Based on the metric system.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Unit</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>meter</td>
<td>m</td>
</tr>
<tr>
<td>Mass</td>
<td>kilogram</td>
<td>kg</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>Amount of Substance</td>
<td>mole</td>
<td>mol</td>
</tr>
<tr>
<td>Electric Current</td>
<td>ampere</td>
<td>A</td>
</tr>
<tr>
<td>Luminous Intensity</td>
<td>candela</td>
<td>cd</td>
</tr>
<tr>
<td>Volume</td>
<td>m³</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>kg/m³</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>m/s</td>
<td></td>
</tr>
<tr>
<td>Force</td>
<td>kg m/s² = N</td>
<td></td>
</tr>
</tbody>
</table>

**Factor-Label Method (Dimensional Analysis)**

Use to convert between units.

Ex. What is the mass of a 120. lb dog in SI units?

Equality: \( 1 \text{ lb} = 0.45359237 \text{ kg} \)
Factor-Label Method: Examples

1. The gravity on Saturn is 1117.0 cm/s\(^2\). What is the gravity in units of yd/min\(^2\)?

2. When 85 J of heat was added to a substance with a specific heat of 0.451 J/g·C, the temperature increased by 15 °C. What mass of substance was present?

3. The density of gold is 19.31 g/cm\(^3\). What is the density of gold in lb/gal? in lb/in\(^3\)?

Metric System Review

<table>
<thead>
<tr>
<th>Metric Multipliers/Conversion Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
</tr>
<tr>
<td>kilometer (km)</td>
</tr>
<tr>
<td>meter (m)</td>
</tr>
<tr>
<td>centimeter (cm)</td>
</tr>
<tr>
<td>millimeter (mm)</td>
</tr>
<tr>
<td>micrometer ((\mu)m)</td>
</tr>
<tr>
<td>nanometer (nm)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metric Conversions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 7.591 mL = ? L</td>
</tr>
<tr>
<td>2. 311 ks = ? (\mu)s</td>
</tr>
<tr>
<td>3. 8.501\times10(^{-2}) cg = ? kg</td>
</tr>
</tbody>
</table>
Density and Use of as Conversion

**Density**
- \( d = \text{mass}/\text{volume} = \frac{m}{V} \)
  - Units: g/mL, g/cm\(^3\), kg/m\(^3\) (SI), g/L
- Value does NOT depend on size of sample. Density is an *intensive property*.
- Value of density depends on:
  - Substance
  - Physical state
  - Temperature (as \( T \) increases, \( d \) decreases)

<table>
<thead>
<tr>
<th>Substance</th>
<th>density (g/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid water</td>
<td>1.000 at 4 °C</td>
</tr>
<tr>
<td>Ice</td>
<td>0.917</td>
</tr>
<tr>
<td>Fat</td>
<td>0.94</td>
</tr>
<tr>
<td>Hg(l)</td>
<td>13.55</td>
</tr>
</tbody>
</table>

**Density as Conversion Factor**

**Example:**
A vessel weighs 58.321 g. When filled with liquid water at 25 °C, the vessel weighs 76.216 g. What is the volume of the vessel? At 25 °C, the density of liquid water is 0.99704 g/mL.

Weight/Mass Percent and Use of as Conversion

**Mass Percent**
- \( \text{Mass} \% = \frac{\text{mass component}}{\text{mass whole}} \times 100\% \)

**Example:**
A solution is made by dissolving 10.5 g sugar in 80.5 g water. Calculate the mass percentages of sugar and water in the solution.

**Mass Percent as Conversion Factor**

**Examples:**
A sample of coal is 4.7% sulfur (w/w). How many pounds of sulfur are present in 2.5 tons of this coal?

A sample of environmental grade HCl solution has a density of 1.19 g/mL and is 37.5% HCl. What volume of his solution will provide 20.0 g HCl?
Temperature Scales and Conversions

<table>
<thead>
<tr>
<th>Temperature Scales</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fahrenheit Scale (°F)</td>
<td>A. Convert 1236 °F to Celsius.</td>
</tr>
<tr>
<td>2. Celsius Scale (°C)</td>
<td>B. Room temperature is 25 °C. What is RT in Fahrenheit? in Kelvin?</td>
</tr>
<tr>
<td>3. Kelvin Scale (K)</td>
<td>C. The boiling point of He is 4.1 K. What is the boiling point of He in Fahrenheit?</td>
</tr>
</tbody>
</table>

Conversions

Celsius to Fahrenheit:
\[ t_F = \left(\frac{9}{5}\right)t_C + 32 \]

Celsius to Kelvin:
\[ t_K = t_C + 273.15 \]