To Do:
1) Make Note/Summary Sheet for each unit
2) Complete problems in this packet.

As part of our review process, you will make a note sheet (max 1 SHEET per UNIT) that summarizes the main concepts for each unit. Formulas, definitions, shortcuts, examples, etc., are some suggestions for what to put on your note sheet. You may use whatever resources you like, but don’t simply copy definitions you don’t understand. Help each other. Ask questions. Be proactive. Make the notes as useful and informative for you as possible.

The note sheets and this packet will count as a grade towards your midterm.
# Topics:

## Unit 1: Matter and Measurement
- laboratory equipment and safety rules
- classification of matter (pure substances—elements & compounds vs mixtures—homo/heterogeneous)
- physical vs chemical properties
- separation of mixtures techniques
- Density
- Measurement
- significant figures
- scientific notation
- unit conversions (dimensional analysis)
- accuracy vs precision
- percent error

## Unit 2: Mole Concept
- mole, molar mass, molar conversions (grams <-> moles <-> molecules)
- percent composition
- empirical vs molecular formula
- solutions
- molarity calculations
- dilutions calculations

## Unit 3: Atomic Theory and Nuclear Chemistry
- Atomic Theory and History
- Atomic Structure (protons, neutrons, electrons, isotopes, ions)
- Average Atomic Mass
- Nuclear Stability
- Nuclear Decay Equations
- Half Life

## Unit 4: Electrons and Energy
- Energy, Wavelength, Frequency
- Ground vs. Excited State
- Orbital Diagrams
- Electron Configuration

## Unit 5: Periodic Table
- Organization of the periodic table
- Periodic trends (radius, ionization energy, electronegativity, reactivity)
- Properties of metals vs. nonmetals

## Unit 6: Physical Behavior of Matter
- Intermolecular forces & their relationship with viscosity, volatility, vapor pressure, boiling point, surface tension, phases of matter
- Phases of matter graphs: heating curve, phase diagram, vapor pressure curve, solubility curve
- Polarity
- Heat calculations
- **Colligative properties (freezing point depression, boiling point elevation)**
What is the volume of liquid in the graduated cylinders below? Express your answer using the proper number of significant figures.
- **Classification of Matter**: Classify each of the following as either a substance or a mixture.
  - If it is a pure substance, write “element” or “compound” in the substance column.
  - If it is a mixture, write “homogenous” or “heterogeneous” under the mixture column.

<table>
<thead>
<tr>
<th>Type of Matter</th>
<th>Pure Substance</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugar Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rocky Road Ice Cream</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pure Air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Physical vs Chemical Properties and Changes**: Classify the following as either a physical or chemical property

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Chemical Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue color</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td></td>
</tr>
<tr>
<td>Flammability</td>
<td></td>
</tr>
<tr>
<td>Solubility</td>
<td></td>
</tr>
<tr>
<td>Reacts with acid to form H₂</td>
<td></td>
</tr>
<tr>
<td>Supports combustion</td>
<td></td>
</tr>
<tr>
<td>Sour taste</td>
<td></td>
</tr>
<tr>
<td>Melting point</td>
<td></td>
</tr>
<tr>
<td>Reacts with water to form a gas</td>
<td></td>
</tr>
<tr>
<td>Reacts with base to form water</td>
<td></td>
</tr>
<tr>
<td>Hardness</td>
<td></td>
</tr>
<tr>
<td>Boiling point</td>
<td></td>
</tr>
<tr>
<td>Can neutralize a base</td>
<td></td>
</tr>
<tr>
<td>Luster</td>
<td></td>
</tr>
<tr>
<td>odor</td>
<td></td>
</tr>
</tbody>
</table>
### Separation Techniques

<table>
<thead>
<tr>
<th>Image of separation technique</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image-url" alt="Separation technique image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separates mixture based on this different physical property</td>
</tr>
</tbody>
</table>

### Metric Conversions

<table>
<thead>
<tr>
<th>Basic Unit</th>
<th>mega (M)</th>
<th>kilo (k)</th>
<th>hecto (h)</th>
<th>deca (da)</th>
</tr>
</thead>
<tbody>
<tr>
<td>gram (g)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>liter (L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>meter (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metric Conversion</th>
<th>deci (d)</th>
<th>centi (c)</th>
<th>milli (m)</th>
<th>micro (μ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>gram (g)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>liter (L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>meter (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Convert the following.

1. 35 mL = ________ dL
2. 950 g = ________ kg
3. 275 mm = ________ cm
4. 1,000 L = ________ kL
5. 1,000 mL = ________ L
6. 4,500 mg = ________ g
7. 25 cm = ________ mm
8. 0.005 kg = ________ dag
9. 0.075 m = ________ cm
10. 15 g = ________ mg

### Scientific Notation

Convert the following to scientific notation.

1. 0.005 = __________
2. 5,050 = __________
3. 0.0008 = __________
4. 1,000 = __________

Convert the following to standard notation.

1. $1.5 \times 10^3$ = __________
2. $1.5 \times 10^{-3}$ = __________
3. $3.75 \times 10^2$ = __________
4. $3.75 \times 10^2$ = __________
• Significant Figures: Determine the number of significant figures for the following measurements.

1.  0.02  ____
2.  0.020  ____
3.  501  ____
4.  501.0  ____
5.  5,000  ____
6.  5,000.  ____
7.  6,051.00  ____
8.  0.0005  ____
9.  0.1020  ____
10. 10,001  ____

• Sig Figs and Calculations: Perform the following operations and express the final answer with the proper units and correct number of significant figures.

1.  $1.35 \text{ m} \times 2.467 \text{ m} = \underline{\text{}}$
2.  $12.01 \text{ mL} + 35.2 \text{ mL} + 6 \text{ mL} = \underline{\text{}}$
3.  $55.46 \text{ g} - 28.9 \text{ g} = \underline{\text{}}$
4.  $.021 \text{ cm} \times 3.2 \text{ cm} \times 100.1 \text{ cm} = \underline{\text{}}$
5.  $0.15 \text{ cm} + 1.15 \text{ cm} + 2.051 \text{ cm} = \underline{\text{}}$

• Density

1. Calculate the density of an object whose mass is 1.6g and volume is 0.234 mL. Report your answer using the proper number of significant figures!

2. A cube has a mass of 3.56g with a length of 33.3cm, width of 10.9cm, and a height of 0.22cm. Calculate the density. Report your answer using the proper number of significant figures!
- **Percent Error**: Determine the percent error for the following experiments

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Experimental Value</th>
<th>Accepted Value</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.24 g</td>
<td>1.30 g</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>252 mL</td>
<td>225 mL</td>
<td></td>
</tr>
</tbody>
</table>

**Unit 2**

- **Mole, Molar Conversions**

1. What is the number of moles of 512 grams of methanol, CH<sub>3</sub>OH?

2. How many moles are in 352 g of calcium carbonate, CaCO<sub>3</sub>?

3. How many atoms are in solid piece of iron (Fe) that has the mass of 62.0 g?

4. A solid piece of Sodium (Na) has 1.01 x 10<sup>22</sup> atoms, what is the mass of the sample of sodium?

5. How many molecules are in 46.5 mol of potassium hydroxide, KOH?

6. What is the mass of 5.3 x 10<sup>22</sup> molecules of CuSO<sub>4</sub>?
- **Percent Composition:** Determine the percent composition of each of the compounds below:

1. \( \text{KMnO}_4 \)
   - \( \text{K} = \) ______
   - \( \text{Mn} = \) ______
   - \( \text{O} = \) ______

2. \( \text{HCl} \)
   - \( \text{H} = \) ______
   - \( \text{Cl} = \) ______

3. \( \text{Mg(NO}_3\text{)}_2 \)
   - \( \text{Mg} = \) ______
   - \( \text{N} = \) ______
   - \( \text{O} = \) ______

- **Empirical and Molecular Formulas**

1. The empirical formula of a compound is \( \text{NO}_2 \). Its molecular mass is 92 g/mol. What is its molecular formula?

2. The empirical formula of a compound is \( \text{CH}_2 \). Its molecular mass is 70 g/mol. What is its molecular formula?

3. A compound is found to be 40.0% carbon, 6.7% hydrogen and 53.5% oxygen. Its molecular mass is 60. g/mol. What is its molecular formula?

4. A compound is 64.9% carbon, 13.5% hydrogen and 21.6% oxygen. Its molecular mass is 74 g/mol. What is its molecular formula?
### Molarity

1. What is the molarity of a solution in which 58 g of NaCl are dissolved in 1.0 L of solution?

2. What is the molarity of a solution in which 10.0 g of AgNO₃ is dissolved in 500. mL of solution?

3. How many grams of KNO₃ should be used to prepare 2.00 L of a 0.500 M solution?

4. To what volume should 5.0 g of KCl be diluted in order to prepare a 0.25 M solution?

### Dilutions

1. How much concentrated 18 M sulfuric acid is needed to prepare 250 mL of a 6.0 M solution?

2. How much concentrated 12 M hydrochloric acid is needed to prepare 100 mL of a 2.0 M solution?

3. To what volume should 25 mL of 15 M nitric acid be diluted to prepare a 3.0 M solution?

4. To how much water should 50. mL of 12 M hydrochloric acid be added to produce a 4.0 M solution?
Unit 3
- **Atoms & stability**: Complete the table below and determine if the element is a cation, an anion, or a neutral atom

<table>
<thead>
<tr>
<th>Nuclear Notation</th>
<th>Atomic Number</th>
<th>Mass Number</th>
<th># Protons</th>
<th># Neutrons</th>
<th># Electrons</th>
<th>Cation? Anion? Neutral?</th>
<th>Stable or unstable?</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\begin{array}{c} 7 \ 3 \end{array} Li$</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>neutral</td>
<td>unstable</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td></td>
<td></td>
<td>18</td>
<td></td>
<td>Cation (+1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35</td>
<td></td>
<td></td>
<td>20</td>
<td></td>
<td>Anion (-2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>28</td>
<td></td>
<td>31</td>
<td></td>
<td></td>
<td>neutral</td>
<td></td>
</tr>
<tr>
<td></td>
<td>39</td>
<td></td>
<td></td>
<td>19</td>
<td></td>
<td>neutral</td>
<td></td>
</tr>
</tbody>
</table>

- **Average Atomic Mass**: Determine the average atomic mass of the following mixtures of isotopes.
  1) 15% Fe-55, 85% Fe-56

2) 80% $^{127}I$, 17% $^{126}I$, 3% $^{128}I$

- **Nuclear Decay Equations**: Complete/write balanced nuclear decay equations for:

  1. $^{42}K \rightarrow ^{0}_1e + \text{__________}$
  2. $^{239}Pu \rightarrow ^{4}_2He + \text{__________}$
  3. $^{235}U \rightarrow \text{__________} + ^{231}_90Th$
  4. The alpha decay of Francium-220
  5. The beta decay of Strontium-90
Half-Life

1) How much of a 100.0 gram sample of $^{198}$Au is left after 8.10 days if its half-life is 2.70 days?

2) A 50.0 g sample of N-16 decays to 12.5 g in 14.4 seconds. What is its half-life?

3) There are 5.0 g of $^{131}$I left after 40.35 days. How many grams were in the original sample if its half-life is 8.07 days?

Unit 4: Electrons and Electron Configuration

- Draw a Bohr (Electron-Shell) Diagram and the Lewis Dot structure for a neutral atom of Magnesium.

- What is the relationship between energy, wavelength, and frequency?

- What is the difference between ground state and excited state?

- Explain why you see colored light during the flame test lab (use the terms energy, ground state, excited state)
- Orbital Diagrams/Electron Configuration
  Draw the orbital diagram for the following elements

1) Chlorine

   \[ \begin{array}{c}
   & & & \\
   & 3p & & \\
   & 2p & & \\
   & 2s & & \\
   & 1s & & \\
   \end{array} \]

2) Nitrogen

   \[ \begin{array}{c}
   & & & \\
   & 3p & & \\
   & 2p & & \\
   & 2s & & \\
   & 1s & & \\
   \end{array} \]

3) Aluminum

   \[ \begin{array}{c}
   & & & \\
   & 3p & & \\
   & 2p & & \\
   & 2s & & \\
   & 1s & & \\
   \end{array} \]

4) Oxygen

   \[ \begin{array}{c}
   & & & \\
   & 3p & & \\
   & 2p & & \\
   & 2s & & \\
   & 1s & & \\
   \end{array} \]

Write the long and short form (noble gas abbreviation) electron configuration for the following elements

1) Potassium

2) Cobalt

3) Zirconium

4) Sulfur
Unit 5: Periodic Table

1. Where are the most active metals located? ________________________________

2. Where are the most active nonmetals located? ____________________________

3. As you go from left to right across a period, the atomic size ( decreases / increases ). Why? ________________________________

4. As you travel down a group, the atomic size ( decreases / increases ). Why? ________________________________

5. A negative ion is ( larger / smaller ) than its parent atom.

6. A positive ion is ( larger / smaller ) than its parent atom.

7. As you go from left to right across a period, the first ionization energy generally ( decreases / increases ). Why? ________________________________

8. As you go down a group, the first ionization energy generally ( decreases / increases ). Why? ________________________________

9. Where is the highest electronegativity found? ________________________________

10. Where is the lowest electronegativity found? ________________________________

11. Elements of Group 1 are called ________________________________.

12. Elements of Group 2 are called ________________________________.

13. Elements of Group 3-12 are called ________________________________.

14. As you go from left to right across the periodic table, the elements go from ( metals / nonmetals ) to ( metals / nonmetals ).

15. Group 17 elements are called ________________________________.

16. The most active element in Group 17 is ________________________________.

17. Group 18 elements are called ________________________________.

18. What sublevels are filling across the Transition Elements? ________________________________

19. Elements within a group have a similar number of ________________________________.

20. Elements across a series have the same number of ________________________________.

21. A colored ion generally indicates a ________________________________.

22. As you go down a group, the elements generally become ( more / less ) metallic.

23. The majority of elements in the periodic table are ( metals / nonmetals ).

24. Elements in the periodic table are arranged according to their ________________________________.

25. An element with both metallic and nonmetallic properties is called a ________________________________.
Unit 6
INTERMOLECULAR FORCES
1. Fill in the diagram (with high or low) to show how intermolecular forces influence the volatility, vapor pressure, and boiling point of a substance.

[Diagram with weak and strong intermolecular forces]

VAPOR PRESSURE: Use the graph below to answer the following questions.

2. What is the vapor pressure of CHCl₃ at 50°C?

3. What is the boiling point of H₂O when the external pressure is 30 kPa?

4. What is the normal boiling point of CCl₄?

5. Which substance has the weakest IMF?

HEATING CURVES. Use the heating curve below to answer the following questions.

6. What is the melting point of the substance?

7. What is the boiling point of the substance?

8. Which letter represents heating of the solid?

9. Which letter represents heating of the vapor?

10. Which letter represents melting of the solid?

11. Which letter represents boiling of the liquid?
**Phase Diagrams.** Use the phase diagram for water below to answer the following questions.

12. What is the state of water at 2 atm and 50°C?

13. What phase change will occur if the temperature is lowered from 80°C to -5°C at 1 atm?

14. You have ice at -10°C and 1 atm. What could you do in order cause the ice to sublime?

**Solubility:** Use the solubility curve below to answer the following questions:

1. How is the solubility of gases in water different from the solubility of solids in water?

2. At 60°C, what is the saturation point for NaCl? In other words, how much NaCl can be dissolved in 100 g of water at 60°C to make a saturated solution?

3. At 50°C, 115 g of NaNO₃ has been dissolved in water. Is this solution saturated, unsaturated, or supersaturated?

4. At 20°C, 100 g of KI has been dissolved in water. Is this solution saturated, unsaturated, or supersaturated?

5. At 5°C, 60 g of KCl has been dissolved in water. Is this solution saturated, unsaturated, or supersaturated?

6. Explain the term “like dissolves like” regarding how polarity and solubility are related.
Heat Calculations:
1. The specific heat of ethanol is 2.44 J/g°C. Find the heat required to raise the temperature of 193 g of ethanol from 19°C to 35°C.

2. When a 120 g sample of aluminum absorbs 9612 J of energy, its temperature increases from 25°C to 115°C. Find the specific heat of aluminum. Be sure to include the correct unit for specific heat!

3. When a solid is melting to a liquid, does the temperature change? Why or why not?

4. When a liquid is being heated up to, but not at its boiling point, does the temperature change? Why or why not?

5. What is the relationship between temperature and equilibrium vapor pressure? Explain.

- Phase Changes
  1. Draw a particle diagram for a sample in the:
     (i) solid phase (labeled A), (ii) liquid phase (labeled B), and (iii) gas phase (labeled C).
  2. Label each arrow (D, E, F, G, H, I) with the appropriate phase change (ex. fusion/melting).