The problems in this review are designed to help prepare you for your upcoming exam. Questions pertain to material covered in the course and are intended to reflect the topics likely to appear in the exam. Keep in mind that this worksheet was created by CARE tutors, and while it is thorough, it is not comprehensive. In addition to exam review sessions, CARE also hosts regularly scheduled tutoring hours.

**Empirical/Molecular Formula**

A molecule has molar mass 180.18 g/mole and is 40.00% C, 6.73% H, and 53.28% O. What is its molecular formula?

\[
\begin{align*}
40\text{g C} & / 12\text{ g/mol} = 3.33 \text{ mol C} \\
6.73\text{g H} & / 1.008\text{g/mol} = 6.67 \text{ mol H} \\
53.28\text{g O} & / 16\text{g/mol} = 3.33\text{mol O}
\end{align*}
\]

Divide by 3.33 → CH₂O empirical; mass = 30g → 180/30 = 6
Molecular formula = 6*empirical

\[\text{C}_6\text{H}_{12}\text{O}_6\]

**Electrolytes**

What is the definition of an electrolyte? Give some examples of strong, weak and non-electrolytes

Substance that conducts electric current as a result of a dissociation into positively and negatively charged ions, which migrate toward and ordinarily are discharged at the negative and positive terminals (cathode and anode) of an electric circuit, respectively

Strong Electrolytes → Compounds that completely dissociate: Salts, strong acids or bases (NaCl, KBr, NaOH, HI, etc)
Weak Electrolytes → Compounds that weakly dissociate (Acetic Acid, Carbonic Acid, Ammonia, etc)
Non-Electrolytes → Compounds that don’t really dissociate (Glucose)
Which of the following will conduct electricity best?

a) Ethanol C₂H₆O
d) Nitric Acid HNO₃
b) Water H₂O
c) Urea CO(NH₂)₂

The strongest acid conducts electricity the best. Nitric Acid is the strongest acid out of the options.

Rank the following in terms of electrolyte strength (C₂H₆O, H₂O, CO(NH₂)₂, NHO₃)

\[
NHO_3 > H_2O > C_2H_6O > CO(NH_2)_2
\]

Net Ionic Equations

What are the ionic and net ionic equations for the following reactions?

\[
CaCl_2 (aq) + FeSO_4 (aq) \rightarrow CaSO_4 (s) + FeCl_2 (aq)
\]

\[
Ca^{2+}_{(aq)} + (SO_4)^{2-}_{aq} \rightarrow CaSO_4(s)
\]

\[
SrCl_2 (aq) + NiSO_4 (aq) \rightarrow SrO_4 (aq) + NiCl_2 (aq)
\]

No Net Ionic Equation (all aqueous) - Only element producing a precipitate (solid) left in net equation.
Making Solutions

Stock Solution: 4L of 6M HCl

Determine the volume of the stock solution needed to make 10 liters of a 2M solution

\[ \text{Desired outcome } (M_2V_2) \rightarrow (10L)(2M) \]
\[ M_1V_1 \text{ (stock)} = M_2V_2 \]
\[ 6V_1 = (10L)(2M) = 20 \rightarrow V_1 = 3.33L \]

What volume of .1M solution could you make with the remaining stock?

Starting with 4L, you now have 4 - 3.33 = 0.67L leftover
\[ (0.67L)(6M) = V_{\text{resultant}}(0.1M) \rightarrow V_{\text{resultant}} = 40.2L \]

Mass Percent

Calculate the mass percent composition of the following compound

\[ \text{C}_3\text{H}_4\text{O}_2 \]

C: \[ \left( \frac{12.01 \times 3}{72.062} \right) \times 100 \% = 50\% \]
H: \[ \left( \frac{1.008 \times 4}{72.062} \right) \times 100 \% = 5.6\% \]
O: \[ \left( \frac{16 \times 2}{72.062} \right) \times 100 \% = 44.4\% \]
Polarity

1. Circle the following compounds that are polar.

   a) CF₄  
   b) SF₄  
   c) KrCl₂  
   d) PCl₅  
   e) SeF₂

2. Which of the following compounds is least soluble in water? (Hint: Water is a polar solvent)

   a) KrF₂  
   b) PF₃  
   c) IF₅  
   d) COS  
   e) SO₂

3. Which of the following compounds will be most soluble in water? (Hint: Water is a polar solvent and “like dissolves like”)

   a) KrF₂  
   b) PF₃  
   c) IF₅  
   d) COS  
   e) SO₂

VSEPR

Molecule: BrF₅
Find the geometry, shape, bond angles and polarity:

Geometry: Octahedral, Shape: Square Pyramidal, Bond Angles: 90°, Polarity: Polar
How many of the following compounds have a square planar shape? *(see if you can also figure out the bond angles present)*

a) $\text{KrF}_4$ (Square Planar)

b) $\text{PCl}_5$ (Triagonal Bipyramidal)

c) $\text{XeO}_4$ (Tetrahedral)

d) $\text{TeF}_4$ (See-Saw)

e) $\text{ICl}_3$ (T-Shaped)

Vapor Pressure

Which has a higher boiling point?

a. Ethanol (vapor pressure 10 mm Hg)

b. Water (vapor pressure 8 mm Hg)

c. Diethyl ether (vapor pressure 12 mm Hg)

d. Acetone (vapor pressure 13 mm Hg)

Water has the lowest vapor pressure and therefore has the strongest intermolecular forces, thus it has the highest boiling point.

You have acetone ($\text{CH}_3\text{COCH}_3$) and water.

1. Draw the Lewis structure for each

\[
\begin{align*}
\text{H} & \quad :\text{O} : \quad \text{H} \\
\text{H} & \quad | \quad | \quad | \\
\text{H} & \quad \text{C} \quad | \quad | \quad \text{C} \quad | \quad \text{C} \quad | \quad \text{H} \\
\text{H} & \quad | \quad | \\
\text{H} & \quad \text{H}
\end{align*}
\]

\[
\begin{align*}
\text{H} & \quad \text{O} \quad \text{H} \\
\text{H} & \quad | \\
\text{H} & \quad \text{H}
\end{align*}
\]
2. Name the inter-molecular forces present in each

<table>
<thead>
<tr>
<th>London dispersion</th>
<th>London Dispersion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dipole-Dipole</td>
<td>Dipole-Dipole</td>
</tr>
</tbody>
</table>

Hydrogen Bonds

3. Rank the boiling point and vapor pressure

Water has a higher BP and lower VP due to higher inter-molecular forces

Solubility

75 mL of 0.2M Al(NO$_3$)$_3$ with 100 mL of 0.2 M K$_2$CO$_3$ react to form a precipitate. How many moles of the precipitate form?

0.075L * 0.2M = 0.15 moles Al$^{3+}$ (limiting)
0.1L * 0.2M = 0.02 moles PO$_4^{3-}$
1-1 ratio between limiting reactants and precipitate

0.015 moles formed

Consider the products for the following four aqueous reactions:

(I) K$_2$S (aq) + NaCl (aq) → KCl (aq) + Na$_2$S (aq)

(II) AgNO$_3$ (aq) + MgCl$_2$ (aq) → AgCl (s) + Mg(NO$_3$)$_2$ (aq)

(III) CuCl$_2$ (aq) + Na$_2$SO$_4$ (aq) → CuSO$_4$ (aq) + 2NaCl (aq)

(IV) Li$_2$CO$_3$ (aq) + Ni(NO$_3$)$_2$ (aq) → LiNO$_3$ (aq) + NiCO$_3$ (s)

Which reactions result in the formation of a precipitate?

a) (II), (III), and (IV)  c) (I), (II) and (III)  e) (II) and (III)

b) (I) and (III)  d) (II) and (IV)