Unit 2—Introduction to Chemistry

1. $0.0006 \text{ mm} = \ ? \text{ \mu m}$

$$6 \times 10^{-4} \text{ mm} \times \frac{10^{-3} \text{ m}}{1 \text{ mm}} \times \frac{1 \text{ \mu m}}{10^{-6} \text{ m}}$$

Answer $0.6 \text{ \mu m}$

2. $0.054 \text{ mL} = \ ? \text{ nL}$

$$5.4 \times 10^{-2} \text{ mL} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} \times \frac{1 \text{ nL}}{10^{-9} \text{ L}}$$

Answer $5.4 \times 10^4 \text{ nL}$

3. $3.5 \text{ \mu g} / \text{L} = \ ? \text{ mg} / \text{mL}$

$$\frac{3.5 \text{ \mu g}}{1 \text{ L}} \times \frac{10^{-6} \text{ g}}{1 \text{ \mu g}} \times \frac{1 \text{ mg}}{10^{-3} \text{ g}} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}}$$

Answer $3.5 \times 10^{-6} \text{ mg/mL}$

4. The density of iron is $7860 \text{ g/L}$. Calculate the mass of a $3.2 \text{ mL}$ sample of iron.

$$0.0032 \text{ L} \times \frac{7860 \text{ g}}{1 \text{ L}}$$

Answer $25.2 \text{ g}$

5. Manganese has a density of $7.20 \text{ g/mL}$. Calculate the volume occupied by a $4.0 \text{ kg}$ piece of manganese.

$$V = \frac{m}{D} = \frac{4000 \text{ g}}{7.20 \text{ g/mL}} = 555.56 \text{ mL}$$

Answer $558 \text{ mL}$

6. A $0.0460 \text{ L}$ piece of copper has a mass of $410.32 \text{ g}$. Calculate the density of copper in $\text{g/mL}$.

$$D = \frac{m}{V} = \frac{410.32 \text{ g}}{460 \text{ mL}} = 0.92 \text{ g/mL}$$

Answer $0.92 \text{ g/mL}$
7. Give the number of significant digits in each of the following. Assume they are all measurements.

a) 0.0023 ........................................... 2  
   d) \(3.2 \times 10^{-4}\) .................................. 2  

b) 3953 000 ........................................... 4  
   e) 50020.000 ...................................... 8  

c) 1.0200 \(\times 10^5\) .................................. 5  
   f) 3450 ............................................. 3  

8. Perform the following calculations and round the answers off to the correct number of significant digits as justified by the data. Assume all numbers are measurements.

a) \(2.1500 \times 0.31\) .................................. 0.67  
   f) \(8.90 \times 10^3 \div 4.400 \times 10^{-6}\) ............ \(2.02 \times 10^7\)  

b) \(0.05 + 394.7322\) ................................ 394.78  
   g) \(83.00 \div 1.2300 \times 10^3\) ................. 0.6748  

c) \(4.905 \times 10^6 \div 4 \times 10^2\) .................. \(1 \times 10^8\)  
   h) \(98.0076 - 2.195\) .......................... 95.813  

d) \((3.33 \times 9.52) + 13.983\) .................. 45.7  
   i) \(0.00000200 \times 245.912\) ................... \(4.92 \times 10^{-7}\)  

e) \(3.813 + 98.98 + 2.669\) ..................... 105.46  
   j) \(5.802 \div 6.21 + 2.41 \div 9.2565\) ........... 1.195  

9. Round the following numbers to 2 significant digits. (4 marks)

a) 2 000 000 000 ................................ 2.0 \(\times 10^9\)  
   c) 3.88945 \(\times 10^{28}\) .................. 3.9 \(\times 10^{28}\)  

b) 106 000 ........................................ 1.1 \(\times 10^5\)  
   d) 0.000 000 7895 .......................... 7.9 \(\times 10^{-7}\)  

Unit 3—Properties of Matter

Draw the diagram from your notes outlining the Classification of Matter. Make sure you can define each classification.

```
Matter
  ↓
Pure Substances
  ↓
elements
  ↓
metals
  ↓
ionic
  ↓
solution
  ↓
mixtures
  ↓
mech mixtures
  ↓
covalent
  ↓
suspension
```
# ANSWER KEY

<table>
<thead>
<tr>
<th>Chemistry 11</th>
<th><strong>Organic Chemistry Review</strong></th>
<th>Assignment</th>
</tr>
</thead>
</table>

1. Identify the following as either an alkane, alkene or alkyne.

   a. alkene     b. alkane     c. alkyne    d. alkyne    e. alkane

2. Identify which class of organic compounds each of the following belongs to: halocarbon, alcohol, ether, aldehyde, ketone, carboxylic acid, ester, amine, amide, alkane, alkene, or alkyne. Name each compound.

   a. **Ketone;** 4,4-dimethyl-2-pentanone
   b. **Halocarbon;** 3,3-dibromo-2,2-dichlorohexane
   c. **Alkyne;** 4-2-ethyl-7-methyl-2-octyne
   d. **Alkane;** 3,4-dimethylhexane
   e. **Carboxylic acid;** methylpropanoic acid
   f. **Ester;** methylhexanoate
   g. **Alkane;** 7-ethyl-3-methyldecane
   h. **Alkene;** 4,4-dimethyl-1-pentene
   i. **Ketone;** propanone
   j. **Alcohol;** 2-pentanol
   k. **Ester;** ethylbutanoate
   l. **Carboxylic acid;** propanoic acid
   m. **Aldehyde;** propanal
   n. **Aldehyde;** 2-methylbutanal
   o. **Cyclic hydrocarbon;** 1,3-diethyl-6,8-dimethylcyclononane
   p. **Cyclic halocarbon;** 1,4-dichloro-2,3-diethylcyclopentane
   q. **Amine;** trimethylamine
   r. **Amide;** propanamide
   s. **Ether;** 1-propoxypropane

3. ANSWERS ON THE FOLLOWING PAGE
#3 a. \( \text{CH}_3\cdot\text{CH}_2\cdot\text{CH}_6\cdot\text{CH}_8\cdot\text{CH}_6\cdot\text{CH}_9\cdot\text{CH}_8\cdot\text{CH}_6\cdot\text{CH}_5\cdot\text{C}^{-\text{OH}} \)

b. \( \text{CH}_3\cdot\text{CH}_2\cdot\text{CH}_6\cdot\text{CH}_6\cdot\text{CH}_8\cdot\text{CH}_2\cdot\text{C}^{-\text{O}-\text{CH}_3} \)

c. \( \text{CH}_3\cdot\text{C}^{-\text{≡C-C-C-C-C}}\cdot\text{CH}_3 \)

d. \( \text{CH}_3\cdot\text{CH}_5\cdot\text{CH}^{-}\text{CH}^{-}\text{C}^{-\text{CH=CH}_2} \)

e. \( \text{CH}^{-}\text{≡C-CH-CH}_2 \)

f. \( \text{CH}_3\cdot\text{CH}_9\cdot\text{C}^{-}\text{CH}_8\cdot\text{C}^{-\text{≡C}}\cdot\text{H} \)

\(\text{CH}_3\cdot\text{N}^{-}\cdot\text{CH}_6\cdot\text{CH}_3 \)

i. \( \text{CH}_3\cdot\text{CH}_9\cdot\text{CH}^{-}\text{CH}=\text{CH-CH}_3 \)

j. \( \text{CH}_2\cdot\text{CH}_5\cdot\text{CH}^{-}\text{CH}^{-}\text{C}^{-\text{O-CH}_5}\cdot\text{CH}_5\cdot\text{CH}_5\cdot\text{CH}_5 \)

K. \( \text{CH}_3\cdot\text{CH}_9\cdot\text{CH}_6\cdot\text{C}^{-}\cdot\text{CH}_3 \)

M. \( \text{CH}_3\cdot\text{CH}^{-}\text{CH}-\text{CH}-\text{CH}_9\cdot\text{CH}_8\cdot\text{CH}_3 \)

O. \( \text{CH}_3\cdot\text{CH}_6\cdot\text{CH}_8\cdot\text{CH}_3 \)

P. \( \text{Cl}^{-}\text{C}^{-}\cdot\text{F}^{-}\text{Cl}^{-}\cdot\text{Cl}^{-}\cdot\text{Cl}^{-}\cdot\text{F}^{-}\cdot\text{Cl}^{-} \)

q. \( \text{CH}_3\cdot\text{CH}^{-}\cdot\text{C}^{-}\cdot\text{C}^{-\text{N}^{-}\text{H}_2} \)

r. \( \text{CH}_3\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{CH}^{-}\cdot\text{CH}_9\cdot\text{CH}_8\cdot\text{CH}_5\cdot\text{CH}_6\cdot\text{CH}_6\cdot\text{CH}_6 \)
S. \[ \text{CH}_3 - \text{CH}_2 - \text{CH} - \text{CH}_2 - \text{CH}_3 \]

O. \[ \text{CH}_3 - \text{CH}_2 - \text{CH} - \text{CH} - \text{C} = \text{O} \]

W. \[ \text{CH}_2 - \text{CH} - \text{C} - \text{CH}_3 \]

+ \[ \text{CH}_3 - \text{CH} - \text{CH}_2 - \text{CH}_2 - \text{CH} - \text{CH}_2 - \text{CH} - \text{CH}_3 \]

V. \[ \text{CH}_3 - \text{O} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3 \]

X. \[ \text{OH} \]

\[ \text{CH}_3 \]

\[ \text{CH}_3 \]

\[ \text{CH}_3 \]
2. Define a physical change: 

Change where chemical make up does not change.

Give some examples of physical changes.

Rip paper

3. Define a chemical change -

new substance is formed.

Give some examples of chemical changes.

burning; cooking; neutralization

4. Given the following graph of Temperature vs. Time for warming substance “X” which starts out as a solid, answer the questions below:

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>13</td>
</tr>
<tr>
<td>5.0</td>
<td>43</td>
</tr>
<tr>
<td>15.0</td>
<td>77</td>
</tr>
<tr>
<td>20.0</td>
<td>90</td>
</tr>
</tbody>
</table>

a) During time 0.0 – 5.0 minutes, the added heat energy is being used to ______ incr. temp of solid ______

b) During time 5.0 – 15.0 minutes, the added heat energy is being used to ______ break bonds holding together solid ______

c) During time 15.0 – 20.0 minutes, the added heat energy is being used to ______ increase T of liquid ______

d) During time 20.0 – 28.0 minutes, the added heat energy is being used to ______ break bonds of liquid ______

e) The melting point of substance “X” is ______ 43 °C ______

f) The boiling point of substance “X” is ______ 77 °C ______

g) If a greater amount of substance “X” was used, the melting point would be

1. a lower temperature
2. a higher temperature
3. the same temperature

Answer ______ 3 ______

h) What phase is substance “X” at 90°C? ______ Gas ______
Unit 4 — Names and Formulas for Compounds

1. Write the correct formula for the following compounds:
   a) ammonium chlorate: \( \text{NH}_4\text{ClO}_3 \)
   b) copper (II) sulphite: \( \text{Cu}_2\text{SO}_3 \)
   c) zinc carbonate tetrahydrate: \( \text{ZnCO}_3 \cdot 4\text{H}_2\text{O} \)
   d) nitric acid: \( \text{HNO}_3 \)
   e) phosphorus pentaiodide: \( \text{PI}_5 \)
   f) iron (III) thiocyanate: \( \text{Fe(}\text{SCN})_3 \)
   g) sulphuric acid: \( \text{H}_2\text{SO}_4 \)
   h) dinitrogen tetrafluoride: \( \text{N}_2\text{F}_4 \)

2. Write the correct names for the following compounds:
   a) \( \text{Mn(SO}_4\text{)}_2 \): Manganese (IV) sulphate
   b) \( \text{PbCrO}_4\cdot 6\text{H}_2\text{O} \): Lead (II) chromate hexahydrate
   c) \( \text{As}_2\text{O}_3 \): Diarsenic trioxide
   d) \( \text{CH}_3\text{COOH} \): Acetic acid
   e) \( \text{Ni}_2(\text{C}_2\text{O}_4)_3 \): Nickel (III) oxalate
   f) \( \text{NF}_3 \): Nitrogen trifluoride
   g) \( \text{(NH}_4\text{)}_2\text{HPO}_4 \): Ammonium monohydrogen phosphate
   h) \( \text{Ba(OH)}_2\cdot 10\text{H}_2\text{O} \): Barium hydroxide decahydrate

Unit 5 — The Mole Concept

1. Make the following conversions, clearly showing your steps. Include proper units in all of your work and in your answer.
   a) 133.44 grams of \( \text{PCl}_3 \) = ? moles
      \[
      133.44 \text{ g} \times \frac{1 \text{ mol}}{108.1 \text{ g}} = 1.23 \text{ mol}
      \]
      Answer: 0.64 mol
d) \[ 570.625 \text{ g of PCl}_3 \text{ gas} = \text{? L (STP)} \]

\[
570.625 \text{ g} \times \frac{1 \text{ mol}}{137.5 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 92.96 \text{ L}
\]

Answer \[ 92.96 \text{ L} \]

e) \[ 1030.4 \text{ mL of C}_2\text{H}_6 \text{ gas at STP} = \text{? g} \]

\[
1.0304 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{30.09 \text{ g}}{1 \text{ mol}} = 1.38 \text{ g}
\]

Answer \[ 1.38 \text{ g} \]

f) \[ 5.00 \text{ kg of nitrogen gas} = \text{? L (STP)} \]

\[
5000 \text{ g} \times \frac{1 \text{ mol}}{28.0 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 4000 \text{ L}
\]

Answer \[ 4000 \text{ L} \]

g) \[ 0.5696 \text{ kg of CH}_4(\text{g}) = \text{? mL} \]

\[
0.5696 \text{ kg} = 569.6 \text{ g} \times \frac{1 \text{ mol}}{16.0 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} \times \frac{1 \text{ mL}}{10^{-3} \text{ L}} = 7.97 \times 10^5 \text{ mL}
\]

Answer \[ 7.97 \times 10^5 \text{ mL} \]

2. The density of liquid ethanol (C\(_2\)H\(_5\)OH) is 0.790 g/mL. Calculate the number of molecules in a 35.0 mL sample of liquid ethanol. (NOTE: You CAN'T use 22.4 L/mol since this is NOT a gas at STP!)

\[
\frac{0.790 \text{ g}}{\text{mL}} \times 35.0 \text{ mL} = 27.65 \text{ g} \times \frac{1 \text{ mol}}{46.07 \text{ g}} \times \frac{6.022 \times 10^{23} \text{ molec}}{1 \text{ mol}} = 3.62 \times 10^{23} \text{ molec}
\]

Answer \[ 3.62 \times 10^{23} \text{ molec.} \]
7. A compound was analyzed and the following results were obtained:
Molar mass: 270.4 g/mol
Mass of sample: 162.24 g
Mass of potassium: 46.92 g
Mass of sulphur: 38.52 g
Mass of oxygen: the remainder of the sample is oxygen

a) Determine the mass of oxygen in the sample.
\[
\text{Mass of oxygen} = 162.24 - 46.92 - 38.52 = 76.8 \text{ g}
\]

b) Determine the empirical formula for this compound.

\[
\begin{align*}
\text{Potassium} & \quad \frac{46.92}{162.24} \times 100\% \times \frac{1 \text{ mol}}{39.1 \text{ g}} = 1.20 \div 1.2 = 1 \\
\text{Sulphur} & \quad \frac{38.52}{162.24} \times 100\% \times \frac{1 \text{ mol}}{32.1 \text{ g}} = 1.2 \div 1.2 = 1 \\
\text{Oxygen} & \quad \frac{76.8}{162.24} \times 100\% \times \frac{1 \text{ mol}}{16 \text{ g}} = 4.8 \div 1.2 = 4 \\
\end{align*}
\]
Answer: Empirical Formula: \( \text{K}_2\text{S}_2\text{O}_8 \)

c) Determine the molecular formula for this compound.

\[
\frac{\text{MF}}{\text{EF}} = \frac{270.4 \text{ g/mol}}{135.25 \text{ g/mol}} = 2 \times \text{K}_2\text{S}_2\text{O}_8
\]
Answer: Molecular Formula: \( \text{K}_2\text{S}_2\text{O}_8 \)

8. 123.11 g of zinc nitrate, \( \text{Zn(NO}_3\text{)}_2 \) are dissolved in enough water to form 650.0 mL of solution. Calculate the \([\text{Zn(NO}_3\text{)}_2]\) Include proper units in your work and in your answers.

\[
\begin{align*}
\text{Zinc nitrate} & \quad \frac{123.11}{189.49} \text{ mol} = 0.65 \text{ mol} \\
\text{Molarity} & \quad \frac{0.65 \text{ mol}}{0.65 \text{ L}} = 1.0 \text{ M}
\end{align*}
\]
9. Calculate the mass of potassium sulphite (K₂SO₃) needed to make 800.0 mL of a 0.200 M solution of K₂SO₃. Include proper units in your work and in your answers.

\[
0.200 \text{ mol} \times \frac{0.800 \text{ L}}{1 \text{ L}} = 0.160 \text{ mol} \times \frac{158.3 \text{ g}}{1 \text{ mol}}
\]

Answer \(25.328 \text{ g}\)

10. What volume of 2.50 M Li₂CO₃ would need to be evaporated in order to obtain 47.232 g of solid Li₂CO₃? Include proper units in your work and in your answers.

\[
47.232 \text{ g} \times \frac{1 \text{ mol}}{73.8 \text{ g}} = 0.64 \text{ mol}
\]

\[
V = \frac{0.64 \text{ mol}}{2.50 \text{ M}} = 0.256 \text{ L}
\]

Answer \(0.256 \text{ L}\)

11. 150.0 mL of water are added to 400.0 mL of 0.45 M HNO₃. Calculate the final \([\text{HNO}_3]\). Include proper units in your work and in your answers.

\[
m_1 v_1 = m_2 v_2
\]

\[
m_2 = \frac{(0.45 \text{ M})(400 \text{ mL})}{(150 \text{ mL})} = 0.327 \text{ M}
\]

Answer \(0.327 \text{ M}\)

12. What volume of water needs to be added to 150.0 mL of 4.00 M H₂SO₄ in order to bring the concentration down to 2.50 M? Include proper units in your work and in your answers.

\[
m_1 v_1 = m_2 v_2
\]

\[
(4.00 \text{ M})(150 \text{ mL}) \rightarrow v_2 = 240 \text{ mL} - 150 \text{ mL}
\]

Answer \(90 \text{ mL}\)

Unit 6—Chemical Reactions

1. Balance the following equations

\[
4 \text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}
\]

\[
3 \text{(NH}_4\text{)}_2\text{C}_2\text{O}_4 + 2\text{AlCl}_3 \rightarrow \text{Al}_2\text{(C}_2\text{O}_4)_3 + 6 \text{NH}_4\text{Cl}
\]

\[
2 \text{C}_6\text{H}_5\text{H}_3\text{O} + 4\text{B}_2 \rightarrow 2\text{B}_2\text{O}_3 + 3\text{H}_2\text{O}
\]

\[
2\text{Fe} + 6\text{HNO}_3 \rightarrow 2\text{Fe(NO}_3)_3 + 3\text{H}_2
\]
2. Write a balanced chemical equation for each of the following, and classify each as synthesis, decomposition, single replacement, double replacement, neutralization or combustion.

a) potassium sulphate is mixed with cobalt (III) nitrate

\[ 3 K_2SO_4 + 2Co(NO_3)_3 \rightarrow Co_3(SO_4)_3 + 6 KNO_3 \ (DR) \]

b) liquid propanol (C_3H_7OH) is burned in air

\[ 2C_3H_7OH + 9O_2 \rightarrow 6CO_2 + 8H_2O \ (combustion) \]

c) ammonium nitrate is decomposed into its elements

\[ 2 NH_4NO_3 \rightarrow 2N_2 + 4H_2O + 3O_2 \ (decomposition) \]

d) a piece of zinc is placed in a test-tube containing a solution of silver nitrate

\[ Zn + 2AgNO_3 \rightarrow 2Ag + Zn(NO_3)_2 \ (S.R.) \]

e) bromine reacts with sodium iodide

\[ Br_2 + 2NaI \rightarrow I_2 + 2NaBr \ (S.R.) \]

f) bromine reacts with aluminum

\[ 3Br_2 + 2Al \rightarrow 2AlBr_3 \ (synthesis) \]

g) rubidium reacts with chlorine gas

\[ 2Rb + Cl_2 \rightarrow 2RbCl \ (synth.) \]

h) hydrochloric acid reacts with strontium hydroxide

\[ 2HCl + Sr(OH)_2 \rightarrow 2H_2O + SrCl_2 \ (neutral) \]

3. State whether each of the following are exothermic or endothermic.

\[ HCl + 432 \text{ kJ} \rightarrow H + Cl \]

Answer \( \text{endo} \)

\[ C_12H_22O_11 + 12 O_2 \rightarrow 12CO_2 + 11H_2O \quad \Delta H = -5638 \text{ kJ} \]

Answer \( \text{exo} \)

\[ H_2O_{(s)} \rightarrow H_2O_{(l)} \]

Answer \( \text{endo} \)
Given the equation: \( \text{C}_{12}\text{H}_{22}\text{O}_{11} + 12\text{O}_2 \rightarrow 12\text{CO}_2 + 11\text{H}_2\text{O} + 5638 \text{ kJ} \)

a. How much heat is released during the formation of 880.0 g of \( \text{CO}_2 \)?

\[
880.0 \text{ g} \cdot \frac{1 \text{ mol}}{44 \text{ g} \cdot \text{mol}^{-1}} \cdot \frac{5638 \text{ kJ}}{12 \text{ mol}} = 9396.67 \text{ kJ}
\]

b. How much heat is released during the formation of 5.6 moles of \( \text{H}_2\text{O} \)?

\[
5.6 \text{ mol} \cdot \frac{5638 \text{ kJ}}{12 \text{ mol}} = 2870.25 \text{ kJ}
\]

c. If 179.2 L of \( \text{O}_2 \) (STP) are consumed, how much heat is released?

\[
179.2 \text{ L} \cdot \frac{1 \text{ mol}}{22.4 \text{ L}} \cdot \frac{5638 \text{ kJ}}{12 \text{ mol}} = 3758.67 \text{ kJ}
\]

5. Calculate the amount of heat (in Joules) required to warm 200.0 g of water from 8.0°C to 45.0°C. (Heat Capacity \( C \) for \( \text{H}_2\text{O} \) is 4180 J/kg °C)

\[
E = mc \Delta T = (0.200 \text{ kg}) \cdot (4180 \text{ J/kg °C}) \cdot (37°C - 8°C) = 30932 \text{ J}
\]

6. 13.376 kJ of heat are added to a 400.0 gram sample of water initially at 4.0°C. Calculate the final temperature of the water sample. Be careful with units! (Heat Capacity \( C \) for \( \text{H}_2\text{O} \) is 4180 J/kg °C)

\[
13376 \text{ J} = (0.4 \text{ kg}) \cdot (4180 \text{ J/kg °C}) \cdot \Delta T
\]

\[
\Delta T = \frac{13376 \text{ J}}{0.4 \text{ kg} \cdot 4180 \text{ J/kg °C}} = 8°C
\]

Final = 4°C + 8°C
Answers:

1) \([H^+] = 0.50 \text{ M} \quad [\text{Cl}] = 0.50 \text{ M}\)
2) \([H^+] = 6.00 \text{ M} \quad [\text{SO}_4^{2-}] = 3.00 \text{ M}\)
3) \([\text{Na}^+] = 4.61 \text{ M} \quad [\text{PO}_4^{3-}] = 1.54 \text{ M}\)
4) \([\text{Cu}^{2+}] = 0.0801 \text{ M} \quad [\text{SO}_4^{2-}] = 0.0801 \text{ M}\)
5) a) 0.0625 mol NaOH
   b) 0.0625 mol Na\(^+\) 0.0625 mol OH\(^-\)
6) a) 5.00 x 10\(^{-4}\) mol CoCl\(_2\)
   b) 5.00 x 10\(^{-4}\) mol Co\(^{2+}\) 1.00 x 10\(^{-3}\) mol Cl\(^-\)
7) a) 1.71 mol H\(_3\)PO\(_4\)
   b) 5.12 mol H\(^+\) 1.71 mol PO\(_4^{3-}\)
8) a) 5.79 x 10\(^{-3}\) mol Ca(OH)\(_2\)
   b) 5.79 x 10\(^{-3}\) mol Ca\(^{2+}\) 1.16 x 10\(^{-2}\) mol OH\(^-\)
9) a) 2.91 M H\(_2\)SO\(_4\)
   b) [H\(^+\)] = 5.81 M [SO\(_4^{2-}\)] = 2.91 M
10) a) 2.44 M HCl
    b) [H\(^+\)] = 2.44 M [Cl\(^-\)] = 2.44 M
11) a) 0.667 M KOH
    b) [K\(^+\)] = 0.667 M [OH\(^-\)] = 0.667 M
12) a) 0.395 M LiNO\(_3\) 1.51 M FeCl\(_3\)
    b) [Li\(^+\)] = 0.395 M [NO\(_3^-\)] = 0.395 M
    [Fe\(_{3+}\)] = 1.51 M [Cl\(^-\)] = 4.54 M
13) 62.5 mL of 12.0 M HCl mixed with water to raise volume to 250.0 mL
14) 2.77 mL of 18.0 M H\(_2\)SO\(_4\) mixed with water to raise volume to 50.0 mL
15) 3.33 mL of 15.0 M CH\(_3\)COOH mixed with water to raise volume to 100.0 mL
16) 50.0 mL of 15.0 M NH\(_3\) mixed with water to raise volume to 500.0 mL
Unit 7—Stoichiometry

1. Given the following balanced equation, answer the questions following it:

\[ 2\text{NF}_3(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + 6\text{HF}(\text{g}) \]

a) If 5.5 moles of \( \text{H}_2 \) are reacted, how many moles of \( \text{NF}_3 \) will be consumed?

\[
5.5 \text{ moles } \text{H}_2 \times \frac{2}{3} = \text{Answer } 3.67 \text{ mol}
\]

b) In order to produce 0.47 moles of \( \text{HF} \), how many moles of \( \text{NF}_3 \) would be consumed?

\[
0.47 \text{ mol } \text{HF} \times \frac{2}{6} = \text{Answer } 0.157 \text{ mol}
\]

c) If you needed to produce 180.6 g of \( \text{N}_2 \), how many moles of \( \text{H}_2 \) would you need to start with?

\[
180.6 \text{ g } \text{N}_2 \times \frac{1 \text{ mol}}{28 \text{ g}} \times 3 = \text{Answer } 19.35 \text{ mol}
\]

d) If you completely react 17.04 g of \( \text{NF}_3 \), what mass of \( \text{HF} \) will be produced?

\[
17.04 \text{ g } \text{NF}_3 \times \frac{1 \text{ mol}}{71 \text{ g}} \times \frac{6}{2} \times \frac{20.09 \text{ g}}{1 \text{ mol}} = \text{Answer } 14.4 \text{ g}
\]

2. Given the following balanced equation, answer the questions following it:

\[ \text{HBrO}_3 + 5 \text{ HBr} \rightarrow 3 \text{ H}_2\text{O}(\text{l}) + 3 \text{ Br}_2(\text{g}) \]

a) If 3.56 moles of \( \text{HBr} \) are reacted, how many Litres of \( \text{Br}_2 \) will be formed at STP?

\[
3.56 \text{ mol } \text{HBr} \times \frac{3}{5} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = \text{Answer } 47.85 \text{ L}
\]

b) In order to produce \( 3.311 \times 10^{24} \) molecules of \( \text{Br}_2 \), what mass of \( \text{HBr} \) is needed?

\[
3.311 \times 10^{24} \text{ molecules} \times \frac{1 \text{ mol}}{6.022 \times 10^{23}} \times \frac{5}{3} \times \frac{80.9 \text{ g}}{1 \text{ mol}} = \text{Answer } 741.6 \text{ g}
\]
4. Given the following balanced equation, answer the questions below it.

\[ \text{Ba(OH)}_2(\text{aq}) + 2 \text{HNO}_3(\text{aq}) \rightarrow 2 \text{H}_2\text{O}(\text{l}) + \text{Ba(NO}_3)_2 \]

\( \text{a) In a titration, 18.20 mL of 0.300 M Ba(OH)}_2 \text{ is required to react completely with a 25.0 mL sample of a solution of HNO}_3. \text{ Find the } [\text{HNO}_3]. \)

\[ \text{mol}_{\text{Ba(OH)}_2} = \frac{0.300 \text{ mol}}{0.0182 \text{ L}} = 0.00546 \text{ mol} \]

\[ \text{mol}_{\text{HNO}_3} = \frac{0.00546 \text{ mol} \times 2}{1} = 0.01092 \text{ mol} \]

\[ [\text{HNO}_3] = \frac{0.01092 \text{ mol}}{0.0250 \text{ L}} = 0.437 \text{ M} \]

\( \text{b) In a titration, 11.06 mL of 0.200 M HNO}_3 \text{ is required to react completely with a sample of 0.250 M Ba(OH)}_2. \text{ Find the volume of the Ba(OH)}_2 \text{ sample.} \)

\[ \text{mol}_{\text{HNO}_3} = \frac{0.200 \text{ mol}}{0.01106 \text{ L}} = 0.002212 \text{ mol} \]

\[ \text{mol}_{\text{Ba(OH)}_2} = \frac{0.002212 \text{ mol} \times 1}{2} = 0.001106 \text{ mol} \]

\[ V = \frac{0.001106 \text{ mol}}{0.250 \text{ M}} = 0.004424 \text{ L} \]

5. Given the following balanced equation, answer the questions below it.

\[ 3 \text{Cu(s)} + 8\text{HNO}_3(\text{l}) \rightarrow 3 \text{Cu(NO}_3)_2(\text{aq}) + 2\text{NO}_2(\text{g}) + 4 \text{H}_2\text{O}(\text{l}) \]

\( \text{a) If 317.5 grams of Cu are placed into 756.0 grams of HNO}_3, \text{ determine which reactant is in excess.} \)

\[ \text{Cu} = \frac{317.5 \text{ g}}{63.5 \text{ g}} \times 5 \text{ mol} = 5.0 \text{ mol} \]

\[ \text{HNO}_3 = \frac{756.0 \text{ g}}{63.5 \text{ g}} \times \frac{2}{8} \times \frac{30 \text{ g}}{1 \text{ mol}} = 90 \text{ mol} \]

\[ \text{Cu is in excess} \]

\( \text{b) If the reaction in (a) is carried out, what mass of NO will be formed?} \)

\[ \text{HNO}_3 \text{ is limiting reagent:} \]

Answer \[ 90.0 \text{ g} \]
Unit 8—Atoms, Periodic Table and Bonding

1. Give the number of protons, neutrons and electrons in the following:

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Protons</th>
<th>Neutrons</th>
<th>Electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{194}_{1}Ir^{3+}$</td>
<td>77</td>
<td>117</td>
<td>74</td>
</tr>
<tr>
<td>$^{202}_{80}Hg^{2+}$</td>
<td>80</td>
<td>122</td>
<td>78</td>
</tr>
<tr>
<td>$^{125}_{52}Te^{2-}$</td>
<td>52</td>
<td>73</td>
<td>54</td>
</tr>
<tr>
<td>$^{263}_{106}Sg$</td>
<td>106</td>
<td>157</td>
<td>106</td>
</tr>
<tr>
<td>$^{2}_{1}H^{+}$</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

2. Give the nuclear notation of the following:

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Protons</th>
<th>Neutrons</th>
<th>Electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{262}_{105}Db^{+2}$</td>
<td>105</td>
<td>157</td>
<td>103</td>
</tr>
<tr>
<td>$^{125}_{51}Sb^{+3}$</td>
<td>51</td>
<td>72</td>
<td>48</td>
</tr>
<tr>
<td>$^{75}_{33}As^{-3}$</td>
<td>33</td>
<td>42</td>
<td>36</td>
</tr>
<tr>
<td>$^{133}_{54}Xe$</td>
<td>54</td>
<td>79</td>
<td>54</td>
</tr>
<tr>
<td>$^{244}_{94}Pu^{+5}$</td>
<td>94</td>
<td>150</td>
<td>91</td>
</tr>
</tbody>
</table>
Write the ground state electron configurations (eg. 1s^2 2s^2 2p^6) for the following atoms or ions. You may use the core notation.

- **P**: [Ne] 3s^2 3p^3
- **b) Mo**: [Kr] 5s^2 4d^4
- **c) Se**: [Ar] 4s^2 3d^10 4p^4
- **d) Rb**: [Kr] 5s^1
- **e) Cl**: [Ne] 3s^2 3p^6
- **f) Al^3+**: [Ne] 2s^2 2p^6
- **g) K^+**: [Ne] 3s^2 3p^6
- **h) S^2-**: [Ne] 3s^2 3p^6

In order to become stable,

- an atom of Sr will lose 2 electrons and become the ion Sr^{+2}
- an atom of As will gain 3 electrons and become the ion As^{-3}
- an atom of Al will lose 3 electrons and become the ion Al^{3+}
- an atom of Se will gain 2 electrons and become the ion Se^{-2}
- an atom of N will gain 3 electrons and become the ion N^{-3}
- an atom of I will gain 1 electron and become the ion I^{-}
- an atom of Cs will lose 1 electron and become the ion Cs^{+}
- an atom of Te will gain 2 electrons and become the ion Te^{-2}

Circle the metalloid: Be Rb Os Ge Pb Al

Circle the most reactive element in the following: Na Mg Si Al Ar
Circle the most reactive element in the following: Na K Rb Cs Li
Circle the most reactive element in the following: Cl Br I At Ne
Circle the element with the largest atomic radius of these: Na Mg Si Al Ar
Circle the element with the largest atomic radius of these: N P As Sb Br
Circle the element with the largest ionization energy of these: K Ca Ga As Kr

Circle the element with the largest ionization energy of these: Si Ge Sn Pb

What is meant by ionization energy? E to remove outer e

Circle the element with the largest density of these: C Si Ge Sn Pb

Circle the element with the largest density of these: Na K Rb Li

Circle the element with the highest electronegativity of these: Mg Sr Ba Ra

Circle the element with the highest electronegativity of these: Mg Si S Cl

Circle the element with the highest electronegativity of these: Cl Br I

What is meant by electronegativity? attraction of an atom for e− of another atom

Circle the most metallic element of these: Be Mg Ca Sr Ba

Circle the most metallic element of these: B Al Ga In

Circle the most metallic element of these: Ga Ge Se Br Kr

Write a balanced equation for the reaction of potassium with water.

\[ 2K + 2H_2O \rightarrow H_2 + 2KOH \]

Write a balanced equation for the reaction of aluminum with bromine.

\[ 2Al + 3Br_2 \rightarrow 2AlBr_3 \]

In an ionic bond, electrons are
a. shared equally by two atoms
b. shared unequally by two atoms
c. transferred from a metal to a non-metal
d. transferred from a non-metal to a metal
e. closer to one end of a molecule, forming a temporary dipole

Answer ________

In a covalent bond, electrons are
f. shared equally by two atoms
g. shared unequally by two atoms
h. transferred from a metal to a non-metal
i. transferred from a non-metal to a metal
j. closer to one end of a molecule, forming a temporary dipole

Answer ________

In London forces, electrons are
p. shared equally by two atoms
q. shared unequally by two atoms
r. transferred from a metal to a non-metal
s. transferred from a non-metal to a metal
t. closer to one end of a molecule, forming a temporary dipole

Answer ________
What physical evidence do we have that ionic bonds are very strong?

Ionic compounds have high melting points.

29. Write electron-dot diagrams for:
   MgCl₂ (ionic)       PBr₃ (covalent)       SeF₄ (covalent)       CH₃CH₂I (covalent)

\[ \text{Cl}^\text{-} \quad \text{Mg}^{2+} \quad \text{Br}^- \quad \text{P} \quad \text{Br}^- \quad \text{Se} \quad \text{F} \quad \text{H} \quad \text{C} \quad \text{H} \quad \text{H} \quad \text{C} \quad \text{E} \]
Yet More Lewis Structures – Answers

For those of you that enjoy such things, some more Lewis structures to draw:

1) BSF

\( \overset{\cdot}{S} = B - \overset{\cdot}{F} \)

2) HBr

\( H - Br \)

3) C\(_2\)H\(_5\)OH (ethanol)

\( H - C - C - O - H \)

4) N\(_2\)F\(_4\)

\( \overset{\cdot}{F} - N = N = F \)

5) SF\(_6\)

\( F - S - F \)

6) \( [O - P - O]^{-3} \)

7) \( [O - H]^{-1} \)