Introduction to Chemistry

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

   Answer ________________

2. \( 0.054 \text{ mL} = ? \text{ nL} \)

   Answer ________________

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

   Answer ________________

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

   Answer ________________

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

   Answer ________________

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

   Answer ________________

7. Give the number of significant digits in each of the following. Assume they are all measurements.

   a) 0.0023 ________________  d) \( 3.2 \times 10^{-4} \) __________________

   b) 3953 000 ________________  e) 50020.000 __________________

   c) \( 1.0200 \times 10^3 \) ________________  f) 3450 __________________

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) \( 2.1500 \times 0.31 \) ________________  f) \( 8.90 \times 10^3 - 4.00 \times 10^4 \) ________________

   b) 0.05 + 394.7322 ________________  g) 83.00 ÷ 1.2300 \times 10^2 ________________

   c) \( 4.905 \times 10^6 ÷ 4 \times 10^{-2} \) ________________  h) 98.0076 - 2.195 ________________

   d) \( (3.33 \times 9.52) + 13.983 \) ________________  i) 0.00000200 \times 245.912 ________________

   e) \( 3.813 + 98.98 + 2.669 \) ________________  j) \( 5.802 ÷ 6.21 + 2.41 ÷ 9.2565 \) ________________

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

   a) 2 000 000 000 ________________  c) \( 3.88945 \times 10^{28} \) ________________

   b) 106 000 ________________  d) 0.00 000 7895 ________________
Properties of Matter


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

3. Concerning separation techniques…
   a) Explain how distillation can be used to separate the substances in a solution.
   b) What types of mixtures does paper chromatography work best for?
   c) Explain how a centrifuge separates the components of a suspension.

4. Define a physical change –
   Give some examples of physical changes.

5. Define a chemical change –
   Give some examples of chemical changes.
6. Given the following graph of Temperature vs. Time for warming substance “X” which
starts out as a solid, answer the questions below:

![](image)

a) During time 0.0 – 5.0 minutes, the added heat energy is being used to
__________________________________________________________________________

b) During time 5.0 – 15.0 minutes, the added heat energy is being used to
__________________________________________________________________________

c) During time 15.0 – 20.0 minutes, the added heat energy is being used to
__________________________________________________________________________

d) During time 20.0 – 28.0 minutes, the added heat energy is being used to
__________________________________________________________________________

e) The melting point of substance “X” is _________________________

f) The boiling point of substance “X” is _________________________

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 _________________________

h) What phase is substance “X” at 90°C? ______________________________

i) Explain WHY the curve levels off between 5.0 min. and 15.0 min.

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Names and Formulas for Compounds

1. Write the correct formula for the following compounds:
   a) ammonium chlorate ...................................................... ________________________
   b) copper (II) sulphite ........................................................ ________________________
   c) zinc carbonate tetrahydrate ........................................... ________________________
   d) nitric acid ...................................................................... ________________________
   e) phosphorus pentaiodide ................................................ ________________________
   f) iron (III) thiocyanate ..................................................... ________________________
   g) sulphuric acid ................................................................ ________________________
   h) dinitrogen tetrafluoride ................................................. ________________________

2. Write the correct names for the following compounds:
   a) Mn(SO₄)₂ ...................................... _________________________________________
   b) PbCrO₄·6H₂O ............................... _________________________________________
   c) As₂O₃ ............................................ _________________________________________
   d) CH₃COOH ................................... _________________________________________ acid
   e) Ni₂(C₂O₄)₃ ........................................ _________________________________________
   f) NF₃ ............................................... _________________________________________
   g) (NH₄)₂HPO₄ ........................................ _________________________________________
   h) Ba(OH)₂·10H₂O............................ _________________________________________
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 PCl₅ = ? moles

   Answer __________________________

   b) 0.00256 moles of Li₂Cr₂O₇ = ? grams

   Answer __________________________

   c) 170.24 L of NO₂ at STP = ? moles

   Answer __________________________

   d) 570.625 g of PCl₃ gas = ? L (STP)

   Answer __________________________

   e) 1030.4 mL of C₂H₆ gas at STP = ? g

   Answer __________________________

   f) 5.00 kg of nitrogen gas = ? L (STP)

   Answer __________________________

2. The density of liquid ethanol (C₂H₅OH) 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!)

   Answer __________________________

3. A 100.0 mL sample of liquid mercury contains 6.78 moles. Calculate the density of liquid mercury from this data.

   Answer __________________________

4. Calculate the density of PCl₃(g) at STP.

   Answer __________________________
5. a) The density of a gas at STP is 4.955 g/L. Calculate the molar mass of this gas.

b) The gas is an oxide of selenium. Determine the molecular formula.

Answer __________________________

6. Find the percent composition (% by mass of each element) in the following compound: Sr₃(PO₄)₂. Show your work.

Answer _______%Sr, _______%P, _______%O

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.

Answer ___________________

b) Determine the empirical formula for this compound.

Answer: Empirical Formula: _____________________

c) Determine the molecular formula for this compound.

Answer: Molecular Formula: _____________________

8. 123.11 g of zinc nitrate, Zn(NO₃)₂, are dissolved in enough water to form 650.0 mL of solution. Calculate the [Zn(NO₃)₂] Include proper units in your work and in your answers.

Answer _______________________________

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.

Answer ______________________

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.

Answer ______________________

11. 150.0 mL of water are added to 400.0 mL of 0.45 M HNO₃. Calculate the final [HNO₃]. Include proper units in your work and in your answers.

Answer ______________________
12. What volume of water needs to be added to 150.0 mL of 4.00 M H\textsubscript{2}SO\textsubscript{4} in order to bring the concentration down to 2.50 M? Include proper units in your work and in your answers.

Answer ______________________

13. Give directions on how to make 5.00 L of 0.020 M Ca(ClO)\textsubscript{2} using solid Ca(ClO)\textsubscript{2} and water. Include proper units in your work and in your answers.

Directions:

**Chemical Reactions**

1. Balance the following equations

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

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

   \[ \text{C}_4\text{H}_{10} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]

   \[ \text{Fe} + \text{HNO}_3 \rightarrow \text{Fe(NO}_3)_3 + \text{H}_2 \]

   \[ \text{P}_4 + \text{Cl}_2 \rightarrow \text{PCl}_3 \]

   \[ \text{Na}_2\text{Cr}_2\text{O}_7 + \text{HCl} \rightarrow \text{NaCl} + \text{CrCl}_3 + \text{H}_2\text{O} + \text{Cl}_2 \]

   \[ \text{H}_3\text{PO}_4 + \text{Ca(OH)}_2 \rightarrow \text{Ca}_3(\text{PO}_4)_2 + \text{H}_2\text{O} \]

   \[ \text{Ba(ClO}_4)_2 \rightarrow \text{Ba} + \text{Cl}_2 + \text{O}_2 \]

   \[ \text{C}_7\text{H}_{15}\text{OH} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]

   \[ \text{MgSO}_4\cdot5\text{H}_2\text{O} \rightarrow \text{MgSO}_4 + \text{H}_2\text{O} \]
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
b) liquid propanol (C₃H₇OH) is burned in air
c) ammonium nitrate is decomposed into it’s elements
d) a piece of zinc is placed in a test-tube containing a solution of silver nitrate
e) bromine reacts with sodium iodide
f) bromine reacts with aluminum
g) rubidium reacts with chlorine gas
h) hydrochloric acid reacts with strontium hydroxide

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

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Energy (kJ)</th>
<th>Reaction Proceeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCl + 432 kJ → H + Cl</td>
<td>Answer</td>
<td></td>
</tr>
<tr>
<td>C₁₂H₂₂O₁₁ + 12 O₂ → 12CO₂ + 11H₂O + 5638 kJ</td>
<td>ΔH = -5638 kJ</td>
<td>Answer</td>
</tr>
<tr>
<td>H₂O(l) → H₂O(l)</td>
<td>Answer</td>
<td></td>
</tr>
<tr>
<td>A + B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD → C + D</td>
<td>ΔH= 65.7 kJ</td>
<td>Answer</td>
</tr>
<tr>
<td>E + F + 437 kJ → G + H</td>
<td>Answer</td>
<td></td>
</tr>
</tbody>
</table>

4. Given the equation: C₁₂H₂₂O₁₁ + 12 O₂ → 12CO₂ + 11H₂O + 5638 kJ

a. How much heat is released during the formation of 880.0 g of CO₂?
   Answer ___________________________

b. How much heat is released during the formation of 5.6 moles of H₂O?
   Answer ___________________________

c. If 179.2 L of O₂ (STP) are consumed, how much heat is released?
   Answer ___________________________
Stoichiometry

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

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

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

Answer ____________

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

Answer ____________

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

Answer ____________

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

Answer ____________

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

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

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

Answer ______________

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

Answer ______________

3. Given the following balanced chemical equation, answer the question below it.

\[ \text{MgCO}_3(s) + 2\text{HCl}(aq) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O}(l) + \text{MgCl}_2(aq) \]

a) What mass of MgCO\(_3\) will react completely with 15.0 mL of 1.5 M HCl?

Answer ______________

b) Calculate the volume of 2.0 M HCl which would be needed to react completely with 37.935 grams of magnesium carbonate.

Answer ______________
4. Given the following balanced equation, answer the questions below it.

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

a) In a titration, 18.20 mL of 0.300 M Ba(OH)₂ is required to react completely with a 25.0 mL sample of a solution of HNO₃. Find the [HNO₃].

Answer _______________________

b) In a titration, 11.06 mL of 0.200 M HNO₃ is required to react completely with a sample of 0.250M Ba(OH)₂. Find the volume of the Ba(OH)₂ sample.

Answer _______________________

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

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

a) If 317.5 grams of Cu are placed into 756.0 grams of HNO₃, determine which reactant is in excess.

Answer _______________________

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

Answer _______________________

6. Given the balanced equation: \[2\text{BN} + 3\text{F}_2 \rightarrow 2\text{BF}_3 + \text{N}_2\]

When 161.2 grams of BN are added to an excess of F₂, a reaction occurs in which 326.118 grams of BF₃ are formed.

a) Calculate the theoretical yield of BF₃ in grams.

Answer _______________________

b) Calculate the percentage yield of BF₃.

Answer _______________________

7. When reacting \(\text{NH}_3\) with \(\text{O}_2\) according to the reaction:

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

Using 163.2 grams of \(\text{NH}_3\) with an excess of \(\text{O}_2\) produces a 67% yield of NO.

a) Calculate the theoretical yield of NO in grams.

Answer _______________________

b) Calculate the actual yield of NO in grams.

Answer _______________________
Atoms, Periodic Table and Bonding

2. Consider the following ideas:
   ➢ Compounds are made up of molecules which are combinations of atoms
   ➢ All atoms of an element are the same
   ➢ Atoms of different elements are different
   ➢ Atoms are indivisible particles
   Who came up with these ideas? ______________________ He called the ideas, the ______________________ Theory.

3. __________________ measured the charge/mass ratio of an electron and came up with the so-called “plum pudding” model of the atom.

4. __________________ devised the Scattering Experiment, which showed that all atoms had a small dense ______________________.

5. Bohr came up with an atomic model to explain the spectrum of ______________________. He said that the atom has certain _______________ levels which are allowed. These levels corresponded to _______________ in which electrons move. If an electron absorbs a certain photon of energy, it will jump to a _______________ level. It will release this energy (in the form of __________________) when it jumps back to a _______________ level.

What were two limitations of Bohr’s atomic model?

6. 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>194Ir^{3+}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>206Hg^{2+}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>125Te^{-}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>261Sg^{-}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>^{1}H</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. 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>105</td>
<td>51</td>
<td>72</td>
<td>48</td>
</tr>
<tr>
<td>51</td>
<td>33</td>
<td>42</td>
<td>36</td>
</tr>
<tr>
<td>33</td>
<td>54</td>
<td>79</td>
<td>54</td>
</tr>
<tr>
<td>94</td>
<td>150</td>
<td>91</td>
<td></td>
</tr>
</tbody>
</table>

8. Element “X” is composed of the following naturally occurring isotopes:

<table>
<thead>
<tr>
<th>Isotope</th>
<th>% Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>50.69</td>
</tr>
<tr>
<td>X</td>
<td>49.31</td>
</tr>
</tbody>
</table>

Calculate the average atomic mass of element “X” to 3 decimal places.

Element “X” is actually the real element ______________________.

9. Regions in space occupied by electrons are called _______________.

10. The principal quantum number is given the letter ____ and refers to the _______________ level.
11. Write the ground state electron configurations (e.g. 1s² 2s² 2p⁶) for the following atoms or ions. You may use the core notation.
   a) P
   b) Mo
   c) Se
   d) Rb
   e) Cl⁻
   f) Al³⁺
   g) K⁺
   h) S²⁻

12. In order to become stable,
   an atom of Sr will __________   ___ electrons and become the ion ________
   an atom of As will __________   ___ electrons and become the ion ________
   an atom of Al will __________   ___ electrons and become the ion ________
   an atom of Se will __________   ___ electrons and become the ion ________
   an atom of N will __________   ___ electrons and become the ion ________
   an atom of I will __________   ___ electrons and become the ion ________
   an atom of Cs will __________   ___ electrons and become the ion ________
   an atom of Te will __________   ___ electrons and become the ion ________

13. Circle the metalloid:   Be   Rb   Os   Ge   Pb   Al

14. Circle the most reactive element in the following:  Na   Mg   Si   Al   Ar

15. Circle the most reactive element in the following:  Na   K   Rb   Cs   Li

16. Circle the most reactive element in the following:  Cl   Br   I   At   Ne

17. Circle the element with the largest atomic radius of these:  Na   Mg   Si   Al   Ar

18. Circle the element with the largest atomic radius of these:  N   P   As   Sb   Bi

19. Circle the element with the largest ionization energy of these:  K   Ca   Ga   As   Kr

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

21. What is meant by ionization energy?

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

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

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

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

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

27. What is meant by electronegativity?

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

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

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

31. 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 ________

32. 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 ________

33. In a polar covalent bond, electrons are
   k. shared equally by two atoms
   l. shared unequally by two atoms
   m. transferred from a metal to a non-metal
   n. transferred from a non-metal to a metal
   o. closer to one end of a molecule, forming a temporary dipole   Answer ________
34. 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 ________

35. What evidence do we have that ionic bonds are very strong?

36. Write electron-dot diagrams for:
   MgCl₂ (ionic)    PBr₃ (covalent)    SeF₆ (covalent)    CH₃CH₂I (covalent)

Remember...

Organic Chemistry and Safety are also Fair game for the Final!!

Study Hard!

"OK, Mr. Dittmars, remember: That brain is only a temporary, so don't think too hard with it!"