*Dr Brian Bridgewater*
*Science Faculty*
*Notre Dame High School*

**AP Chem Summer Work**

Hello Chemists!

Welcome to Advanced Placement Chemistry aka "AP Chem". This course is a college level endeavor and as such you are expected to prepare for it and participate in it at a level that would be expected in college. College level Chemistry assumes that you have not only previously taken Chemistry in high school but that you fully mastered that material and are ready, willing, and able to build on it. Your AP Chem course at Notre Dame will begin and continue in a similar vein.

The good news is that the first half of the formal Summer Packet attached below for completion ahead of the course is provided with answers but as they say "Every silver lining has a cloud." and you may still find that you have a lot of work to do in order to be prepared before class starts. Students who are successful at Chemistry in college are students who not only work hard, work smartly, continuously pursue their own independent study to address gaps in their skills and knowledge but also make sure that they have everything nailed down thoroughly from high school chemistry *before* they walk into their first college Chemistry class.

Those of you who had me as a STEM teacher know I'm fond of telling my students in the STEM Chemistry Unit that, "*Your Chemistry teacher next year will expect you to be able to do this the moment you walk in your door*." Well, that will be my approach to the content of your previous Honors Chemistry class from the moment you walk into our AP Chem class. To give you the opportunity to assess how well you have maintained your mastery of the content you encountered in your Honors Chemistry class **the first few days of AP Chemistry will contain three high school Honors Chemistry level assessments** – a smallish one on a core skill in Chemistry, a medium sized one based on the packet attached below (yes, you'll be able to refer to it), and a large Test level one. These assessments ***will* be graded and they *will* count towards your overall grade** for the course. Following that we will spend a day or two, at most, doing some very quick review and then launch into the new stuff!

The material I'll be expecting you to walk in the door knowing is essentially anything and everything that was covered in Honors Chemistry. These topics can include *but are **not** limited to* the following:

- Formula Naming & Writing.
- Reaction types, including balancing and predicting products.
- Stoichiometry, including limiting/excess reagents and percentage yield.
- Atomic Structure and Atomic Theory.
- Electron configuration including orbital diagrams.
- Nuclear chemistry.

- Matter, including categories of matter, states of matter, its properties and the changes it undergoes.
- Simple chemical calculations such as determining empirical formulas.
- Bonding and shapes including VSEPR theory.
- Gas Laws.
- Acids and Bases.
- Navigating and Using the Periodic Table including periodic trends.
- Measurement and how it impacts the precision of quantities in Chemistry including considering significant figures.
- Units and their manipulation including Dimensional Analysis.

You may be wondering how best to prepare for these early days of AP Chem and I have a few suggestions:

- Your initial starting point should be your course materials from your previous Honors Chemistry class.
- If your teacher utilized Topics pages on the school website you *should* still have access to any resources and prior online assessments that were posted there.
- If you utilized CK-12 previously there is a wealth of Chemistry material available to you on there. This includes reading material, tutorial videos, practice assessments, and even a text book or two. The scope of materials available to you ranges from very basic to very advanced and you should be able to dial it in to your needs.
- YouTube has some excellent tutorial videos for you to use. There's the ever present Kahn Academy but two that I prefer are the Brightstorm (search YouTube for "Brightstorm Chemistry") and Tyler DeWitt (search YouTube for "Tyler DeWitt Cheistry").

Remember that a successful AP Chem student continuously utilizes all of the skills that a successful college Chemistry student would need to employ and, as I mentioned earlier, this includes an ability to "*pursue their own independent study to address gaps in their skills and knowledge*". **We'll be starting with an assessment on the first day of AP Chem** from one of the topics above; it's up to you to make sure you are fully prepared!

Happy Studying!

Dr B

**AP Chemistry Summer Packet**

Part A: Practice – complete before looking at the rest of the packet.

Part B: Review – use to address any gaps in your understanding you discovered working on Part A.

Part C: Assessment – have Part C fully completed for the first day of class.

**Part A: Practice – complete before looking at the rest of the packet.**

1. Describe solids, liquids and gases in terms of how they fill a container. Use your descriptions to identify the physical state (at room temperature) of the following: (a) helium in a child's balloon; (b) mercury in a thermometer; (c) soup in a bowl.
2. Define physical change and chemical change. State which type of change occurs in each of the following statements: (a) Passing an electric current through molten magnesium chloride yields molten magnesium and gaseous chlorine. (b) The iron in discarded automobiles slowly forms reddish brown, crumbly rust.
3. Which of the following is a chemical change? Explain your reasoning; (a) boiling canned soup; (b) toasting a slice a bread; (c) chopping a log; (d) burning a log.
4. For each pair, which has higher kinetic energy? (a) A sled resting at the top of a hill or a sled sliding down the hill (b) Water above a dam or water falling over the dam.
5. Why is a quantitative observation more useful than a nonquantitative one? Which of the following are quantitative? (a) The sun rises in the east. (b) A person weighs one-sixth as much on the moon as on earth (c) ice floats on water (d) a hand pump cannot draw water from a well more than 34 feet deep.
6. Explain the difference between mass and weight. Why is your weight on the moon one-sixth that on earth?
7. For each of the following cases, state whether the density of the object increases, decreases or remains the same: (a) a sample of chlorine gas is compressed (b) a lead weight is carried up a high mountain (c) a sample of water is frozen (d) an iron bar is cooled (e) a diamond is submerged in water.
8. What is the length in inches of a 100 meter soccer field?
9. The center on your basketball team is 6 ft. 10 in tall. How tall is the player in mm?
10. The speed of light in a vacuum is $2.998 \times 10^8$ m/s. What is its speed in (a) km/h; (b) miles/min
11. The average density of Earth is 5.52 g/cm$^3$. What is its density in (a) kg/m$^3$; (b) lb/ft$^3$?
12. A small cube of aluminum measures 15.6 mm on a side and weighs 10.25 g. What is the density of aluminum in g/cm$^3$?
13. Perform the following conversions: (a) 68$^o$F (a pleasant spring day) to $^o$C and K (b) -164$^o$C (the boiling point of methane, the main component of natural gas) to K and $^o$F. (c) 0 K (absolute zero) to $^o$C and $^o$F.
14. Round off each number to the indicated number of significant figures (sf): (a) 0.0003554 (to 2 sf); (b) 35.8348 (to 4 sf); (c) 22.4555 (to 3 sf).

15. Round off each number to the indicated number of significant figures (sf):
    (a) 231.554 (to 4 sf); (b) 0.00845 (to 2 sf); (c) 144,000 (to 2 sf).

16. Carry out the following calculations, making sure that your answer has the correct number of significant figures:

    a. $\dfrac{2.795 \text{ m} \times 3.10 \text{ m}}{6.48 \text{ m}}$

b. $V = 4/3\ \pi r^2$ where r = 17.282 mm
c. 1.110 cm + 17.3 cm + 108.2 cm + 316 cm

17. Write the following numbers in scientific notation:
    a. 131,000.0
    b. 0.00047
    c. 210,006
    d. 2160.5
18. Write the following numbers in standard notation. Use a terminal decimal point when needed:
    a. $5.55 \times 10^3$
    b. $1.0070 \times 10^4$
    c. $8.85 \times 10^{-7}$
    d. $3.004 \times 10^{-3}$

19. Convert the following into correct scientific notation:
    a. $802.5 \times 10^2$
    b. $1009.8 \times 10^{-6}$
    c. $0.077 \times 10^{-9}$
20. A laboratory instructor give a sample of amino-acid powder to each of four students (I, II, III, and IV) and they weigh the samples. The true value is 8.72 g. Their results for three trials are

    I: 8.72 g, 8.74 g, 8.70 g

    II: 8.56 g, 8.77 g, 8.83 g

    III: 8.50 g, 8.48 g, 8.51 g

    IV: 8.41 g, 8.72 g, 8.55 g

    (a) Calculate the average mass from each set of data, and tell which set is the most accurate.
    (b) Precision is a measure of the average of the deviations of each piece of data from the average value. Which set of data is the most precise? Is this set also the most accurate?
    (c) Which set of data is both the most accurate and most precise?
    (d) Which set of data is both the least accurate and least precise?

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21. What is the key difference between an element and a compound?
22. List two differences between a compound and a mixture.
23. Which of the following are pure substances? Explain.

a. Calcium chloride, used to melt ice on roads, consists of two elements, calcium and chlorine, in a fixed mass ratio.
b. Sulfur consists of sulfur atoms combined into octatomic molecules.
c. Baking powder, a leavening agent, contains 26% to 30% sodium hydrogen carbonate and 30% to 35% calcium dihydrogen phosphate by mass.
d. Cytosine, a component of DNA, consists of H, C, N and O atoms bonded in a specific arrangement.

24. Classify each substance in number 23 as an element, compound, or mixture, and explain your answers.

25. Samples of illicit "street" drugs often contain an inactive component, such as ascorbic acid (vitamin C). After obtaining a sample of cocaine, government chemists calculate the mass of vitamin C per gram of drug sample, and use it to track the drug's distribution. For example, if different samples of cocaine obtained on the streets of New York, Los Angeles, and Paris all contain 0.06384 g of vitamin C per gram of sample, they very likely come from a common source. Do these street samples consist of a compound element, or mixture? Explain.
26. Magnesium oxide forms when the metal burns in air. How many grams of Mg are in 534 g of MgO?
27. Argon has three naturally occurring isotopes, $^{36}Ar$, $^{38}Ar$, and $^{40}Ar$. What is the mass number of each? How many protons, neutrons, and electrons are present in each?
28. Chlorine has two naturally occurring isotopes, $^{35}Cl$ and $^{37}Cl$. What is the mass number of each isotope? How many protons, neutrons, and electrons are present in each?
29. Do both members of the following pairs have the same number of protons? Neutrons? Electrons?
    a. $^{16}O$ and $^{17}O$
    b. $^{40}Ar$ and $^{41}K$
    c. $^{60}Co$ and $^{60}Ni$

    Which pair(s) consist(s) of atoms with the same Z value (atomic number)? N value (number of neutrons)? A value (mass number)?

30. Gallium has two naturally occurring isotopes, $^{69}Ga$ (isotopic mass 68.9256 amu, abundance 60.11%) and $^{71}Ga$ (isotopic mass 70.9247 amu, abundance 39.89%). Calculate the atomic mass of gallium.
31. Magnesium has three naturally occurring isotopes, $^{24}Mg$ (isotopic mass 23.9850 amu, abundance 78.99%), $^{25}Mg$ (isotopic mass 24.9858 amu, abundance 10.00%), and $^{26}Mg$ (isotopic mass 25.9826 amu, abundance 11.01%). Calculate the atomic mass of magnesium.
32. Correct each of the following statements:
    a. In the modern periodic table, the elements are arranged in order of increasing atomic mass.
    b. Elements in a period have similar chemical properties
    c. Elements can be classified as either metalloids or nonmetals.

33. Give the name, atomic symbol, and group number of the element with the following Z value and classify it as a metal, nonmetal or metalloid:
    a. Z = 32
    b. Z = 15
    c. Z = 2
    d. Z = 3
    e. Z = 42

34. Write an empirical formula for each of the following:
    a. Hydrazine, a rocket fuel, molecular formula, $N_2H_4$
    b. Glucose, a sugar, molecular formula $C_6H_{12}O_6$

35. Give the name and formula of the compound formed from the following elements:
    a. Sodium and nitrogen
    b. Oxygen and strontium
    c. Aluminum and chlorine
36. Give the name for the formula or the formula for the name in each:
    a. $Na_2HPO_4$
    b. Potassium carbonate dehydrate
    c. $NaNO_2$
    d. Ammonium perchlorate

37. Correct each of the following formulas:
    a. Barium oxide $BaO_2$
    b. Iron (II) nitrate $Fe(NO_3)_3$
    c. Magnesium sulfide $MnSO_4$

38. Correct each of the following names:
    a. CuI is cobalt (II) iodide
    b. $Fe(HSO_4)_3$ is iron (II) sulfate
    c. $MgCr_2O_7$ is magnesium dichromium heptoxide
39. Many chemical names are similar at first glance. Give the formulas of the species in each set:
    a. Ammonium ion and ammonia
    b. Magnesium sulfide and magnesium sulfite and magnesium sulfate
    c. Hydrochloric acid, chloric acid and chlorous acid
    d. Copper (I) bromide and copper (II) bromide

40. Correct the name to match the formula of the following comounds
    a. Calcium (II) dichloride $CaCl_2$
    b. Copper (II) oxide $Cu_2O$
    c. Tin (II) tetrafluoride $SnF_4$
    d. Hydrogen chloric acid HCl

41. Give the number of atoms of the specified element in a formula unit of each of the following compounds, and calculate the molecular (formula) mass:
    a. Hydrogen in ammonium benzoate, $C_6H_5COONH_4$
    b. Nitrogen in hydrazinium sulfate, $N_2H_6SO_4$
    c. Oxygen in the mineral leadhilite, $Pb_4SO_4(CO_3)_2(OH)_2$
42. Write the formula of each compound, and determine its molecular (formula) mass;
    a. Ammonium sulfate
    b. Sodium dihydrogen phosphate
    c. Potassium bicarbonate
43. Before the use of systematic names, many compounds had common names. Give systematic name for each of the following:
    a. Blue vitriol, $CuSO_4 \cdot 5H_2O$
    b. Slaked lime, $Ca(OH)_2$
    c. Oil of vitriol, $H_2SO_4$
    d. Washing soda, $Na_2CO_3$
    e. Muriatic acid, HCl
    f. Epsom salt, $MgSO_4 \cdot 7H_2O$
    g. Chalk, $CaCO_3$
    h. Dry ice, $CO_2$
    i. Baking soda, $NaHCO_3$
    j. Lye, NaOH
44. Ammonium dihydrogen phosphate, formed from the reaction of phosphoric acid with ammonia, is used as a crop fertilizer as well as a component of some fire extinguishers.
    a. What are the mass percentages of N and P in the compound?
    b. How much ammonia is incorporated into 100. g of compound?
45. Give the formula of the compounds in each set
    a. Lead (II) oxide and lead (IV) oxide
    b. Lithium nitride, lithium nitrite, lithium nitrate
    c. Strontium hydride and strontium hydroxide
    d. Magnesium oxide and manganese (II) oxide
46. Give the number of atoms of the specified element in a formula unit of each of the following compounds, and calculate the molecular (formula) mass:
    a. Oxygen in aluminum sulfate
    b. Hydrogen in ammonium hydrogen phosphate
    c. Oxygen in the mineral azurite, $Cu_3(OH)_2(CO_3)_2$

**Part B: Review – use to address any gaps in your understanding you discovered working on Part A.**

Link to Part B (you must use your ND login)

**Part C: Assessment – have Part C fully completed for the first day of class.**

# AP Chemistry Summer Assignment

| | |
|---|---|
| **Topic 1** | Significant Figures |
| **Topic 2** | Metric and Temperature Conversions |
| **Topic 3** | Nomenclature |
| **Topic 4** | Atomic Structure |
| **Topic 5** | Writing and Balancing Chemical Equations |
| **Topic 6** | Moles and Stoichiometry |
| **Topic 7** | Graphing and Data Analysis |
| **Topic 8** | Particulate Drawings |

# Topic 1: Significant Figures

1. Determine the number of significant figures in each of the following:

   a. 0.7540 _____

   b. 12500 _____

   c. 1000.01 _____

   d. 1200 _____

   e. $1.04 \times 10^3$ _____

   f. 0.0080050 _____

2. Perform the following calculations and round to the appropriate number of significant figures:

   a. $34.66 + 333.0$ _____

   b. $1.23 + 9.66$ _____

   c. $455 - 1.22$ _____

   d. $18.2 \times 1.998$ _____

   e. $10.2 \div 1.34$ _____

   f. $\frac{100.23+59.4}{5.22}$ _____

3. Round each of the following numbers to three significant figures:

   a. 167.789 _____

   b. 0.00000445345 _____

   c. 25.0545 _____

   d. 3.1415926536 _____

   e. 8504.0435 _____

   f. 14.4355 _____

# Topic 2: Metric and Temperature Conversions

1. Use dimensional analysis (factor-label method) to make the following metric conversions:

   a. 3.40 m to cm _____ × _____ = _____

   b. 289 cm to nm _____ × _____ × _____ = _____

   c. 125145 J to kJ _____ × _____ = _____

   d. 164 mg to g _____ × _____ = _____

   e. 46.5 mL to L _____ × _____ = _____

2. Make the following temperature conversions:

   a. 162°F to °C _____

   b. 0.0 °F to K _____

   c. -18 °C to K _____

   d. 212 K to °C _____

   e. 98.6 °F to K _____

# Topic 3: Nomenclature

1. Name or write the formula for the following ionic compounds:

| | | | |
|---|---|---|---|
| a. LiCl | | g. tin(II) bromide | |
| b. $Mg(OH)_2$ | | h. potassium phosphate | |
| c. $K_3P$ | | i. nickel(II) perchlorate | |
| d. $Fe_2O_3$ | | j. sodium hydroxide | |
| e. FeO | | k. zinc phosphate | |
| f. $ZnCl_2$ | | l. ammonium sulfate | |

2. Name or write the formula for the following covalent compounds:

| | | | |
|---|---|---|---|
| a. CO | | e. nitrogen tribromide | |
| b. $CBr_4$ | | f. tetraphosphorus decaoxide | |
| c. $SO_2$ | | g. xenon hexafluoride | |
| d. $N_2O_4$ | | h. dicarbon tetrafluoride | |

3. Name or write the formula for the following acids:

| | | | |
|---|---|---|---|
| a. HCl | | e. hydrobromic acid | |
| b. $HNO_3$ | | f. hydronitric acid | |
| c. $HC_2H_3O_2$ | | g. phosphoric acid | |
| d. $H_2SO_4$ | | h. hydrosulfuric acid | |

# Topic 4: Atomic Structure

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

   a. $^{39}_{19}K$ protons: _____ neutrons: _____ electrons: _____

   b. $^{23}_{11}Na^{1+}$ protons: _____ neutrons: _____ electrons: _____

   c. $^{208}_{82}Pb$ protons: _____ neutrons: _____ electrons: _____

   d. $^{33}_{15}P^{3-}$ protons: _____ neutrons: _____ electrons: _____

2. Write the symbol for the atom that contains
   a. 24 protons, 21 electrons and 24 neutrons

   b. 34 protons, 45 neutrons, 34 electrons

   c. 8 protons, 10 neutrons, 10 electrons

3. What experimental evidence supports these statements?
   a. The nucleus of an atom is small.

   b. The atom consists of both positive and negative charges.

   c. The nucleus of the atom is positive.

# Topic 5: Writing and Balancing Chemical Equations

1. Balance the following chemical equations:
   a. _____ $Cr_{(s)}$ + _____ $O_{2(g)} \rightarrow$ _____ $Cr_2O_{3(s)}$

   b. _____ $SiH_{4(g)} \rightarrow$ _____ $Si_{(s)}$ + _____ $H_{2(g)}$

   c. _____ $SO_{3(g)} \rightarrow$ _____ $SO_{2(g)}$ + _____ $O_{2(g)}$

   d. _____ $Pb(NO_3)_{2(s)} \rightarrow$ _____ $PbO_{(s)}$ + _____ $NO_{2(g)}$ + _____ $O_{2(g)}$

   e. _____ $C_3H_{8(g)}$ + _____ $O_{2(g)} \rightarrow$ _____ $CO_{2(g)}$ + _____ $H_2O_{(g)}$

   f. _____ $C_2H_5OH_{(l)}$ + _____ $O_{2(g)} \rightarrow$ _____ $CO_{2(g)}$ + _____ $H_2O_{(g)}$

2. Write a balanced chemical equation for each of the following reaction descriptions:
   a. When solid calcium carbonate is heated, solid calcium oxide and gaseous carbon dioxide are formed.

   b. Aluminum metal reacts with oxygen to form solid aluminum oxide.

   c. When solid mercury(II) sulfide is heated with oxygen, liquid mercury metal and gaseous sulfur dioxide are produced.

   d. When aqueous solutions of aluminum sulfate and barium chloride are mixed, solid barium sulfate and aqueous aluminum chloride are formed.

   e. Solid sodium bicarbonate reacts with hydrochloric acid to produce sodium chloride, water, and carbon dioxide gas.

   f. Gaseous ammonia and oxygen react to produce nitrogen monoxide gas and water

# Topic 6: Moles and Stoichiometry

1. Vinegar is a dilute solution of acetic acid, $CH_3COOH$.
   a. Calculate the molar mass of acetic acid.

   b. How many molecules of $CH_3COOH$ are contained within 43.4 g of acetic acid?

   c. How much would 0.450 moles of acetic acid weigh?

2. How many moles of hydrogen gas can be produced if 1.35 g of solid zinc reacts with excess hydrochloric acid according to the equation

$$Zn + 2\ HCl \rightarrow H_2 + ZnCl_2$$

3. The reaction for the combustion of propane is

$$\_\_\_\_ C_3H_8 + \_\_\_\_ O_2 \rightarrow \_\_\_\_\_ CO_2 + \_\_\_\_ H_2O$$

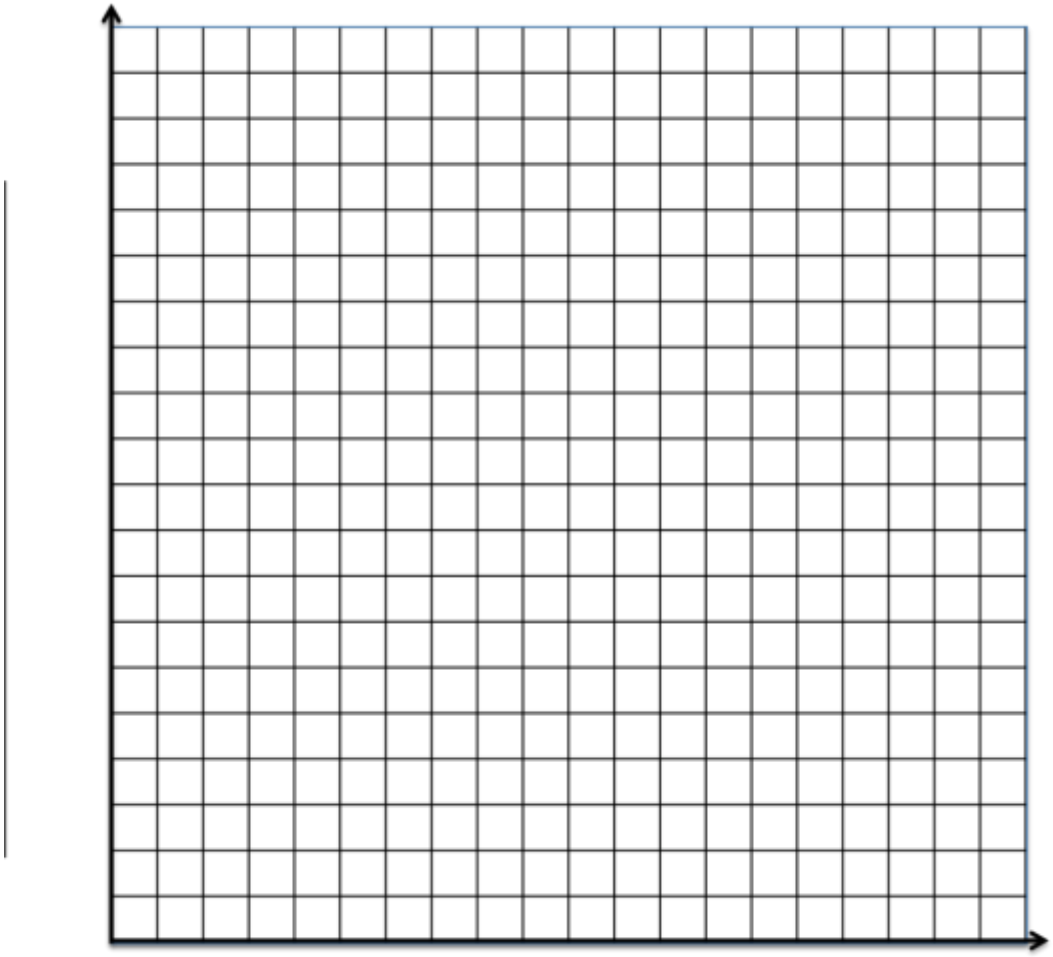
   a. If 20.0 g of $C_3H_8$ and 20.0 g of $O_2$ are reacted, how many moles of $CO_2$ can be produced?

4. If 20.0 g of $C_3H_8$ and 80.0 g of $O_2$ are reacted, how many grams of $CO_2$ can be produced

4. When anhydrous calcium chloride is dissolved in water, the temperature of the system changes. A student obtains the following data when dissolving increasing amounts of $CaCl_2$ into 100 mL of water:

| **Mass of $CaCl_2$ dissolved, g** | 0.91 | 2.94 | 5.92 | 8.81 | 10.89 |
|---|---|---|---|---|---|
| **$\Delta$T, $^{\circ}$C** | 1.8 | 6.6 | 12.8 | 18.9 | 23.2 |

Plot the data on the graph below. Choose an appropriate scale, and label the axes appropriately.



*Refer to the graph to answer the following questions.*

Independent Variable: _____

Dependent Variable: _____

Provide a descriptive title for the graph:
_____

5. Describe the relationship between grams of calcium chloride salt and change in temperature in a sentence.

6. Draw a line of best fit. Determine its slope, including units.

7. Predict the change in temperature when

    a. 4.33 g of $CaCl_2$ are dissolved

    b. 9.56 g of $CaCl_2$ are dissolved

    c. 15.4 g of $CaCl_2$ are dissolved

8. Predict what mass of $CaCl_2$ will result in

    d. a 12.4˚C change in temperature

    e. a 44.9 ˚C change in temperature

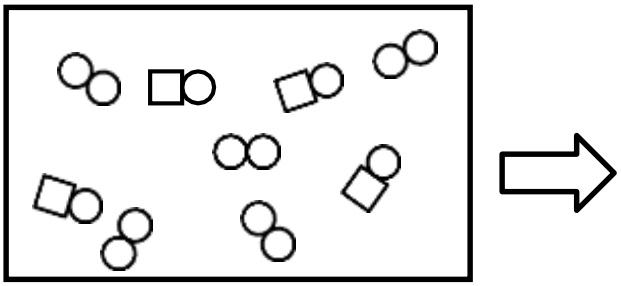
# Topic 8: Particulate Diagrams

1. Consider the synthesis of nitrogen dioxide

$$2\ NO + 1\ O_2 \longrightarrow 2\ NO_2$$

   a. In the diagram below, nitrogen atoms are represented with squares and oxygen atoms are represented with circles. Using the conservation of matter, draw what you would expect to find in the reaction vessel once the reaction is complete.

Before Reaction: After Reaction

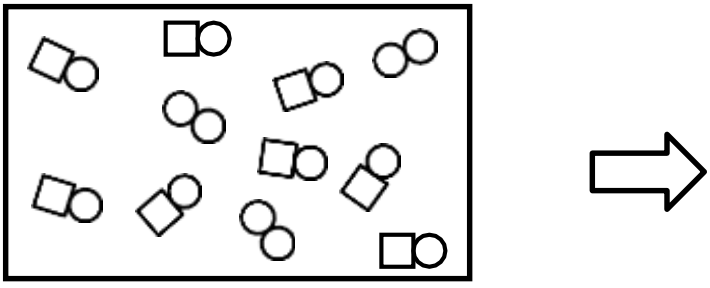


Limiting Reactant: Excess Reactant:

Explanation

   b. Consider the same reaction, with different starting quantities. Draw the contents of the reaction vessel after the reaction is complete.

Before Reaction: After Reaction



Limiting Reactant: Excess Reactant:

Explanation