

Name: _____

AP Chemistry Winter Assignment 2024 - 2025 DUE FRIDAY JANUARY 10th

Mental Math

There are CALCULATORS permitted on the multiple choice section of the AP Exam this year, however it is a timed exam so it is critical that you are able to do some math in your head (or with pencil/paper only). This packet will review basic math and concepts from Pre-AP Chemistry that will be important and not re-taught in AP Chemistry. **Please print it and complete it by Friday January 10th.** *If this is beyond your math skill level, AP Chem might not be the best course option for you.*

Significant Figures

Need a tutorial? [Elegante Podcast Sigfigs](#)

(Khan Academy video list): <https://goo.gl/uuOU2w>

- Round each of the following off to the specified number of sig fig's:
 - Round 78.241 g to 4 sf: _____ 3 sf: _____ 2 sf: _____ 1 sf: _____
 - Round 0.2983 g to 4 sf: _____ 3 sf: _____ 2 sf: _____ 1 sf: _____
 - Round 50,001 g to 4 sf: _____ 3 sf: _____ 2 sf: _____ 1 sf: _____
- Solve, and round answers to the proper number of sig figs. SHOW YOUR WORK & include units in your answer.
 - A 5627 g brick measures 5.60 cm x 4.51 cm x 24.71 cm. What is its density?
 - Before a titration, the initial reading from a buret is 0.75 mL. Afterwards, the reading is 13.22 mL. What volume of liquid was used in the titration?
 - A 45.67g stone with a density of 6.81 g/cm³ is placed in a graduated cylinder, what is its volume?
 - A series of masses are added together: 23.1g + 4.77g + 125.39g + 3.581g. What is the total mass?

Dimensional Analysis: (AKA factor-labeling or unit conversions) - [Elegante Podcast 1.3](#)

Need a tutorial?

1 hr = 60 min	1 min = 60 sec	1 ton = 2000 lbs	7 days = 1 week
24 hrs = 1 day	1 kg = 2.2 lbs	1 gal = 3.79 L	264.2 gal = 1 cubic meter
1 mi = 5,280 ft	1 kg = 1000 g	1 lb = 16 oz	20 drops = 1 mL
365 days = 1 yr	52 weeks = 1 yr	2.54 cm = 1 in	1 L = 1000 mL
0.621 mi = 1.00 km	1 yd = 36 inches	1 cc is 1 cm ³	1 mL = 1 cm ³

<http://www.chem.tamu.edu/class/fyp/mathrev/mr-da.html>

- The moon is 250,000 miles away. How many feet is it from earth?
- There are 355 ml of soda in a can. How many gallons is this?
- How many feet per second is a wave going if it travels a distance of 1.00 mile in 7.35 min?
- A speed of 60.0 miles/ hour is how many ft/sec?

7. A liquid has a density of 0.729 g/mL. What is the volume of 1.45 tons of this liquid?

Atomic Structure: The Basics

Need a tutorial? <http://www.kentchemistry.com/links/AtomicStructure/protneuele.htm>

8. Complete the following table.

Nuclear Symbol	# of protons	# of neutrons	# of electrons	Atomic #	Mass #	Charge
		28	21	25		
			18	15	31	
$^{13}_6\text{C}$					13	
	17				36	1-
$^{56}_{26}\text{Fe}^{3+}$			23		56	

Need a tutorial? <http://www.kentchemistry.com/links/AtomicStructure/atomicmasscalc.htm>
[Elegante Podcast 2.3](#)

9. Calculate the average atomic mass for each of the following elements assuming that each consists of the isotopic mixtures given below:

a. $^{10}\text{B} = 20.0\%$, $^{11}\text{B} = 80.0\%$

B: _____

b. $^{20}\text{Ne} = 90.9\%$, $^{21}\text{Ne} = 0.3\%$, $^{22}\text{Ne} = 8.8\%$

Ne: _____

Nomenclature:

Identify the type of substance, then either name it or write the correct formula

Need a tutorial? <http://www.kentchemistry.com/links/naming.htm>

[Elegante Podcast 4.5](#) [Elegante Podcast 4.6](#) [Elegante Podcast 4.7](#)

10.

Name	Type of Compound? (ionic, covalent, or acid)	Formula
		Hydrobromic acid
		Dinitrogen pentoxide
BaI ₂		
SO ₂		
		Nickel II chloride
H ₂ CO ₃		
		Phosphorous acid
		Potassium dichromate
Hg(OH) ₂		
HF		
HNO ₂		
NiI ₃		
		Zinc arsenide
		Xenon tetrafluoride
		Iron III nitrate
Cu ₂ Cr ₂ O ₇		
PCl ₃		
		Ammonium sulfide
K ₂ O		

Solubility Rules: [Elegante Podcast 5.3](#)**Need a tutorial?** <http://www.kentchemistry.com/links/Kinetics/PredictingDR.htm>

12. Predict whether each of these double replacement reactions will give a precipitate or not based on the solubility of the products. If yes, identify the precipitate.

silver nitrate and potassium chloride _____

magnesium nitrate and sodium carbonate _____

strontium bromide and potassium sulfate _____

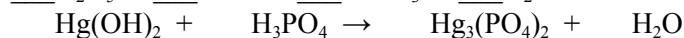
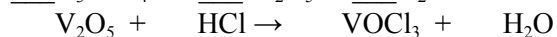
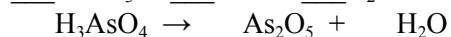
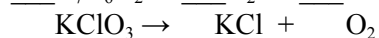
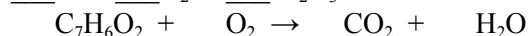
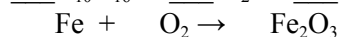
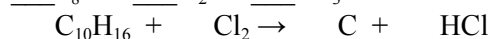
cobalt (III) bromide and potassium sulfide _____

ammonium hydroxide and copper (II) acetate _____

lithium chlorate and chromium (III) fluoride _____

Chemical Equations: [Elegante Podcast 5.1](#)**Need a tutorial?** <https://www.sophia.org/tutorials/balancing-chemical-equations--2>

13. Balance the following equations with the lowest whole number coefficients.

**Need a tutorial? (identify reaction types):** <https://chemfiesta.wordpress.com/2015/09/08/the-six-types-of-reaction/>
(predicting products): <https://chemfiesta.org/2015/03/20/predicting-reaction-products/>

14. For each of the following reactions:

- Identify the type of reaction (decomposition, synthesis, single replacement, double replacement, acid-base neutralization, or combustion).
- Predict products and write a balanced equation

<u>Reactants</u>	<u>Type of Reaction</u>	<u>Complete Balanced Equation</u>
Ammonium chloride is added to silver nitrate		
Magnesium is added to a solution of copper II nitrate		
Calcium carbonate decomposes		
Octane (C ₈ H ₁₈) is burned in air		
Calcium hydroxide is added to sulfuric acid		
Strontium is added to hydrochloric acid		
Aluminum metal reacts with oxygen gas		

A solution of tin IV sulfate is added to a solution of ammonium hydroxide		
Lithium chloride is added to zinc phosphate		
Ethanol (C ₂ H ₅ OH) is burned in the air		

Stoichiometry and Limiting Reactant

Need a tutorial? (list of tutorials & activities): <http://chemcollective.org/stoichiometry>
<https://chemfiesta.org/2015/09/18/reactions-and-stoichiometry/> (scroll down for list of stoichiometry resources)

15. Given the equation below, what mass of water would be needed to react with 10.0g of sodium oxide?



16. $2\text{NaClO}_3 \rightarrow 2\text{NaCl} + 3\text{O}_2$

a. What mass of sodium chloride is formed along with 45.0g of oxygen gas?

b. If only 49.1g of sodium chloride form, what is the percent yield?

17. $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$

What mass of water will be produced when 100.0g of ammonia is reacted with excess oxygen?

18. If the reaction above is done with 25.0g of each reactant, which would be the limiting reactant?

19. What volume of hydrogen gas (measured at STP) would result from reacting 75.0g of sodium hydroxide with 50.0g of aluminum? $6\text{NaOH} + 2\text{Al} \rightarrow 2\text{Na}_3\text{AlO}_3 + 3\text{H}_2$

20. $\text{Na}_2\text{S} + 2\text{AgNO}_3 \rightarrow \text{Ag}_2\text{S} + 2\text{NaNO}_3$

If the above reaction is carried out with 50.0g of sodium sulfide and 35.0g of silver nitrate, which is the limiting reactant?

What mass of the excess reactant remains?

What mass of silver sulfide would precipitate?

Percent Composition, Empirical and Molecular Formulas [Elegante Podcast 4.8](#)

Need a tutorial? <http://www.kentchemistry.com/aplinks/chapters/3Stoich.htm>

21. Bismuth subsalicylate, a medication used to treat upset stomachs, has the formula $C_7H_5BiO_4$.
- Calculate its percent composition.
 - If each tablet of the medication contains 262 milligrams of $C_7H_5BiO_4$ calculate the mass of Bi in 2 tablets.
22. Determine the empirical and molecular formulas of each of the following substances:
- Benzene contains only carbon and hydrogen and is 7.74% hydrogen by mass. The molar mass of benzene is 78.1 g/mol.
 - Ibuprofen, a headache remedy, contains 75.69 percent C, 8.80 percent H, and 15.51 percent O by mass; molar mass about 206 g
 - Naphthalene, used in mothballs, is composed of 93.7% carbon and 6.3% hydrogen. If naphthalene has a molar mass of 128 g/mol, what is its molecular formula?
23. Many homes in rural America are heated by propane gas, a compound that contains only carbon and hydrogen. Complete combustion of a sample of propane produced 2.641 g of carbon dioxide and 1.442 g of water as the only products. Find the empirical formula of propane. (Hint: Figure out how many moles of C and H were produced. They all came from the fuel.)

24. Menthol, the substance we can smell in mentholated cough drops, is composed of C, H, and O. A 0.1005 g sample of menthol is combusted, producing 0.2829 g of CO_2 and 0.1159 g of H_2O . Menthol has a molar mass of 156.27 g/mol. What is the molecular formula of menthol?

Solutions: Visit Elegante Podcast Unit 8:

<https://www.youtube.com/watch?v=ikF6YPnYm40&list=PLS2O9oFLOCoGliPxp4xrBnZXCn-s2prwI&index=32>

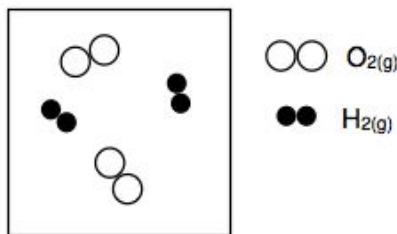
Need a tutorial? <http://www.kentchemistry.com/aplinks/chapters/4chemrxns.htm>

25. If 6.73 g of Na_2CO_3 is dissolved in enough water to make 250.0 mL of solution, what is the molarity of the sodium carbonate solution?
26. What is the mass, in grams, of solute in 250.0 mL of a 0.0125 M solution of KMnO_4 ?
27. What volume of 0.123 M NaOH , in milliliters, contains 25.0 g of NaOH ?
28. If 4.00 mL of 0.0250 M CuSO_4 is diluted to 10.0 mL with pure water, what is the molarity of copper(II) sulfate in the diluted solution?
29. For each solution, identify the ions that exist in aqueous solution & specify the concentration of each.
 - a) 0.25 M $(\text{NH}_4)_2\text{SO}_4$
 - b) 0.056 M HNO_3
 - c) 0.123 M Na_2CO_3
 - d) 0.00124 M KClO_4
30. What volume of 0.125 M HNO_3 , in milliliters, is required to react completely with 1.30 g of $\text{Ba}(\text{OH})_2$?
$$2 \text{HNO}_3(\text{aq}) + \text{Ba}(\text{OH})_2(\text{s}) \rightarrow \text{Ba}(\text{NO}_3)_2(\text{aq}) + 2 \text{H}_2\text{O}(\text{l})$$
31. What volume of 0.955M HCl , in milliliters, is needed to completely react with 12.8 mL of 1.27M Na_2CO_3 ?
$$\text{Na}_2\text{CO}_3(\text{aq}) + 2 \text{HCl}(\text{aq}) \rightarrow 2 \text{NaCl}(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$$

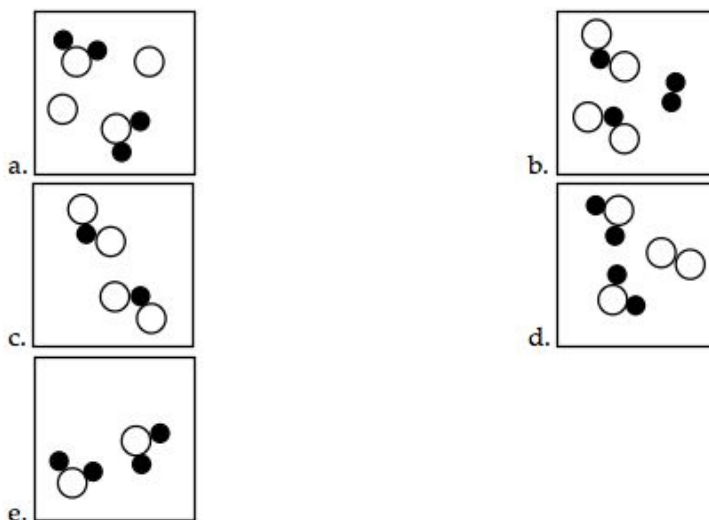
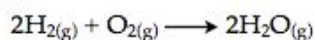
Sample AP Multiple Choice Questions

32. In which of the following groups are the three species isoelectronic; i.e., have the same number of electrons?
 (A) S^{2-} , K^+ , Ca^{2+} (B) Sc , Ti , V^{2+} (C) O^{2-} , S^{2-} , Cl^- (D) Mg^{2+} , Ca^{2+} , Sr^{2+} (E) Cs , Ba^{2+} , La^{3+}
33. What number of moles of O_2 are needed to produce 14.2 grams of P_4O_{10} from P? (Molecular weight $P_4O_{10} = 284$)
 (A) 0.0500 mole (B) 0.0625 mole (C) 0.125 mole (D) 0.250 mole (E) 0.500 mole

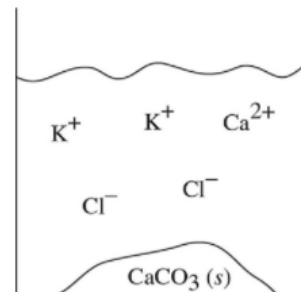
34.



The picture above is a representation of $H_2(g)$ and $O_2(g)$ in a sealed container. Which of the following pictures would be the best representation of the products if the reaction below were to run to completion?



35. Barium reacts with a polyatomic ion to form a compound with the general formula $Ba_3(X)_2$. What would be the most likely formula for the compound formed between sodium and the polyatomic ion X?
 A) NaX B) Na_3X C) Na_2X D) Na_3X_2 E) Na_2X_2
36. Which one of the following molecular formulas is also an empirical formula?
 A) C_2H_6SO B) $C_6H_6O_2$ C) H_2O_2 D) $H_2P_4O_6$ E) C_6H_6
37. Solutions of potassium carbonate and calcium chloride are mixed together, and the particulate representation shows what is present after the reaction has gone to completion. Which of the two original solutions is the limiting reagent and why?
- The potassium carbonate, because of the polyatomic anion
 - The potassium carbonate, because there is no carbonate left after the reaction
 - The calcium chloride, because there is an excess of calcium ions post-reaction
 - The calcium chloride, because the component ions are smaller than those in potassium carbonate



Sample AP Free Response Questions (FRQ)

Note: Portions of each FRQ that we would not yet know how to do have been omitted.

38. Water is added to 4.267 grams of uranium hexafluoride. The only products are 3.730 grams of a solid containing only uranium, oxygen and fluorine and 0.970 gram of a gas. The gas is 95.0% fluorine, and the remainder is hydrogen.

(a) From these data, determine the empirical formula of the gas.

(b) What fraction of the fluorine of the original compound is in the solid and what fraction in the gas after the reaction?

(c) What is the formula of the solid product?

39. Solid mercury(II) oxide decomposes as it is heated in an open test tube in a fume hood.

a. Write a balanced equation for this reaction.

b. After the reaction is complete, is the mass of the material in the test tube greater than, equal to, or less than the mass prior to heating? Justify your answer.

40. Answer the following questions about acetylsalicylic acid, the active ingredient in aspirin.

(a) The amount of acetylsalicylic acid in a single aspirin tablet is 325 mg, yet the tablet has a mass of 2.00 g. Calculate the mass percent of acetylsalicylic acid in the tablet.

(b) The elements contained in acetylsalicylic acid are hydrogen, carbon, and oxygen. The combustion of 3.000 g of the pure compound yields 1.200 g of water and 3.72 L of dry carbon dioxide, measured at STP. Determine the mass, in g, of each element in the 3.000 g sample of the compound.