AP Chemistry Summer Assignment

Due: Monday, August 26th, 2019

This optional summer assignment is designed to help you review what you learned in Form III Chemistry, so that we can move quickly into new content in the AP Chemistry course. The assignment is optional, but highly recommended, as we will move quickly through the review unit at the beginning of the year.

If you complete this assignment and turn it in by Monday, August 26th, you will receive a **5% bonus** on your first exam.

You are allowed to consult any resources you want in order to complete this assignment (old notes, websites, etc.), but you may not copy from each other. If you have questions, I will occasionally check my email over the summer: jmartin@saintanselms.org. I will get back to you as soon as I see the email.

Attached to the assignment are the official AP Periodic Table and Equation Sheet. They are identical to what you will see on the AP Exam in May, and may be helpful for you to answer the questions in this assignment.

PERIODIC TABLE OF THE ELEMENTS

1 **H** 1.008																	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.30											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.91	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57 ***La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** 226.02	89 **†Ac** 227.03	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (266)	107 **Bh** (264)	108 **Hs** (277)	109 **Mt** (268)	110 **Ds** (271)	111 **Rg** (272)							

*Lanthanide Series	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 151.97	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
†Actinide Series	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

AP Chemistry Equations & Constants

Throughout the test the following symbols have the definitions specified unless otherwise noted.

L, mL	=	liter(s), milliliter(s)	mm Hg	=	millimeters of mercury
g	=	gram(s)	J, kJ	=	joule(s), kilojoule(s)
nm	=	nanometer(s)	V	=	volt(s)
atm	=	atmosphere(s)	mol	=	mole(s)

ATOMIC STRUCTURE

$E = h\nu$

$c = \lambda\nu$

E = energy
ν = frequency
λ = wavelength

Planck's constant, $h = 6.626 \times 10^{-34}$ J s

Speed of light, $c = 2.998 \times 10^{8}$ m s^{-1}

Avogadro's number = 6.022×10^{23} mol^{-1}

Electron charge, $e = -1.602 \times 10^{-19}$ coulomb

EQUILIBRIUM

$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$, where $a\,A + b\,B \rightleftarrows c\,C + d\,D$

$K_p = \frac{(P_C)^c(P_D)^d}{(P_A)^a(P_B)^b}$

$K_a = \frac{[H^+][A^-]}{[HA]}$

$K_b = \frac{[OH^-][HB^+]}{[B]}$

$K_w = [H^+][OH^-] = 1.0 \times 10^{-14}$ at 25°C

$= K_a \times K_b$

$pH = -\log[H^+]$, $pOH = -\log[OH^-]$

$14 = pH + pOH$

$pH = pK_a + \log\frac{[A^-]}{[HA]}$

$pK_a = -\log K_a$, $pK_b = -\log K_b$

Equilibrium Constants

K_c (molar concentrations)
K_p (gas pressures)
K_a (weak acid)
K_b (weak base)
K_w (water)

KINETICS

$\ln[A]_t - \ln[A]_0 = -kt$

$\frac{1}{[A]_t} - \frac{1}{[A]_0} = kt$

$t_{1/2} = \frac{0.693}{k}$

k = rate constant
t = time
$t_{1/2}$ = half-life

GASES, LIQUIDS, AND SOLUTIONS

$$PV = nRT$$

$$P_A = P_{\text{total}} \times X_A, \text{ where } X_A = \frac{\text{moles A}}{\text{total moles}}$$

$$P_{total} = P_A + P_B + P_C + \ldots$$

$$n = \frac{m}{M}$$

$$\text{K} = {}^\circ\text{C} + 273$$

$$D = \frac{m}{V}$$

$$KE \text{ per molecule} = \frac{1}{2}mv^2$$

Molarity, M = moles of solute per liter of solution

$$A = abc$$

P = pressure
V = volume
T = temperature
n = number of moles
m = mass
M = molar mass
D = density
KE = kinetic energy
v = velocity
A = absorbance
a = molar absorptivity
b = path length
c = concentration

Gas constant, $R = 8.314 \text{ J mol}^{-1} \text{K}^{-1}$
$= 0.08206 \text{ L atm mol}^{-1} \text{K}^{-1}$
$= 62.36 \text{ L torr mol}^{-1} \text{K}^{-1}$
1 atm = 760 mm Hg
= 760 torr
STP = 0.00 °C and 1.000 atm

THERMOCHEMISTRY/ ELECTROCHEMISTRY

$$q = mc\Delta T$$

$$\Delta S^\circ = \sum S^\circ \text{ products} - \sum S^\circ \text{ reactants}$$

$$\Delta H^\circ = \sum \Delta H_f^\circ \text{ products} - \sum \Delta H_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \sum \Delta G_f^\circ \text{ products} - \sum \Delta G_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$
$$= -RT \ln K$$
$$= -nFE^\circ$$

$$I = \frac{q}{t}$$

q = heat
m = mass
c = specific heat capacity
T = temperature
S° = standard entropy
H° = standard enthalpy
G° = standard free energy
n = number of moles
E° = standard reduction potential
I = current (amperes)
q = charge (coulombs)
t = time (seconds)

Faraday's constant, F = 96,485 coulombs per mole of electrons

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}}$$

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Scientific Notation:

Write the following in scientific notation

1. 17600.0 _____
2. 0.00135 _____
3. 1000.0 _____
4. -670.30 _____
5. 476.3 _____
6. -0.1544 _____
7. 301.0 _____
8. -0.000130 _____
9. 0.00000298 _____
10. 34000000 _____

Write the following in regular notation.

1. 4.96×10^{-2} _____
2. 5.50×10^{4} _____
3. -9.3×10^{-3} _____
4. -8.37×10^{1} _____
5. 7.01×10^{0} _____
6. 5.61×10^{-3} _____
7. 4.92×10^{2} _____
8. -9.23×10^{-1} _____
9. 3.21×10^{-3} _____
10. 5.92×10^{5} _____

Significant Figures:

How many sig figs are in the following?

1. 0.0023 _____
2. 1203 _____
3. 90060 _____
4. 0.027060 _____
5. 0.320200 _____
6. 1.02×10^{3} _____
7. 6.022×10^{23} _____
8. 0.00050 _____
9. 600 _____
10. 3200 _____

Record each answer with proper sig figs.

1. $97.381 + 4.2502 + 0.99195 =$
2. $171.5 + 72.915 - 8.23 =$
3. $1.00914 + 0.87104 + 1.2012 =$
4. $0.14 \times 6.022 \times 10^{23} =$
5. $(2.00 \times 10^{6})(3.00 \times 10^{-7}) =$
6. $4.184 \times 100.62 \times (25.27 - 24.16) =$
7. $150 / 4.2 =$
8. $505 - 450.25 =$
9. $1.252 \times 0.115 \times 0.012 =$
10. $(3.2 \times 0.64) + (4.5 \times 0.36) =$

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Metric Unit Conversions:

Perform the following conversions using dimensional analysis. Give your answer in scientific notation with proper sig figs and box your answer.

1. Convert 653 nm to m
2. Convert 567 mL to L
3. Convert 96 g to kg
4. Convert 454 km to nm
5. Convert 15 μg to g
6. Convert 5.8×10^2 kg to g
7. Convert 735 nm to m
8. Convert 45.2 mL to pL
9. Convert 45.96 μL to L
10. Convert 25.0 kJ to J

Temperature and Pressure Conversions:

Perform the following conversions. Give your answer with proper sig figs and box your answer.

1. 15°C to Kelvin
2. 623K to °C
3. 900°C to Kelvin
4. 745K to °C
5. 92.5 torr to atm
6. 3.20 atm to mmHg
7. 0.520 atm to torr
8. 562 torr to atm
9. 1.2 atm to mmHg
10. 754 mmHg to atm

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Density: Answer the following questions with proper units and significant figures.

1. A rectangular block has dimensions of 2.9 cm x 3.5 cm x 10.0 cm. The mass of the block is 615.0 g. What is the density of the block?

2. An experiment requires 15.0 g of cyclohexane (density = 0.7781 g/mL at 25°C) to be used. What volume of cyclohexane should be used?

3. A sample of silver pellets was analyzed in lab in order to determine the density of silver. The following data was collected after the sample of pellets was added to water in a graduated cylinder. Calculate the density of the silver.

Mass of Silver	5.25 g
Mass of graduated cylinder	10.2 g
Volume of water (initial)	11.2 mL
Volume of water (after silver pellets added)	11.7 mL

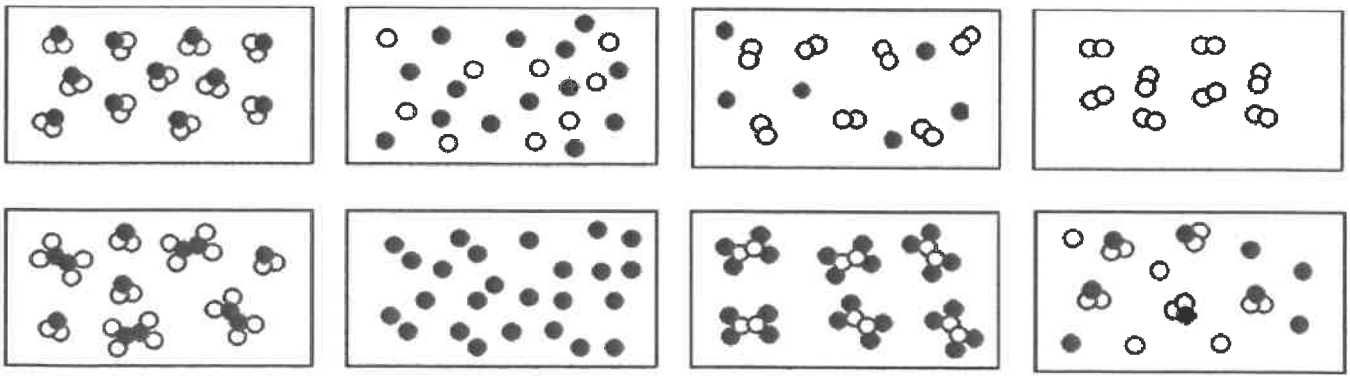
4. The mass of a diamond is measured in carats (1 carat = 0.200 g). The density of diamond is 3.51 g/cm^3. What is the volume of a 5.0 carat diamond?

5. The volume of a diamond is found to be 2.8 cm^3. What is the mass of the diamond in carats?

Classification of Matter: Each circle represents an atom. Each color represents a different kind of atom. If atoms are touching they are bonded. Classify each of the pictures below using the following codes.

A= Element **B**= Compound **C**= Mixture of elements
D= Mixture of compounds **E**= Mixture of elements and compounds

I. II. III. IV.



V. _____ VI. _____ VII. _____ VIII. _____

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Atomic Structure: Fill in the table with any missing information.

Symbol	Mass Number	# Protons	# Neutrons	# Electrons	Ionic Charge
1.		33	42		+3
2. $^{128}_{52}Te^{-2}$				54	
3.		16	16	16	
4.		81	123		+1
5. $^{195}_{78}Pt$					
6.		92	147		0
7.	59	27			+2
8. $^{209}_{83}Bi$					
9.	36			18	-1
10.	241		146		0

Identify whether each would gain or lose electrons to form a cation or anion and what ionic charge is expected to form.

	Gain/Lose	Cation/Anion	Ionic Charge		Gain/Lose	Cation/Anion	Ionic Charge
11. Na				12. O			
13. Ba				14. H			
15. S				16. Br			
17. Al				18. Ne			
19. Se				20. P			

Formula Writing: Write the correct formula for the following substances.

21. sodium bromide _____
22. phosphoric acid _____
23. copper(II) hydroxide _____
24. carbon monoxide _____
25. bromine pentafluoride _____
26. lead(IV) iodide _____
27. copper(I) bromide _____
28. calcium sulfide _____
29. sulfuric acid _____
30. nitrogen _____
31. diphosphorus pentoxide _____
32. sulfur hexafluoride _____
33. calcium carbonate _____
34. aluminum phosphide _____
35. ammonium sulfate _____
36. acetic acid _____
37. perchloric acid _____
38. carbon _____
39. dinitrogen tetroxide _____
40. magnesium chloride _____
41. fluorine _____
42. iron(II) hydroxide _____
43. lead(II) chloride _____
44. arsenic pentafluoride _____
45. hydrosulfuric acid _____
46. chlorous acid _____
47. potassium phosphate _____
48. diboron tetrachloride _____
49. sulfur trioxide _____
50. nickel(II) acetate _____

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Average Atomic Mass:

1. Magnesium has three stable isotopes with the masses and abundances given in the table to the right. Use this information to calculate the average atomic mass of the magnesium.

Isotope	Mass (amu)	Abundance
Magnesium-24	23.9850	78.99 %
Magnesium-25	24.9858	10.00 %
Magnesium-26	25.9826	11.01 %

Precipitate Reactions:

Write the balanced net ionic equation for each of the following precipitation reactions.

1. A solution of $AgNO_3$ is added to a solution of $CaCl_2$

2. A solution of $Pb(NO_3)_2$ is added to a solution of KI

3. A solution of $Na_2C_2O_4$ is added to a solution of SnF_2

Balancing Equations: Place appropriate coefficients in each blank so that each satisfies the law of conservation of mass.

1. ___Cu + ___$AgNO_3$ → ___Ag + ___$Cu(NO_3)_2$
2. ___$Al(OH)_3$ + ___HCl → ___$AlCl_3$ + ___H_2O
3. ___$AgNO_3$ + ___H_2SO_4 → ___Ag_2SO_4 + ___HNO_3
4. ___FeO + ___O_2 → ___Fe_2O_3

Molar Mass: Calculate the molar mass for each compound.

1. NO_5
2. H_2SO_4
3. $Al(OH)_3$
4. $C_7H_{14}O_2$
5. C_2H_5OH
6. $Mg_3(PO_4)_2$

Mole Calculations:

1. How many moles of molecules are in 35.0 g of SO_2?

2. How many water molecules are in 100.0 g of water?

3. How many formula units of $CaCl_2$ are in 4.5 moles of $CaCl_2$?

4. What is the mass, in grams, of 7.8 moles of glucose ($C_6H_{12}O_6$)?

5. How many nitrogen ions are present in 5.00g of magnesium nitride, Mg_3N_2?

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Percent Composition: Calculate the percent composition by mass of **each** of the elements in the compounds below.

1. $C_4H_6O_2$
2. $Ba(NO_3)_2$

Empirical and Molecular Formulas:

1. Determine the empirical formula of a compound that contains 0.104 mol K, 0.052 mol H, and 0.156 mol O.

2. Determine the empirical formula of a compound that contains 5.28 g Sn and 3.37 g F.

3. Determine the empirical formula of a compound that is 87.5% N and 12.5% H by mass.

4. What is the molecular formula of a carbohydrate if the molar mass is 240.0 g/mol and the empirical formula is CH_2O?

5. A compound has an empirical formula of $ClCH_2$ and a molar mass of 98.96 g/mol. What is the molecular formula?

6. What is molecular formula of a compound if analysis show it to be 62.09% C, 10.41% H, and 27.57% O? The molar mass of the compound is 116.2 g/mol.

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Reaction Stoichiometry:

1. Hydrofluoric acid cannot be stored in glass bottles because compounds called silicates in the glass are attacked by the acid. Sodium silicate (Na_2SiO_3), for example, reacts as follows:

$$Na_2SiO_3(s) + 8HF(aq) \rightarrow H_2SiF_6(aq) + 2NaF(aq) + 3H_2O(l)$$

   a. How many moles of HF are needed to react completely with 0.300 mol of Na_2SiO_3?

   b. If 0.500 mol of HF react with excess Na_2SiO_3, what mass of NaF is formed?

   c. Calculate the mass of Na_2SiO_3 necessary to react with 0.800 g of HF.

2. The fizz produced when an Alka-Seltzer tablet is dissolved in water is due to the reaction between sodium bicarbonate ($NaHCO_3$) and citric acid ($H_3C_6H_5O_7$) shown in the equation below.

$$3NaHCO_3\ (aq) + H_3C_6H_5O_7\ (aq) \rightarrow 3CO_2\ (g) + 3H_2O\ (l) + Na_3C_6H_5O_7\ (aq)$$

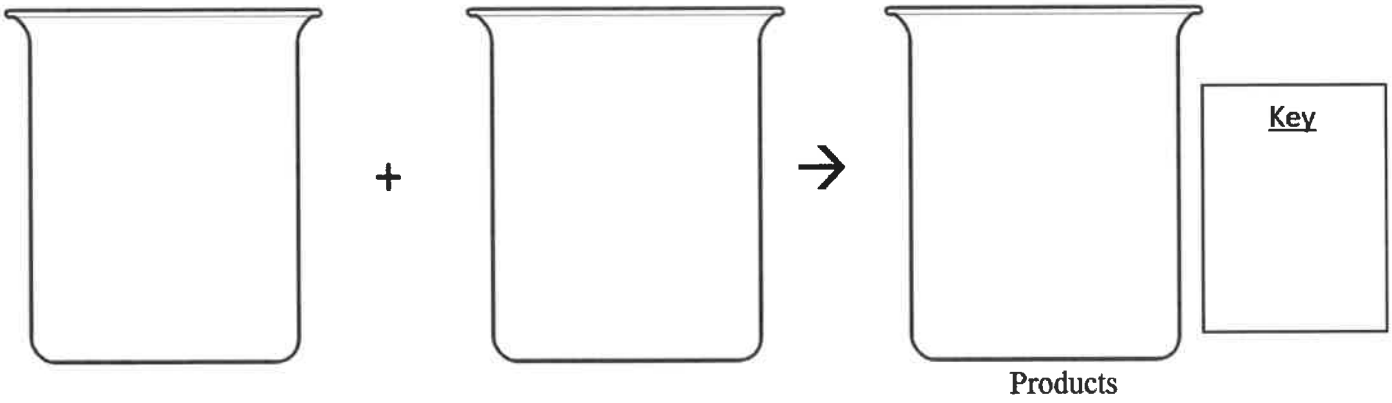
   a. In a certain lab experiment, 1.00 g of sodium bicarbonate and 1.00 g of citric acid are allowed to react until the reaction goes to completion. Determine the limiting reagent.
   b. Calculate the mass of CO_2 gas formed.
   c. Calculate the volume of CO_2 gas formed at 25°C at 1.00 atm of pressure.
   d. Calculate the mass of the excess reactant remaining if the limiting reactant is completely consumed.

3. 213.00 mL of a 0.100 *M* sodium phosphate solution is mixed with 122.00 mL of a 0.200 *M* barium nitrate solution in order to precipitate barium phosphate at 25°C.

$$2Na_3PO_4(aq) + 3Ba(NO_3)_2(aq) \rightarrow Ba_3(PO_4)_2\ (s) + 6NaNO_3(aq)$$

   a. Write the net ionic equation for the reaction.
   b. What mass of the barium phosphate can be precipitated if the reaction goes to completion?
   c. What mass of the excess reagent will remain for a student that desires to run a second trial?
   d. Calculate the concentration of Na^+, PO_4^{3-}, Ba^{2+}, and NO_3^- in the solution at the end of the reaction.
   e. Draw a particle diagram of each starting solution and of the resulting solution (with precipitate).

Sodium Phosphate **Barium Nitrate**



4. Aspirin ($C_9H_8O_4$) is produced from salicylic acid ($C_7H_6O_3$) and acetic anhydride ($C_4H_6O_3$).

$$C_7H_6O_3 + C_4H_6O_3 \rightarrow C_9H_8O_4 + HC_2H_3O_2$$

   a. What is the theoretical yield of aspirin if 185 kg of salicylic acid is reacted with 125 kg of acetic anhydride?
   b. Calculate the percent yield of the reaction if the situation described in part (b) produces 182 kg of aspirin.

5. When aqueous solutions of Na_2SO_4 and $Pb(NO_3)_2$ are mixed, $PbSO_4$ precipitates. Calculate the mass of $PbSO_4$ formed when 1.25 L of 0.0500 *M* $Pb(NO_3)_2$ and 2.00 L of 0.0250 *M* Na_2SO_4 are mixed.

Gases

1. A sample of an ideal gas at 15.0°C and 1.00 atm has a volume of 2.58 L. If the temperature is raised to 38.0°C at a constant pressure, calculate the new volume of the gas.

2. A sample of hydrogen gas (H_2) has a volume of 8.56 L at a temperature of 0.00°C and a pressure of 1.50 atm. Calculate the number of moles of H_2 molecules present in this gas sample.

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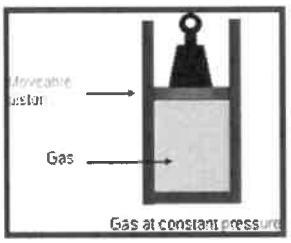
3. A sample of diborane gas (B_2H_6) has a pressure of 345 torr at a temperature of -15°C and a volume of 3.48 L. If conditions are changed so that the temperature is 36°C and the pressure is 468 torr, what will be the volume of the sample?

4. The diagram to the right shows a sample of gas in a closed container with a moveable piston. If the piston is depressed, will the pressure of the gas increase, decrease, or stay the same? Explain using kinetic molecular theory.



5. Calculate the mass of copper needed to produce 4.00 L of NO*(g)* at 1.012 atm and 22°C.

$$3Cu\ (s) + 8HNO_3\ (aq) \rightarrow 3Cu(NO_3)_2\ (aq) + 2NO\ (g) + 4H_2O\ (l)$$

6. Calculate the volume of $O_2(g)$ produced by the decomposition of 0.600 mol of $KClO_3$ at 20°C and 0.980 atm.

$$2KClO_3(s) \rightarrow 2KCl(l) + 3O_2(g)$$