AP Chemistry Summer Assignment

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Due Date: First day of class

Why is there summer work for AP Chemistry?
To be successful in AP Chemistry, you need to make sure you remember key concepts learned in Honors Chemistry and that you can use these with confidence. This is just to ensure that you are aware of areas that you need to review.

What is expected of you for this assignment?
Take a look at the problems in each section. If you remember how to do the problems without looking at old materials, great! If not, use resources you have to try to figure it out (Honors Chem notes/materials, Khan Academy, etc). If you are still struggling, feel free to email me with a question. If you know someone else taking the course, work together and check your answers with one another. Do not, however, just copy the answers. If you cannot do most of these on your own in the end, you are going to have a very hard time in AP Chem.

Math problems require all work to be shown (exceptions: molar mass calculations and simple conversions like mL to L). Include all units for any numerical value, both within the problem and in the answer. Make sure answers are rounded to the proper amount of significant figures.

Complete this work in hard-copy form. Have it ready to turn in on the first day of class. I will grade it based on completion, being on time, showing all calculations and accuracy. This will be your first major assignment grade. This will be marked down 5 points per day late.

What do I need to memorize for AP Chemistry?
This does not need to be done before the end of summer, but something to make a note of and start working on. Some things need to be memorized in AP Chemistry that weren't necessarily in Honors Chem. You need to know the charges of ions when they form as well as the polyatomic ions (I provided a list of which ions you must know). You will need to be able to identify elements (don't panic- not ALL, but the common ones) without their names being present on the periodic table. You will also need to memorize the solubility rules and the six strong acids, but this is not necessary until later in the year.

References Provided
You will always, on any assignment, including the AP Test itself, have a periodic table provided and a formula sheet. I have included copies of those as well!

Looking forward to a great year!
~Mrs. Cahill

Name ______________________________ Per _______ Date ____________________

AP SUMMER ASSIGNMENT
What Do I Need To Know Already?

Intro Materials (Lab, Dimensional Analysis, Scientific Notation, Significant Figures)

1) What lab equipment is used to measure the following variables and what would the correct unit(s) be?

   a. Mass

   b. Volume

   c. Length

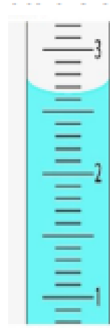
   d. temperature

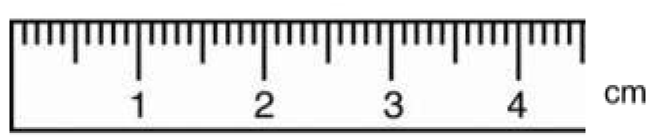
2) How do you find the volume of a solid object - procedure and equipment?

3) What is the difference between mass and weight (units and concept)?

4) What is the proper way to heat a test tube?

5) Record the measurements to the correct number of significant figures.





a. ______________ b. _______________ c. _______________

6) Perform the following conversions. Watch sig figs. If the answer is less than 0.001 or greater than 1000, put the answer in scientific notation.

   a. 8.60 cm to nm

   b. 3.00 days to s

   c. 75.00 km/hr to m/s

   d. 55.35 m^3 to cm^3

   e. 1.08 atm to kPa

   f. 900.0 mmHg to atm

7) Round each of the following to four significant figures, and express the result in scientific notation:

   a. 300.235800

   b. 456,500

   c. 0.006543210

   d. -0.000957830

   e. -0.035000

8) Perform the following mathematical operations, rounding properly:

   a. 1.0 + 3.45 + 18 =

   b. 7.81 + 2 =

   c. 3.4 x 2.10 x 5 =

   d. 30 x 11.00 =

9) Can you use density as a conversion factor in a problem?

a. The density of pure silver is 10.5 g/cm3 at 20 oC. If 5.25 g of pure silver pellets are added to a graduated cylinder containing 11.2 mL of water, to what volume level will the water in the cylinder rise?

b. The density of air at ordinary atmospheric pressure and 25 oC is 1.19 g/L. What is the mass, in kilograms, of the air in a room that measures 12.5 x 15.5 x 8.0 ft? (Note: 1 foot = 0.3048 m)

The Atom

10) What subatomic particles make up an atom? What are their masses and charges?

11)What is the difference between an element and an ion?

a. What makes a positive ion positive?

b. What makes a negative ion negative?

12) What would be the most common charge for:
*Make sure you can find this from a periodic table without charges!

a. Oxygen:

b. Calcium:

c. Neon:

d. Nitrogen:

e. Aluminum:

13) Look up the following information on a periodic table:

a. Mass of copper:

b. Number of electrons that phosphorus has:

c. Number of neutrons that lithium has:

d. Number of protons that nitrogen has:

e. Number of VALANCE electrons that sulfur has:

14) Name all of the diatomic elements. Why are they as such?

15) Identify the following as metals, nonmetals or metalloids: *Note: be able to do this without a staircase drawn on a periodic table!

a. Zinc:

b. Hydrogen:

c. Helium:

d. Sodium:

e. Silicon:

16) What element is bigger?

a. Lithium or fluorine? Why?

b. Fluorine or bromine? Why?

17) If you are holding two atoms of carbon that are isotopes, describe what the two have in common and how they differ.

18) Only two isotopes of copper occur naturally, Cu-63 (abundance 69.09 percent) and Cu-65 (abundance 30.91 percent). Calculate the average atomic mass of copper.

Electrons

19) How many orbitals and electrons to the following energy levels have?

a. s

b. p

c. d

d. f

20) Write the electron configuration for the following: *Note: be able to do without the order of orbitals provided.

a. magnesium:

b. oxygen

c. argon

21) Draw an orbital diagram (lines and arrows) for the following atoms:

a. phosphorus

b. fluorine

Compounds

22) Write the chemical formula for the following compounds: *Note: be able to do without the charges provided and/or prefixes provided. Also will not be given polyatomic ions.

a. potassium sulfide

b. iron (II) nitride

c. nitrogen monoxide

d. lithium nitrate

e. magnesium sulfate

f. disulfur trioxide

g. hydrogen cyanide

h. iodic acid

i. sulfurous acid

j. aluminum hydroxide

23) Write the chemical name for the following compounds: *Note: be able to use a periodic table without element/polyatomic ion names.

a. $ZnCl_2$
b. Na_2SO_3
c. Be_3N_2
d. N_2O_5
e. $AlBr_3$
f. $Ca(NO_3)_2$
g. H3PO4
h. HBr
i. $(NH)_2SO_4$
j. $Fe(OH)_2$

24) Draw the Lewis Dot Structure for:

a. $AlCl_3$

b. NH_3

c. CO_2

25) Calculate the percentage by mass of oxygen in the following compounds:

a. NO_2

b. $Cr(NO_3)_3$

Energy and Mass Conservation

26) Write the following reactions, balance them and write the type of chemical reaction: *Note: again, be able to use the PT provided- no names/charges given

a. sodium nitrate + water → sodium oxide and nitric acid

type of reaction ______________________

b. magnesium + sulfate → magnesium sulfate

type of reaction ______________________

c. magnesium chloride + oxygen → magnesium oxide + chlorine

type of reaction ______________________

27) Perform the following conversions, using the following balanced equation:

$$Al_2O_3 + 6\ KNO_3 \rightarrow 3\ K_2O + 2\ Al(NO_3)_3$$

a. Determine the number of moles of potassium oxide that will form if starting with 2.3 moles aluminum oxide when going to completion.

b. Determine the number of grams needed of potassium nitrate to form 45.3 grams potassium oxide if going to completion.

c. Which is the limiting reactant in the reaction?

28) Determine the empirical and molecular formulas of each of the following substances:

a. 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

b. Benzene contains only carbon and hydrogen and is 7.74% hydrogen by mass. The molar mass of benzene is 78.1 g/mol.

Acids and Bases

29) Find the pH of the following: *Note: equations given on equations sheet

a. $[H+] = 4.5 \times 10^{-9}$ M

b. pOH = 4

c. $[H+] = 0.001$ M

30) Identify the following conjugate acid/base pairs:

d. $H_2O + HF \rightarrow H_3O^+ + F^-$

Pair 1: Acid ______________ Base _______________

Pair 2: Acid ______________ Base _______________

e. $NH_3 + H_2SO_4 \rightarrow NH_4^+ + HSO_4^-$

Pair 1: Acid ______________ Base _______________

Pair 2: Acid ______________ Base _______________

Concentration

31) a. What is the concentration of a copper (II) chloride solution where 5.00 g of copper(II) chloride solid is placed in a volumetric flask and dissolved in deionized water up to the 250 mL mark?

b. What is the concentration of copper(II) ions in the solution above?

c. What is the concentration of chloride ions in the solution above?

32) A student is given a stock solution of sodium acetate that is 8.000 M.

a. If 25.00 mL of the stock solution was placed in a 100 mL volumetric flask and filled to the line with distilled water, what would be the concentration of the new solution?

b. How many milliliters of the stock solution would be needed if the student wanted to make 1.00 L of 0.250 M sodium acetate?

c. Describe the procedure, including the specific glassware or tools that would be needed for the student to make the solution described in part b).

Challenge Question!

Hydrogen peroxide is oxidized with permanganate solution to produce oxygen gas by the following reaction.

$$2\ H^+\ (aq) + H_2O_2\ (aq) + 2\ MnO_4^-\ (aq) \rightarrow 2\ MnO_2\ (aq) + 4\ H_2O + 3\ O_2\ (g)$$

In the lab a student mixed 30.0 mL of 0.30 M hydrogen peroxide solution with 30.0 mL of 0.30 M potassium permanganate solution. The oxygen that was produced was collected by water displacement at 298 K and 1.00 atm of pressure. The volume of oxygen collected was 178 mL. (Ignore the effect of water vapor in the collection tube here.)

a. What is the limiting reactant?

b. What is the theoretical yield of oxygen gas, in milliliters?

c. What is the percent yield of oxygen gas?

Names and Electrical Charges of Common Ions

(note: you will always have a periodic table available)

CATIONS

Cations (1+ charge)	**Cations (2+ charge)**	**Cations (3+ charge)**
H^+ hydrogen ion	Be^{2+} beryllium ion	Al^{3+} aluminum ion
Li^+ lithium ion	Mg^{2+} magnesium ion	
Na^+ sodium ion	Ca^{2+} calcium ion	
K^+ potassium ion	Sr^{2+} strontium ion	
Rb^+ rubidium ion	Ba^{2+} barium ion	
Cs^+ cesium ion	Ra^{2+} radium ion	
Fr^+ francium ion	Zn^{2+} zinc ion	
Ag^+ silver ion	Cd^{2+} cadmium ion	
NH_4^+ ammonium ion		
H_3O^+ hydronium ion		

Transition Metal Ions (cations with varying oxidation numbers)

Cu^+ copper(I) or cuprous ion
Cu^{2+} copper(II) or cupric ion
Fe^{2+} iron(II) or ferrous ion
Fe^{3+} iron(III) or ferric ion
Hg_2^{+2} mercury(I) or mercurous ion *note: mercury (I) exists as a diatomic ion
Hg^{2+} mercury(II) or mercuric ion
Sn^{2+} tin(II) or stannous ion
Sn^{4+} tin(IV) or stannic ion
Cr^{2+} chromium(II) ion
Cr^{3+} chromium(III)ion
Mn^{2+} manganese(II)ion
Mn^{3+} manganese(III)ion
Co^{2+} cobalt(II) ion
Co^{3+} cobalt(III)ion
Ni^{2+} nickel(II) ion
Tl^+ thallium(I) ion
Tl^{3+} thallium(III)ion

ANIONS

Anions(1- charge)	**Anions(2- charge)**	**Anions(3- charge)**
F^- fluoride ion	O^{2-} oxide ion	P^{3-} phosphide ion
Cl^- chloride ion	S^{2-} sulfide ion	N^{3-} nitride ion
Br^- bromide ion	CrO_4^{2-} chromate ion	PO_4^{3-} phosphate ion
I^- iodide ion	$Cr_2O_7^{2-}$ dichromate ion	PO_3^{3-} phosphite ion
H^- hydride ion	CO_3^{2-} carbonate ion	
CN^- cyanide ion	SO_4^{2-} sulfate ion	
OH^- hydroxide ion	SO_3^{2-} sulfite ion	
NO_3^- nitrate ion	$S_2O_3^{2-}$ thiosulfate ion	
NO_2^- nitrite ion	O_2^{2-} peroxide ion*	
$C_2H_3O_2^-$ acetate ion (also seen as CH_3COO^-)	HPO_4^{2-} monohydrogen phosphate ion	
MnO_4^- permanganate ion		
$H_2PO_4^-$ dihydrogen phosphate ion		
HCO_3^- bicarbonate ion		
HSO_4^- bisulfate ion		
HSO_3^- bisulfite ion		
**XO^- hypohalite ion		
**XO_2^- halite ion		
**XO_3^- halite ion		
**XO_4^- perhalate ion		

*Note: O has a -1 oxidation number here

**X = halogen other than F (Cl, Br, I)
Examples: ClO^- = hypochlorite ion
BrO_2^- = bromite ion
IO_3^- = iodate ion
IO_4^- = periodate ion

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
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** 47.87	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** 65.38	31 **Ga** 69.72	32 **Ge** 72.63	33 **As** 74.92	34 **Se** 78.97	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** 95.95	43 **Tc**	44 **Ru** 101.07	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** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57-71 *	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	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**	85 **At**	86 **Rn**
87 **Fr**	88 **Ra**	89-103 †	104 **Rf**	105 **Db**	106 **Sg**	107 **Bh**	108 **Hs**	109 **Mt**	110 **Ds**	111 **Rg**	112 **Cn**	113 **Nh**	114 **Fl**	115 **Mc**	116 **Lv**	117 **Ts**	118 **Og**

*Lanthanoids	57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm**	62 **Sm** 150.36	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** 173.05	71 **Lu** 174.97
†Actinoids	89 **Ac**	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np**	94 **Pu**	95 **Am**	96 **Cm**	97 **Bk**	98 **Cf**	99 **Es**	100 **Fm**	101 **Md**	102 **No**	103 **Lr**

AP® CHEMISTRY EQUATIONS AND CONSTANTS

Throughout the exam 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 $= 6.022 \times 10^{23}$ mol^{-1}

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

EQUILIBRIUM

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

$$K_p = \frac{(P_{\mathrm{C}})^c(P_{\mathrm{D}})^d}{(P_{\mathrm{A}})^a(P_{\mathrm{B}})^b}$$

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

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

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

$$= K_a \times K_b$$

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

$$14 = \mathrm{pH} + \mathrm{pOH}$$

$$\mathrm{pH} = \mathrm{p}K_a + \log\frac{[\mathrm{A}^-]}{[\mathrm{HA}]}$$

$$\mathrm{p}K_a = -\log K_a,\ \mathrm{p}K_b = -\log K_b$$

<u>Equilibrium Constants</u>

K_c (molar concentrations)

K_p (gas pressures)

K_a (weak acid)

K_b (weak base)

K_w (water)

KINETICS

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

$$\ln[\mathrm{A}]_t - \ln[\mathrm{A}]_0 = -kt$$

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

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

k = rate constant

t = time

$t_{1/2}$ = half-life

GASES, LIQUIDS, AND SOLUTIONS

$$PV = nRT$$

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

$$P_{total} = P_{\text{A}} + P_{\text{B}} + P_{\text{C}} + \ldots$$

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

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

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

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

Molarity, M = moles of solute per liter of solution

$$A = \varepsilon bc$$

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

Gas constant, R = 8.314 J mol^{-1} K^{-1}
= 0.08206 L atm mol^{-1} K^{-1}
= 62.36 L torr mol^{-1} K^{-1}

1 atm = 760 mm Hg = 760 torr

STP = 273.15 K and 1.0 atm

Ideal gas at STP = 22.4 L mol^{-1}

THERMODYNAMICS / ELECTROCHEMISTRY

$$q = mc\Delta T$$

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

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

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

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

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

$$E_{cell} = E_{cell}^\circ - \frac{RT}{nF}\ln Q$$

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

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

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