AP Chemistry Summer Assignment

The summer assignment for AP Chemistry is simple, but not easy. You need to master the formulas, charges, and names of the common ions (monatomic and polyatomic). ***On the second day of the school year, you will be given a quiz on these items.*** You will be asked to:

Write the names of the ions when given the formula and charge

Write the formula and charge when given the names.

I have included several resources in this packet. There is a list of ions you must know by memory. A common ion chart is not given on any tests or on the AP exam. There is also a sheet with some suggestions for making the process of memorization easier. Also included is a copy of the periodic table used in AP Chemistry. This is the same periodic table that you will be allowed to use on the AP test. Notice that it has the symbols of the elements, but NOT the names.

I have included a sheet of flashcards for the polyatomic ions that you must learn. I strongly suggest that you cut them out or make some of your own and begin memorizing them soon. Use the hints on the common ions sheet to help you reduce the amount of memorizing you must do. Notice that there are no flashcards for monatomic ions. You should be able to identify these using their placement on the periodic table. If you have trouble identifying the charge of monatomic ions (or the naming system), then I suggest you spend some time this summer working on those as well.

Some students will procrastinate and try to do all of this studying just before the start of school to prepare for the quiz. However, these students will quickly forget the ions, and struggle every time these formulas are used in lecture, homework, quizzes, test and labs. Frequent, short periods of study, spread over long periods of time will produce greater retention than long periods of study over a short amount of time. Begin studying these things early in the summer and take advantage of every opportunity to review them.

It is recommended you have a spiral bound, graph paper notebook on day 1. All of your work for the class will be kept in this notebook.

A diagnostic quiz will be given on the first week of school to see what you have retained from first year chemistry. You should spend some time this summer looking over your notes from your chemistry class to prepare yourself for this quiz. Much of this information will be reviewed very quickly at the beginning of the course.

I look forward to seeing all of you at the beginning of the next school year. Have a wonderful summer and happy studying!

Ms. Collier

Common Ions and Their Charges

A mastery of the common ions, their formulas and their charges, is essential to success in AP Chemistry. You are expected to know all of these ions on the first day of class, when I will give you a quiz on them. You will always be allowed a periodic table, which makes indentifying the ions on the left "automatic." For tips on learning these ions, see the opposite side of this page.

From the table:	
Cations	**Name**
H^+	Hydrogen
Li^+	Lithium
Na^+	Sodium
K^+	Potassium
Rb^+	Rubidium
Cs^+	Cesium
Be^{2+}	Beryllium
Mg^{2+}	Magnesium
Ca^{2+}	Calcium
Ba^{2+}	Barium
Sr^{2+}	Strontium
Al^{3+}	Aluminum
Anions	**Name**
H^-	Hydride
F^-	Fluoride
Cl^-	Chloride
Br^-	Bromide
I^-	Iodide
O^{2-}	Oxide
S^{2-}	Sulfide
Se^{2-}	Selenide
N^{3-}	Nitride
P^{3-}	Phosphide
As^{3-}	Arsenide
Type II Cations	**Name**
Fe^{3+}	Iron(III)
Fe^{2+}	Iron(II)
Cu^{2+}	Copper(II)
Cu^+	Copper(I)
Co^{3+}	Cobalt(III)
Co^{2+}	Cobalt(II)
Sn^{4+}	Tin(IV)
Sn^{2+}	Tin(II)
Pb^{4+}	Lead(IV)
Pb^{2+}	Lead(II)
Hg^{2+}	Mercury(II)

Ions to Memorize	
Cations	**Name**
Ag^+	Silver
Zn^{2+}	Zinc
Hg_2^{2+}	Mercury(I)
NH_4^+	Ammonium
Anions	**Name**
NO_2^-	Nitrite
NO_3^-	Nitrate
SO_3^{2-}	Sulfite
SO_4^{2-}	Sulfate
HSO_4^-	Hydrogen sulfate (bisulfate)
OH^-	Hydroxide
CN^-	Cyanide
PO_4^{3-}	Phosphate
HPO_4^{2-}	Hydrogen phosphate
$H_2PO_4^-$	Dihydrogen phosphate
NCS^-	Thiocyanate
CO_3^{2-}	Carbonate
HCO_3^-	Hydrogen carbonate (bicarbonate)
ClO^-	Hypochlorite
ClO_2^-	Chlorite
ClO_3^-	Chlorate
ClO_4^-	Perchlorate
BrO^-	Hypobromite
BrO_2^-	Bromite
BrO_3^-	Bromate
BrO_4^-	Perbromate
IO^-	Hypoiodite
IO_2^-	iodite
IO_3^-	iodate
IO_4^-	Periodate
$C_2H_3O_2^-$	Acetate
MnO_4^-	Permanganate
$Cr_2O_7^{2-}$	Dichromate
CrO_4^{2-}	Chromate
O_2^{2-}	Peroxide
$C_2O_4^{2-}$	Oxalate
NH_2^-	Amide
BO_3^{3-}	Borate
$S_2O_3^{2-}$	Thiosulfate

Tips for Learning the Ions

"From the Table"

These are ions can be organized into two groups.

1. Their place on the table suggests the charge on the ion, since the neutral atom gains or loses a predictable number of electrons in order to obtain a noble gas configuration. This was a focus in first year chemistry, so if you are unsure what this means, get help BEFORE the start of the year.
   a. All Group 1 Elements (alkali metals) lose one electron to form an ion with a 1+ charge
   b. All Group 2 Elements (alkaline earth metals) lose two electrons to form an ion with a 2+ charge
   c. Group 13 metals like aluminum lose three electrons to form an ion with a 3+ charge
   d. All Group 17 Elements (halogens) gain one electron to form an ion with a 1- charge
   e. All Group 16 nonmetals gain two electrons to form an ion with a 2- charge
   f. All Group 15 nonmetals gain three electrons to form an ion with a 3- charge

   Notice that cations keep their name (sodium ion, calcium ion) while anions get an "-ide" ending (chloride ion, oxide ion).

2. Metals that can form more than one ion will have their positive charge denoted by a roman numeral in parenthesis immediately next to the name of the

Polyatomic Anions

Most of the work on memorization occurs with these ions, but there are a number of patterns that can greatly reduce the amount of memorizing that one must do.

1. "ate" anions have one more oxygen then the "ite" ion, but the same charge. If you memorize the "ate" ions, then you should be able to derive the formula for the "ite" ion and vice-versa.
   a. sulfate is SO_4^{2-}, so sulfite has the same charge but one less oxygen (SO_3^{2-})
   b. nitrate is NO_3^-, so nitrite has the same charge but one less oxygen (NO_2^-)

2. If you know that a sufate ion is SO_4^{2-} then to get the formula for hydrogen sulfate ion, you add a hydrogen ion to the front of the formula. Since a hydrogen ion has a 1+ charge, the net charge on the new ion is less negative by one.
   a. Example:

PO_4^{3-}	→	HPO_4^{2-}	→	$H_2PO_4^-$
phosphate		hydrogen phosphate		dihydrogen phosphate

3. Learn the hypochlorite → chlorite → chlorate → perchlorate series, and you also know the series containing iodite/iodate as well as bromite/bromate.
   a. The relationship between the "ite" and "ate" ion is predictable, as always. Learn one and you know the other.
   b. The prefix "hypo" means "under" or "too little" (think "hypodermic", "hypothermic" or "hypoglycemia")
      i. Hypochlorite is "under" chlorite, meaning it has one less oxygen
   c. The prefix "hyper" means "above" or "too much" (think "hyperkinetic")
      i. the prefix "per" is derived from "hyper" so perchlorate (hyperchlorate) has one more oxygen than chlorate.
   d. Notice how this sequence increases in oxygen while retaining the same charge:

ClO^-	→	ClO_2^-	→	ClO_3^-	→	ClO_4^-
hypochlorite		chlorite		chlorate		perchlorate

Sulfite	Sulfate	Hydrogen sulfate
Phosphate	Dihydrogen Phosphate	Hydrogen Phosphate
Nitrite	Nitrate	Ammonium
Thiocyanate	Carbonate	Hydrogen carbonate
Borate	Chromate	Dichromate
Permanganate	Oxalate	Amide
Hydroxide	Cyanide	Acetate
Peroxide	Hypochlorite	Chlorite
Chlorate	Perchlorate	Thiosulfate

HSO_4^-	SO_4^{2-}	SO_3^{2-}
HPO_4^{2-}	$H_2PO_4^-$	PO_4^{3-}
NH_4^+	NO_3^-	NO_2^-
HCO_3^-	CO_3^{2-}	NCS^- SCN^-
$Cr_2O_7^{2-}$	CrO_4^{2-}	BO_3^{3-}
NH_2^-	$C_2O_4^{2-}$	MnO_4^-
$C_2H_3O_2^-$ CH_3COO^-	CN^-	OH^-
ClO_2^-	ClO^-	O_2^{2-}
$S_2O_3^{2-}$	ClO_4^-	ClO_3^-

AP Chemistry Summer Assignment – Naming Compounds

Do some research and complete the following chart with rules for naming different types of compounds. Being able to name compounds and write formulas is very important background knowledge in AP Chemistry. It is something that will apply in every unit of study. Make sure you become very comfortable with naming ionic and molecular compounds as well as acids and bases.

Ionic Compounds

2 elements only	With a transition metal	With polyatomic ion(s)

Molecular (Covalent) Compounds

Acids

Without Oxygen (Binary acids)	With Oxygen (polyatomic ion)

Name the following compounds on a separate sheet of paper

1. NaCl
2. $Fe_2(CO_3)_3$
3. $Cu(OH)_2$
4. $(NH_4)_2SO_4$
5. $LiNO_3$
6. $BaSO_4$
7. $Mg(NO_3)_2$
8. AgCl
9. $Al(OH)_3$
10. $CaSO_4$
11. FeS
12. $PbCl_2$
13. NaI
14. $MgCO_3$
15. Br_2I_4
16. P_5F_8
17. NO_5
18. NBr_3
19. N_2O_5
20. $BrCl_3$
21. N_2O
22. $HClO_4$
23. H_3PO_4
24. HCl
25. H_2SO_4
26. HNO_2
27. HF
28. HCN
29. H_2CO_3
30. HNO_3

Write Formulas for the following compounds on sep sheet of paper

1. Sodium bicarbonate
2. Sodium Fluoride
3. Iron (III) Chloride
4. Sodium Carbonate
5. Copper (II) Sulfate
6. Magnesium Hydroxide
7. Barium Nitrate
8. Lithium Sulfate
9. Magnesium Chloride
10. Silver Nitrate
11. Aluminum Sulfate
12. Calcium Hydroxide
13. Calcium Sulfate
14. Mercury (II) Nitrate
15. Lead (IV) Nitrate
16. Magnesium Iodide
17. Sodium Nitride
18. Disulfur tetrafluoride
19. Carbon trioxide
20. Nitrogen Pentoxide
21. Nitrogen tribromide
22. Dinitrogen heptachloride
23. Carbon Tetrachloride
24. Trihydrogen monophosphide
25. Hydroiodic acid
26. Perchloric acid
27. Acetic acid
28. Nitrous acid
29. Sulfurous acid
30. Phosphoric acid

DO NOT DETACH FROM BOOK.

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)

SOLUBILITY OF COMMON INORGANIC COMPOUNDS IN WATER

These Anions		Form Soluble Compounds With These Cations	Form Slightly Soluble Compounds With These Cations (Precipitates)
NO_3	nitrate	Most Cations	No common cations
CH_3COO^- or $C_2H_3O_2^-$	acetate	Most Cations	Ag^+
Cl^- Br^-, I^-	halides	Most Cations	Ag^+, Pb^{2+}, Hg^{2+}
SO_4^{2-}	sulfate	Most Cations	Ba^{2+}, Sr^{2+}, Ag^+, Pb^{2+}, Ca^{2+}
CrO_4^{2}	chromate	Most Cations	Ba^{2+}, Sr^{2+}, Ag^+, Pb^{2+}
S^{2-}	sulfide	NH_4^+, and the cations of Group 1 and 2	Most other cations
OH	hydroxide	NH_4^+, the cations of Group 1 and Ba^{2+} and Sr^{2+} of Group 2	Most other cations
CO_3^{2-}	carbonate	NH_4^+, and the cations of Group 1, except Li^+	Most other cations
PO_4^{3-}	phosphate	NH_4^+, and the cations of Group 1, except Li^+	Most other cations

These Cations	Form Soluble Compounds With These Anions	Form Slightly Soluble Compounds With These Anions
Cations of Group 1 and NH_4^+	Most Anions	No common anions
$Hh^+(aq)$	Most Anions	No common anions

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 = 6.022×10^{23} mol^{-1}

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

EQUILIBRIUM

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

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

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

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

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

$= K_a \times K_b$

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

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

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

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

Equilibrium Constants

K_c (molar concentrations)

K_p (gas pressures)

K_a (weak acid)

K_b (weak base)

K_w (water)

KINETICS

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

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

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

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 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

THERMODYNAMICS / ELECTROCHEMISTRY

$$q = mc\Delta T$$

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

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

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

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

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

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)

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

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