Welcome to AP Chemistry!

The first part of the summer assignment for AP Chemistry is quite simple (but not easy). You need to master the formulas, charges, and names of the common ions. During the first week of the school year, you will be given a quiz on these ions. You will be asked to:

- write the names of these ions when given the formula and charge
- write the formula and charge when given the names

I have included several resources in this packet. First, there is a list of the ions that you must know. This list also has, on the back, some suggestions for making the process of memorization easier. For instance, many of you will remember that most of the monatomic ions have charges that are directly related to their placement on the periodic table. There are naming patterns that greatly simplify the learning of the polyatomic ions as well.

I have included a sheet of flashcards for the polyatomic ions that you must learn. I strongly suggest that you cut them out and begin memorizing them immediately. Use the hints on the common ions sheet to help you reduce the amount of memorizing that you must do. Do not let the fact that there are no flashcards for monatomic ions suggest to you that the monatomic ions are not important. They are every bit as important as the polyatomic ions. If you have trouble identifying the charge of monatomic ions (or the naming system) then I suggest that you make yourself some flashcards for those as well.

The second part of the summer assignment contains review material that is necessary for your success in this course. The questions cover chemical formulas, equation writing and balancing, formula and reaction stoichiometry, and gasses. Use significant figures where appropriate for all calculations. If you have difficulty, you are more than welcome to email me, at any point during the summer, at the email address below.

Doubtless, there will be some students who will procrastinate and try to do all of this studying just before the start of school. Those students may even cram well enough to do well on the initial quiz. However, they will quickly forget the ions, and struggle every time that these formulas are used in lecture, homework, quizzes, tests and labs. *All research on human memory shows us that frequent, short periods of study, spread over long periods of time will produce much greater retention than long periods of study of a short period of time*.

I could wait and throw these at you on the first day of school, but I don't think that would be fair to you. Use every modality possible as you try to learn these – **speak them**, **write them**, **visualize them**. Use the internet to help you practice!

I look forward to seeing you all at the beginning of the next school year. If you need to contact me during the summer, you can email me and I will get back to you quickly.

This review packet will be collected and there will be a test during the second week of school covering the concepts in this packet. Please take the assignment seriously, and do not procrastinate. I look forward to seeing you next fall.

Mr. Rust
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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 by the third day of class, when I will give you a quiz on them. You will always be allowed a periodic table, which makes identifying the ions on the left "automatic."

Cation	Name
H^+	Hydrogen
Li^+	Lithium
Na^+	Sodium
K^+	Potassium
Rb^+	Rubidium
Cs^+	Cesium
Mg^{2+}	Magnesium
Ca^{2+}	Calcium
Ba^{2+}	Barium
Sr^{2+}	Strontium
Al^{3+}	Aluminum
Anion	**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^{3+}	Cobalt (II)
Sn^{4+}	Tin (IV)
Sn^{2+}	Tin (II)
Pb^{4+}	Lead (IV)
Pb^{2+}	Lead (II)
Hg^{+2}	Mercury (II)

Cation	Name
Ag^+	Silver
Zn^{2+}	Zinc
Hg_2^{2+}	Mercury (I)
NH_4^+	Ammonium
Anion	**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
SCN^-	Thiocyanate
CO_3^{2-}	Carbonate
HCO_3^{2-}	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 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 parentheses immediately next to the name of the element.

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 sulfate 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. $PO_4^{3-} \rightarrow HPO_4^{2-}$ (phosphate → hydrogen phosphate)
b. $HPO_4^{2-} \rightarrow H_2PO_4^-$ (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")
   Example: Hypochlorite is "under" chlorite, meaning it has one less oxygen
c. The prefix "hyper" means "above" or "too much" (think "hyperkinetic")
   Example: the prefix "per" is derived from "hyper" so perchlorate has one more oxygen than chlorate.
d. Notice how this sequence increases in oxygen while retaining the same charge:
   a. $ClO^- \rightarrow ClO_2^- \rightarrow ClO_3^- \rightarrow ClO_4^-$ (hypochlorite → chlorite → chlorate → perchlorate)

AP Chemistry Summer Review Questions

This assignment will be collected at the start of school in August.

There will be a test on this material during the second week.

I. Chemical Formulas

Write formulas for the following substances:

a. Barium sulfate

b. Ammonium chloride

c. Chlorine monoxide

d. Silicon tetrachloride

e. Magnesium fluoride

f. Sodium oxide

g. Sodium peroxide

h. Copper (I) iodide

i. Zinc sulfide

j. Potassium carbonate

k. Hydrobromic acid

l. Nitric acid

m. Lead (II) acetate

n. Sodium permanganate

o. Lithium oxalate

p. Potassium cyanide

q. Iron (III) hydroxide

r. Silicone dioxide

s. Nitrogen trifluoride

t. Chromium (III) oxide

u. Calcium chlorate

v. Cobalt (III) nitrate

w. Nitrous acid

x. Ammonium phosphate

y. Potassium chromate

Name each of the following compounds (Give acid names where appropriate)

a. $CuSO_4$

b. PCl_3

c. Li_3N

d. $BaSO_3$

e. N_2F_4

f. $KClO_4$

g. NaOH

h. $(NH_4)_2Cr_2O_7$

i. HNO_2

j. Sr_3P_2

k. $Mg(OH)_2$

l. Al_2S_3

m. AgBr

n. P_4O_{10}

o. $HC_2H_3O_2$

p. CaI_2

q. MnO_2

r. Li_2O

s. FeI_3

t. Cu_3PO_4

u. PCl_3

v. NaCN

w. Cs_3N

x. $Zn(NO_3)_2$

y. N_2O

z. HF

II. Chemical Equations

Tell the type of reaction, predict the products and write a balanced chemical equation for each of the following, as shown in the example:

Ex: Solutions of silver nitrate and magnesium iodide are combined.
This is a double replacement reaction.
$2AgNO_3 + MgI_2 \rightarrow 2AgI + Mg(NO_3)_2$

1. Ammonium sulfate reacts with barium nitrate

2. Zinc metal is added to a solution of copper (II) chloride.

3. Propane gas (C3H8) is burned completely in excess oxygen.

4. Solid calcium chlorate is heated strongly.

5. Sodium hydroxide solution is added to a solution of iron (III) bromide.

6. Chlorine gas is bubbled through a solution of sodium bromide.

7. Solutions of lead(II) nitrate and calcium iodide are combined.

8. Sulfuric acid is combined with solid magnesium hydroxide.

9. Isopropyl alcohol (C3H7OH) is burned incompletely in air.

10. Iron metal shavings are added to hydrochloric acid. Iron will form the iron(II) ion.

11. Solid sodium carbonate is heated in a crucible.

12. Sodium metal is added to distilled water.

II. Stoichiometry: Show all your work and use significant figures where appropriate.

1. Benzene contains only carbon and hydrogen and has a molar mass of 78.1 g/mol. Analysis shows the compound to be 7.74% H by mass. Find the empirical and molecular formulas of benzene.

2. Find the mass percent of nitrogen in each of the following compounds:
   a. NO

   b. NO_2

   c. N_2O_4

   d. N_2O

3. Calcium carbonate decomposes upon heating, producing calcium oxide and carbon dioxide gas.
   a. Write a balanced chemical equation for this reaction.

   b. How many grams of calcium oxide will remain after 12.25 g of calcium carbonate is completely decomposed?

   c. What volume of carbon dioxide gas is produced from this amount of calcium carbonate? The gas is measured at 0.95 atm and 10°C.

4. Hydrogen gas and bromine gas react to form hydrogen bromide gas.
   a. Write a balanced chemical equation for this reaction.

   b. How many grams of hydrogen bromide gas can be produced from 3.2 g of hydrogen gas and 9.5 g of bromine gas?

   c. How many grams of which reactant is left unreacted?

   d. What volume of HBr, measured at STP, is produced from the data in question b)?

5. When ammonia gas, oxygen gas and methane gas (CH_4) are combined, the products are hydrogen cyanide gas and water.

a. Write a balanced chemical equation for this reaction.

b. Calculate the mass of each product produced when 225 g of oxygen gas is reacted with an excess of the other two reactants.

c. If the actual yield of the experiment in question b) is 105 g of HCN, calculate the percent yield.