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Naming Compounds

& Writing Formulas

Simple Ionic Compounds, Molecular Compounds, and Transitional Metal Compounds

Periodic Table Layout

Naming Compounds BASICS

1. Periodic table layout and the properties of metals, non-metals, and metalloids
2. Mono-atomic ions
3. Polyatomic ions (table E)
4. Ionic bonding
5. Naming ionic compounds, writing ionic compound formulas, writing formula from names
6. Transitional metal with multiple cations: the Roman Numeral or STOCK naming
7. Molecular compounds
8. Naming molecular compounds using the prefix methods, DIATOMIC ELEMENTS
9. Oxidation numbers, using to make sensible molecular compound ratios
10. Naming of acids and bases (tables K and L).

Periodic Table Layout (revisited)

The periodic table was designed to list the elements in a way to group them by similarity, and to also order them with regular "periodic" repetitions of chemical properties. It has a oddly shaped outer border, but to keep the elements in groups that make sense, this is the shape it must have.

The Periodic Law states: when the atoms are arranged in order of increasing atomic number (in this weird shape) that there is a periodic repetition of chemical properties, that arise in the groups.

The vertical columns are the GROUPS. Elements in GROUPS have similar chemical properties.

Group 1 are the ALKALI metals. Group 1 elements have just one electron in its outermost orbital.
Outermost orbitals are called VALENCE ORBITALS.
Group 1 elements all have 1 VALENCE ELECTRON in their VALENCE ORBITALS.

Group 2 are the ALKALINE EARTH metals.
Group 2 elements have two valence electrons in their valence orbitals.
This gives every atom in group 2 similar bonding abilities and ion formation.

Group 18 are the NOBLE gases. These have eight valence electrons in its valence orbital, except for He. Helium is too small and has just that baby sized orbital which fits up to 2 electrons.
All group 18 elements have only complete outer orbitals, the PERFECT ARRANGEMENT of ELECTRONS.
Because of this they do not make any compounds, they do not bond with other elements.

Group 17 are the HALOGEN gasses. They all have 7 valence electrons in its valence orbital.

Going left to right, the horizontal rows on the periodic table are called PERIODS. The periods number matches the number of orbitals in any atom. Period 2 elements all have 2 orbitals. Period 5 elements all have 5 orbitals. (check this now, make sure)

All elements on the left side of the DARK STAIRCASE LINE are the metals. (except hydrogen)

The nonmetals are all on the right side of this STAIRCASE line (except hydrogen).

There are nine elements TOUCHING THE STAIRCASE, and seven of them are called the Metalloids, or the semi-metals. They are metals that have some non-metallic properties, or non-metals with some metallic properties.

Two elements that touch the line, aluminum & polonium (the Al-Po exception) are not metalloids. They are both metals and have only metallic characteristics.

Sometimes the nice order of the table is slightly less than perfect, but it's the best anyone has yet devised to keep properties ordered, atomic numbers ordered, and periodicity
intact. A few asterisks are good for the soul.

MONO-ATOMIC IONS

All atoms are neutral because all atoms have the same number of positive protons as they do negative electrons. When the positives equal the negatives, you have a neutral. **Atoms like to be neutral.**

In order to bond, a metal atom atom would have to give up this neutrality and form into an ion. To do so, it loses exactly enough electrons to match a configuration of a noble gas. Metals, because of their electron configurations will only lose electrons rather than gain them, to get this noble gas configuration come about.

When an atom gains that perfect NOBLE GAS electron configuration it is said to be ISOELECTRIC to that noble gas.

Isoelectric means... having the same electron configuration as...

The sodium atom has a 2-8-1 electron configuration. If it changes to just 2-8, it has "lost" it's outmost electron. Since is now has 11 protons but only 10 electrons, it now has a +1 overall charge.

It has become isoelectric to neon. It does not become neon, or does it become a gas.
It's sodium, but now it is a sodium positive one ion. It's able to bond.

The sulfur atom has a 2-8-6 electron configuration and is neutral. 16 protons= 16 electrons.
The positives equal the negatives, which is normal for all atoms.
To bond with a metal it must gain enough electrons to become isoelectric to a noble gas.

If it gains 2 electrons, its configuration becomes 2-8-8, matching argon—becoming isoelectric to argon. Sulfur does no become argon, and doesn't become a gas either. It now has the same orbital situation as argon. It can bond, but is has a –2 overall charge. It still has 16 protons, but now 18 electrons.

Group 1 metals all have one valence electron, which each would give up to obtain a noble gas electron configuration. Na at 2-8-1 would become the sodium ion (Na^{+1})with a 2-8 configuration. Since the number of protons is constant, the ion becomes a net +1 charge.

Group 1 metals, the ALKALI METALS, all "lose" one electron to become isoelectric to a noble gas, so they all form into +1 cations.

A positive ion is called a CATION.

Group 2, the ALKALINE EARTH METALS, all have two valence electrons. Each of these metals will lose these two valence electrons when they form into cations, leaving them then with full outer orbitals, and all end up +2 cations. For example, Mg becomes the Mg^{+2} cation when it loses its 2 outer, valence electrons.

Aluminum atoms have a 2-8-3 electron configuration. In order to bond, the aluminum atom gives up three electrons to become isoelectric to neon, making the aluminum cation +3! The Al^{+3} cation has a 2-8 electron configuration.

METALS MAKE CATIONS, all metals ONLY lose electrons in order to become isoelectric to noble gases, to get that "bonding orbital system".

On the other side of the table are the nonmetals. Due to their electron arrangements, they all have more valence electrons than the metals do, it makes more sense for them to gain electrons to get a complete outer orbital. Nonmetals ONLY gain electrons to become isoelectric to noble gases.

Group 17 atoms (the HALOGENS) all have 7 valence electrons. It makes sense that they'd each gain one electron to get a complete outer orbital. Hence they form negative one (-1) ANIONS.
The gain of one negative electron by the neutral atoms yields a -1 charge extra.

Group 16 atoms all have outer, valence electron orbitals that end with 6 electrons. In order to gain the perfectly full orbital like the noble gases they need to gain 2 electrons (two extra negative electrons)
They only form negative 2 ions like O^{-2}, and S^{-2}.

Group 15 atoms all have 5 valence electrons. In order to get a perfectly full orbital like a noble gas, they need to gain 3 electrons (that's 3 negative electrons extra) they form negative 3 ions like N^{-3}, and P^{-3}.

A negative ion is called an ANION.

Noble gases do not make any ions at all.

POLYATOMIC IONS

Positive cations and negative anions form for metals and nonmetals. When one atom becomes an ion these are the monoatomic ions (one atom becomes one ion).

In chemistry it is possible for small groups of atoms to unite as a single ion even though they might be 2 to 9 atoms in a small group, and they act as a single cation or anion. These are called polyatomic ions. The only poly-atomic ions that you need to be familiar with are listed in Table E.

The polyatomic ions come in cation form and in anion form.

Their names stick, we never change these names (like we change anions names to the –ide name).

There are many similar but different polyatomic ions (sulfite and sulfate, carbonate and hydrogen carbonate, chromate and dichromate, for example). Put your finger into the right box, little differences mean different things completely. USE THE CORRECT IONS, with the correct ionic charge.

Forming Ionic Compounds

Neutral metal atoms “lose” electrons, and become positive cations. They don’t really lose electrons, that is not allowed. Rather, the electrons are transferred to the nonmetal atoms, which become negative anions at the same time. The nonmetals don’t quite “gain” electrons. The electrons are transferred from metal to non-metal.

The classic starter compound is sodium chloride, NaCl. It forms when one atom of sodium transfers an electron away, to a chlorine atom. The sodium atom “loses” one electron, the chlorine atom gains this electron. A perfect transfer of electrons, forming a +1 cation and a –1 anion.

The smallest part of an ionic compound is not a molecule. These ionic compounds exist only in the crystal form as solids, millions of ions connected. You could “imagine” just a single unit of an ionic compound formula, for instance “a NaCl” unit. This imaginary particle is called a single FORMULA UNIT. You can’t have one, but you can imagine that it might be the smallest possible unit of an ionic compound.

Starting point	Electron transfers	Forming	→	A neutral ionic compound
Na atom 2-8-1	“loses” 1 electron	Na^{+1} cation		
	↓		Ions attract due to opposite charges	→ NaCl
Cl atom 2-8-7	“gains” 1 electron	Cl^{-1} anion		

Starting point	Electron transfers	Forming	→	A neutral ionic compound
Mg atom 2-8-2	“loses” 2 electrons	Mg^{+2} cation	Ions attract due to opposite charges	
	↓			→ MgO
O atom 2-7	“gains” 2 electrons	O^{-2} anion		2:2 ratio changes to 1:1 simple whole number ratios only

Starting point	Electron transfers	Forming	→	A neutral ionic compound
Al atom 2-8-3	“loses” 3 electrons	Al^{+3} cation		
	↓		Ions attract due to opposite charges	→ Al_2S_3
S atom 2-8-6	“gains” 2 electrons	S^{-2} anion		The smallest, simple whole number ratio that sums to neutral.
				2 Al^{+3} = +6

John Dalton said that compounds form in simple whole number ratios. There are a limited number of possible ions from the periodic table, cations and anions. They are +1, +2, +3, and -1, -2, and -3.
A neutral ionic compound can only be made from a balanced ratio of positive cations and negative anions. The only possible ratios of ions from these are as follows:

	cation charge	anion charge	ratio of cations : anions in a neutral ionic compound	Example compounds
	+1	-1	1:1	$NaCl$ sodium chloride
	+2	-1	1:2	MgF_2 magnesium fluoride
	+3	-1	1:3	$AlBr_3$ aluminum bromide
	+1	-2	2:1	Li_2O lithium oxide
☼	+2	-2	(2:2 is not simple →) 1:1	MgO magnesium oxide
	+3	-2	2:3	Al_2S_3 aluminum sulfide
	+1	-3	3:1	K_3P potassium phosphide
	+2	-3	3:2	Ba_3N_2 barium nitride
☼	+3	-3	(3:3 is not simple →) 1:1	AlP aluminum phosphide

The "easy" way to figure out IONIC COMPOUND FORMULAS

<u>Five Examples</u>

Na^{+1} and Cl^{-1} → criss-cross the charges and you end up with Na_1Cl_1, but we don't write ones: $NaCl$

Al^{+3} and Br^{-1} → criss-cross the charges and you end up with Al_1Br_3, but we don't write ones: $AlBr_3$

Li^{+1} and O^{-2} → criss-cross the charges and you end up with Li_2O_1, but we don't write ones: Li_2O

Al^{+3} and S^{-2} → criss-cross the charges and you end up with Al_2S_3

MOLECULAR COMPOUNDS

Are formed from 2 or more non-metals combining together. There are NO METALS, there are NO IONS, and the compounds formed are still neutral, but because they form from neutral ATOMS.

The electrons are NOT transferred from one atom/ion to another. Here the electrons are shared, they remain with their original atoms.

The smallest part of a molecular compound is called the molecule. There are specific ratios of atoms that can make real molecules. To determine how these atoms fit together (or do not fit together), we use the selected oxidation states listed in our periodic tables.

Selected oxidation states ARE NOT IONS, nor ionic charges that need to be neutral.
They are a set of numbers that allow you to determine which atom ratios are possible or impossible for molecules to form into.

The numbers are listed and come in positive or negative values. These numbers ARE NOT ionic forms, and many atoms have many different oxidation states. Many more selected oxidation states exist, not all of them are listed.

We use these numbers to see how the atoms can combine into particular ratios and make compounds that can exist. The atoms need to combine so that these oxidation numbers end up to a net zero, similar of course to ionic compounds needing to balance the + cation charges against equal but opposite - anion charges.

The oxidation numbers are a set of numbers, used to make ratios that sum to zero, but are not ions! There are NO CHARGES for molecular compounds.

Nitrogen	Oxygen	What are ALL of the possible nitrogen-oxygen compounds in high school?
~~-3~~ ~~-2~~ ~~-1~~	-2	Nothing here. The negative oxidation states of nitrogen can never "balance" or sum to zero with a –2 oxidation state of oxygen, so those are not used to form N-O compounds. They're like your other shoes in your closet. You don't need them today, but you might wear them with a different outfit. They are real, but not used when bonding to oxygen, they are for bonding to some atom with a positive selected oxidation state, like chlorine, or many other atoms.
+1		N^{+1} and O^{-2} combine in a 2:1 ratio: N_2O dinitrogen monoxide
+2		N^{+2} and O^{-2} combine in a 1:1 ratio: NO nitrogen monoxide
+3		N^{+3} and O^{-2} combine in a 2:3 ratio: N_2O_3 dinitrogen trioxide
+4		N^{+4} and O^{-2} combine in a 1:2 ratio: NO_2 nitrogen dioxide
+5		N^{+5} and O^{-2} combine in a 2:5 ratio: N_2O_5 dinitrogen pentoxide

The oxidation states also tell us what is NOT possible.

Carbon trioxide CO_3 is NOT POSSIBLE. (it does look so good though, doesn't it?) J

The Periodic Table show us that carbon can be C^{-4}, C^{+2} or C^{+4} only, while oxygen can only be O^{-2}.

These are possible: C^{+2} and O^{-2} → CO C^{+4} and O^{-2} → CO_2

For CO_3 to exist, that would mean that C^{+6} would need to be available to allow this to happen:
C^{+6} and O^{-2} → C_2O_6 which would become → CO_3
This cannot ever form, carbon trioxide is not a real molecular compound.

The CARBONATE ANION on Table E is CO_3^{-2}, but it's NOT a neutral molecular compound, it is a polyatomic anion made up of 4 atoms plus 2 extra electrons. It's not the same thing.

Molecular compounds ARE compounds, not ions.

When the oxidation numbers are the same sign (both negative, or both positive) we disregard them since they cannot combine in any way that would give us a net zero. They're like extra shoes, we need them for other compounds, but not now.

The DIATOMIC ELEMENTS

There are 7 elements that do not exist in the pure form as individual atoms.

They exist only in pairs, or twins. They are H, O, N, Cl, Br, I, and F (the HONClBrIF twins).

These seven elements exist in the pure form as H_2, O_2, N_2, Cl_2, Br_2, I_2, and F_2 only.

They are diatomic—two of the same atoms bonded into a molecule.

They are technically molecules, as they are made up of 2 or more non-metals bonded together by sharing electrons in a molecular bond. They are NOT COMPOUNDS, they are elements.

Transitional Metal Cations

The transitional metals include groups 3 to 12, plus we include the metals in the "triangle" shape that are under the staircase on the Periodic Table (aluminum to thallium and to polonium). Because of their complex sub-orbitals that they have, that you do not have to learn about, they do not always follow the simple become isoelectric to a noble gas. They are able to lose any number of electrons and become stable cations. The transitional metals live in funkytown.

The oxidation numbers shown on the periodic table are PRIMARILY for making molecular compounds, where nonmetals and nonmetals bond together, the selected oxidation numbers in the transitional metal part of the table show the cations that can form.

All of group 1 metals have a +1 selected oxidation state. They also only make +1 cations.

All of group 2 metals have a +2 selected oxidation state. They also only make +2 cations.

Many transitional metals, such as scandium, zinc, yttrium, zirconium, silver, cadmium, indium, tantalum, and tungsten, etc. make ONLY ONE type of cation. That would be the same charged cation as the selected oxidation state on our periodic table.

Some transitional metal cations: Sc^{+3}, Zn^{+2}, Y^{+3}, Zr^{+4}, Ag^{+1}, Cd^{+2}, In^{+3}, Ta^{+5}, W^{+6}, etc.

Why this is is too difficult for high school chemistry, but the cation charges that are possible are in the boxes of the elements for you to point at. You can know them, but not why they can form.
These cations bond in the same way as the other "simple" cations in groups 1 and 2 do.

Many transitional metals make more than one stable type of cation, indicated by MORE THAN ONE POSITIVE oxidation state.

Titanium is # 22. It can make a +2, +3 or a +4 cation. Copper, number 29, can make a +1 or +2 cation. The cations that are possible in high school are the positive oxidation states listed on the periodic table.

Lead, element number 82 can make a Pb^{+2} or Pb^{+4} cation.
Vanadium, element number 23 forms V^{+2}, V^{+3}, V^{+4}, and V^{+5} cations.

Different ions of copper will form different ionic compounds, with different ratios cations to anions. These have different formulas, different properties, they are different compounds.

<table>
<tr><td>Copper ion</td><td>Combines with</td><td>Oxygen anion</td><td>And makes</td><td rowspan="3">We can't use the simple 1st name rule and 2nd name rule or else both of these compounds would have the same name!

They can't both be copper oxide!</td></tr>
<tr><td>Cu^{+1}</td><td>and</td><td>O^{-2}</td><td>Cu_2O</td></tr>
<tr><td>Cu^{+2}</td><td>and</td><td>O^{-2}</td><td>CuO</td></tr>
</table>

Copper ion	Combines with	Oxygen anion	And makes	names
Since we are using the Cu^{+1} cation, we insert that roman numeral into the name				
Cu^{+1}	and	O^{-2}	Cu_2O	Copper (I) oxide
Cu^{+2}	and	O^{-2}	CuO	Copper (II) oxide
Since we are using the Cu^{+2} cation, we insert that roman numeral into the name				

In this next example, chromium makes 3 different cations, and they all combine to chlorine in different ratios, making three different chromium chloride compounds, that all have different properties, different formulas, and different names.

cation	anion	formula	name
Cr^{+2}	Cl^{-1}	$CrCl_2$	chromium (II) chloride SAY: chromium roman numeral 2 chloride
Cr^{+3}	Cl^{-1}	$CrCl_3$	chromium (III) chloride SAY: chromium roman numeral 3 chloride
Cr^{+6}	Cl^{-1}	$CrCl_6$	chromium (VI) chloride SAY: chromium roman numeral 6 chloride

In this last example, silver, element 47, only makes one cation, Ag^{+1}. It can only bond to a nonmetal in one way. We'll use fluorine for example. Since there is just one cation possible, no roman numeral is needed. It's got to be the Ag^{+1} cation, there are no other silver ions possible.

cation	anion	formula	name
Ag^{+1}	F^{-1}	AgF	silver fluoride no roman numeral necessary

IONIC COMPOUNDS

Cations + anions form neutral compounds

Only metals form cations.
Only non-metals form anions

Ionic compounds are all neutral. The charges of the cations to anions must balance. Simple whole number ratios only. Use the ion charges to "criss-cross" the formulas.

Ions transfer electrons from metal to nonmetals, These ions bond with IONIC BONDS.

Metals make cations that have lost 1, 2, or 3 electrons. This makes them +1, +2, or +3

Nonmetals make anions that have gained 12, 2, or 3 electrons. This makes them –1, –2, or –3

The smallest part of an ionic compound is called a FORMULA UNIT.

Ionic compounds only exist as solids in a giant crystal form. A single grain of NaCl has millions of ions. You can't really have just one (like Lay's Potato Chips!) You can have a single unit of an ionic compound, but only theoretically.

NAMING IONIC COMPOUNDS

1st name rule: say the name of the metal cation.

2nd name rule: say the name of the anion*

*If the anion is MONO-ATOMIC, change the anion atomic name to end in -ide.

*If the anion is POLY-ATOMIC, don't change the polyatomic ion name from Table E

*If the cation is polyatomic, don't change the name of that ion from Table E.

*If transitional metal is involved and it makes more than one cation use a Roman Numeral to distinguish which cation you are using.

MOLECULAR COMPOUNDS

Have no ions. Atoms combine as atoms.

NO METALS in any molecular compounds.

Bonds between 2 or more Non-Metals form into molecules.

Atoms combine together to form neutral molecular compounds

They are neutral because they form from neutral atoms.

The ratios are also very particular, and we use the selected oxidation numbers to determine what these ratios are. We make "T" charts to figure out which compounds are possible.

The electrons are shared by the atoms that bond into molecules. There is no transfer of electrons from one atom to another.

The smallest part of a molecular compound is called a molecule.

NAMING MOLECULAR COMPOUNDS

1st name rule: Single atoms get called by their name, multiple atoms get a prefix.

2nd name rule: 2nd atom always gets a prefix.

These rules are clear if you remember the names & formulas of these compounds:

CO, CO_2, H_2O. Carbon monoxide, carbon dioxide, and dihydrogen monoxide.

The prefixes from 1—10 are: mono, di, tri, tetra, penta, hexa, hepta, octa, nona, and deca.

Properties of metals, non-metals, metalloids, ionic & molecular compounds

property	metals	nonmetals	metalloids	ionic compounds	molecular compounds
luster	yes	no	some have luster, like silicon	no	not usually
malleable, ductile	yes, yes	no, mostly brittle	few	no, mostly brittle	no, mostly brittle
conduct heat	yes	no	no	no	no
conduct electricity	yes	no	some can, such as silicon	no	no
form cations or anions?	cations only	anions only	Only these are possible in our class As^{-3} Ge^{+2} Ge^{+4} Sb^{+3} Sb^{+5} Te^{-2}	formed from cations & anions, but are neutral	none
smallest particle	atoms	atoms or diatomic molecules	atoms	formula units	molecules
density	fairly high	fairly low	varies, see table S	medium high	varies
melting point	relatively high	relatively lower	varies	extremely high	low compared to metals or ionic compounds
phase at room temp	almost all are solid	solid, liquid, or gas	solid	solid	Solid, liquid, or gas

Naming Compounds Notes

What are ions, how and why do they form, what can they do together?

1. All atoms are neutral because they have equal numbers of ________________ and __________________.

   Helium has 2 protons and 2 electrons, sodium has ____ protons and ________electrons, mercury has 80 protons and 80 electrons.

2. All atoms have a unique number of protons, and all have the exact same number of __________________.

3. All atoms are always neutral. The ____________________ = ______________________________,

4. All atoms are neutral, this is okay, but in order to bond together, atoms must first become ____________.

5. An ion is an atom that is no longer _________________________.
6. A metal atom will lose an electron, which makes it have a net charge of _________.

7. It's still a metal, it's still the same metal, but now it is the ____________________________, it has a charge of +1, and it can bond.
8. For example….Lithium atoms have __________ and ___________ (it's neutral)
9. If lithium "loses" an electron, it has 2 protons and now only 2 electrons, which sums to net _________

10. ______________ + _______________ = +1 net charge

11. Group 1 atoms	ATOM Electron configurations	ION Electron configuration and Ion Symbol	Ion becomes Isoelectric to
lithium	2-1		
sodium	2-8-1		
potassium	2-8-8-1		
rubidium	2-8-18-8-1		

12. ___________________________ to a noble gas means that the atom has an electron configuration

that matches a _________________________________.

13. Count the pumpkins, make fun of the superstitious! Ha!

14. Metals ____ noble gases, they form into metal ions, that happen to have the same electron configuration as a noble gas.

15. We use the noble gases to guide us, metals lose ____ to a noble gas.

16	Fill in this chart to see how group 2 metals become ions.			
	Atom	Atomic Electron config. From Periodic Table	Ionic Electron Configuration	Ion symbol with charge
A	beryllium	2-2		
B	magnesium	2-8-2		
C	calcium	2-8-8-2		
D	strontium	2-8-18-8-2		
E	barium	2-8-18-18-8-2		
F	radium	2-8-18-32-18-8-2		

17. All group 2 metals ____ to become isoelectric to noble gases.

18. They do not ____, nor do they turn into gases, they are ions with a +2 charge because they have "lost" 2 electrons to get that perfect electron orbital system, like the noble gases.

Fill in the chart

Be^{+2}	is isoelectric to →	He helium
Mg^{+2}	is isoelectric to →	
Ca^{+2}	is isoelectric to →	
Sr^{+2}	is isoelectric to →	
Ba^{+2}	is isoelectric to →	

20	Last metal of the day… (fill in this table)			
	Atom	Atomic Electron configuration from Periodic Table	Ionic Electron Configuration	Ion symbol with charge
Al	Aluminum	2-8-3	→	

21. ____ when they form ions.

22. Metals lose 1, 2, 3 electrons to form ____ ions.

23. A ____ has lost electrons.

24. Another name for a positive ion is a _______________________________________.

25. Nonmetals ____.

26. Nonmetals must ____to become ISOELECTRIC to a noble gas.

27. They will end up with a -1, -2, or -3 _______________________, depending if they gain 1, 2 or 3 electrons.

28. Metals ____when they "lose" electrons.

Nonmetals ____when they "gain" electrons.

29. In truth, no electrons are ever lost or gained. Electrons ____ from metals to nonmetals.

30. The positive and negative ions form ______________________________________, at the same time,

________________________________,with no leftover electrons, or IOU electrons that I promise I'll give them to you later.

31. Ions do not have to form, but ____ they first need to become ions.

32. There needs to be a ____of electrons.

33. Both the metal and nonmetal will be ____ to noble gases.

34. Metals only ____ to become positive ions.

Nonmetals only ____ to become negative ions

36. Fill in this table now.			
Atom symbol	Atomic electron configuration	Ionic electron configuration	Ion symbol *(isoelectric to)*
Fluorine F	2-7		
Chlorine Cl	2-8-7		
Bromine Br	2-8-18-7		
Iodine I	2-8-18-18-7		

35. The bond metal ion & nonmetal ions is called an ____.

37. ____to become isoelectric to a noble gas, all become -1 ions.

38. Nonmetals gain electrons and form into ________________________________

39. The rest of the Periodic Table Anions: Group 16 (top three) Group 15 (last three)			
Atom symbol	Atomic electron configuration	Ionic electron config	Ion symbol *(isoelectric to)*
O – oxygen	2-6		
S – sulfur	2-8-6		
Se - selenium	2-8-18-6		
N - nitrogen	2-5		
P - phosphorous	2-8-5		
As - arsenic	2-8-18-5		

End of class one (wow)

Naming Simple Monoatomic Ionic Compounds

40. Ionic compounds form when positive metal cations bond with negative ____________________________

41. They are wildly attracted to each other due to their ____

42. Cations form when metals ____to nonmetals, which simultaneously form anions.

43. Opposites attract, it's like love!!!

44. There is ALWAYS a ____of electrons, and if it's not a perfect transfer, nothing happens.

45	There are 2 rules for naming simple monoatomic ionic compounds. (think: NaCl)
1st name rule	
2nd name rule	

The metals in groups 1, 2 and Al, are easy enough to say, we already practiced them. Here come nonmetals.

46. Say, and write the anion names in the proper boxes.	N	O	F
	P	S	Cl
	As	Se	Br
These are the ONLY anions that form in high school.			I

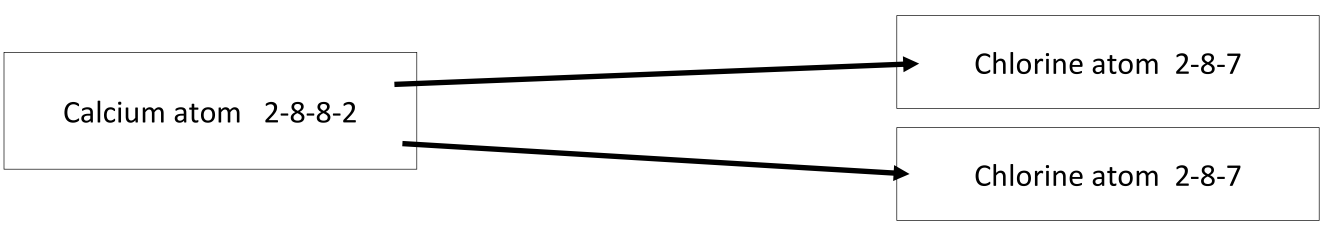
47. Fill in this table with the proper compound names	
Formulas	simple monoatomic ionic compound names
LiBr	
CaO	
BeS	
MgO	
CsF	
SrS	
AlP	

48. Na^{+1} and Cl^{-1} combine in a ________________________________, because (+1) + (-1) = 0

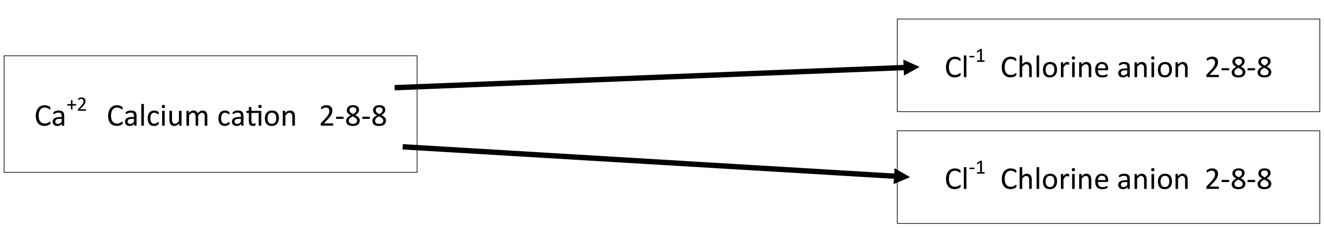
49. What happens if we try to combine something like calcium and chlorine?

____________ ___________ will form into ______________________

50.



Becomes…



51. Fill in the cations and anions, then write formulas and names			
Cation	Anion	Formula of compound	Name of compound
Na^{+1}	P^{-3}	Na_3P	Sodium phosphide
Ca^{+2}	S^{-2}		
Al^{+3}	P^{-3}		
Mg^{+2}	Br^{-1}		
Li^{+1}	O^{-2}		

John Dalton said atoms can combine together to form compounds in SIMPLE WHOLE NUMBER RATIOS.

52. An easy way to determine formulas… Let's bond some magnesium and bromine together.

Mg^{+2} Br^{-1} → ______________________________

use the criss cross method!

53. Fill in the cations & anions, then criss cross to get the formulas, and then write the names			
Cation	Anion	Formula of compound	Name of compound
Be^{+2}	F^{-1}		
Sr^{+2}	Cl^{-1}		
Ba^{+2}	N^{-3}		
K^{+1}	I^{-1}		
Al^{+3}	O^{-2}		

54. Name these monoatomic ionic compounds with proper names, two at a time because you are so good at this already (☺)	
NaF	
Sr_3N_2	
Al_2S_3	
BeO	
Ba_3N_2	
Rb_2Se	
K_3P	
CsI	

55. The compounds formed when ions bond together are called ______________________________________

56. The bonds that form are called ____

57. They are so strong, ionic compounds always have HIGH ____

and very high ____.

Naming Class #3 Objective: Transitional Metals become ions too. The rules for ionic bonding and naming ionic compounds from the middle of the periodic table.

58. Group 1 all make ________________________________, because all LOSE 1 electron in the outer orbital.
examples: Li^{+1}, Na^{+1}, K^{+1}, etc.

59. Group 2 all make +2 cations, because they all ______________________________from their outer orbital
examples: Be^{+2}, Mg^{+2}, Ca^{+2}, etc.

60. Al makes ____ it forms the cation Al^{+3}

61. Group ____, because they all need to gain 1 electron to become isoelectric to the noble gases.

62. Group _________________________________, they all need to gain 2 electrons to fill their outer orbital

63. ____ -3 anions (you know why)

All of these, Group 1 and 2 metals, and aluminum, and group 17, 16, and 15 all follow the

simple ____
when becoming ions. They are truly simple and there are no exceptions here.

64. The TRANSITIONAL METALS, in ____, and

____ have sub-orbitals that can make funky electron configurations.

65. Scandium makes a ______________________________. See that +3 in the corner? That's what it means.

66. Yttrium is next, it also makes a ________________________________

Peek at zinc, it only makes a ____ also.

67. The transitional metals make the cations that are indicated, they __________________________________ follow the simple "isoelectric rule" like the metals we've seen in groups 1 and 2, and Al.

68. Sc^{+3} + Cl^{-1} → _____________________ called ____

69	Atoms	Ions	Formula	name
ex	Na Cl	Na^{+1} Cl^{-1}	NaCl	Sodium chloride
	Zr P			
	In F			
	Ag Cl			

70. Titanium can make ____.

71. Look in box 22, Titanium can make ____.

72. Let's look at each of these atoms and determine what cations that they make:	
V (#23)	
Cr (#24)	
Fe (#26)	
Cu (#29)	
Ga (#31)	
Cd (#48)	
Nb (#41)	
Hg (#80)	

73. Let's see what happens when we combine chlorine to both gold cations… (criss cross)

Metal Atom	Nonmetal Atom	Cation	Anion	Compound Formula	Compound Name
Au	Cl	Au^{+1}	Cl^{-1}		
Au	Cl	Au^{+3}	Cl^{-1}		

74. The Roman Numerals you need in chemistry are 1-7

____

75. Combine every type of manganese cation with bromine. Write the CATION CHARGES first, then the criss crossed formulas, and finally the stock names (roman numeral names) for each one.

Cation	Anion	Formula of compound	Stock Name of compound
Mn^{+}	Br^{-1}		
Mn^{+}	Br^{-1}		
Mn^{+}	Br^{-1}		
Mn^{+}	Br^{-1}		

76. Do the same for both copper cations bonding to oxygen			
Cation	Anion	Formula of compound	Stock Name of compound
	O^{-2}		
	O^{-2}		

77. Last one (this is tricky). Combine tantalum (element 73) with sulfur.			
Cation	Anion	Formula of compound	Stock Name of compound
	S^{-2}		

Naming Class #4 Objective: Table E, the polyatomic ions, making more ionic compounds!

78. Table E shows us the ____.
Poly means more than one, here, atomic means atoms that are stuck together.

79. POLYATOMIC IONS can be ________________________________ or ____________________________.
They have fun names that we never change.

80. Most of their names end in _____________________. Some don't. Why? Just because.
These Table E polyatomic ions follow their own "rules".

81. We will start talking about AMMONIUM. Formula is __________________________

Ammonium is ________ atom of ________ bonded to _______ atoms of _______, with a ____ charge.

82. ____________ + ____________ → ____________

83. Polyatomic ions NAMING RULES…

Cations ___________________________, always.

Anions always _______________________________________. Never change their names.

84. Criss cross the ions to determine formulas, then write their proper names.			
Cation	Anion	Formula of compound	Stock Name of compound
Na^{+1}	$C_2H_3O_2^{-1}$		
K^{+1}	CN^{-1}		
Mg^{+2}	CO_3^{-2}		

85. Magnesium cation + hydroxide ion → magnesium hydroxide (write ions, then formula)

___________ + ___________ → ____________________________

86. __________________ is correct. What's wrong with these mistakes?

$MgOH_2$ ____

MgO_2H_2 ____

87	cation	anions	formula	name
ex	Na^{+1}	Cl^{-1}	NaCl	Sodium chloride
a	Li^{+1}	CrO_4^{-2}		
b	Al^{+3}	ClO^{-1}		
c	Mg^{+2}	SCN^{-1}		
d	Ca^{+2}	MnO_4^{-1}		

88	cation	anions	formula	name
a				beryllium phosphate
b				sodium hydrogen carbonate
c				ammonium nitrate
d				ammonium dichromate

89	cation	anions	formula	name
e				Bismuth (V) thiosulfate
f				Cobalt (III) chlorate

Objective: Naming molecular compounds, writing molecular formulas, and determining how for form molecular compounds using the selected oxidation states.

90. Ionic compounds form when positive cations and negative anions combine in the proper ratios with each other, and form neutral compounds with each other because of opposite charge.

____

91. Molecular compounds contain __________________________________.

Molecular compounds form when 2 or more nonmetals bond together, in the proper ratios.

In Molecular Compounds ____

92. When two or more nonmetal atoms bond together, they form a _________________________________.

93. A molecule is the smallest part of a ____

94. Fill in the compound names	(there are NO METALS in molecular compounds)
CO_2	
CO	
HCl	
NH_3	(nitrogen trihydride)
CH_4	(carbon tetrahydride)
H_2O	(dihydrogen monoxide)
C_8H_{18}	(gasoline)

95. The bonds that hold these atoms together in molecules is called the

____.

96. Co – means to ____________________________

– valent refers to ____

97. When 2 or more ions bond, they make ionic bonds, and they form into __________________________.

We can abbreviate that as _______________________

98. Ionic compounds do not form into __________________________________, they form __________'s!

NAMING RULES FOR MOLECULAR COMPOUNDS
If you can remember what CO, CO_2, and H_2O are, then the naming rules are easy
carbon monoxide, carbon dioxide + dihydrogen monoxide (write these on your periodic table now)

99. NAMING RULES FOR MOLECULAR COMPOUNDS		**FILL IN BELOW**
	A single atom?	→
1st name rule		
	Multiple atoms?	→
2nd name rule	one or more atoms...	→

100. List of the TEN Latin Prefixes to memorize for molecular compounds 1 to 10				
1	2	3	4	5
6	7	8	9	10

101	Compound Name		Compound Name
HF		SF_6	
CS_2		N_7Cl_3	
SO_3		Cl_2O_8	
CCl_4		I_4O_9	
PF_5		N_2F_{10}	

102. Write formulas for each compound	
Phosphorous tribromide	
Diphosphorous trioxide	
Oxygen difluoride	
Dihydrogen monoxide	
Nitrogen monoxide	
Carbon tetrafluoride	

102. Name these compounds	
NO_2	
CI_4	
N_2O	
SO_3	
N_2O_5	
HCl	

103. On the periodic table there are ____

Draw the "T" chart below. List the 2 oxidation state for hydrogen and the one for oxygen with signs.

106. Do this again, another “T” chart for carbon and oxygen, try to figure out ALL of the possible carbon-oxygen compounds.

107. Another: Nitrogen and oxygen. Formulas and names (there are five!)

108. Last one, it’s short. All the fluorine and bromine compounds, formulas and names.