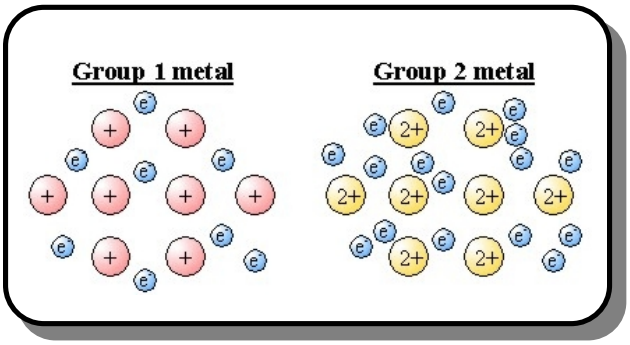
Test Review № 6

Types of Bonds. Pure substances can be held together by ionic bonds, covalent bonds, metallic bonds, or intermolecular forces. All ionic substances are crystalline solids. Diamonds are also crystalline solids, but they are made of pure carbon. Large crystals such as diamond or sand (SiO_2) that have a network of covalent bonds are called **macromolecules** or **network solids**. Smaller compounds containing covalent bonds are called **molecules**. The molecules of a substance may be attracted to each other to form solids or liquids by intermolecular forces. These are often called **molecular** compounds. Molecular solids are softer than covalent solids (network solids) and ionic solids, because intermolecular forces are weaker than chemical bonds. If the substance is polar, it is held together by **dipole-dipole attractions**. If the polar substance contains hydrogen atoms attached to either oxygen, nitrogen, or fluorine atoms, it forms especially strong dipole-dipole attractions called a **hydrogen bonds**. Hydrogen bonds are responsible for the three dimensional shapes of many proteins because the large protein molecule folds in such a way that hydrogens in one part of the molecule are close to oxygens or nitrogens in another part of the molecule. Nonpolar molecules are attracted to each other only by the weakest intermolecular forces called **London dispersion forces**.

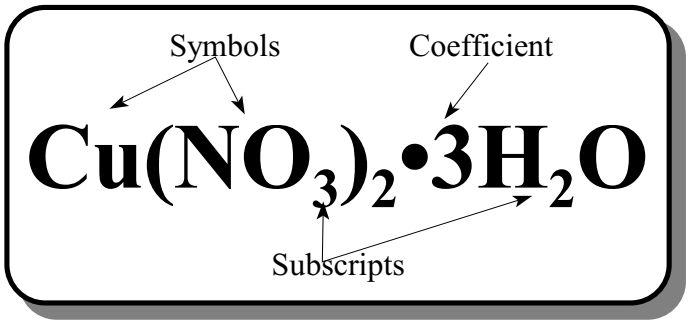
Metallic Bonding. Metals have low ionization energies. This means they hold onto electrons loosely. As a result, in a metal crystal, the valence electrons move easily and do not belong to any single atom. Since the atoms in the crystal do not hold on to their own valence electrons, they become like cations in a sea of mobile electrons. The attraction between the cations and the electrons holds the metal crystal together. Because of this, metals are lustrous, flexible, good conductors of heat and electricity, and are solids at room temperature except for mercury.



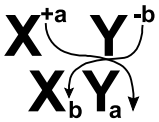
Chemical Formulas. A chemical formula consists of chemical symbols, subscripts, and, in some cases, a coefficient. The chemical symbols show which elements are present in the compound. Subscripts are small numbers written to the lower right of the symbol to which they refer.

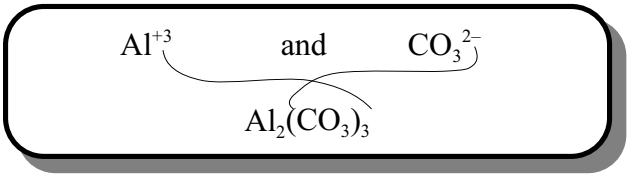
Example (Atoms in a Formula)

$5(NH_4)_3PO_4$ . . . . . N = 15, H = 60, P = 5, O = 20, *TOTAL* = 100



Formula Writing. The quickest way to determine the formula of a compound of two elements or polyatomic ions is to use the Cross-Over Rule. Look up the oxidation state of each element or ion and reduce to lowest terms. Then cross over the oxidation states in lowest terms without the sign to find the subscripts as shown in the diagram to the right and the example below.





Finding the Charge on Polyvalent Metals. Many transition metals have more than one oxidation state. They are called polyvalent. The fact that a metal is polyvalent becomes important when the compound is named. In order to properly name a compound, it is necessary to first check the *Periodic Table* to see if the metal is polyvalent. If it is, you need to figure out the oxidation state of the metal by checking to see which one will make the sum of the oxidation states in the compound add up to zero. The process is only applied for metals that have more than one oxidation state.

The Stock System . The stock system is a set of rules for naming compounds of metals and non metals. The metal always comes first in the name and the formula. Monatomic metal ions, those consisting of only one type of atom, come in two varieties – univalent and polyvalent. For univalent metal ions, those having only one oxidation state, the name of the ion is exactly the same as that of the element that formed it. For polyvalent metal ions, those having multiple oxidation states, a roman numeral indicates the oxidation state. Polyatomic metal ions, those consisting of more than one type of element such as NH_4^+, ammonium, are found on *Table E*.

The nonmetal always comes last in the name and in the formula. For monatomic nonmetal ions, delete the last part of the elements name and add "IDE". Polyatomic nonmetal ions, such as SO_4^{-2} (sulfate) or OH^- (hydroxide) are found on *Table E*.

To write the name from the formula, it is necessary to first check the *Periodic Table* to see if the metal is polyvalent. If it is, you need to figure out the oxidation state of the metal by checking to see which one will make the sum of the oxidation states in the compound add up to zero. To write the formulas from the name, you need to look up the oxidation states of the ions, and apply the crossover rule

Binary Covalent Compounds. Two nonmetals can combine to form compounds. When two nonmetals combine, they form covalent bonds. The nonmetal with the lower electronegativity behaves like a metal and has a positive oxidation state. In carbon dioxide (CO_2), the carbon behave like a metal while the oxygen behaves like a nonmetal. The metal is written first in the name and the formula. The name of the metal is the same as the name of the element. If there is more than one atom of the metal, the number of atoms is indicated with a prefix. (See the list of prefixes below.) The nonmetal is written last in the name and formula..The name of the nonmetal is the same as the name of the element minus the final syllable or two, plus IDE.The number of nonmetal atoms is indicated with a prefix (even when there is only one). Writing formulas for these compounds is easy, because the prefix tells the subscript.

Number of Atoms	Prefix
1	mono
2	di
3	tri
4	tetra
5	penta
6	hexa
7	hepta
8	octa
9	nona
10	deca

Answer the questions below by circling the number of the correct response

1. What is the total number of oxygen atoms in the formula $MgSO_4 \cdot 7H_2O$? [The • represents seven units of H_2O attached to one unit of $MgSO_4$.] (1) 11 (2) 5 (3) 7 (4) 4

2. In the formula for water, H_2O, the number 2 refers to the number of (1) hydrogens and oxygens, (2) waters, (3) hydrogens only, (4) oxygens only.

3. The number of atoms in $Cu_3(PO_4)_2$ is (1) 13, (2) 9, (3) 10, (4) 24.

4. Which of the following has the most oxygen? (1) $4Fe_2O_3$ (2) $3Ba_3(PO_4)_2$ (3) $2(NH_4)_2CO_3$ (4) $3Al(CO_3)_3$

5. The formula of a compound between Ba^{+2} and PO_4^{-3} is (1) $BaPO_4$ (2) $Ba_2(PO_4)_3$ (3) $Ba_3(PO_4)_2$ (4) $Ba_4(PO_3)_2$

6. What type of bonds are present in a strip of magnesium ribbon? (1) covalent (2) metallic (3) ionic (40 van der Waals

7. Which substance, in the solid state, is the best conductor of electricity? (1) Ag (2) NaCl (3) I_2 (4) CO_2

8. Which substance exists as a metallic crystals? (1) Ar (2) SiO_2 (3) Au (4) CO_2

9. Mobile electrons are a distinguishing characteristic of (1) an ionic bond (2) a metallic bond (3) an electrovalent bond (4) a covalent bond

10. Which element consists of positive ions immersed in a "sea" of mobile electrons.? (1) sulfur (2) calcium (3) nitrogen (4) chlorine

11. Which of the following is an example of hydrogen bonding? (1) $H_2(\ell)$ (2) $I_2(s)$ (3) $CH_3OH(\ell)$ (4) $C_8H_{18}(\ell)$

12. The boiling point increases as you go down the halogen family because of the increase in (1) London dispersion forces, (2) metallic properties, (3) polarity, (4) covalent bonding.

13. In the family of compounds including H_2O, H_2S, H_2Se, and H_2Te, water has the highest boiling point because it has the greatest (1) London dispersion forces, (2) metallic bonding, (3) polarity, (4) covalent bonding.

In questions 14-16, which of the following substances: (1) Hydrogen gas, H_2; (2) Carbon monoxide, CO; (3) Potassium, K; (4) Aluminum oxide, Al_2O_3; (5) Bromine, Br_2; is described by the statements below?

14. Substance held together by metallic bonds

15. Substance held together by ionic bonds

16. Consists of polar molecules

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17. In which compound is the oxidation state of iron +3? (1) $FeCl_2$ (2) FeO (3) $FePO_4$ (4) FeS_2O_3

18. What is the formula for a compound of NH_4 and CO_3? (1) NH_4CO_3 (2) $(NH_4)_2CO_3$ (3) $NH_4(CO_3)_2$ (4) NH_3CO_4

19. What is the correct formula for copper II nitrate? (1) $Cu(NO_3)_2$ (2) Cu_3N_2 (3) Cu_2NO_3 (4) Cu_2N_3

20. What is the correct name for BaO? (1) barium oxide (2) barium oxygen (3) barium II oxide (4) barium oxalate

21. The formula for zinc hydroxide is (1) $Zn(OH)_2$, (2) $ZnOH_2$, (3) ZnH_2, (4) Zn_2H.

22. The formula for ammonium carbonate is (1) $(NH_3)_2(CO_4)_3$, (2) $NH_2(CO_3)_4$, (3) $(NH_4)_3CO$, (4) $(NH_4)_2CO_3$.

23. The formula for iron II sulfide is (1) $Fe_2(SO_4)_3$, (2) FeS, (3) Fe_2S_3 (4) $FeSO_4$.

24. The name of the compound $CuCO_3$ is (1) copper II carbonate, (2) copper I carbonate, (3) copper III carbonate, (4) copper oxide.

25. The formula for barium nitrate is (1) Ba_3NO_2, (2) Ba_3N_2, (3) $Ba(NO_3)_2$, (4) BaN.

26. The name of the compound H_2S is (1) hydrogen II sulfate, (2) hydrogen sulfate, (3) helium I sulfide, (4) hydrogen sulfide.

27. Which is the compound whose formula is P_2O_5? (1) potassium dioxide (2) dipotassium pentoxide (3) phosphorus dioxide (4) diphosphorus pentoxide

28. The formula for sulfur hexafluoride is (1) SHF, (2) SF, (3) SF_6, (4) S_6F.

29. The IUPAC name for N_2O_3 is (1) dinitrogen trioxide, (2) nitrogen oxide, (3) nitrogen trioxide, (4) dinitrogen oxide.

30. The prefix used to show there are four atoms of an element in a binary covalent compound is (1) quadra, (2) recta, (3) hepta, (4) tetra.

31. Which of the following is a binary covalent compound? (1) Na_2O (2) P_2S_5 (3) Hg_2Cl_2 (4) KI

Answers

1. 1 7. 1 13. 3 19. 1 25. 3
2. 3 8. 3 14. 3 20. 1 26. 4
3. 1 9. 2 15. 4 21. 1 27. 4
4. 4 10. 2 16. 2 22. 4 28. 3
5. 3 11. 3 17. 3 23. 2 29. 1
6. 2 12. 1 18. 2 24. 1 30. 4
31. 2