Test Review № 5

Bonding. The electrons of one atom are attracted to the protons of another. When atoms combine, there is a tug of war over the valence electrons. The combining atoms either lose, gain, or share electrons in such a way that they complete their outer shells. Whether atoms gain, lose, or share electrons depends how tightly they hold onto their own electrons and how strongly they pull on the electrons of another atom.

Ionic Bonds. Ionic bonds are caused by the attraction between oppositely charged ions. Ions form as follows: The electrons of one atom are attracted to the protons of another. Metals hold onto electrons loosely while nonmetals hold onto electrons tightly. As a result, metals lose electrons and nonmetals gain electrons in such a way that they complete their outer shells. Atoms that gain or lose electrons become electrically charged. Metals become positively charged ions by losing electrons. Nonmetals become negatively charged ions by gaining electrons. Metal cations and nonmetal anions become ionically bonded because they are oppositely charged. Atoms gain or lose electrons in such a way that they complete their outer shells. This gives them the same electron configuration as a noble gas. For example, potassium, with an electron configuration of 2-8-8-1 loses an electron to become K^+ with an electron configuration of 2-8-8, the same as argon. Chlorine, with an electron configuration of 2-8-7, gains an electron to become Cl^-, with an electron configuration also of 2-8-8.

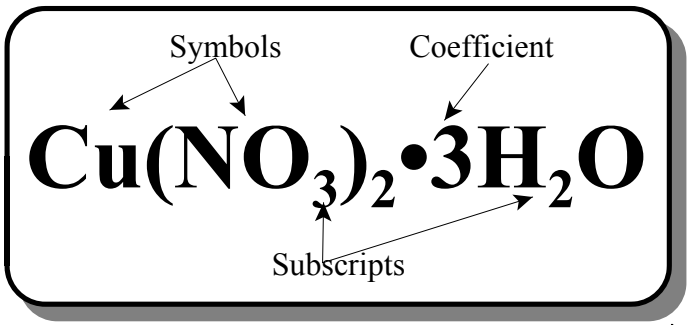
Covalent Bonds. Covalent bonds are bonds formed by sharing electrons. The electrons of one atom are attracted to the protons of another, but neither atom pulls strongly enough to remove an electron from the other. Covalent bonds form when the electronegativity difference between the elements is less than 1.7 (see the Electronegativity table on the back of the Periodic Table) or when hydrogen behaves like a metal. When a covalent bond forms, no valence electrons are transferred, rather, they are shared. During covalent bonding, unpaired electrons pair up in such a way that the atoms complete their outer shells. This can be illustrated with electron dot diagrams.

Bond Type and Polarity. When the electronegativity difference is greater than or equal to 1.7, the atom with the greater electronegativity gains the electron, and an **ionic bond** is formed. Electronegativity differences below 1.7 result in covalent bonds or sharing. If the electronegativity difference is close to zero (<0.4), the atoms share equally and a **nonpolar bond** forms. Higher electronegativity differences (still below 1.7) result in unequal sharing or **polar bonds**.

Electron Dot Diagrams. Electron dot diagrams show valence electrons as dots at 12 o'clock, 3 o'clock, 6 o'clock, and 9 o'clock, and the rest of the atom, known as the kernel, as a symbol. Electrons will move into the *s* orbital first. Once the *s* is filled, additional electrons will go into each of the three *p* orbitals without pairing until each *p* orbital has one electron. During bonding, however, the outer shell of the atom is composed of four equal orbitals. Electrons do not pair up until each orbital contains an electron.

Polar Molecules. Electronegativity differences between 0.4 and 1.7 are found in molecules with polar bonds. These molecules can be polar depending on their shapes. Molecules with polar bonds distributed symmetrically are nonpolar. Asymmetrical molecules with polar bonds are polar. Water is polar. An imaginary line can be drawn through a water molecule separating the positive pole from the negative pole. This is because the charges are distributed asymmetrically. Carbon dioxide is nonpolar because the electronegative oxygens are distributed symmetrically around the carbon. (O=C=O)

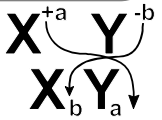
Chemical Formulas. A chemical formula consists of chemical symbols, subscripts, and, in some cases, a coefficient. The chemical symbols show which elements are present in the compound. Subscripts are small numbers written to the lower right of the symbol to which they refer.

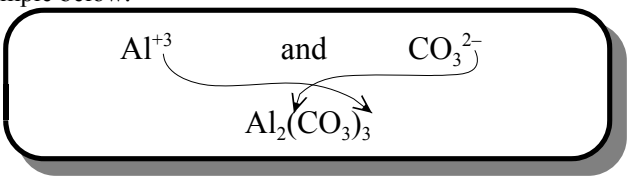


Example (Atoms in a Formula)

$5(NH_4)_3PO_4$ . . . . . 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 shown in the box to the left. The process is only applied for metals that have more than one oxidation state.

Finding the Charge on the Cation

Prepare a table as shown to the right.

Step 1: List the subscripts for the cations and the anions.

Step 2: Look up the oxidation state of the anion on the *Periodic Table.*

Step 3: Multiply the oxidation state of the anion by the its subscript to get the total charge.

Step 4: Determine the total charge of the cations by calculating the number which, when added to the total charge of the anions, gives the compound a total charge of zero.

Step 5: Divide the total charge of the cations by the subscript of the cation to get the oxidation state.

$Fe(SO_4)$

ion	Fe	SO_4	
subscript	2	3	
oxidation state	+3	−2	Total
total	+6	−6	0

STEP 1, STEP 2, STEP 3, STEP 4, STEP 5

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*.

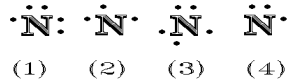
The nonmetal always comes last in the name and in the formula. For monatomic nonmetal ions, delete the last part of the elements name and add "IDE". Polyatomic nonmetal ions, such as SO_4^{-2} (sulfate) or OH^- (hydroxide) are found on *Table E*.

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

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

1. Barium combines by (1) gaining two electrons, (2) losing two electrons, (3) sharing two electrons, (4) sharing 3 electrons.

2. Which of the following is the correct electron dot diagram for nitrogen?



(1) (2) (3) (4)

3. In water, the bond between hydrogen and oxygen is (1) ionic, (2) polar covalent, (3) nonpolar covalent, (4) nonpolar noncovalent.

4. Which of the following occurs during covalent bonding? (1) Electrons are lost. (2) Electrons are gained. (3) Valence electrons fall from the excited state to the ground state. (4) Unpaired electrons form pairs.

5. Which of the following is an example of a substance with a nonpolar covalent bond? (1) HCl (2) Cl_2 (3) $HClO_2$ (4) NaCl

6. The electronegativity of sulfur is (1) 16, (2) 239, (3) 2.6, (4) 32.

7. Which of the following elements has the highest electronegativity? (1) fluorine (2) chlorine (3) barium (4) hydrogen

8. The formula for magnesium fluoride is MgF_2. The best explanation for this fact is that when they combine (1) each of two magnesium atoms lose an electron and a fluorine atom gains two, (2) a magnesium atom loses two electrons and each of two fluorine atoms gains one, (3) a magnesium atom shares two electrons with two fluorine atoms, (4) each of two magnesium atoms share an electron with a fluorine atom.

9. When calcium combines, it usually (1) loses two electrons, (2) gains six electrons, (3) shares two electrons, (4) shares six electrons.

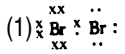
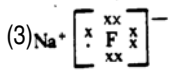
10. Which compound contains a bond with the *least,* ionic character? (1) CO (2) K_2O (3) CaO (4) Li_2O

11. Which type of bond is contained in a water molecule? (1) nonpolar covalent (2) ionic (3) polar covalent (4) electrovalent

12. The bonding in NH_3 most similar to the bonding in (1) H_2O (2) MgO (3) NaCl (4) KF

13. Which is the formula of an ionic compound? (1) SO_2 (2) CH_3OH (3) CO_2 (4) NaOH

14. Which electron dot formula represents a molecule that contains a nonpolar covalent bond?

(1)  (2)  (3)  (4) 

15. When a reaction occurs between atoms with ground state electron configurations 2–1 and 2–7, the predominant type of bond formed is (1) polar covalent, (2) ionic, (3) nonpolar covalent, (4) metallic.

16. The P—Cl bond in a molecule of PCl_3 is (1) nonpolar covalent, (2) coordinate covalent, (3) polar covalent, (4) electrovalent.

17. The formula H_2 represents one (1) gram, (2) atom, (3) liter, (4) molecule

18. A Ca^{2+} ion differs from a Ca atom in that the Ca^{2+} ion has (1) more protons, (2) more electrons, (3) fewer protons, (4) fewer electrons.

19. Which molecule is nonpolar and has a symmetrical shape? (1) HCl (2) CH_4 (3) H_2O (4) NH_3

20. Which formula represents a polar molecule? (1) CH_4 (2) Cl_2 (3) NH_3 (4) N_2

21. In which compound does the bond between the atoms have the least ionic character? (1) HF (2) HCl (3) HBr (4) HI

22. Which substance contains a polar covalent bond? (1) Na_2O (2) Mg_3N_2 (3) CO_2 (4) N_2

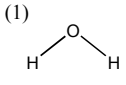
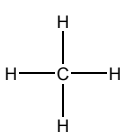
23. In which pair do the members have identical electron configurations? (1) S^{2-} and Cl^- (2) S^0 and Ar^0 (3) K^0 and Na^+ (4) Cl^- and K^0

24. When a chlorine atom reacts with a sodium atom to form an ion, the chlorine atom will (1) lose one electron, (2) gain one electron, (3) lose two electrons, (4) gain two electrons.

25. When a calcium atom loses its valence electrons, the ion formed has an electron configuration that is the same as the configuration of an atom of (1) Cl (2) Ar (3) K (4) Sc

26. Which molecule is nonpolar and contains a nonpolar covalent bond? (1) CCl_4 (2) F_2 (3) HF (4) HCl

27. Which structural formula represents a nonpolar symmetrical molecule?

(1)  (2)  (3) (4) 

28. Which of the following compounds has the most ionic character? (1) KI (2) NO (3) HCl (4) MgS

29. Which atom has the strongest attraction for electrons? (1) Cl (2) F (3) Br (4) I

30. Which compound is ionic? (1) HCl (2) $CaCl_2$ (3) SO_2 (4) H_2O

31. Two atoms of element A unite to form a molecule with the formula A_2. The bond between the atoms in the molecule is (1) electrovalent, (2) nonpolar covalent, (3) ionic, (4) polar covalent.

32. When an ionic bond is formed, the atom that transfers its valence electron is the atom that has the (1) higher electronegativity value, (2) lower atomic number. (3) higher atomic mass, (4) lower ionization energy.

33. When an ionic bond is formed, the atom that transfers its valence electron becomes an ion with (1) positive charge and more protons, (2) positive charge and no change in the number of protons, (3) negative charge and more protons, (4) negative charge and no change in the number of protons.

34. Which compound best illustrates ionic bonding? (1) CCl_4 (2) $MgCl_2$ (3) H_2O (4) CO_2

35. An atom that loses or gains one or more electrons becomes (1) an ion, (2) an isotope, (3) a molecule, (4) an electrolyte

36. Which kind of bond is formed when two atoms share electrons to form a molecule? (1) ionic (2) metallic (3) electrovalent (4) covalent

37. Which type of bonding is usually exhibited when the electronegativity difference between two atoms is 1.2? (1) ionic (2) metallic (3) network (4) covalent

38. Why is NH_3 classified as a polar molecule? (1) It is a gas at STP. (2) H—H bonds are nonpolar. (3) Nitrogen and hydrogen are both nonmetals. (4) NH_3 molecules have asymmetrical charge distributions.

39. Which statement best explains why carbon tetrachloride (CCl_4) is nonpolar? (1) Each carbon-chloride bond is polar. (2) Carbon and chlorine are both nonmetals. (3) Carbon tetrachloride is an organic compound. (4) The carbon tetrachloride molecule is symmetrical.

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

41. 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.

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

43. 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) $3Al(CO_3)_3$

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

45. 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

46. 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

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

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

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

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

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

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

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

Answers

1.	2	12.	1	23.	1	34.	2	45.	2
2.	3	13.	4	24.	2	35.	1	46.	1
3.	2	14.	1	25.	2	36.	4	47.	1
4.	4	15.	2	26.	2	37.	4	48.	1
5.	2	16.	3	27.	2	38.	4	49.	4
6.	3	17.	4	28.	1	39.	4	50.	2
7.	1	18.	4	29.	2	40.	1	51.	1
8.	2	19.	2	30.	2	41.	3	52.	3
9.	1	20.	3	31.	2	42.	1	53.	4
10.	1	21.	4	32.	4	43.	4		
11.	3	22.	3	33.	2	44.	3		