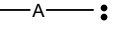
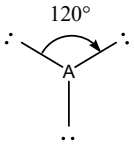
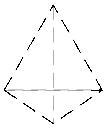
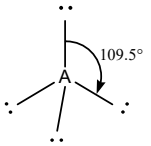
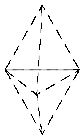
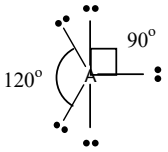
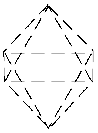
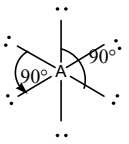
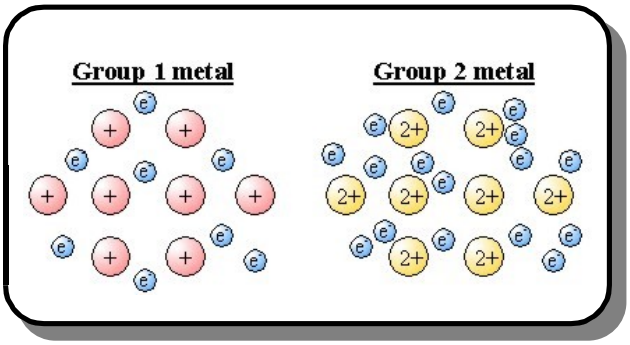
Test Review № 6

VSEPR. One approach to predicting molecular shape is the valence shell electron repulsion model (VSEPR). According to VSEPR theory, repulsion between sets of valence shell electrons causes them to be as far apart as possible. Taking this repulsion into account, the shape of a molecule depends upon how many pairs of valence electrons surround the central atom, the number of lone pairs of electrons, and the presence of multiple bonds (double bonds or tripe bonds)

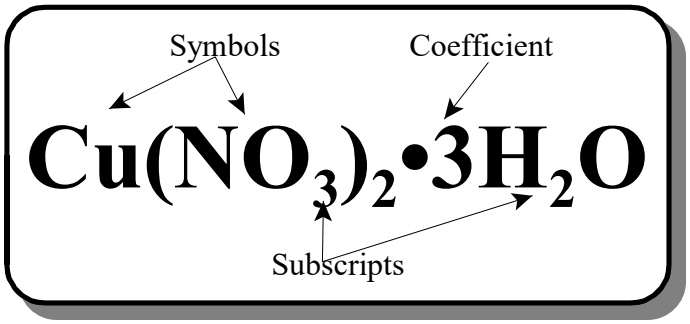
Number of Electron Pairs	Shape	Arrangement of Electron Pairs	
2	Linear		
3	Trigonal planar		
4	Tetrahedral		
5	Trigonal bipyramidal		
6	Octahedral		

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) **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.



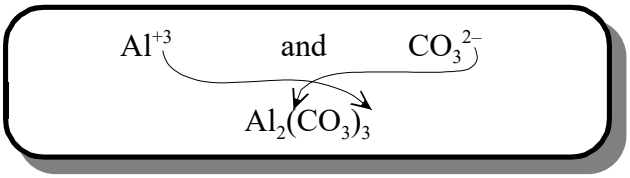
Chemical Formulas. A chemical formula consists of chemical symbols, subscripts, and, in some cases, a coefficient. The chemical symbols show which elements are present in the compound. Subscripts are small numbers written to the lower right of the symbol to which they refer.

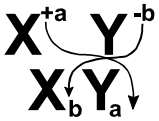


Example (Atoms in a Formula)

$5(NH_4)_3PO_4$ . . . . . 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.





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

1. Which of the following molecules has a nonlinear structure? (1) PbO_2 (2) $BeCl_2$ (3) O_3 (4) CO_2 (5) N_2O (central atom is N)

2. Which formula represents a tetrahedral molecule? (1) $CaCl_2$ (2) Br_2 (3) CH_4 (4) HBr

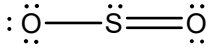
3. Which formula represents a bent molecule? (1) Br_2 (2) HBr (3) $CaCl_2$ (4) SO_2

4. The four single bonds of a carbon atom are spatially directed toward the comers of a regular (1) rectangle (2) tetrahedron (3) triangle (4) square

5. What is the molecular geometry of the NH_3? (1) octahedral (2) pyramidal (3) linear (4) bent (5) tetrahedral

6. What is the molecular shape of water? (1) bent (2) octahedral (3) pyramidal (4) linear (5) tetrahedral

7. What is the molecular shape of the following molecule?



(1) bent (2) linear (3) octahedral (4) tetrahedral (5) pyramidal

8. What would be the shape of a molecule where the central atom has two lone pairs and two bonds? (1) pyramidal (2) octahedral (3) tetrahedral (4) linear (5) bent

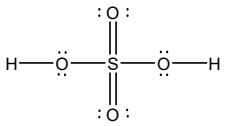
9. Which of the following molecules is linear? (1) CO_2 (2) SO_2 (3) O_3 (4) H_2O (5) all of the above

10. Which of the following molecules has two pairs of nonbonding electrons on the central atom? (1) BH_3 (2) CO_2 (3) H_2O (4) H_2S (5) choices 3 and 4

11. Which of the following molecules should have the same molecular shape and approximate bond angles as ammonia, NH_3? (1) SO_3 (2) CH_4 (3) PH_3 (4) BH_3 (5) NO_2

12. Germanium chloride, $GeCl_2$, has only two atoms surrounding the central germanium atom. Why then is the germanium chloride molecule bent? (1) It is bent only periodically as it swings between both bent and linear shapes. (2) A lone pair of electrons on germanium pushes it to this orientation. (3) There is a covalent bond between the two chlorine atoms. (4) Lone pairs of electrons on the chlorine atoms push it to this orientation.

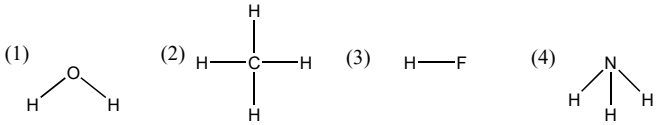
13. In two dimensions sulfuric acid, H_2SO_4, is often written as shown below. What three-dimensional shape does this molecule most likely have?



(1) trigonal planar (2) octahedral (3) trigonal bipyramid (4) tetrahedal

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

15. Which structural formula represents a nonpolar symmetrical molecule?



16. 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.

17. 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.

18. The geometry of a molecule of SO_2 is (1) linear, (2) bent, (3) trigonal planar, (4) trigonal pyramidal, (5) tetrahedral.

19. Which molecule is a polar molecule? (1) N_2 (2) H_2O (3) CH_4 (4) CO_2 (5) KCl

20. 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

21. 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.

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

23. 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) $3Al(CO_3)_3$

24. 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) $Ba_4(PO_3)_2$

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

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

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

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

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

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

31. 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.

32. 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 33-35, which of the following substances: (1) Hydrogen gas, H,; (2) Carbon monoxide, CO; (3) Potassium, K; (4) Aluminum oxide, Al_2O_3; (5) Bromine, Br_2; is described by the statements below?

33. Substance held together by metallic bonds

34. Substance held together by ionic bonds

35. Consists of polar molecules

Answers

1. 3	8. 5	15. 2	22. 1	29. 2
2. 3	9. 1	16. 4	23. 4	30. 3
3. 4	10. 5	17. 4	24. 3	31. 1
4. 2	11. 3	18. 2	25. 2	32. 3
5. 2	12. 2	19. 2	26. 1	33. 3
6. 1	13. 4	20. 1	27. 3	34. 4
7. 1	14. 2	21. 3	28. 2	35. 2