

Chemical Bonding

Name _____ Class _____ Date _____

Part I

Select the answer that best completes each statement. Write the letter of each answer in the space provided on the left.

- b 1. Between atoms in a covalent bond, _____
 a. the attractions are weaker than the repulsions
 b. electrons are shared
 c. no electrons are located
 d. the electronegativity difference is 1.7 or greater
- d 2. As two atoms approach each other to bond, _____
 a. electrons are repelled by protons
 b. attractive forces decrease in strength
 c. orbitals merge completely
 d. the potential energy is lowered
- a 3. A dipole occurs when _____
 a. two atoms with an electronegativity difference of between 0.3 and 1.6 bond
 b. electrons are transferred from one atom to another
 c. two atoms of the same electronegativity bond
 d. electrons are shared equally between two atoms
- a 4. In ionic bonding, _____
 a. the electronegativity difference between atoms is 1.7 or greater
 b. electrons are shared equally
 c. protons are transferred
 d. there are no more than two atoms
- b 5. Substances with polar molecules tend to exhibit _____
 a. less attraction than usual between the molecules
 b. higher boiling points than expected
 c. less solubility than expected
 d. lower bond energies than expected
- c 6. Which of the following would not have a molecular dipole?
 a. HCl
 b. H₂O
 c. BeH₂
 d. NH₃
- c 7. The CCl₄ molecule does not behave as a polar molecule because _____
 a. the C-Cl bonds are nonpolar
 b. the C-Cl bonds are ionic
 c. the bond dipoles cancel
 d. the shape of the molecule is linear
- d 8. Which of the following does not describe the growth of crystals?
 a. The potential energy of the system decreases.
 b. Ions form a lattice.
 c. Heat is removed.
 d. Melting temperature decreases.

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- c 9. Van der Waals forces include _____
 a. dipole-dipole forces
 b. London forces
 c. both a and b
 d. neither a nor b
- a 10. Noble gases liquefy because of _____
 a. momentary dipoles
 b. permanent dipoles
 c. hydrogen bonds
 d. ionic attractions
- b 11. Which of the following is the weakest?
 a. covalent bonds
 b. London forces
 c. hydrogen bonds
 d. dipole-dipole forces
- b 12. The valence shell electron pair repulsion theory (VSEPR) would account for the fact that _____
 a. all valence electrons must be involved in the bonding process
 b. the C-H bonds in the CH₄ molecule all have bond angles of 109.5°
 c. the carbon atom has four electrons available for bonding
 d. no two bond angles in the same molecule have equal measure
- c 13. Exceptions to the octet rule arise when _____
 a. a stable molecule possesses a central atom with fewer than eight electrons
 b. a stable molecule possesses a central atom surrounded by more than eight electrons
 c. both a and b
 d. neither a nor b

Part II

Select the answer that best completes each statement or fill in the blank with the correct answer.

- c 14. In which of the following are electrons shared unequally?
 a. H₂
 b. S₈
 c. HCl
 d. Cl₂
- d 15. The electron dot formula for atom X, which has the electron configuration 1s² 2s² 2p⁵, is _____
 a. $\cdot\ddot{X}\cdot$
 b. $\cdot\ddot{X}$
 c. $\cdot\ddot{X}\cdot$
 d. $\cdot\ddot{X}$
- b 16. The correct electron dot formula for C₃H₈ is _____
 a. $\begin{array}{c} \text{H H H} \\ | | | \\ \text{H} \cdot \text{C} \cdot \text{C} \cdot \text{C} \cdot \text{H} \cdot \text{H} \cdot \text{H} \\ | \\ \text{H} \end{array}$
 b. $\begin{array}{c} \text{H H H} \\ | | | \\ \text{H} \cdot \text{C} \cdot \text{C} \cdot \text{C} \cdot \text{H} \\ | | | \\ \text{H H H} \end{array}$
 c. $\begin{array}{c} \text{H} \cdot \text{C} \cdot \text{C} \cdot \text{C} \cdot \text{H} \\ | | | \\ \text{H H H} \end{array}$
 d. $\begin{array}{c} \text{H H} \\ | | \\ \text{H} \cdot \text{C} \cdot \text{C} \cdot \text{C} \cdot \text{H} \\ | | \\ \text{H H} \end{array}$
- c 17. In which of the following is the carbon-carbon bond distance the greatest?
 a. $\begin{array}{c} \text{H H} \\ | | \\ \text{C} \cdot \text{C} \\ | | \\ \text{H H} \end{array}$
 b. $\text{H} \cdot \text{C} \cdot \text{C} \cdot \text{H}$
 c. $\begin{array}{c} \text{H H} \\ | | \\ \text{H} \cdot \text{C} \cdot \text{C} \cdot \text{H} \\ | | \\ \text{H H} \end{array}$
 d. $\begin{array}{c} \text{H H H} \\ | | | \\ \text{C} \cdot \text{C} \cdot \text{C} \\ | | | \\ \text{H H H} \end{array}$

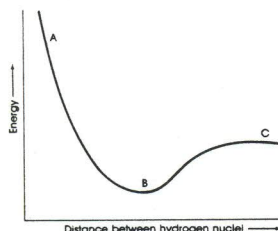
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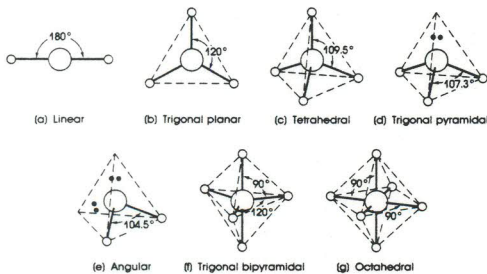
Questions 18 through 20 refer to the graph.

- c 18. For which of the lettered regions (A-C) there are no significant forces between the atoms?
a 19. For which of the lettered regions are repulsive forces stronger than attractive forces?
b 20. For which of the lettered regions are the atoms forming a chemical bond?



For each of the following, choose the letter of the drawing, below, that best represents its shape.

- c 21. NH₄⁺
f 22. AsF₅
e 23. H₂O
a 24. BeH₂
b 25. BF₃
g 26. SF₆
d 27. AsCl₃



28. Indicate whether the bonds in each of the following molecules are ionic (I), polar covalent (P), or nonpolar covalent (C). Electronegativities are given in the chart below.

ELECTRONEGATIVITIES	
Hydrogen 2.1	Sodium 0.9
Boron 2.0	Chlorine 3.0
Carbon 2.5	Calcium 1.0
Oxygen 3.5	Bromine 2.8
Fluorine 4.0	Iodine 2.5

- P a. HBr
I b. CaO
P c. CO₂
P d. CCl₄
C e. I₂
I f. NaBr
C g. B₂H₆

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Part III

Draw electron dot structures for the following compounds.

29. F₂
 $\cdot\ddot{F}\cdot\ddot{F}\cdot$
30. H₂O₂
 $\text{H} \cdot \ddot{\text{O}} \cdot \ddot{\text{O}} \cdot \text{H}$
31. CH₄
 $\begin{array}{c} \text{H} \\ | \\ \text{H} \cdot \text{C} \cdot \text{H} \\ | \\ \text{H} \end{array}$
32. CO
 $\cdot\ddot{\text{C}}::\ddot{\text{O}}\cdot$
33. N₂H₂
 $\text{H} \cdot \ddot{\text{N}} \cdot \ddot{\text{N}} \cdot \text{H}$
34. SiCl₄
 $\begin{array}{c} \cdot\ddot{\text{Cl}}\cdot \\ | \\ \cdot\ddot{\text{Si}}\cdot\ddot{\text{Cl}}\cdot \\ | \\ \cdot\ddot{\text{Cl}}\cdot \end{array}$
35. NCl₃
 $\begin{array}{c} \cdot\ddot{\text{Cl}}\cdot \\ | \\ \cdot\ddot{\text{N}}\cdot\ddot{\text{Cl}}\cdot \\ | \\ \cdot\ddot{\text{Cl}}\cdot \end{array}$

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KEY

11. Silicon compounds usually exhibit bonding which is primarily
(A) covalent (C) electrovalent
(B) ionic (D) coordinate
12. Which of the following in its solid phase contains positive ions immersed in a sea of mobile electrons?
(A) O₂ (C) Cu
(B) SiO₂ (D) CuO
13. If a pure substance is a good conductor of electricity in both its solid and its liquid phases, then the bonding in the substance is predominantly
(A) ionic (C) polar covalent
(B) metallic (D) nonpolar covalent
14. Which compound exhibits bonds having the least ionic character?
(A) CsCl (C) KF
(B) RbBr (D) NaI
15. A pure substance melts at 38°C and does not conduct electricity in either the solid or liquid phase. The substance is classified as
(A) ionic (C) electrovalent
(B) metallic (D) molecular
16. Which molecule is not a dipole? ← polar molecule
(A) HBr (B) H₂O (C) NH₃ (D) CCl₄
17. Experiment shows that H₂O is a dipole while CO₂ is not a dipole. The two structures that best illustrate this fact are



18. Which molecule is a dipole?
(A) H₂ (B) N₂ (C) CH₄ (D) HF
19. Which molecule is polar?



20. Which best explains why a methane (CH₄) molecule is nonpolar?
(A) Each carbon-hydrogen bond is polar.
(B) Carbon and hydrogen are both nonmetals.
(C) Methane is an organic compound.
(D) The methane molecule is symmetrical.

11. A
12. C
13. B
14. D
15. D
16. D
17. A
18. D
19. A
20. D

KEY

21. Hydrogen bonds are formed between molecules in which hydrogen is covalently bonded to an element whose atomic radius and electronegativity, respectively, are
 (A) large and low (C) large and high
 (B) small and low (D) small and high
 21. D
22. Multiple covalent bonds exist in a molecule of
 (A) F₂ (B) H₂ (C) N₂ (D) Cl₂
 22. C
23. Which is an example of a nonpolar molecule that contains polar covalent bonds?
 (A) CCl₄ (B) N₂ (C) H₂O (D) NH₃
 23. A
24. As the distance between molecules decreases, the effect of the van der Waals forces between the molecules
 (A) decreases (B) increases (C) remains the same
 24. B
25. Which molecule is nonpolar?
 (A) H₂O (B) HF (C) NF₃ (D) CF₄
 25. D
26. Which reaction would require the greatest amount of energy?
 (A) Na + energy → Na⁺ + e⁻
 (B) Mg + energy → Mg⁺ + e⁻
 (C) Al + energy → Al⁺ + e⁻
 (D) Si + energy → Si⁺ + e⁻
 26. D
27. In which noble gas are the van der Waals forces the greatest?
 (A) Ne (B) Ar (C) Kr (D) Xe
 27. D
28. What is the nature of the bond in ICl?
 (A) ionic (C) polar covalent
 (B) nonpolar (D) coordinate covalent
 28. C
29. The attraction that nonpolar molecules have for each other is primarily caused by
 (A) hydrogen bonding
 (B) high ionization
 (C) electronegativity differences
 (D) van der Waals forces
 29. D
30. Xenon has a higher boiling point than neon because xenon has
 (A) smaller molecules
 (B) weaker van der Waals forces
 (C) a smaller molecular mass
 (D) more electrons per atom
 30. D
31. The major attractive force between polar molecules is usually
 (A) dipole attraction (C) hydrogen bonding
 (B) electrostatic bonding (D) van der Waals forces
 31. A
32. Which type of bonding accounts for the high boiling point of H₂O as compared with the relatively low boiling point of H₂S?
 (A) van der Waals forces (C) covalent bonds
 (B) hydrogen bonds (D) electrovalent bonds
 32. B

Self Test 4-C

Bonding II - TEST REVIEW

From the list A-F below, select the bond or attractive force that is most closely associated with each of the following phrases, and write its letter in the space at the right.

- (A) ionic bonds (C) coordinate covalent bonds (E) van der Waals forces
 (B) hydrogen bonds (D) metallic bonds (F) covalent bonds

- | | |
|--|--------------|
| 1. Hold the iodine atoms together in a molecule of I ₂ . | 1. <u>F</u> |
| 2. Hold the many molecules of I ₂ together in a crystal of iodine. | 2. <u>E</u> |
| 3. Account for the relatively high boiling and freezing points of pure water. | 3. <u>B</u> |
| 4. Are illustrated by the compounds formed when fluorine reacts with active metals. | 4. <u>A</u> |
| 5. Hold magnesium atoms in a crystal lattice. | 5. <u>D</u> |
| 6. Mobile electrons in the crystal that permit electrical conductivity in the solid state. | 6. <u>D</u> |
| 7. Responsible for the extremely high melting point of diamond (above 3500°C). | 7. <u>F</u> |
| 8. Permit helium and hydrogen to exist in liquid or solid phases under conditions of low temperature and high pressure. | 8. <u>E</u> |
| 9. Link water molecules to neighboring water molecules. | 9. <u>B</u> |
| 10. Produce substances that are nonconductors in the solid phase and conductors in the liquid phase. | 10. <u>A</u> |
| 11. Are weak enough to permit solid iodine to sublime readily upon heating. | 11. <u>E</u> |
| 12. Cause the boiling point of hydrogen fluoride to be much higher than that of hydrogen chloride, hydrogen bromide, or hydrogen iodide. | 12. <u>B</u> |
| 13. Link the atoms within a molecule of a diatomic gaseous element. | 13. <u>F</u> |
| 14. Bond noble gas atoms in the liquid phase. | 14. <u>E</u> |
| 15. Account for the attraction between gas molecules in a nonideal gas. | 15. <u>E</u> |
| 16. Responsible for the formation of ice crystals. | 16. <u>B</u> |

Select the best answer and write its letter in the space at the right.

- | | |
|---|--------------|
| 17. Among the following, the compound that has the highest degree of ionic bonding is
(A) CCl ₄ (B) MgCl ₂ (C) H ₂ O (D) CO ₂ | 17. <u>B</u> |
| 18. A compound that has polar molecules is
(A) CCl ₄ (B) MgCl ₂ (C) H ₂ O (D) CO ₂ | 18. <u>C</u> |
| 19. When compared to hydrogen chloride (HCl), hydrogen fluoride (HF) has an unusually high boiling point. This is due to the magnitude of the
(A) hydrogen bonds (C) van der Waals forces
(B) coordinate covalent bonds (D) nonpolar covalent bonds | 19. <u>A</u> |

KEY

20. ~~All chemical bonds are the result of the~~ → electrostatic forces
 (A) elevation of electrons to higher energy levels
 (B) transfer of electrons from one atom to another
 (C) attraction of electrons to each other
 (D) simultaneous attraction of electrons to two nuclei
21. The correct ranking of bonds in order of greatest to least bond strength is
 (A) covalent, van der Waals, hydrogen
 (B) van der Waals, hydrogen, covalent
 (C) covalent, hydrogen, van der Waals
 (D) hydrogen, van der Waals, covalent

20. OMIT

* NOTE -
 - these bozo's for London bonds
 use Van der Waals

21. C

From the list A-D below, select the compound that best answers each question, and write its letter in the space at the right.

- (A) CsCl (B) CO₂ (C) CCl₄ (D) H₂O

22. Which compound best represents a tetrahedral molecule?
 23. Which compound would show a bent (V-shaped) molecular structure?
 24. Which compound has the highest degree of ionic bonding?
 25. Which compound probably has double bonds within its molecular structure?
 26. Which compound has polar covalent molecules?

22. C
 23. D
 24. A
 25. B
 26. D

From the list A-D below, select the type of bond that is found between the atoms described in each phrase and write its letter in the space at the right.

- (A) ionic bond (C) nonpolar covalent bond
 (B) metallic bond (D) polar covalent bond

27. the hydrogen and chlorine atoms in HCl
 28. the magnesium and chlorine particles in MgCl₂
 29. the nitrogen and hydrogen atoms in NH₃
 30. the nitrogen atoms in N₂
 31. the atoms in Cu wire

27. D
 28. A
 29. D
 30. C
 31. B

From the list A-G below, select the formula most closely associated with each phrase, and write its letter in the space at the right.

- (A) HCl (C) CH₄ (E) Cu (G) KBr
 (B) N₂ (D) SiO₂ (F) Xe

32. Conducts an electric current in the molten state but not in the solid state. (ionic)
 33. Its molecules contain only one atom. (noble gas)
 34. Mobile electrons permit electrical conductivity in the solid phase. (metal)
 35. A nonpolar covalent compound.
 36. An example of a network solid.

32. G
 33. F
 34. E
 35. C
 36. D