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POLARITY OF MOLECULES

Name _____

Determine whether the following molecules are polar or nonpolar.

| | |
|-----------|--------------|
| 1. N_2 | 7. HF |
| 2. H_2O | 8. CH_3OH |
| 3. CO_2 | 9. H_2S |
| 4. NH_3 | 10. I_2 |
| 5. CH_4 | 11. $CHCl_3$ |
| 6. SO_3 | 12. O_2 |

Determine if the following molecules are Polar or NonPolar by 1/4

VI. Draw the Lewis Dot (Electron) Diagrams for the following Covalent Compounds:

Dot Structure

Polar/Non Polar Molecule

IMF

| | | | |
|---------------------|--|--|--|
| 1) CH ₄ | | | |
| 2) N ₂ | | | |
| 3) NH ₃ | | | |
| 4) H ₂ | | | |
| 5) H ₂ O | | | |
| 6) Cl ₂ | | | |
| 7) CO ₂ | | | |
| 8) F ₂ | | | |
| 9) CCl ₄ | | | |
| 10) O ₂ | | | |

(6)

Write the number of the bond or attractive force, chosen from the list below, which is most closely associated with each phrase.

(1) covalent bond

(2) ionic bond

(3) metallic bond

(4) hydrogen bonds

(5) Van der Waals' forces (*dispersion*)

(6) dipole-dipole forces

NOTE:

Hydrogen bonds exist between molecules containing H-F, H-O, or H-N bonds.

Van der Waals forces exist between nonpolar molecules.

Dipole-dipole forces exist between polar molecules.

- _____ 1. Hold the iodine atoms together in a molecule of I_2 .
- _____ 2. Hold the many molecules of I_2 together in a crystal of iodine.
- _____ 3. Account for the relatively high boiling and freezing points of pure water.
- _____ 4. Are illustrated by the compounds formed when fluorine reacts with active metals.
- _____ 5. Hold magnesium atoms in a crystal lattice.
- _____ 6. Mobile electrons in the crystal permit electrical conductivity in the solid state.
- _____ 7. Permit oxygen and hydrogen to exist in liquid or solid phases under conditions of low temperature and pressure.
- _____ 8. Produce substances that are nonconductors in the solid phase and conductors in the liquid phase.
- _____ 9. Are weak enough to permit solid iodine to sublime readily upon heating.
- _____ 10. Cause the boiling point of hydrogen fluoride to be much higher than that of hydrogen chloride, hydrogen bromide, or hydrogen iodide.
- _____ 11. Link the atoms in a molecule of a diatomic gaseous element.
- _____ 12. Interaction between noble gas atoms in the liquid phase.
- _____ 13. Responsible for the formation of ice crystals.
- _____ 14. Account for the attraction between gas molecules in a non-ideal gas such as NO_2 .

15. What kind of bond exists *between the atoms* in a polyatomic ion? _____

16. Circle the polyatomic ions in the list below:

Br^- H_2O CO_3^{2-} Cl^- CO_2 OH^- H_2SO_4 $C_2H_3O_2^-$ Mg^{2+}

17. Are Van der Waals forces greater in the solid, liquid, or gas phase of a particular substance? Explain.

- In substances that sublime, the intermolecular forces of attraction are
 - weak and the vapor pressure is low
 - weak and the vapor pressure is high
 - strong and the vapor pressure is low
 - strong and the vapor pressure is high
- Argon has a higher boiling point than neon because argon has
 - fewer electrons in its 2nd principal energy level
 - more electrons in its outermost principal energy level
 - weaker intermolecular forces of attraction
 - stronger intermolecular forces of attraction
- The abnormally high boiling point of HF as compared to HCl is primarily due to intermolecular forces of attraction called
 - network bonds
 - electrovalent forces
 - van der Waals forces
 - hydrogen bonds
- Based on Reference Table H, which substance has the weakest intermolecular forces?
 - ethanoic acid
 - ethanol
 - propanone
 - water
- Which of these substances has the strongest intermolecular forces?
 - H₂O
 - H₂S
 - H₂Se
 - H₂Te
- Based on intermolecular forces, which of these substances would have the highest boiling point?
 - He
 - O₂
 - CH₄
 - NH₃
- At 50.°C and standard pressure, intermolecular forces of attraction are strongest in a sample of
 - ethanoic acid
 - ethanol
 - propanone
 - water
- The atoms in a molecule of hydrogen chloride are held together by
 - ionic bonds
 - polar covalent bonds
 - van der Waals forces
 - dipole-dipole attraction

- Which type of attraction occurs between nonpolar covalent molecules?

- hydrogen bonding
- van der Waals forces
- ion-ion attraction
- molecule-ion attraction

- The table below shows four compounds and the boiling point of each.

| Compound | Boiling Point |
|-------------------|---------------|
| H ₂ O | 100.°C |
| H ₂ S | -60.7°C |
| H ₂ Se | -41.5°C |
| H ₂ Te | -2.2°C |

Which type of molecular attraction accounts for the high boiling point of H₂O?

- molecule-ion
 - ion-ion
 - hydrogen bonding
 - van der Waals forces
- Which formula represents a polar molecule?
 - O₂
 - CO₂
 - NH₃
 - CCl₄
 - Which formula represents a Bent molecule?
 - CH₄
 - CaCl₂
 - NH₃
 - H₂O
 - Which formula has an asymmetrical charge distribution?
 - O₂
 - CO₂
 - PF₃
 - CH₄
 - Which statement describes the charge distribution and the polarity of a CH₄ molecule?
 - The charge distribution is symmetrical and the molecule is nonpolar.
 - The charge distribution is asymmetrical and the molecule is nonpolar.
 - The charge distribution is symmetrical and the molecule is polar.
 - The charge distribution is asymmetrical and the molecule is polar.
 - Which is the formula of a nonpolar molecule containing nonpolar bonds?
 - CO₂
 - H₂
 - NH₃
 - H₂O

Molecular Polarity

16. Base your answer to the following question on the information below.

Molar Mass and Boiling Point of Four Substances

| Substance | Molar Mass (g/mol) | Boiling Point at 1 atm (K) |
|-----------|-----------------------|-------------------------------|
| methane | 16 | 112 |
| ethane | 30 | 185 |
| propane | 44 | 231 |
| butane | 58 | 273 |

State, in terms of intermolecular forces, why the boiling point of propane at 1 atmosphere is *lower* than the boiling point of butane at 1 atmosphere.

17. Which molecule is nonpolar?

- 1) H_2O 2) NH_3 3) CO 4) CO_2

Molecular Polarity

18. Base your answer to the following question on the information below.

Carbon forms molecular compounds with some elements from Group 16. Two of these compounds are carbon dioxide, CO_2 , and carbon disulfide, CS_2 .

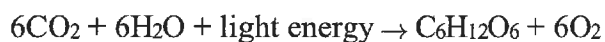
Carbon dioxide is a colorless, odorless gas at room temperature. At standard temperature and pressure, $\text{CO}_2(\text{s})$ changes directly to $\text{CO}_2(\text{g})$.

Carbon disulfide is formed by a direct reaction of carbon and sulfur. At room temperature, CS_2 is a colorless liquid with an offensive odor. Carbon disulfide vapors are flammable.

Compare the intermolecular forces in CO_2 and CS_2 at room temperature.

19. Base your answer to the following question on the information below and on your knowledge of chemistry.

As plants grow, light energy is converted into chemical energy during the process of photosynthesis. The reaction produces glucose and oxygen. The balanced equation below represents photosynthesis.



State the molecular polarity for each of the reactants in the equation.

20. Base your answer to the following question on the information below.

Some Properties of Three Compounds at Standard Pressure

| Compound | Boiling Point (°C) | Solubility in 100. Grams of H_2O at 20.°C (g) |
|-------------------|-----------------------|--|
| ammonia | -33.2 | 56 |
| methane | -161.5 | 0.002 |
| hydrogen chloride | -84.9 | 72 |

Explain, in terms of molecular polarity, why hydrogen chloride is more soluble than methane in water at 20.°C and standard pressure.
