Name_____ Date_____ Period_____

Topic: Bonding

Bonding Outline

1. Chemical compounds are formed when atoms are bonded together.

- ✓ Breaking a chemical bond is an endothermic process.
- ✓ Forming a chemical bond is an exothermic process.
- ✓ Compounds have less potential energy than the individual atoms they are formed from.

2. Two major categories of compounds are ionic and molecular (covalent) compounds.

- ✓ Ionic compounds tend to be a metal bonding with a nonmetal; or a metal with a polyatomic ion
- ✓ Molecular (covalent) compounds tend to be two or more nonmetals combined.

3. Compounds can be differentiated by their chemical and physical properties.

- ✓ Ionic substances have high melting and boiling points, form crystals, dissolve in water (dissociate), and conduct electricity in solution and as liquids.
- ✓ Covalent or molecular substances have lower melting and boiling points, do not conduct electricity.

4. Atoms gain a stable electron configuration by bonding with other atoms.

- ✓ Atoms are stable when they have a full valence level.
- ✓ Most atoms need 8 electrons to fill their valence level.
- ✓ H and He only need 2 electrons to fill their valence level.
- ✓ The noble gases (group 18) have filled valence levels. They do not normally bond with other atoms.

5. Chemical bonds are formed when valence electrons are:

- ✓ Transferred from one atom to another – ionic.
- ✓ Shared between atoms – covalent.
- ✓ Mobile in a free moving "sea" of electrons – metallic.

6. In multiple (double or triple) covalent bonds more than 1 pair of electrons are shared between two atoms.

- ✓ oxygen and it's family (group 16) form double bonds with each other (O_2)
- ✓ nitrogen and it's family (group 15) form triple bonds with each other (NH_3)
- ✓ carbon can form double and triple bonds with itself & group 16 and 15 elements (ex: CO_2)

7. Polarity of a molecule can be determined by its shape and the distribution of the charge.

- ✓ Polar molecules have an asymmetrical (uneven) distribution of electrons in them.
- ✓ As a result, polar molecules have (+) and (-) charged ends.
- ✓ Water is the most common substance composed of polar molecules; O end is (-), H ends are (+).
- ✓ Nonpolar molecules have symmetrical (even) distribution of electrons in them.
- ✓ Polar substances are dissolved only by another polar substance. Non-polar substances are dissolved only by other non-polar substances.

8. The electronegativity difference between two bonded atoms can determine the type of bond and its polarity.

0.0 = non-polar covalent
0.0 -1.7 = polar covalent
1.7+ = ionic

9. Bonding guidelines:

- ✓ Metals react with nonmetals to form ionic compounds.
- ✓ Nonmetals bond with nonmetals to form covalent compounds (molecules).
- ✓ Ionic compounds with polyatomic ions have both ionic and covalent bonds.

10. Intermolecular forces allow different particles to be attracted to each other to form solids and liquids.

- ✓ Hydrogen bonds are an example of a strong IMF between polar molecules.
- ✓ Hydrogen bonds exist between atoms of hydrogen on one molecule and atoms of either oxygen, fluorine, or nitrogen on a neighboring molecule.
- ✓ Substances with hydrogen bonds tend to have much higher melting and boiling points than those without hydrogen bonds. Water is one such substance
- ✓ Ordinary polar molecules simply attract each other as their oppositely charged ends line up.
- ✓ Nonpolar molecules use weak Vander Waal's forces of attraction and as a result tend to have lower melting points, and higher vapor pressures.

11. Metallic bonding occurs between atoms of metal. The valence electrons are loosely held by all atoms in a mobile "sea" of valence electrons.

- ✓ This type of bonding accounts for some of the unique properties of metals, such as their ability to conduct electricity, luster, and malleability.

12. Physical properties of a substance can be explained in terms of chemical bonds and intermolecular forces. These include conductivity, malleability, solubility, ductility, hardness, melting point and boiling point, vapor pressure.

Bonding – Practice Questions

1. The forces between atoms that create chemical bonds are the result of interactions between
   (1) nuclei
   (2) electrons
   (3) protons and electrons
   (4) protons and nuclei

2. According to Reference Table S, which sequence correctly places the elements in order of increasing ionization energy?
   (1) H → Li → Na → K
   (2) I → Br → Cl → F
   (3) O → S → Se → Te
   (4) H → Be → Al → Ga

3. Electronegativity is a measure of an atom's ability to
   (1) attract the electrons in the bond between the atom and another atom
   (2) repel the electrons in the bond between the atom and another atom
   (3) attract the protons of another atom
   (4) repel the protons of another atom

4. If the electronegativity difference between the elements in compound NaX is 2.0, what is element X?
   (1) bromine (2) chlorine (3) fluorine (4) oxygen

5. An element with an electronegativity of 0.9 bonds with an element with an electronegativity of 3.1. Which phrase best describes the bond between these elements?
   (1) mostly ionic in character and formed between two nonmetals
   (2) mostly ionic in character and formed between a metal and a nonmetal
   (3) mostly covalent in character and formed between two nonmetals
   (4) mostly covalent in character and formed between a metal and a nonmetal

6. Which type of bond exists between an atom of carbon and an atom of fluorine?
   (1) ionic (2) metallic (3) polar covalent (4) nonpolar covalent

7. Which pair of atoms is held together by a covalent bond?
   (1) HCl (2) LiCl (3) NaCl (4) KCl

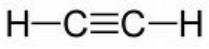
8. Which substance contains nonpolar covalent bonds?
   (1) H_2 (2) H_2O (3) $Ca(OH)_2$ (4) CaO

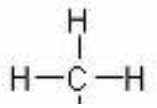
9. Given the reaction: **$Cl\ (g) + Cl\ (g) \rightarrow Cl_2\ (g) + energy$**
   Which statement best describes the reaction?
   (1) A bond is formed and energy is absorbed.
   (2) A bond is formed and energy is released.
   (3) A bond is broken and energy is absorbed.
   (4) A bond is broken and energy is released.

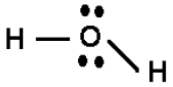
10. The primary forces of attraction between water molecules in H_2O (l) are
    (1) ionic bonds
    (2) hydrogen bonds
    (3) molecule-ion attractions
    (4) van der Waals forces

11. Which structure represents a polar molecule?

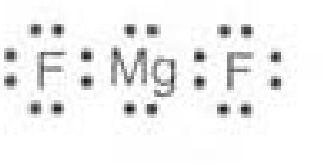
(1) H – H

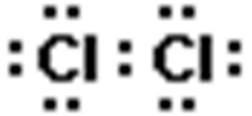
(2) 

(3) 

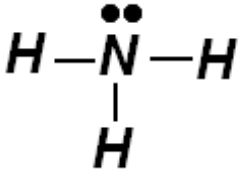
(4) 

12. Which electron dot diagram represents a molecule that has a polar covalent bond?

1) 

2) 

3) 

4) 

Bonding Review – questions from previous Regents exams

1. Given the balanced equation:

$$I + I \rightarrow I_2$$

Which statement describes the process represented by this equation?
(1) A bond is formed as energy is absorbed.
(2) A bond is formed and energy is released.
(3) A bond is broken as energy is absorbed.
(4) A bond is broken and energy is released.

2. An oxygen molecule contains a double bond because the two atoms of oxygen share a total of
(1) 1 electron (3) 3 electrons
(2) 2 electrons (4) 4 electrons

3. A double carbon-carbon bond is found in a molecule of
(1) pentane (3) pentyne
(2) pentene (4) pentanol

4. At STP, fluorine is a gas and bromine is a liquid because, compared to fluorine, bromine has
(1) stronger covalent bonds
(2) stronger intermolecular forces
(3) weaker covalent bonds
(4) weaker intermolecular forces

5. Which term indicates how strongly an atom attracts the electrons in a chemical bond?
(1) alkalinity
(2) atomic mass
(3) electronegativity
(4) activation energy

6. Magnesium nitrate contains chemical bonds that are
(1) covalent, only
(2) ionic, only
(3) both covalent and ionic
(4) neither covalent nor ionic

7. A solid substance is an excellent conductor of electricity. The chemical bonds in this substance are most likely
(1) ionic, because the valence electrons are shared between atoms
(2) ionic, because the valence electrons are mobile
(3) metallic, because the valence electrons are stationary
(4) metallic, because the valence electrons are mobile

8. When sodium and fluorine combine to produce the compound NaF, the ions formed have the same electron configuration as atoms of
(1) argon, only
(2) neon, only
(3) both argon and neon
(4) neither argon nor neon

9. Atoms of which element have the greatest tendency to gain electrons?
(1) bromine (3) fluorine
(2) chlorine (4) iodine

10. Which polyatomic ion contains the greatest number of oxygen atoms?
(1) acetate (3) hydroxide
(2) carbonate (4) peroxide

11. Which formula represents an ionic compound?
(1) H_2 (3) CH_3OH
(2) CH_4 (4) NH_4Cl

12. Which liquid has the highest vapor pressure at 75°C?
(1) ethanoic acid (3) propanone
(2) ethanol (4) water

13. Given the balanced equation representing a reaction:

$$Cl_2(g) \rightarrow Cl(g) + Cl(g)$$

What occurs during this change?
(1) Energy is absorbed and a bond is broken.
(2) Energy is absorbed and a bond is formed.
(3) Energy is released and a bond is broken.
(4) Energy is released and a bond is formed.

14. At standard pressure, a certain compound has a low boiling point and is insoluble in water. At STP, this compound most likely exists as
(1) ionic crystals
(2) metallic crystals
(3) nonpolar molecules
(4) polar molecules

15. Which group on the Periodic Table of the Elements contains elements that react with oxygen to form compounds with the general formula X_2O?

(1) Group 1
(2) Group 2
(3) Group 14
(4) Group 18

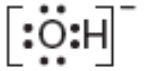
16. Which two substances are covalent compounds?

(1) $C_6H_{12}O_6(s)$ and KI(s)
(2) $C_6H_{12}O_6(s)$ and HCl(g)
(3) KI(s) and NaCl(s)
(4) NaCl(s) and HCl(g)

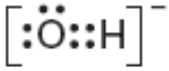
17. Which compound has hydrogen bonding between its molecules?

(1) CH_4
(2) CaH_2
(3) KH
(4) NH_3

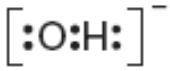
18. Which Lewis electron-dot diagram correctly represents a hydroxide ion?



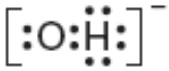
(1)



(3)



(2)

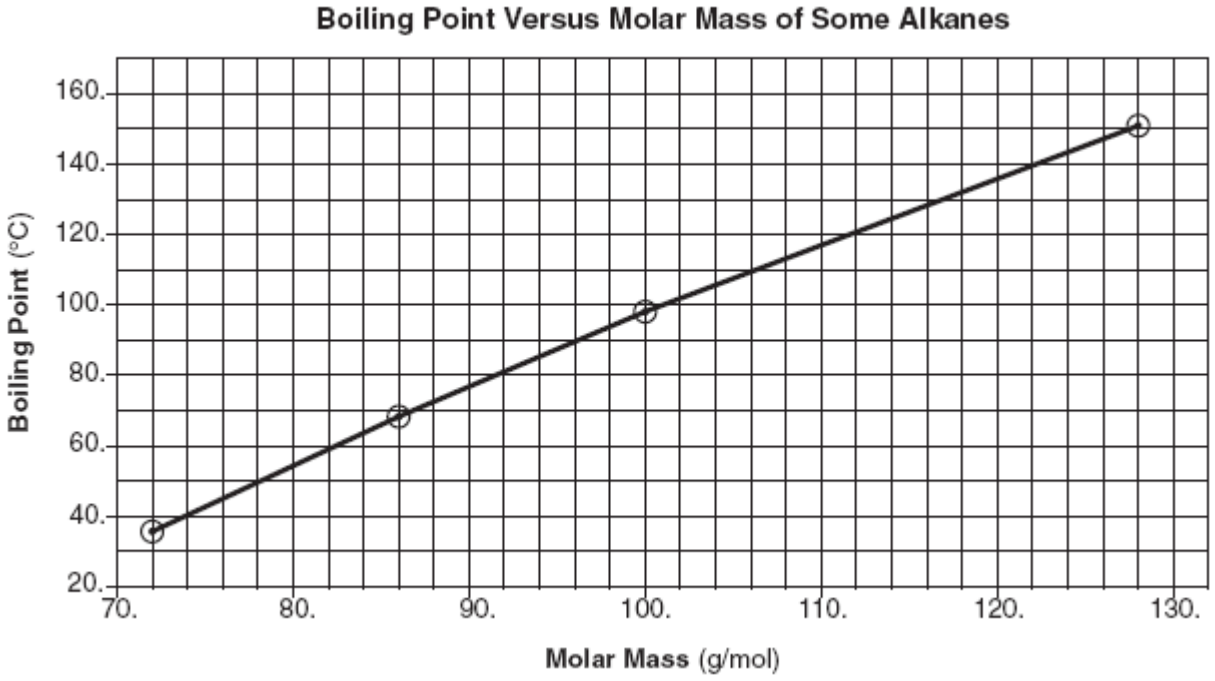


(4)

19. Explain, in terms of electronegativity, why a P–Cl bond in a molecule of PCl_5 is more polar than a P–S bond in a molecule of P_2S_5. [1]

Base your answers to questions 20 and 21 on the information below.

The graph below shows the relationship between boiling point and molar mass at standard pressure for pentane, hexane, heptane, and nonane.

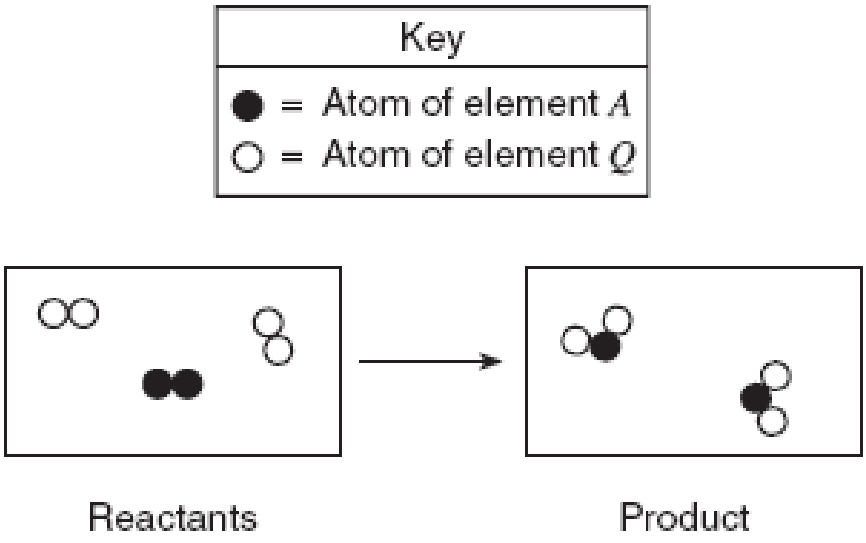


20. Octane has a molar mass of 114 grams per mole. According to this graph, what is the boiling point of octane at standard pressure? [1] _____

21. State the relationship between molar mass and the strength of intermolecular forces for the selected alkanes. [1]

Base your answers to questions 22 through 24 on the information below.

The particle diagrams below represent the reaction between two nonmetals, A_2 and Q_2.



22. Using the symbols *A* and *Q*, write the chemical formula of the product. [1] _____

23. Identify the type of chemical bond between an atom of element *A* and an atom of element *Q*. [1]

24. Compare the total mass of the reactants to the total mass of the product. [1]

25. Explain, in terms of molecular structure or distribution of charge, why a molecule of methane is nonpolar. [1]

26. A liquid boils when the vapor pressure of the liquid equals the atmospheric pressure on the surface of the liquid. Using Reference Table *H*, determine the boiling point of water when the atmospheric pressure is 90. kPa. [1]

Base your answers to questions 27 through 30 on the information below.

Have you ever seen an insect called a water strider "skating" across the surface of a calm pond? Have you ever "floated" a sewing needle on the water in a glass? If you have, then you've observed one of water's many amazing properties. Water's surface tension keeps the water strider and the sewing needle from sinking into the water. Simply stated, the surface tension is due to the forces that hold the water molecules together.
Without these intermolecular forces, the water strider and the sewing needle would sink below the surface of the water. The surface tension of water at various temperatures is given in the data table below.

Surface Tension at Different Water Temperatures

Water Temperature (°C)	Surface Tension (mN/m)
10.	74.2
25	72.0
50.	67.9
75	63.6
100.	58.9

27. **On a piece of graph paper**, plot the data from the data table. Circle and connect the five points. [1]

28. According to your graph, what is the surface tension of water at 60.°C? [1]_____mN/m

29. State the relationship between the surface tension and the temperature of water. [1]

30. The surface tension of liquid tetrachloromethane, CCl_4, at 25°C is 26.3 millinewtons/ meter (mN/m). Compare the intermolecular forces between molecules of CCl_4 to the intermolecular forces between molecules of water, H_2O, at 25°C. [1]