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Chemistry ~ *Ms. Hart* **Class:** Anions or Cations

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STATION 7: Electron Configuration

Key Points:

- The electron configuration of an atom tells us how many electrons exist on each energy level of the atom. The closer to the nucleus, the lower the energy.
- The first energy level can only hold up to 2 electrons, the second energy level can hold up to 8 electrons and the third energy level can hold up to 18 electrons.
- Electron configurations can be found at the bottom of each element box on the periodic table
- A ground state atom and an excited state atom can be determined by looking at its electron configuration. If the lower electron shells have less than the full amount, the electron is in the excited state. An electron could move to an excited state if the energy is increased (heated for example)
- When an electron moves from the excited state back to the ground state (from the higher energy level to the lower energy level), energy is emitted (released) in the form of light (photons)
- Valence electrons are the electrons that exist on the outer most shell of an atom. They can be represented via a Lewis dot diagram

Questions:

1. Where in the atom do electrons have the lowest energy? Highest energy? → farthest from nucleus
↓
closest to nucleus

2. How do you find the number of valence electrons in an atom?
look to see how many e⁻ in the outermost shell!

3. Why is the number of valence electrons so important in chemistry?
predicts reactivity

4. How do you excite an electron?
Heat, energy

5. What is produced when an excited electron comes back to the ground state?
light, photon (energy)

6. How do you know the difference between a ground state electron configuration and an excited state electron configuration?
ground state is full shells (except valence)
excited has less than full wide shells

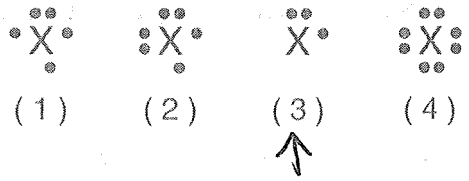
7. How do the energy and the most probable location of an electron in the third shell of an atom compare to the energy and the most probable location of an electron in the first shell of the same atom?
   (1) In the third shell, an electron has more energy and is closer to the nucleus.
   (2) In the third shell, an electron has less energy and is closer to the nucleus.
   (3) In the third shell, an electron has less energy and is farther from the nucleus.
   → (4) In the third shell, an electron has more energy and is farther from the nucleus.

8. An atom of oxygen is in an excited state. When an electron in this atom moves from the third shell to the second shell, energy is
   (1) absorbed by the nucleus
   (2) absorbed by the electron
   (3) emitted by the nucleus
   → (4) emitted by the electron

9. What is the total number of protons in an atom with the electron configuration 2-8-18-32-18-1?
   (1) 69
   (2) 118
   (3) 197
   → (4) 79

10. Which electron configuration represents an atom of aluminum in an excited state?
(1) 2-7-4
(2) 2-7-7
(3) 2-8-6
(4) 2-8-3

11. An atom in the ground state contains a total of 5 electrons, 5 neutrons, and 5 protons. Which Lewis electron-dot diagram represents this atom?



12. What is represented by the dots in a Lewis electron-dot diagram of an atom of an element in Period 2 of the Periodic Table?
(1) the number of neutrons in the atom
(2) the number of valence electrons in the atom
(3) the total number of electrons in the atom
(4) the number of protons in the atom

13. Write an electron configuration for an atom of aluminum-27 in the excited state.
2-7-4 or 2-8-2-1

14. What is the total number of valence electrons in a germanium atom in the ground state?
(1) 22
(2) 2
(3) 32
(4) 4

15. An atom of argon rarely bonds to an atom of another element because an argon atom has
(1) 8 valence electrons
(2) 2 electrons in the first shell
(3) 3 electron shells
(4) 22 neutrons

16. What is the total number of valence electrons in an atom with the electron configuration 2-8-5?
(1) 5
(2) 11
(3) 3
(4) 15

17. What is the total number of valence electrons in an atom with the electron configuration 2-7?
(1) 1
(2) 5
(3) 7
(4) 9

18. Which is the electron configuration of a neutral atom in the ground state with a total of six valence electrons?
(1) 2-4
(2) 2-6
(3) 2-8
(4) 2-8-8

19. What is the total number of valence electrons in an atom of boron in the ground state?
(1) 1
(2) 7
(3) 3
(4) 5

20. When electrons in an atom in an excited state fall to lower energy levels, energy is
(1) absorbed, only
(2) released, only
(3) neither released nor absorbed
(4) both released and absorbed

21. The light emitted from a flame is produced when electrons in an excited state
(1) absorb energy as they move to lower energy states
(2) absorb energy as they move to higher energy states
(3) release energy as they move to lower energy states
(4) release energy as they move to higher energy states

22. From which of these atoms in the ground state can a valence electron be removed using the least amount of energy?
(1) nitrogen
(2) oxygen
(3) carbon
(4) chlorine

ionization energy!

23. Which electron configuration represents an atom of aluminum in an excited state?
(1) 2-7-4
(2) 2-7-7
(3) 2-8-3
(4) 2-8-6

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STATION 8: Parts of the Periodic Table

Key Points:

- The periodic table is arranged in order of increasing atomic number
- There are three main classification of elements: metals, non-metals, and metalloids
- A row of the periodic table is called a period and a column is called a group
- Elements within the same group are chemically similar to each other because they have the same number of valence electrons
- Metals are located on the left side of the periodic table
- Nonmetals are on the right side
- The noble gases are in group 18
- Metalloids are along the staircase on the left side of the table.
- Metals are shiny, malleable, good conductors of electricity
- Nonmetals are dull and brittle and do not conduct electricity

Questions:

1. Give three examples of a metal

   Li, Na, K

2. Give three examples of a nonmetal

   O, N, C

3. Give three examples of a metalloid

   B, Si, Ge, As, Sb, Te

4. What are some differences between a metal and a nonmetal?

   dull, brittle

   shiny, malleable, conduct electr.

5. What is so special about the noble gases?

   full valence shell

6. What is the name of Group 1 metals?

   alkali metals

7. The elements in the Periodic Table are arranged in order of increasing
   (1) atomic radius
   → (2) atomic number
   (3) mass number
   (4) neutron number

8. The elements located in the lower left corner of the Periodic Table are classified as
   → (1) metals
   (2) nonmetals
   (3) metalloids
   (4) noble gases

9. Germanium is classified as a
   (1) Metal
   → (2) Metalloid
   (3) Nonmetal
   (4) Noble gas

10. Element X is a solid that is brittle, lacks luster, and has six valence electrons. In which group on the Periodic Table would Element X be found?
    (1) 1
    (2) 2
    (3) 15
    → (4) 16

    means group 16!

11. What are two properties of most nonmetals?
    → (1) high ionization energy and poor electrical conductivity
    (2) high ionization energy and good electrical conductivity
    (3) low ionization energy and poor electrical conductivity
    (4) low ionization energy and good electrical conductivity

12. The data table below shows elements Xx, Yy, and Zz from the same group on the Periodic Table.

Element	**Atomic Mass** (atomic mass unit)	**Atomic Radius** (pm)
Xx	69.7	141
Yy	114.8	?
Zz	204.4	171

What is the most likely atomic radius of element Yy?

(1) 103 pm
(2) 127 pm
→(3) 166 pm
(4) 185 pm

13. Which element is a liquid at 305 K and 1.0 atmosphere?

(1) magnesium
(2) fluorine
→(3) gallium
(4) iodine

use melting/boiling point!

14. Which Group 14 element is classified as a metal?

(1) carbon
(2) germanium
(3) silicon
→(4) tin

15. An element that is malleable and a good conductor of heat and electricity could have an atomic number of

(1) 16
(2) 18
→(3) 29
(4) 35

16. At STP, which element is solid, brittle, and a poor conductor of electricity?

(1) Al
(2) K
(3) Ne
→(4) S

17. Which is a property of most nonmetallic solids?

(1) high thermal conductivity
(2) high electrical conductivity
→(3) brittleness
(4) malleability

18. Which element is classified as a noble gas at STP?

(1) hydrogen
(2) oxygen
→(3) neon
(4) nitrogen

20. Which list of elements consists of metalloids, only?

(1) B, Al, Ga
(2) C, N, P
(3) O, S, Se
→(4) Si, Ge, As

Two sources of copper are cuprite, which has the IUPAC name copper(I) oxide, and malachite, which has the formula $Cu_2CO_3(OH)_2$. Copper is used in home wiring and electric motors because it has good electrical conductivity. Other uses of copper not related to its electrical conductivity include coins, plumbing, roofing, and cooking pans. Aluminum is also used for cooking pans.

At room temperature, the electrical conductivity of a copper wire is 1.6 times greater than an aluminum wire with the same length and cross-sectional area. At room temperature, the heat conductivity of copper is 1.8 times greater than the heat conductivity of aluminum. At STP, the density of copper is 3.3 times greater than the density of aluminum.

15. Identify one physical property of aluminum that could make it a better choice than copper for a cooking pan.

lower density so less mass

16. Identify one physical property of copper that makes it a good choice for uses that are not related to electrical conductivity.

very malleable
high melting point

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STATION 9: Trends on the Periodic Table

Key Points:

- Atomic radius is the distance between the nuclei of two atoms of the same elements in the solid state
- Atomic radius increases as we go across a period and decreases as we go down a group
- Electronegativity is an atom's attraction for electrons in a chemical bond
- Ionization energy is the energy required to remove a valence electron from an atom
- Electronegativity and ionization energy increases as we move across a period
- Ionic radius is the radius when an atom gains or loses an electron. If an atom GAINS and electron, the ionic radius will increase. If an atom loses an electron, the ionic radius will decrease.

Questions:

1. What is electronegativity?
   how much it wants electrons!
2. What is ionization energy?
   energy it would take to pull away an e⁻ from outer shell
3. What is the difference between atomic radius and ionic radius?
   ↓ neutral ↓ ion!
4. What is the electronegativity of oxygen?
   Use Table S 3.4

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

6. Which statement best describes Group 2 elements as they are considered in order from top to bottom of the Periodic Table?
   (1) The number of principal energy levels increases, the number of valence electrons increases.
   → (2) The number of principal energy levels increases, the number of valence electrons remains the same.
   (3) The number of principal energy levels remains the same, and the number of valence electrons increases.
   (4) The number of principal energy levels remains the same, and the number of valence electrons remains the same.

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

8. As the elements of Group 17 are considered in order of increasing atomic number, there is an increase in
   → (1) atomic radius
   (2) electronegativity
   (3) first ionization energy
   (4) number of electrons in the first shell

9. Which atom has the weakest attraction for the electrons in a bond with an H atom?
   (1) Cl atom
   (2) F atom
   (3) atom
   → (4) S atom

10. Which general trend is found in Period 3 as the elements are considered in order of increasing atomic number?
(1) increasing atomic radius
(2) increasing electronegativity
(3) decreasing atomic mass
(4) decreasing first ionization energy

11. An atom of which element has the greatest attraction for the electrons in a bond with a hydrogen atom?
(1) chlorine (most electronegative)
(2) phosphorus
(3) silicon
(4) sulfur

12. The strength of an atom's attraction for the electrons in a chemical bond is the atom's
(1) Electronegativity
(2) ionization energy
(3) heat of reaction
(4) heat of formation

13. Which element requires the least amount of energy to remove the most loosely held electron from a gaseous atom in the ground state?
(1) bromine 1140 look at Table S
(2) calcium 590
(3) sodium 496
(4) silver 731

14. Which general trend is found in Period 2 on the Periodic Table as the elements are considered in order of increasing atomic number?
(1) decreasing atomic mass
(2) decreasing electronegativity
(3) increasing atomic radius
(4) increasing first ionization energy

15. Which of the following Group 2 elements has the lowest first ionization energy?
(1) Be
(2) Mg
(3) Ca
(4) Ba

16. Based on Reference Table S, which of the following atoms requires the least energy for the removal of the most loosely bound electron?
(1) Sn 709
(2) Sr 549
(3) Be 900
(4) Br 1140

17. As elements of Group 1 of the Periodic Table are considered in order from top to bottom, the ionization energy of each successive element decreases. This decrease is due to
(1) decreasing radius and decreasing shielding effect
(2) decreasing radius and increasing shielding effect
(3) increasing radius and decreasing shielding effect
(4) increasing radius and increasing shielding effect

18. In Period 2 of the Periodic Table, which Group contains the element with the highest first ionization energy?
(1) alkali metals
(2) alkaline earth metals
(3) halogens
(4) noble gases

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STATION 10: Chemical Bonding

Key Points:

- Noble gases are stable because they have eight valence electrons
- Atoms will gain or lose electrons to achieve a full octet
- Full octet = stability
- Ions are charged atoms
- Ions form by gaining or losing electrons to achieve a full octet
- Ions are positively charged if the atom loses electrons and negatively charged if the atom gains electrons
- Polyatomic ions are listed in Table E and are ions that are made up of two or more elements
- Ionic bonds form between metals and non-metals
- An ionic bond require the transfer of electrons octet
- Covalent bonding is the sharing of electrons between two non-metals so that each atom fulfills the octet rule
- Lewis electron dot diagrams can be used to show the bonding of atoms in a covalently bonded molecule

1. What is the difference between cations and anions?

negative ion — positive ion

2. How do you know if you have a polyatomic ion?

more than 2 elements total in ionic bond

3. What are the three types of chemical bonds?

ionic, covalent, metallic

4. Explain, in terms of electrons, how ionic bonds are different from covalent bonds?

sharing — transfer

5. Which statement best describes electrons?
   (1) They are positive subatomic particles and are found in the nucleus.
   (2) They are positive subatomic particles and are found surrounding the nucleus.
   (3) They are negative subatomic particles and are found in the nucleus
   (4) They are negative subatomic particles and are found surrounding the nucleus.

6. Which Group of the Periodic Table contains atoms with a stable outer electron configuration?
   (1) 1 (3) 8
   (2) 16 (4) 18

7. An atom of carbon-12 and an atom of carbon-14 differ in
   (1) atomic number
   (2) mass number
   (3) nuclear charge
   (4) number of electrons

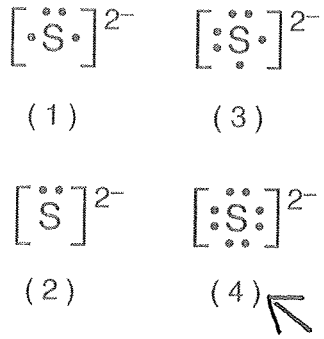
8. Which formulas represent two polar molecules?
   (1) CO_2 and HCl
   (2) CO_2 and CH_4
   (3) H_2O and HCl
   (4) H_2O and CH_4

9. 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

10. Which formula represents a nonpolar molecule?
    (1) H_2S
    (2) HCl
    (3) CH_4
    (4) NH_3

11. What occurs when an atom loses an electron?
    (1) The atom's radius decreases and the atom becomes a negative ion.
    (2) The atom's radius decreases and the atom becomes a positive ion.
    (3) The atom's radius increases and the atom becomes a negative ion.
    (4) The atom's radius increases and the atom becomes a positive ion.

12. Which Lewis electron-dot diagram is correct for S^{2-} ion?



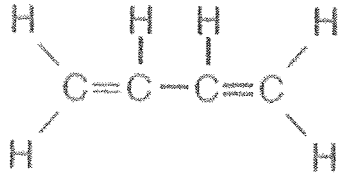
(1) (3)

(2) (4)

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

14. An ion of which element has a larger radius than an atom of the same element?
(1) aluminum
(2) chlorine
(3) magnesium
(4) sodium

15. Given the formula of a substance:



What is the total number of shared electrons in a molecule of this substance?
(1) 22
(2) 11
(3) 9
(4) 6

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

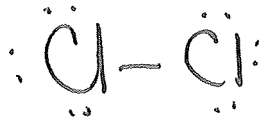
Table E

17. Which isotopic notation represents an atom of carbon-14?
(1) $^{6}_{8}C$
(2) $^{8}_{6}C$
(3) $^{6}_{14}C$
(4) $^{14}_{6}C$

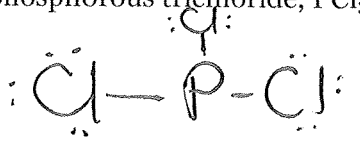
18. Which compound has hydrogen bonding between its molecules?
(1) CH_4
(2) CaH_2
(3) KH
(4) NH_3

19. Which symbol represents a particle with a total of 10 electrons?
(1) N
(2) N^{3+}
(3) Al
(4) Al^{3+}

20. Draw a Lewis electron-dot diagram of Cl_2.



21. Draw a Lewis electron-dot diagram of phosphorous trichloride, PCl_3.



22. 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.

the electronegativity difference between P and Cl is 1 P and S is .4. Greater difference = more polar

23. Explain, in terms of molecular structure or distribution of charge, why methane is nonpolar.

tetrahedral

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STATION 11: Naming

Key Points:

- The criss-cross rule determines the molecular formula of an ionic salt
- The cation is always named first by the name of the element
- The anion is named second by dropping the ending of the element of the element and replacing it with –ide
- Lewis electron dot diagrams can be used to show the bonding of atoms in a covalently bonded molecule
- Numerical prefixes must be used to indicate the number of atoms of each element present

1. For which type of bonding do you use the criss-cross rule?

ionic!

2. For which type of bonding do you use numerical prefixes?

covalent!

3. The roman numeral (ex: Iron (III) oxide) in a compound name is used when the metal is what kind of metal?

transition with more than one oxidation state

4. Write the chemical formula for Lithium oxide.

Li_2O

5. What is the name of CO_2?

carbon dioxide

6. What is the chemical formula for iron (III) oxide?
   (1) FeO (3) Fe_2O_3
   (2) Fe_3O (4) Fe_3O_2

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

nitrate is polyatomic!

8. Which type of bond is found in sodium bromide?
   (1) covalent
   (2) hydrogen
   (3) ionic
   (4) metal

9. Element X reacts with iron to form two different compounds with the formulas FeX and Fe_2X_3. To which group on the Periodic Table does element X belong?
   (1) Group 8
   (2) Group 2
   (3) Group 13
   (4) Group 16

10. What is the total number of different elements present in NH_4NO_3?
    (1) 7
    (2) 9
    (3) 3
    (4) 4

11. What is the chemical formula for sodium sulfate?
(1) Na_2SO_3
(2) Na_2SO_4
(3) $NaSO_3$
(4) $NaSO_4$

12. Which formula represents a hydronium ion?
(1) H_3O^+
(2) NH_4^+
(3) OH^-
(4) HCO_3^-

13. 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

14. Write the IUPAC name for Fe_2O_3.

Iron (III) oxide

15. Write the IUPAC name for Na_2CO3.

sodium carbonate

16. What is the correct IUPAC name for the compound NH4Cl?
(1) nitrogen chloride
(2) nitrogen chlorate
(3) ammonium chloride
(4) ammonium chlorate

A scientist in a chemistry laboratory determined the molecular formulas for two compounds containing nitrogen and oxygen to be NO2 and N2O5

17. Write an IUPAC name for the compound N2O5.

Dinitrogen pentoxide

18. What is the IUPAC name for the compound FeS?
(1) iron(II) sulfate
(2) iron(III) sulfate
(3) iron(II) sulfide
(4) Iron(III) sulfide

19. A compound is made up of iron and oxygen, only. The ratio of iron ions to oxide ions is 2:3 in this compound. The IUPAC name for this compound is
(1) triiron dioxide
(2) iron(II) oxide
(3) iron(III) oxide
(4) iron trioxide

Fe_2O_3

20. Which formula represents lead (II) chromate?
(1) $PbCrO_4$
(2) $Pb(CrO_4)_2$
(3) Pb_2CrO_4
(4) $Pb_2(CrO_4)_3$

$Pb^{2+} CrO_4^{2-}$

$Pb_{2/2}(CrO_4)_{2/2}$

Reduce!

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STATION 12: Grams Formula Mass/Percent Composition/Empirical and Molecular Formula

Key Points:

- The two kinds of chemical formulas: empirical formulas and molecular formulas
- Empirical formula is the simplest whole-number ratio of atoms of the elements in a compound
- The molecular formula is the actual ratio of atoms of the elements that combine to form a compound
- Gram formula mass is the calculated mass of a compound per 1 mole of that compound
- The molecular formula is found by dividing the gram formula mass of the unknown by the gram formula mass of the given empirical formula to produce an integer value
- The integer value will be the number we multiply the subscripts of the empirical formula by to obtain the molecular formula
- The percent composition tells us what percent of a compound is made up of a certain element based on its mass
- Percent composition is calculated by finding the gram-formula mass of an element and then dividing it by the gram formula mass of the compound
-

Questions:

1. What is the difference between molecular and empirical formula?

↓ actual ratio ↓ simplest ratio

2. How do you calculate for the gram-formula mass of a compound?

Find total # of atoms of each element, multiply by mass, add them up

3. How do you solve for the percent composition of an element in a compound?

$\frac{\text{part}}{\text{whole}} \times 100$

4. How do you find the molecular formula from the empirical formula and the molecular mass?

Find mass of empirical divide molecular by empirical. Multiply subscripts by that #

5. What is the gram-formula mass of $Ca_3(PO_4)_2$?
   (1) 248 g/mol
   (2) 263 g/mol
   (3) 279 g/mol
   → (4) 310 g/mol

6. Which is an empirical formula?
   → (1) P_2O_5
   (2) P_4O_6
   (3) C_2H_4
   (4) C_3H_6

7. Which pair consists of a molecular formula and its corresponding empirical formula?
   (1) C_2H_2 and CH_3CH_3
   (2) C_6H_6 and C_2H_2
   → (3) P_4O_{10} and P_2O_5
   (4) SO_2 and SO_3

8. What is the percent composition by mass of aluminum in $Al_2(SO_4)_3$ (gram formula mass = 342 grams/mole)?
   (1) 7.89%
   → (2) 15.8 %
   (3) 20.8%
   (4) 36.0 %

9. A compound has a molar mass of 90. grams per mole and the empirical formula CH_2O. What is the molecular formula of this compound?
   (1) CH_2O
   (2) $C_2H_4O_2$
   → (3) $C_3H_6O_3$
   (4) $C_4H_8O_4$

10. What is the total number of moles in 80.0 grams of C_2H_5Cl (gram-formula mass= 64.5 grams/mole)? you don't know how to do that

11. The molar mass of Ba(OH)2 is
(1) 154.3 g
(2) 155.3 g
(3) 171.3 g
(4) 308.6 g

12. The gram formula mass of NH4Cl is
(1) 22.4 g/mole
(2) 28.0 g/mole
(3) 53.5 g/mole
(4) 95.5 g/mole

13. What is the gram formula mass of Ca3(PO4)2?
(1) 196 g
(2) 214 g
(3) 245 g
(4) 310. g

14. What is the gram formula mass of Li2SO4?
(1) 54 g
(2) 55 g
(3) 110 g
(4) 206 g

15. What is the gram formula mass of CuSO4 • 5H2O?
(1) 160. g
(2) 178 g
(3) 186 g
(4) 250. g

16. A substance has an empirical formula of CH2 and a molar mass of 56 grams per mole. The molecular formula for this compound is
(1) CH2
(2) C4H6
(3) C4H8
(4) C8H4

17. The empirical formula of a compound is CH3. The molecular formula of this compound could be
(1) CH4
(2) C2H4
(3) C2H6
(4) C3H6

18. Which compound has the highest precent composition by mass of strontium?
(1) SrCl2
(2) SrI2
(3) SrO
(4) SrS

19. What is the percent composition by mass of sulfur in the compound MgSO4 (gram-formula mass = 120. grams per mole)?
(1) 20%
(2) 27%
(3) 46%
(4) 53%