Name _____
Date _____

_____ 1. Which mass measurement contains four significant figures?
     1. 0.086   2. 0.431   3. 1003   4. 3870

_____ 2. A student calculates the density of an unknown solid. The mass is 10.04 grams, and the volume
     is 8.21 cubic centimeters. How many significant figures should appear in the final answer?
     1. 1   2. 2   3. 3   4. 4

_____ 3. A 10.0 gram sample of which element has the smallest volume at STP?
     1. aluminum   2. magnesium   3 . titanium   4. zinc

_____ 4. The diagram below represents a portion of a 100-millililter cylinder.
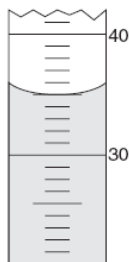
     What is the reading of the meniscus?
     1. 35.0 mL   2. 35.00 mL   3. 45.0 mL   4. 45.00 mL

_____ 5. A student calculated the percent by mass of water in a hydrate as 14.2%. A hydrate is a
     compound that contains water as part of its crystal structure. If the accepted value is 14.7%,
     the student's percent error was:
     1. 3.5%   2. 103.5%   3. 3.4%   4. 96.6%
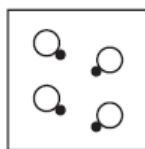
_____ 6. Which grouping of the three phases of bromine is listed in order from left to right for
     increasing distance between bromine molecules?
     1. gas, liquid, solid   2. liquid, solid, gas   3. solid, gas, liquid   4. solid, liquid, gas

_____ 7. Which terms are used to identify pure substances?
     1. an element & a mixture   3. a solution & a mixture
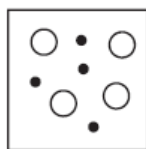   2. an element & compound   4. a solution & a compound

_____ 8. One similarity between all mixtures and compounds is that both:
     1. are heterogeneous   3. combine is a definite ratio
     2. are homogeneous   4. consist of two or more substances

_____ 9. Two grams of potassium chloride are completely dissolved in a sample of water in a beaker. This
solution is classified as
     1. an element   2. a compound   3. a homogeneous mixture   4. a heterogeneous mixture
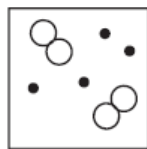
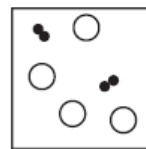_____ 10. Which particle diagram represents one pure substance, only?

(1)   (3)   (2)   (4)

_____ 11. At which temperature would atoms of a $He_{(g)}$ sample have the greatest average kinetic energy?

1. 25° C   2. 37° C   3. 273 K   4. 298 K

_____ 12. The graph below represents the uniform heating of a substance, starting with the substance as a solid below its melting point.

Which line segment represents an increase in potential energy and no change in average kinetic energy?

1. AB   2. BC   3. CD   4. EF

_____ 13. What is the total amount of heat absorbed by 100.0 grams of water when the temperature of the water is increased from 30.0°C to 45.0°C?

1. 418 J   2. 6270 J   3. 12,500 J   4. 18,800 J

_____ 14. A 50.0-gram block of copper at 10.0°C is carefully lowered into 100.0-grams of water at 90.0°C in an insulated container. Which statement describes the transfer of heat in this system?
1. The water loses heat to the block until both are at 10.0°C
2. The block gains heat from the water until both are at 90.0°C
3. The water loses heat and the block gains heat until both are at the same temperature that is between 10.0°C and 90.0 °C
4. The water gains heat and the block loses heat until both are at the same temperature that is between 10.0°C and 90.0 °C

_____ 15. Which process is exothermic?
1. boiling of water   3. condensation of ethanol vapor
2. melting of copper   4. sublimation of iodine

_____ 16. Which of these phrases best describes an atom?
1. a positive nucleus surrounded by a hard negative shell
2. a positive nucleus surrounded by a cloud of negative charges
3. a hard sphere with positive particles uniformly embedded
4. a hard sphere with negative particles uniformly embedded

_____ 17. Chlorine-37 can be represented as
1. $^{17}_{35}Cl$ 2. $^{20}_{37}Cl$ 3. $^{35}_{20}Cl$ 4. $^{37}_{17}Cl$

_____ 18. 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

_____ 19. What is the nuclear charge of a nitrogen atom?
1. $^+5$ 2. $^+2$ 3. $^+7$ 4. $^+17$

_____ 20. The atomic mass of an element is the weighted average of the masses of
1. its two most abundant isotopes   3. its two least abundant isotopes
2. all of its naturally occurring isotopes   4. all of its radioactive isotopes

_____ 21. Which electron configuration represents the electrons of a sulfur atom in an excited state?
1. 2-6-6   2. 2-8-4   3. 2-7-7   4. 2-8-6

_____22. Which statement describes the earliest model of the atom?
  1. An atom is an indivisible hard sphere.   3. Electrons are negative particles in an atom.
  2. An atom has a small, dense nucleus.   4. Electrons in an atom have wave-like properties.

_____23. In all atoms of bismuth, the number of electrons must equal the
  1. number of protons   3. sum of the number of neutrons and protons
  2. number of neutrons   4. difference between the number of neutrons and protons

_____24. Which element has metallic bonds at room temperature?
  1. bromine   2. krypton   3. cesium   4. sulfur

_____25. Elements on the modern Periodic Table are arranged in order of increasing
  1. atomic mass   2. atomic number   3. number of neutrons   4. number of valence electrons

_____26. Which element is a brittle, non-conducting solid at 25°C?
  1. Br   2. S   3. Al   4. Bi

_____27. Which changes occur as a cadmium atom, becomes a cadmium^{+2} ion?
  1. the cadmium atom gains two electrons and its radius decreases
  2. the cadmium atom gains two electrons and its radius increases
  3. the cadmium atom loses two electrons and its radius decreases
  4. the cadmium atom loses two electrons and its radius increases

_____28. Which element is malleable and conducts electricity?
  1. iron   2. iodine   3. sulfur   4. phosphorus

_____29. Which two characteristics are associated with metals?
  1. low first ionization energy and low electronegativity
  2. low first ionization energy and high electronegativity
  3. high first ionization energy and low electronegativity
  4. high first ionization energy and high electronegativity

_____30. Which substances have atoms of the same element but different molecular structures?
  1. $He(g)$ and $Ne(g)$ 2. $K(s)$ and $Na(s)$ 3. $O_2(g)$ and $O_3(g)$ 4. $P_4(s)$ and $S_8(s)$

_____31. Which formulas represent one ionic compound and one molecular compound?
  1. N_2 and SO_2 2. $BaCl_2$ and N_2O_4 3. Cl_2 and H_2S 4. $NaOH$ and $BaSO_4$

_____32. A characteristic of ionic solids is that they:
  1. Have high melting points   3. Conduct electricity
  2.   Have low boiling points   4. Are non-crystalline

_____33. In which compound have electrons been transferred to the oxygen atom?
  1. CO_2 2. NO_2 3. N_2O 4. Na_2O

_____34. Which ion has the electron configuration of a noble gas?
  1. Cu^{+2} 2. Fe^{+2} 3. Ca^{+2} 4. Hg^{+2}

_____35. An atom of which of the following elements has the greatest ability to attract electrons?
  1. Silicon   2. Sulfur   3. Nitrogen   4. Iodine

_____36. In a non-polar covalent bond, electrons are:
    1. located in a mobile "sea" shared by many ions   3. shared equally by two atoms
    2. transferred from one atom to another   4. shared unequally by two atoms

_____37. Which molecule is non-polar and has a symmetrical shape?
    1. HCl   2. CH_4 3. H_2O 4. NH_3

_____38. Hydrogen bonds are strongest between molecules of:
    1. HF   2. HCl   3. HBr   4. HI

_____39. Which statement explains why Br_2 is a liquid and I_2 is a solid at STP?
    1. Molecules of Br_2 are polar, and molecules of I_2 are nonpolar
    2. Molecules of I_2 are polar, and molecules of Br_2 are nonpolar
    3. Molecules of Br_2 have stronger intermolecular forces than molecules of I_2
    4. Molecules of I_2 have stronger intermolecular forces than molecules of Br_2

_____40. What is the correct formula for iron (II) sulfide?
    1. FeS   2. $FeSO_3$ 3. Fe_2S_3 4. $Fe_2(SO_4)_3$

_____41. What is the chemical formula for sodium sulfate?
    1. Na_2SO_3 2. Na_2SO_4 3. $NaSO_3$ 4. $NaSO_4$

_____42. What is the name for the compound $FeSO_4$?
    1. iron (II) sulfate   2. iron (III) sulfate   3. iron (II) sulfide   4. iron (III) sulfide

_____43. What is the correct name for the compound NH_4Cl?
    1. nitrogen chloride   2. nitrogen chlorate   3. ammonium chloride   4. ammonium chlorate

_____44. What is the gram-formula mass of $(NH_4)_3PO_4$?
    1. 112 g/mol   2. 121 g/mol   3. 149 g/mol   4. 242 g/mol

_____45. The gram-formula mass of a compound is 48.0 grams. The mass of 2.0 moles of this compound is
    1. 24 g   2. 48 g   3. 96 g   4. 480 g

_____46. What is the percent composition by mass of sulfur in the compound $MgSO_4$ (gram-formula mass =
     120. grams per mole)?
    1. 20.%   2. 46%   3. 27%   4. 53%

_____47. Which of the following compounds below correctly pair up a molecular formula with an empirical
     formula?
    1. C_2HNO_2 and CHNO   3. $C_4H_2N_2O_4$ and CHNO
    2. C_2HNO_2 and C_2HNO_2 4. $C_4H_2N_2O_4$ and C_2HNO_2

Part B – Short Answer

1. Base your answers to the following on the information below.

    In the modern model of the atom, each atom is composed of three major subatomic (or fundamental) particles.

    a. Name the subatomic particles contained in the nucleus of an atom._____

    b. State the charge associated with each type of subatomic particle contained in the nucleus of the atom.

    _____

    c. What is the net charge of the nucleus? _____

2. Base your answers to the following on the Data Table below which shows three isotopes of neon.

Isotope	Atomic Mass (atomic mass units)	Percent Natural Abundance
^{20}Ne	19.99	90.9 %
^{21}Ne	20.99	0.3 %
^{22}Ne	21.99	8.8 %

    a. In terms of <u>atomic particles</u>, state one difference between these three isotopes of neon

_____

    b. Based on the atomic masses and the natural abundances shown in the data table, calculated the average atomic mass of neon. SHOW YOUR WORK!!!

    c. What is the total number of electrons in an atom of neon – 21 ?_____

3. A student determined the density of aluminum to be 2.9 g/cm^3. Calculate the student's percent error.

4. In the space provided below, calculate the heat released when 25.0 grams of water freezes at 0 °C. Show all work.

5. A hot pack contains chemicals that can be activated to produce heat. A cold pack contains chemicals that feel cold when activated.

    a. Based on energy flow, state the type of chemical change that occurs in a hot pack. _____

    b. A cold pack is placed on an injured leg. Indicate the direction of the flow of energy between the leg and the cold pack.

6. A 100.0 gram sample of $NaCl_{(s)}$ has an initial temperature of 0°C. A chemist measures the temperature of the sample as it is heated. Heat is not added at a constant rate. The heating curve for the sample is shown below.

Heating Curve for Sodium Chloride
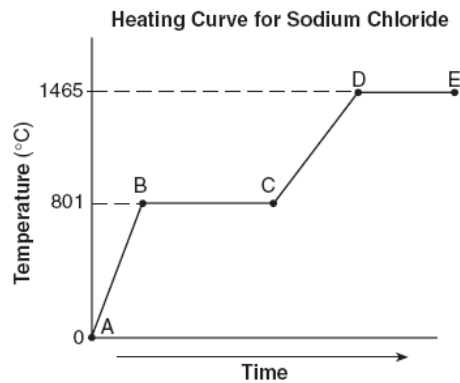
a. Determine the temperature range over which the entire NaCl sample is a liquid. _____

b. Identify one line segment on the curve where the average kinetic energy of the particles of the NaCl sample

is changing_____

c. From the answer to (b) above, describe what is happening to potential energy during that line segment.

d. Identify one line segment on the curve where the NaCl sample is in a single phase and capable of conducting

electricity._____

7. Archimedes (287 – 212 BC.), a Greek inventor and mathematician, made several discoveries important to science today. According to a legend, Hiero, the kind of Syracuse, commanded Archimedes to find out if the royal crown was make of gold, only. The king suspected that the crown consisted of a mixture of gold, tin and copper. Archimedes measured the mass of the crown and the total amount of water displaced by the crown when it was completely submerged. He repeated the procedure using individual samples, one of gold, one tin, and one of copper. Archimedes was able to determine that the crown was not made entirely of gold without damaging it.

a. Identify one physical property that Archimedes used in his comparison of the metal samples._____

b. Determine the volume of a 75-gram sample of gold at standard temperature and pressure.

8. The density of hydrogen at standard temperature and pressure is 0.0899 gram per liter. Express this density to **two** significant figures._____

9. Explain, in terms of atomic structure, why cesium has a *lower* first ionization energy than rubidium.

10. a. As a neutral sulfur atom gains two electrons, what happens to the radius of the atom? _____

b. After a neutral sulfur atom gains two electrons, what is the resulting charge of the atom?_____

11. Explain, in terms of electron configuration, why selenium and sulfur have similar chemical properties.

12. The balanced equation below represents a reaction.

$$O_2(g) + energy \rightarrow O(g) + O(g)$$
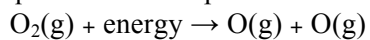
   a) Identify the type of chemical bond in a molecule of the reactant. _____
   b) In the space below, draw a Lewis electron-dot diagram of the oxygen molecule

   c) Explain, in terms of bonds, why energy is absorbed during this reaction.

13. The reaction between aluminum and an aqueous solution of copper(II) sulfate is represented by the unbalanced equation below.

$$Al(s) + CuSO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + Cu(s)$$
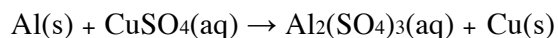
Determine the total mass of Cu produced when 1.08 grams of Al reacts completely with 9.58 grams of $CuSO_4$ to produce 6.85 grams of $Al_2(SO_4)_3$. Show all work for full credit.

14. A total of 1.4 moles of sodium nitrate is dissolved in water to make 2.0 liters of an aqueous solution. The gram-formula mass of sodium nitrate is 85.0 grams.

   a) Write the chemical formula for the substance dissolved in the water. _____

   b) Determine the number of grams of sodium nitrate used to make this solution. Show all work for full credit.