Name: _____

CHM 101 Final Exam

True/False
Indicate whether the statement is true or false.

+   1. The formula weight of an ionic compound is analogous (similar) to a molecular weight of a covalent compound.

F   2. Absolute zero is $0°C$.

F   3. Fe^{2+} and Fe^{3+} are isoelectronic.

F   4. The name for the compound formed between Co^{3+} and O^{2-} is cobalt(II) oxide.

+   5. Attractive forces between solute and solvent molecules are an important factor in solution formation.

+   6. The reactions $NaOH + HCl \rightarrow H_2O + NaCl$ and $Ca(OH)_2 + 2HBr \rightarrow 2H_2O + CaBr_2$ have the same net ionic equation.

+   7. Neutral isotopes of the same element have the same number of electrons.

F   8. One mole of an element would weigh the same as a mole of an isotope of the same element.

F   9. In the reaction $Zn + Cu(NO_3)_2 \rightarrow Cu + Zn(NO_3)$, the Zn is reduced.

F   10. The number twelve, representing a dozen, has two significant figures.

F   11. If 6526 is added to 15.0, the answer should have two significant figures.

+   12. There is a 12 M aqueous HCl solution in the stock room, but a 6 M solution is required for an experiment. Doubling the volume of a 12 M sample with water will produce a 6 M solution.

+   13. In an exothermic reaction, heat is liberated to the surroundings.

Short Answer

14. If 5 grams of CO and 5 grams of O_2 are combined according to the reaction $2CO + O_2 \rightarrow 2CO_2$, which is the limiting reagent?

$$5 \text{ g CO} \times \frac{1 \text{ mol CO}}{28 \text{ g CO}} \times \frac{2 \text{ mol } CO_2}{2 \text{ mol CO}} \times \frac{44 \text{ g } CO_2}{1 \text{ mol } CO_2} = 8 \text{ g } CO_2 \quad \text{LIMITING}$$

$$5 \text{ g } O_2 \times \frac{1 \text{ mol } O_2}{32 \text{ g } O_2} \times \frac{2 \text{ mol } CO_2}{1 \text{ mol } O_2} \times \frac{44 \text{ g } CO_2}{1 \text{ mol } CO_2} = 14 \text{ g } CO_2$$

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15. A sample of gas collected at 21.0°C and a pressure of 0.698 atm has a volume of 1.83 liters. What volume in liters will the gas occupy at 38.0°C under a pressure of 0.658 atm?

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \qquad V_2 = V_1 \times \frac{P_1}{P_2} \times \frac{T_2}{T_1} = \frac{1.83L \times .698 ATM}{.658 ATM} \times \frac{311K}{294K}$$

$$V_2 = 2.05 L$$

16. Given the equation $2CO + O_2 \rightarrow 2CO_2$, how many grams of CO_2 form if 34.0 grams of CO are combined with excess oxygen?

$$34_g CO \times \frac{1 MOL CO}{28_g CO} \times \frac{2 MOL CO_2}{2 MOL CO} \times \frac{44_g CO_2}{1 MOL CO_2} = 53.4_g CO_2$$

17. If urine has a density of 1.08 g/mL, what would be the mass of a 125 mL urine sample?

$$1.08_g = 1 mL \qquad 125 mL \times \frac{1.08_g}{1 ML} = 135_g$$
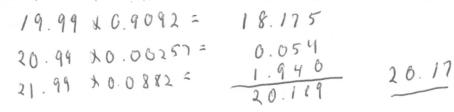
18. A 0.488 g sample of an unknown acid (monoprotic) requires 40.7 ml of 0.100 M NaOH for complete neutralization. What is the molecular weight of the acid in g/mol?

$$40.7 mL \times \frac{1L}{1000 mL} \times \frac{0.100 Mol OH^-}{1L} \times \frac{1 MOL ACID}{1 MOL OH^-} = 0.00407 MOL ACID \qquad \frac{0.488_g}{0.00407 MOL} =$$

$$120_g / mol$$

19. At 1.500 atm and 20 degrees C, it was found that 11.15 L of a gas weighed 30.76 g. What is its molecular mass in grams?

$$PV = mRT$$

$$m = \frac{PV}{RT} = \frac{1.500 ATM \times 11.15L}{0.0821 \frac{L \cdot ATM}{mol \cdot k} \times 293K} = 0.695 MOL \qquad \frac{30.76_g}{0.695 mol} = 44_g / mol$$

20. How many moles of Na_2CO_3 would be needed to react with 750 mL of 0.250 M H_2SO_4 solution?
$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$$

$$750 mL \times \frac{1L}{1000 mL} \times \frac{0.250 mol H_2SO_4}{1L} \times \frac{1 mol Na_2CO_3}{1 mol H_2SO_4} = 0.188 MOL Na_2CO_3$$

21. Naturally occurring neon (Ne) has the following isotopic composition (the mass of each isotope is given in parenthesis). Calculate the atomic weight of neon in u from these data.

   neon-20, 90.92% (19.99 u); neon-21, 0.257% (20.99 u); neon-22, 8.82% (21.99 u)

$$19.99 \times 0.9092 = 18.175$$
$$20.99 \times 0.00257 = 0.054$$
$$21.99 \times 0.0882 = \underline{1.940}$$
$$20.169$$

$$\underline{20.17}$$

Multiple Choice
Identify the choice that best completes the statement or answers the question.

B 22. The primary intermolecular attractions between CH_3-OH and H_2O are
   a. dispersion forces.   c. dipolar forces.
   b. hydrogen bonds.   d. covalent bonds.

C 23. Which of the following electronic changes will cause a Group VA (15) element to achieve a noble gas configuration?
   a. lose three electrons
   b. gain one electron
   c. gain three electrons
   d. gain two electrons

A 24. The correct formula for the ionic compound containing Al^{3+} and PO_4^{3-} would be
   a. $AlPO_4$ b. $Al_3(PO_4)_2$ c. $Al_3(PO_4)_3$ d. $Al_2(PO_4)_3$

D 25. Two pure substances A and B react to form a new pure substance C. From this, we may conclude that
   a. A, B, and C are all compounds
   b. A and B are both elements
   c. C is an element, A and B are compounds
   d. C is a compound, A and B may or may not be elements

C 26. The formula for dinitrogen monoxide is N_2O. If a sample of the oxide was found to contain 0.0800 g of oxygen, how many grams of nitrogen would it contain?
   a. 0.0700   b. 0.560   c. 0.140   d. 0.280

A 27. Arrange the following bonds in order of increasing bond polarity.
   a. $Cl-O < C-O < P-O$ c. $C-O < Cl-O < P-O$
   b. $P-O < Cl-O < C-O$ d. $C-O < P-O < Cl-O$

B 28. Express the following concentration of solution in terms of molarity: 3.00 L of solution contains 1.75 mol of solute.
   a. 1.71 M
   b. 0.583 M
   c. 5.25 M
   d. too little information to know

B 29. Which of the following correctly arranges 1.00 M solutions of the strong electrolytes in order of increasing boiling point (lowest to highest)?
   a. $Al(NO_3)_3 < Mg(NO_3)_2 < NaNO_3$
   c. $Mg(NO_3)_2 < Al(NO_3)_3 < NaNO_3$
   b. $NaNO_3 < Mg(NO_3)_2 < Al(NO_3)_3$
   d. all have the same boiling point.

C 30. What is the volume of a solid that has a density of $3.14 g/cm^3$ and has a mass of 7.04 grams?
   a. $2.242 cm^3$
   b. $22.11 cm^3$
   c. $2.24 cm^3$
   d. $22.1 cm^3$

B 31. What pressure will 3.20 mol of N_2 gas exert if confined in a 15.0 L container at 100°C?
   a. 13.0 atm
   b. 6.53 atm
   c. 3.27 atm
   d. 1.75 atm

A 32. How many unpaired electrons in As?
   a. 3
   c. 1
   b. 4
   d. 2

B 33. What is the oxidation number of Mn in $KMnO_4$?
   a. +4
   b. +7
   c. +5
   d. +9

C 34. Iodine, I_2, is very slightly soluble in water, a polar solvent, but quite soluble in toluene, a nonpolar solvent. What can be inferred about the nature of the I_2 molecule?
   a. It is polar.
   b. It is ionic.
   c. It is nonpolar.
   d. Nothing can be inferred.

B 35. Which element is represented by the distinguishing electron configuration $5d^9$?
   a. Pd
   b. Au
   c. Ag
   d. Pt

C 36. A solution is made by dissolving 5.84 grams of NaCl in enough distilled water to give a final volume of 1.00 L. What is the molarity of the solution?
   a. 0.400
   b. 1.00
   c. 0.100
   d. 0.0250

C 37. How many electrons are in the outer shell of element 15?
   a. 3
   b. 2
   c. 5
   d. 15

D 38. What is the shell number for the outer shell electrons in bromine, Br?
   a. 6
   b. 5
   c. 3
   d. 4

D 39. Which of the following distinguishing electron configurations is characteristic of noble gases?
   a. ns^2
   b. nd^{10}
   c. nf^{14}
   d. np^6

_C_ 40. The radius of a K atom is _____ a Ca atom.
   a.   smaller than
   b.   inverted from
   c.   larger than
   d.   equal to

_C_ 41. In the reaction $2H_2O \rightarrow 2H_2 + O_2$, 2.0 mol water will produce how many grams of O_2?

   a.   36   b.   64   c.   32   d.   16

_C_ 42. Based on data obtained in an experiment, to determine the density of a metal, the following calculation is carried out. Express the answer to the correct number of significant figures.

$$\frac{57.675 \text{ g} - 3.047 \text{ g}}{25.65 \text{ mL} - 0.15 \text{ mL}} = 2.1422745098 \text{ g/mL}$$

   a.   2.1 g/mL   c.   2.142 g/mL
   b.   2.14 g/ml   d.   2.1423 g/mL

_D_ 43. The limit of physical subdivision of pure H_2O is
   a.   the element
   b.   the atom
   c.   a proton
   d.   the molecule

_A_ 44. NH_3 (ammonia) would have what electron group geometry according to VSEPR theory?
   a.   tetrahedral
   b.   pyramidal
   c.   trigonal planar
   d.   none of these

_C_ 45. Ethylene dichloride is an effective cooling agent when allowed to evaporate. The heat of vaporization is 21.4 Joules per gram. How much heat could be removed from the skin if 2.70 grams of ethylene dichloride were sprayed on and allowed to evaporate?
   a.   31.6 J
   b.   0.126 J
   c.   57.8 J
   d.   7.93 J

_A_ 46. Which element has the largest atomic radius?
   a.   Cs   b.   Li   c.   I   d.   F

_A_ 47. Which of the following would you expect to be the most polar molecule?
   a. H_2S b. CO_2 c.   KCl   d. SiH_4

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_A_ 48. How much heat, in J, is required to warm an iron block with a mass of 1.0 kg by 7.0 degrees? The specific heat of iron is 0.449 J g^{-1} $°C^{-1}$.

a. 3100
b. 16,000

c. 3143
d. 15,600

_C_ 49. Which of the following gases is least likely to behave ideally?
a. N_2
b. He
c. HCl
d. H_2