Honors Chemistry: *Final Exam*

1. Aluminum and iron (III) oxide react according to the following equation: $2\ Al + Fe_2O_3 \rightarrow Al_2O_3 + 2\ Fe$
   How many grams of iron are produced from 52.5 g of Fe_2O_3?
   a. 36.7 g
   b. 105 g
   c. 18.3 g
   d. 55.8 g

2. A balanced equation is $CaO + 3\ C \rightarrow CaC_2 + CO$. According to stoichiometry calculations, 75.5 kg of CaO will produce 85.9 kg of CaC_2. If the percent yield is 92.4%, how much CaC_2 will actually be produced?
   a. 69.8 kg
   b. 149 kg
   c. 9.6 kg
   d. 79.4 kg

3. In order to solve a mass-to-mass stoichiometry problem, it is necessary to know the:
   a. coefficients of the balanced equation
   b. rate at which the reaction occurs
   c. phases of the reactants and products
   d. chemical names of reactants and products

4. If a reaction involving substances A and B stops when B is completely used up, then B is referred to as the:
   a. excess reactant
   b. primary reactant
   c. limiting reactant
   d. primary product

5. The measured amount of a product obtained from a chemical reaction is called the:
   a. mole ratio
   b. percent yield
   c. theoretical yield
   d. actual yield

6. A chemist calculates the maximum amount of product possible in a chemical reaction. She is finding the:
   a. mole ratio
   b. percent yield
   c. theoretical yield
   d. actual yield

7. In the reaction $C(s) + O_2(g) \rightarrow CO_2(g)$, 4.286 g of O_2 will yield how many L of CO_2 at STP?
   a. 1.5
   b. 0.5
   c. 2.0
   d. 3.0

8. For the equation $N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$, how many kg of N_2 are needed to make 556 kg NH_3?
   a. 278
   b. 457
   c. 915
   d. 1112

9. The equation for the combustion of methane is $CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(l)$. To calculate the number of grams of CO_2 produced from 29 g of CH_4 with excess O_2, the first conversion factor to use is:
   a. 1 mol CH_4 / 16.0 g CH_4
   b. 2 mol O_2 / 1 mol CO_2
   c. 16.0 g CH_4 / 1 mol CH_4
   d. 29 g CH_4 / 2 mol CO_2

10. Which is an ***incorrect*** interpretation of the following balanced equation?

$$2\ S(s) + 3\ O_2(g) \rightarrow 2\ SO_3(g)$$

a. 2 atoms S + 3 molecules O_2 give 2 molecules SO_3
b. 2 mol S + 3 mol O_2 give 2 mol SO_3
c. 2 g S + 3 g O_2 give 2 g SO_3
d. none of the above; all are correct

11. All of the following values can be used to solve stoichiometry problems EXCEPT:
a. mole ratios
b. rate of reaction
c. molar mass
d. conversion factors

12. When a chemical reaction is performed in industry, the _____ chemical is often chosen as the excess reactant.
a. least expensive and most abundant
b. most expensive and least abundant
c. least expensive and least abundant
d. most expensive and most abundant

13. The actual yield of a chemical reaction is:
a. less than the theoretical yield
b. greater than the theoretical yield
c. equal to the percent yield
d. greater than the percent yield

14. For the balanced equation $CaCO_3 + 2\ HCl \rightarrow CaCl_2 + H_2O + CO_2$, if you start with 112 g of $CaCO_3$ and 48 g of HCl, about how many grams of excess reactant will remain in the reaction vessel?
a. 34
b. 55
c. 20
d. 46

*15. The complete combustion of cyclopropane yields 2,089 kJ of energy per mole of cyclopropane. If 224 L of oxygen gas at 138^{o}C and 188 kPa react with excess cyclopropane to produce 5320 kJ, what is the percent yield of the reaction?
a. 97%
b. 84%
c. 93%
d. 81%

16. The complete combustion of butane yields 124.7 kJ of energy per mole of butane. If you start with 120 g of butane and 380 g of oxygen gas, how much energy is released?
a. 228
b. 114
c. 258
d. 208

17. Which of the following lists gases of the atmosphere in order from smallest percentage to largest percentage?
a. argon, carbon dioxide, oxygen, nitrogen
b. argon, nitrogen, oxygen, carbon dioxide
c. carbon dioxide, oxygen, nitrogen, argon
d. carbon dioxide, argon, oxygen, nitrogen

18. Which of the following is ***TRUE***?
    a. Greenhouse gases contribute to the depletion of the ozone layer.
    b. Carbon dioxide contributes to the depletion of the ozone layer.
    c. CFCs contribute to global warming.
    d. CFCs contribute to the depletion of the ozone layer.

19. Which of the following gases will, on average, travel the fastest if all are at the same temperature?
    a. CH_4
    b. NH_3
    c. NO_2
    d. SO_2

20. A gas occupies a volume of 6240 cm^3 at a temperature of 25^oC. About what volume (in cm^3) will this gas occupy at 55^oC if the pressure is held constant?
    a. 5670
    b. 6870
    c. 13700
    d. 2840

21. You have 2.15 dm^3 of He at a pressure of 58.0 kPa and a temperature of 25^oC. What is the volume (in dm^3) under standard conditions?
    a. 3.44
    b. 1.13
    c. 1.35
    d. 4.10

22. 3.5 g of Ne exert a pressure of 135 kPa and take up 2.3 L of space. The temperature of the gas (in ^oC) is:
    a. –57
    b. 107
    c. 216
    d. 489

23. At 30^oC, the speed of helium is 210 m/s. At the same conditions, find the speed (in m/s) of hydrogen (H_2).
    a. 110
    b. 150
    c. 300
    d. 420

24. Two gases, A and B, are in a balloon. The temperature of the gases is 25^oC, and the molecules of B have a greater mass than those of A. Which of the following is true?
    a. Molecules of B have a greater average kinetic energy than those of A.
    b. Molecules of A have a greater average kinetic energy than those of B.
    c. Molecules of A have a greater average speed than those of B.
    d. Molecules of both gases are moving at the same average speed.

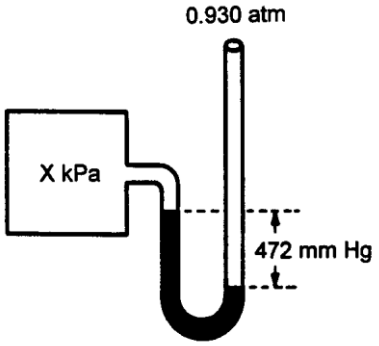
25. A temperature change of one Kelvin is equivalent to a temperature change of:
    a. one ^oC
    b. one Joule
    c. 7.501 mm Hg
    d. 273^oC

26. A 500 mL sample of gas is collected at 101.3 kPa and a temperature of 0^oC. If the temperature rises to 10^oC and the volume remains constant, the sample will:
    a. increase in pressure
    b. decrease in pressure
    c. condense to a liquid
    d. ignite

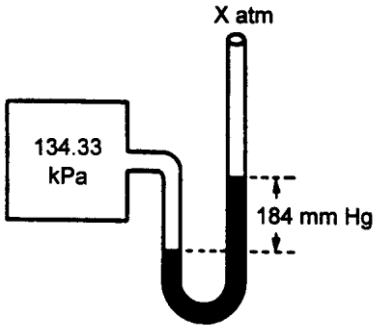
27. An increase in the temperature of a liquid:
    a. causes the liquid to evaporate more quickly
    b. decreases the total kinetic energy of the liquid
    c. causes fewer particles to escape the surface of the liquid
    d. has no effect on the kinetic energy of the liquid

28. Which of these changes would NOT cause an increase in the pressure of a gaseous system?
    a. a second gas is added to the container
    b. more of the same gas is added to the container
    c. temperature is increased
    d. the container is made larger

29. Use the diagram to find the pressure of the confined gas in the manometer (in kPa).
    a. 31.3
    b. 82.0
    c. 118.0
    d. 262.6



30. Use the diagram of the manometer to find the pressure of the atmosphere (in atm).
    a. 0.337
    b. 0.881
    c. 1.084
    d. 1.423



*31. Container A contains gas at a pressure of 2.55 atm and has a volume of 431 mL. Container B contains gas at a pressure of 3.79 atm and has a volume of 196 mL. Container C contains gas at a pressure of 4.69 atm and has a volume of 634 mL. If the gases from A, B, and C are put into Container Z, which has a volume of 585 mL, find the total pressure in Container Z (in atm).
    a. 8.23
    b. 8.08
    c. 7.85
    d. 7.64

32. At 95^{o}C and 137 kPa, 79 dm^{3} of ethane react with excess oxygen. What mass of water (in g) is produced?

$$2\ C_2H_6(g) + 7\ O_2(g) \rightarrow 4\ CO_2(g) + 6\ H_2O(g)$$

    a. 238
    b. 311
    c. 396
    d. 191

33. A 1.45 m long glass tube is clamped in a horizontal position. Two gases, sulfur trioxide and fluorine gas, are then injected into the tube at the same instant from opposite ends of the tube. About how far (in cm) does the fluorine travel before mixing of the two chemicals occurs?
    a. 73
    b. 47
    c. 86
    d. 59
    e. 98

*34. Calculate the boiling point of a solution containing 95 g of sodium chloride dissolved in 2.17 mol of carbon tetrachloride. The following information about carbon tetrachloride may be of use:

normal boiling point:	$76.8^{o}C$
normal freezing point:	$-22.3^{o}C$
K_b:	$5.02^{o}C/m$
K_f:	$29.8^{o}C/m$

a. 81.8
b. 87.7
c. 94.5
d. 101.2

35. Ethylene glycol (antifreeze) and water are completely miscible. If you mix 20 mL ethylene glycol with 10 mL of water in a graduated cylinder, you would expect to see:
a. one homogeneous solution
b. a mixture with a distinct boundary one-third of the way from the bottom of the cylinder
c. a mixture with a distinct boundary two-thirds of the way from the bottom of the cylinder
d. a mixture with a clear liquids above and below, with a cloudy mixture in between

36. If the amount of dissolved solute in a solution is greater than the amount that can permanently remain in solution, the solution is:
a. saturated
b. unsaturated
c. supersaturated
d. dilute

37. In the expression, "like dissolves like," the word "like" refers to similarity in molecular:
a. mass
b. size
c. energy
d. polarity

38. As temperature increases, solubility of gases in liquids:
a. increases
b. decreases
c. is not affected
d. can increase or decrease

*39. A solution of 5.0 g of toluene dissolved in 225 g of benzene has an overall density of 0.876 g/mL. Calculate the molarity (in M) of the solution.
a. 0.18
b. 0.21
c. 0.24
d. 0.27

*40. Using the information from Question 39, find the molality of that solution.
a. 0.18
b. 0.21
c. 0.24
d. 0.27

41. Increasing the temperature of a liquid generally causes the solubility of a solid in a liquid to:
a. increase
b. decrease
c. remain the same
d. not enough info

42. How many mL of 6.0 M HCl(aq) are needed to make 50 mL of 0.5 M HCl(aq)?
    a. 3.1
    b. 4.2
    c. 10.8
    d. 25.6

*43. One cup (~250 mL) of whole milk contains about 0.4 mg of riboflavin, a vitamin B complex, which has the formula $C_{17}H_{20}N_4O_6$. What is the approximate molarity (in M) of riboflavin in whole milk?
    a. 4.3×10^{-5}
    b. 4.3×10^{-6}
    c. 4.3×10^{-3}
    d. 4.3×10^{-9}

44. Find the mass (in g) of $CuSO_4(s)$ in 400 mL of a 2.3 M $CuSO_4$ solution.
    a. 15
    b. 28
    c. 147
    d. 1470

45. Find the molarity of a solution containing 58 g of $H_2SO_4(s)$ in 350 mL of solution.
    a. 0.2 M
    b. 0.6 M
    c. 1.1 M
    d. 1.7 M

*46. Camphor, $C_{10}H_{16}O$, melts at 179.8°C. Its freezing point depression constant K_f is 40.0°C/*m*. When 0.186 g of an unknown nonelectrolyte organic substance is dissolved in 22.01 g of liquid camphor, the freezing point of the mixture is found to be 176.7°C. What is the approximate molar mass (in g) of the solute?
    a. 134
    b. 125
    c. 110
    d. 102

47. Which of the following is ***FALSE***?
    a. An amalgam is an alloy in which one or more metals are dissolved in tin.
    b. A mixture in which an alcohol is the solvent is known as a tincture.
    c. Benzene, phenol, and hexane are all organic solvents.
    d. In an aqueous solution, water is the solvent.

48. All of the following act as emulsifying agents EXCEPT:
    a. detergent
    b. universal indicator
    c. lecithin
    d. eggs

49. Because Vitamin E is stored in the body for long periods of time, it is classified as a _____ vitamin, and examination of its molecular structure would probably show its molecules to be _____.
    a. water-soluble…polar
    b. water-soluble…nonpolar
    c. fat-soluble…polar
    d. fat-soluble…nonpolar

50. How many grams of aluminum will react with 7.25 L of 0.35 M copper (II) chloride solution?

$$3\ CuCl_2(aq) + 2\ Al(s) \rightarrow 2\ AlCl_3(aq) + 3\ Cu(s)$$

    a. 68.5
    b. 45.7
    c. 91.4
    d. 137.0

FOR QUESTIONS ABOUT ACIDS AND/OR BASES, ASSUME 100% DISSOCIATION, UNLESS OTHER INFORMATION IS PROVIDED.

51. Two terms that would best describe 15 M acetic acid are:
    a. weak and concentrated
    b. weak and dilute
    c. strong and concentrated
    d. strong and dilute

52. What is the effect of adding more CO_2 to the following equilibrium reaction?

$$CO_2 + H_2O \leftrightarrow H_2CO_3$$

    a. more H_2CO_3 is produced
    b. more H_2O is produced
    c. the reaction shifts to the left
    d. the reaction does not shift

53. The substance 2,2-dichloroethanoic acid is a weak, monoprotic acid with a K_a of 3.3×10^{-2}. If 0.083 g of 2,2-dichloroethanoic acid are dissolved in 435 mL of solution, find the pH of the solution.
    a. 0.72
    b. 1.10
    c. 2.16
    d. 4.31

54. Which of the following describes an acid solution?
    a. turns litmus paper blue
    b. conducts electricity
    c. tastes bitter
    d. has a pH greater than 7.0

55. During chemical equilibrium:
    a. the forward and reverse reaction rates are equal
    b. reactants are forming products – and products are forming reactants – but not at the same rate
    c. you can observe violent chemical behavior occurring
    d. the forward and reverse reactions stop occurring

56. All of the following are indicators EXCEPT:
    a. universal indicator
    b. phenolphthalein
    c. litmus
    d. all of the above are indicators

57. Which of the following is ***FALSE***?
    a. A Bronsted-Lowry base is a proton acceptor.
    b. Acidosis occurs when the pH of the blood is higher than normal.
    c. Buffers are chemicals that act to resist any change in pH.
    d. An Arrhenius acid produces hydrogen ion in solution.

58. What would be the products if aluminum hydroxide and sulfuric acid react together?
    a. aluminum sulfide and water
    b. sulfuric aluminum and water
    c. water and aluminum sulfite
    d. water and aluminum sulfate

59. How many mL of 0.56 M potassium hydroxide are needed to neutralize 324 mL of 0.12 M nitric acid?
    a. 1512
    b. 69.4
    c. 78.5
    d. 207.4

*60. Calculate the approximate number of hydronium ions in 1.0 mL of pure water at 25°C.
a. 6×10^{23}
b. 6×10^{13}
c. 6×10^{16}
d. 6×10^{33}

61. If 435 mL of 0.14 M sulfuric acid are mixed with 648 mL of 0.06 M aluminum hydroxide, what is the pH of the resulting mixture?
a. 1.93
b. 2.10
c. 2.22
d. 2.32

62. Find the pH of a solution having a hydroxide ion concentration of 8.4×10^{-4} M.
a. 1.2×10^{-11}
b. 1.0
c. 3.1
d. 10.9

63. Two solutions, one of nitric acid and the other of hydrofluoric acid, have the same concentration of 0.084 M. If the K_a of hydrofluoric acid is 6.8×10^{-4}, the concentration of hydronium ion between these solutions differs by a factor of about:
a. 1000
b. 100
c. 10
d. 2
e. none of these; the hydronium ion concentrations are nearly equal

64. Which is the conjugate acid of $H_2AsO_4^{1-}$?
a. $H_3AsO_4^{2-}$
b. $H_3AsO_4^{1-}$
c. $H_2AsO_5^{3-}$
d. H_3AsO_4

65. If 75.3 mL of 0.48 M sulfuric acid are needed to neutralize 57.3 mL of sodium hydroxide solution, find the molarity of the sodium hydroxide.
a. 0.37 M
b. 0.63 M
c. 1.26 M
d. 2.52 M

66. Find the pH of a solution containing 4.33 g of $Ba(OH)_2$ in 8.5 L of solution.
a. 2.2
b. 2.5
c. 11.5
d. 11.8

67. Find the pH of a solution containing 1.43 g of HCl in 5.8 L of solution.
a. 1.4
b. 2.2
c. 11.8
d. 12.6

68. The mass of a uranium-238 nuclide is 238.0003 amu. What is its mass defect (in amu)?
a. 1.9544
b. 1.9571
c. 1.9627
d. 1.9847

69. As the atomic number increases, the neutron-to-proton ratio of stable nuclides:
    a. remains constant
    b. increases
    c. decreases
    d. varies unpredictably

70. Which of the following types of radiation has the most penetrating power?
    a. α particles
    b. β particles
    c. χ rays
    d. positron emission

*71. An iron-56 atom has a binding energy per nucleon of 1.44787×10^{-12} J/nucleon. What is the mass (in amu) of an iron-56 atom?
    a. 55.8412
    b. 56.2114
    c. 55.9720
    d. 57.0061
    e. 55.9207

72. The unstable nuclide oxygen-14 undergoes radioactive decay in which it transmutes into an atom of a different element. Which is the most likely mode of decay of oxygen-14?
    a. alpha emission
    b. beta emission
    c. gamma emission
    d. positron emission

*73. Radiation damage to human tissues is measured in:
    a. rads
    b. rems
    c. roentgens
    d. roms

74. Which of the following is NOT a problem related to generating electricity via nuclear fusion?
    a. No known material can withstand the extreme heat of the reaction.
    b. The fuel used in a fusion reactor is expensive and scarce.
    c. Sustaining a controlled reaction has proven to be difficult.

75. Part of the decay series of a polonium-218 nuclide has the following sequence: alpha, beta, beta, alpha, beta, beta. Which isotope is present after this series of disintegrations?
    a. Pb-210
    b. Pb-214
    c. Po-210
    d. Po-214

76. All of the following are used to detect radiation EXCEPT:
    a. radioactive tracers
    b. film badges
    c. scintillation counters
    d. Geiger-Muller counters

*77. The combustion of 1 mole of graphite releases 393.5 kJ of energy. What mass of graphite is transformed into this amount of energy?
    a. 4.37×10^{-12} kg
    b. 4.37×10^{-12} g
    c. 4.37×10^{-15} kg
    d. 4.37×10^{-15} g

78. Which of the following slows down the neutrons in a controlled nuclear fission reaction, such as what takes place in a nuclear power plant?
    a. shielding
    b. containment vessel
    c. moderator
    d. control rods

79. In nuclear power plants, the fuel is often U-235 or Pu-239. Why are these fuels used, rather than the far-more-plentiful U-238?
    a. the energy released from the fission of U-238 is small compared to that from U-235 or Pu-239
    b. U-238 is not radioactive
    c. the waste products of U-238 are highly toxic, and those of U-235 and Pu-239 are not
    d. U-238 is not fissionable

80. It takes 1 hour 22 minutes for a 1.00 g sample of potassium-44 to decay to 0.125 g. What is the half-life of K-44?
    a. 27 min 33 s
    b. 20 min 50 s
    c. 20 min 30 s
    d. 27 min 20 s

81. Which of the following is produced when a cadmium-107 nuclide transmutes via electron capture?
    a. Pd-106
    b. Pd-108
    c. Ag-107
    d. Cd-106

82. Which of the following results when a bismuth-213 nuclide emits a gamma ray?
    a. Bi-213
    b. Bi-214
    c. Bi-215
    d. Pb-214

83. What is the product when an electron and a positron collide?
    a. nothing
    b. energy
    c. a beta particle
    d. a neutrino

84. Which of the following is an advantage of generating electricity with nuclear power rather than by the chemical combustion of fossil fuels, such as coal or fuel oil?
    a. For a given mass of starting fuel, the energy released from a nuclear reaction is much greater than for a chemical reaction.
    b. Nuclear power plants do not release greenhouse gases into the atmosphere.
    c. Nuclear power plants do not contribute to air pollution (unless they blow up, like at Chernobyl (!))
    d. all of the above

85. Organic compounds that contain at least one carbon-carbon double bond are called:
    a. ketones
    b. alkanes
    c. alkenes
    d. aldehydes
    e. alkynes

*86. Which of the following is a secondary alcohol?

    a. c.

b. d.

87. The reaction shown is an example of:
    a. halogenation
    b. hydrogenation
    c. alkanation
    d. esterification

*88. The name of the structure shown is:
    a. benzene
    b. toluene
    c. cyclohexane
    d. phenyl

*89. When 3,3-diethyl-2,2-dimethyl-4-octene reacts with chlorine gas, what is the molar mass (in g) of the product?
    a. 263
    b. 265
    c. 267
    d. 269

*90. Under ideal conditions, what volume of hydrogen gas at 6.1 atm and 337^{o}C is needed to hydrogenate 55.0 kg of 4-ethyl-2-heptene?
    a. 4.2 kL
    b. 5.4 kL
    c. 2.1 kL
    d. 3.6 kL

*91. The reaction shown is an example of:
    a. halogenation
    b. hydrogenation
    c. alkanation
    d. esterification

*92. In terms of functional group, which structure differs from the other three?

a. c.

b. d.

*93. The reaction shown is an example of:
    a. halogenation
    b. hydrogenation
    c. alkanation
    d. esterification

94. Which are the reactants needed to produce the compound propyl pentanoate?
    a. pentanoic acid + 1-propanol
    b. pentanoic acid + 1-propanal
    c. propanoic acid + pentanol
    d. pentanal + 1-propanol

*95. The compound shown is the flavor cinnamon. Which functional group is in this compound?
    a. alkene
    b. phenyl
    c. aldehyde

d. ether

96. The compound shown is an alcohol commonly known as “antifreeze” or “coolant.” Chemists will often call it “ethylene glycol.” What is the IUPAC name for this compound?
    a. 1,2-ethanetriol
    b. 1,2-diethanol
    c. 1,2-ethanol
    d. 1,2-ethanediol

*97. Give the name of the compound having the structure shown.
    a. *m*-chlorobenzoic acid
    b. 2-chlorobenzoic acid
    c. *p*-chlorobenzoic acid
    d. *o*-chlorobenzoic acid

*98. The structure shown is commonly known as acetone. What is its IUPAC name?
    a. 2-oxypropane
    b. dimethyl ketone
    c. methyl ketone
    d. methyl methyl ketone

*99. The structure shown is that of the male sex hormone testosterone. Which of the following does testosterone NOT contain in its structure?
    a. aldehyde
    b. cycloalkane
    c. cycloalkene
    d. hydroxyl
    e. ketone

*100. How many hydrogen atoms are in the structure shown?
    a. 4
    b. 8
    c. 10
    d. 14