



AMERICAN CHEMICAL SOCIETY

HIGH SCHOOL CHEMISTRY SCHOLARSHIP EXAMINATION

APRIL 17, 1999

MULTIPLE CHOICE

Directions: Choose the single *best* answer in each of the following and darken the corresponding letter on your answer sheet. The score is based on correct answers only - there is no penalty for incorrect guesses.

1. There are 100 questions and 2h30min will be allowed.
2. Calculators are permitted, but stored programs and information are not allowed.
3. You may write on the exam. You may *keep* this exam; it does not need to be returned.
4. Use of significant digits and correct units may be considered in the choice of the best answer.
5. A periodic table is on the last page (and may be detached).

$$R = 8.314 \text{ J/mol K} = .08205 \text{ L atm/mol K}$$

$$N_{\text{O}} = 6.022 \times 10^{23} \text{ mol}^{-1}$$

$$1 \text{ atm} = 101,325 \text{ Pa}$$

$$1 \text{ cal} = 4.184 \text{ J}$$

- The number of significant digits in the mass 0.05010 g is
 - 3
 - 5
 - 4
 - 6
- Which is the largest mass?
 - 1000 mg
 - 1000 μg
 - 1000 kg
 - 1000 g
- What is the mass of a 55.5-mL sample of concentrated sulfuric acid (density 1.84 g/mL)?
 - 30.2 g
 - 57.3 g
 - 102.1 g
 - 112.2 g
- What is the best answer to the following expression: $12.125 + 0.530 + 71.4$
 - 84.055
 - 84.06
 - 84
 - 84.1
- The melting point of mercury is 235 K. This corresponds to:
 - 38°C
 - 20°C
 - 20°C
 - 38°C
- A solution is an example of:
 - a homogeneous mixture
 - a heterogeneous mixture
 - an element
 - a compound
- Which one of the following is **not** a correct match of name and formula?
 - K_2SO_4 , potassium sulfite
 - $\text{Ca}(\text{CN})_2$, calcium cyanide
 - $(\text{NH}_4)_2\text{CO}_3$, ammonium carbonate
 - FeCl_3 , iron(III) chloride
- A correct name for ClO_3^- is
 - hypochlorite ion
 - chlorite ion
 - chlorate ion
 - perchlorate ion
- Which of the following is an alkaline earth metal?
 - Na
 - Cl
 - Ba
 - Cu
- How many electrons does the ion Cl^- have?
 - 17
 - 18
 - 35
 - 37
- The mass in grams of 2.00 moles of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ is
 - 208
 - 244
 - 416
 - 488

- a. trigonal planar
c. tetrahedral
- b. trigonal pyramidal
d. trigonal bipyramidal
55. The bond order for S_2 is
- a. 3
c. 2
- b. 2.5
d. 1.5
56. For a gas, which pair of variables are inversely proportional to each other? Assume all other conditions remain constant.
- a. P, T
c. V, T
- b. P, V
d. n, P
57. The volume occupied by two moles of oxygen gas at STP is:
- a. 22.4 L
c. 11.2 L
- b. 44.8 L
d. none of the above
58. A cylinder of oxygen for medical use contains 35.4 L of oxygen at a pressure of 149.6 atm. What is the volume of this oxygen at 1.00 atm of pressure and at the same temperature?
- a. 5296 L
c. 35.4 L
- b. 0.237 L
d. 7245 L
59. A deep breath of air has a volume of 1.05 L at a pressure of 0.974 atm and body temperature, 37°C . What is the number of moles of air in each breath?
- a. 0.224 mol
c. 0.337 mol
- b. 0.0402 mol
d. 0.0273 mol
60. Which of the following gases will diffuse at the fastest rate at STP?
- a. N_2O
c. NO_2
- b. N_2O_4
d. All diffuse at the same rate.
61. Which of the following compounds is likely to be more soluble in water?
- a. CH_3CH_2OH
c. $CH_3CH_2CH_2CH_2OH$
- b. $CH_3CH_2CH_2OH$
d. None of the above is soluble in water
62. Lithium metal has a body-centered cubic unit cell. How many lithium atoms occupy each unit cell?
- a. 9
c. 2
- b. 5
d. 1
63. Which of the following molecules does not exhibit significant hydrogen bonding?
- a. methane, CH_4
- b. ammonia, NH_3

- c. decreasing the activation energy.
- d. increasing the potential energy of the products.

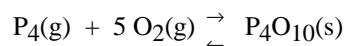
72. The rate determining step in a reaction is:

- a. the fastest step in the reaction mechanism
- b. the slowest step in the reaction mechanism
- c. the step which includes the most chemical species
- d. always the first step in the reaction mechanism

73. If 20.0 g of a radioactive isotope are initially present, and after 4 days there are 5.0 g remaining, then the half-life of the isotope is

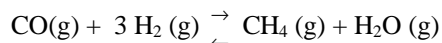
- a. 8 days
- b. 4 days
- c. 2 days
- d. 1 day

74. What is the equilibrium constant expression for the following reaction?



- a. $K_c = \frac{[P_4O_{10}]}{[P_4][O_2]^5}$
- b. $K_c = [O_2]^5 [P_4]$
- c. $K_c = [P_4O_{10}]$
- d. $K_c = \frac{1}{[O_2]^5 [P_4]}$

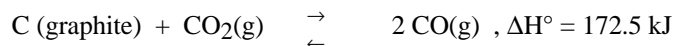
75. Consider the following equation:



The equilibrium composition of the above mixture is: $[CO] = 0.0613M$, $[H_2] = 0.1839M$, $[H_2O] = 0.0387$ and $[CH_4] = 0.0387M$. What is the equilibrium constant for the above reaction?

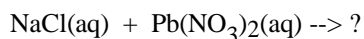
- a. 0.133
- b. 3.93
- c. 10.2
- d. 8.70×10^{-3}

76. For the equilibrium system below, what would be the condition that would favor maximum conversion of reactants to products?



- a. increase the temperature
- b. decrease the temperature
- c. add C (graphite)
- d. a and c

77. Predict the products of the following reaction



- a. $1.82 \times 10^{-3}M$ b. $0.034M$
c. $0.125M$ d. $0.46M$

86. Which of the following is a weak acid?

- a. HF b. HCl
c. HBr d. none of the above

87. A $0.1M$ solution of an electrolyte has a pH of 3.8. The electrolyte is a

- a. strong acid. b. strong base.
c. weak acid. d. weak base.

88. In a buffer solution,

- a. the pH will change only slightly upon addition of a small amount of strong acid or strong base.
b. both a strong acid and the salt of the strong acid are present.
c. the acid is polyprotic.
d. none of the above is true.

89. An oxidation reaction is a reaction where:

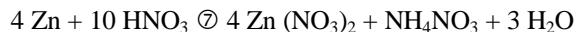
- a. a loss of electrons occurs b. a gain of electrons occurs
c. the oxidation number decreases d. a and c

90. What is the change of oxidation number of chlorine in the following reaction?



- a. 0 b. +1
c. -1 d. +2

91. Which is the reducing agent in the following reaction?

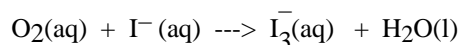


- a. Zn b. HNO_3
c. NH_4NO_3 d. Both Zn and HNO_3 are reducing agents.

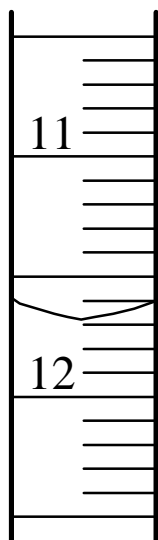
92. Which of the following processes involve redox reactions?

- a. melting of ice b. reaction of HCl with NaOH
c. preparation of metals from their ores d. all of the above

93. Balance the following reaction that occurs in basic solution.



100. What is the buret reading indicated below?



- a. 11.6 mL
- c. 12.32 mL

- b. 11.68 mL
- d. 12.40 mL