Key
5/5/08

Practice Test 2 (4)

Chemistry Section I
Part A

Time—1 hour and 30 minutes
Number of questions—75
Percent of total grade—45

NO CALCULATORS MAY BE USED WITH SECTION I.

Note: For all questions, assume that the temperature is 298 K, the pressure is 1.00 atmosphere, and solutions are aqueous unless otherwise specified.

Throughout the test the following symbols and abbreviations have the definitions specified unless otherwise noted.

T = temperature	M = molar
P = pressure	m = molal
V = volume	L, mL = liter(s), milliliter(s)
S = entropy	g = gram(s)
H = enthalpy	nm = nanometer(s)
G = free energy	atm = atmosphere(s)
R = molar gas constant	J, kJ = joule(s), kilojoule(s)
n = number of moles	V = volt(s)
	mol = mole(s)

Directions: Each set of lettered choices below refers to the numbered statements immediately following it. Select the one lettered choice that best fits each statement and then fill in the corresponding oval on the answer sheet. A choice may be used once, more than once, or not at all in each set.

Questions 1–4 refer to the pH of given solutions.

(A) A solution with a pH of 1
(B) A solution with a pH greater than 1 and less than 7
(C) A solution with a pH of 7
(D) A solution with a pH greater than 7 and less than 13
(E) A solution with a pH greater than 13

For NH_3, $K_b = 1.8 \times 10^{-5}$
For CH_3COOH, $K_a = 1.8 \times 10^{-5}$

D 1. A solution prepared by mixing equal volumes of 0.2-molar NaOH and 0.2-molar CH_3COOH
A 2. A solution prepared by mixing equal volumes of 0.2 *M* NaCl and 0.2 *M* HCl
C 3. A solution prepared by mixing equal volumes of 0.2 *M* NaOH and 0.2 *M* HNO_3
B 4. A solution prepared by mixing equal volumes of 0.2 *M* NH_3 and 0.2 *M* HCl

Questions 5–8 refer to the following terms.

(A) Activation energy
(B) Standard entropy of formation (S_f°)
(C) Enthalpy of reaction (ΔH_{rxn}°)
(D) Total entropy of change for the universe ($\Delta S_{universe}$)
(E) Free-energy formation (ΔG_f°)

D 5. Is always greater than or equal to zero
E 6. Is defined as zero for pure elements in their standard state
B 7. Indicates the amount of disorder in a pure substance at the standard state
C 8. Is always negative for an exothermic reaction

Questions 9–12 refer to the following choices at room temperature.

(A) Grayish solid
(B) Greenish-yellow gas
(C) Pale yellow gas
(D) Reddish-brown gas
(E) Reddish-brown liquid

9. Br_2 E
10. Cl_2 B
11. F_2 C
12. I_2 A

Questions 13–16 refer to the following theories.

(A) Atomic theory
(B) Kinetic molecular theory
(C) VSEPR theory
(D) Transition-state theory
(E) Quantum theory

D 13. Incorporates the activation energy
C 14. Used to determine, predict, or explain molecular geometry
B 15. Used to explain the effects of temperature on reaction kinetics
E 16. Best explains paramagnetism

Questions 17–18 refer to the following elements.

(A) Nitrogen
(B) Sodium
(C) Aluminum
(D) Oxygen
(E) Magnesium

B 17. Gives a yellow flame test and is used in street light lamps
A 18. Reacts with oxygen to form acidic oxides

Chemistry Section I
Part B

Directions: Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case and then fill in the corresponding oval on the answer sheet.

19. Copper does not react with hydrochloric acid, whereas manganese does. This means
(A) that copper is more active than hydrogen
(B) that manganese is less active than hydrogen
(C) that chloride ion will react with copper
(D) that manganese is higher in the activity series than copper
(E) none of the above

20. What mass (in grams) of hydrogen is produced by the reaction of 4.73 g of magnesium with 1.83 g of water?
$(Mg(s) + 2H_2O(l) \rightarrow Mg(OH)_2(aq) + H_2(g))$
(A) 0.102
(B) 0.0162
(C) 0.0485
(D) 0.219
(E) 0.204

21. A compound containing an oxygen atom in the +2 oxidation state is
(A) O_2F_2
(B) OF_2
(C) H_2O
(D) Li_2O
(E) K_2O_2

22. Which reaction produces an increase in the entropy of the system?
(A) $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
(B) $CO_2(s) \rightarrow CO_2(g)$
(C) $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$
(D) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
(E) $H_2O(l) \rightarrow H_2O(s)$

23. Based on quantum numbers, with $n = 4$, give the label for each of the subshells in the level.
(A) Its subshells are labeled 4*s*, 4*p*, and 4*d*.
(B) Its subshells are labeled 4*s*, 4*p*, 4d, and 4*f*.
(C) Its subshells are labeled 4*s*, 4*p*, and 4*f*.
(D) Its subshells are labeled 3*s*, 3*p*, 4*d*, and 4*f*.
(E) Its subshells are labeled 3*s*, 4*p*, 4*d*, and 4*f*.

24. When KNO_3 dissolves in water at room temperature, ΔH is positive for the dissolution process. Given this information, what can you conclude?
(A) $\Delta G > 0$ for the dissolution process.
(B) $\Delta G = 0$ for the dissolution process.
(C) The dissolution of salts in water is always a spontaneous process.
(D) $\Delta S > 0$ for the dissolution process.
(E) $\Delta S < 0$ for the dissolution process.

25. Which of the following binary compounds would you expect to be the most acidic?
(A) NaH
(B) CH_4
(C) SnH_4
(D) H_2O
(E) H_2S

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26. A catalyst increases the rate of a reaction by doing which of the following?
(A) Increasing reactant concentrations
(B) Increasing temperature
(C) Decreasing temperature
(D) Increasing activation energy of the reaction
(E) Decreasing activation energy of the reaction

27. Which of the following statements is/are true?
I. Deviations in the behavior of gases from the ideal-gas equation occur because gas molecules occupy a finite volume in a container.
II. Deviations in the behavior of gases from the ideal-gas equation occur because attractions between gas molecules exist.
III. Deviations in the behavior of gases from the ideal-gas equation decrease with increasing temperature.

(A) I only
(B) II only
(C) I and II
(D) II and III
(E) I, II, and III

28. Which of the following statements about crystalline solids is/are NOT true?
I. Molecules or atoms in molecular solids are held together via intermolecular forces.
II. Metallic solids have atoms in the points of the crystal lattice.
III. Ionic solids have formula units in the point of the crystal lattice.

(A) I
(B) II
(C) III
(D) I and III
(E) None of the above

29. A compound with —COOH is representative of which functional group?
(A) Aldehyde
(B) Ethers
(C) Cycloalkane
(D) Carboxylic acid
(E) None of the above

30. Which type of crystalline solid is SO_2 most like to form?
(A) Ionic
(B) Molecular
(C) Atomic
(D) Metallic
(E) Amorphous

31. A burning splint will burn more vigorously in pure oxygen than in air because
(A) oxygen is a reactant in combustion, and the concentration of oxygen is higher in pure oxygen than it is in air
(B) oxygen is a catalyst for combustion
(C) oxygen is a product of combustion
(D) nitrogen is a product of combustion, and the system reaches equilibrium at a lower temperature
(E) nitrogen is a reactant in combustion, and its low concentration in pure oxygen catalyzes the combustion

32. The hybridizations of nitrogen in NF_3 and NH_3 are
(A) sp^2 and sp^2 respectively
(B) sp and sp^3 respectively
(C) sp^3 and sp respectively
(D) sp^3 and sp^3 respectively
(E) sp^2 and sp^3 respectively

33. What is the molarity of a solution consisting of 1.25 g of NaOH in enough water to form 250 mL of solution?
(A) 1.25 *M*
(B) 0.800 *M*
(C) 8.00 *M*
(D) ~~1.25 × 10^{-4}~~ *M*
(E) 0.125 *M*

34. Which of the following statements is NOT true about hydrogen gas?
(A) Forces between H_2 molecules are weak.
(B) It is a color gas at room temperature and pressure.
(C) It is an effective reducing agent for many metal oxides.
(D) The H—H bond is weak.
(E) Ignition of H_2 in air produces H_2O.

35. Water vapor is a mixture of
(A) $CH_4(g)$ and $H_2O(g)$
(B) $CO(g)$ and $H_2O(g)$
(C) $CO(g)$ and $H_2(g)$
(D) $C(s)$ and $H_2O(g)$
(E) $CO_2(g)$ and $H_2(g)$

36. Which of the expressions below represents the correct rate law of the reaction?

$$2A + B \rightarrow C$$

Experiment	A	B	Initial Rate (Mole/L • Sec)
1	1	1	1.2
2	2	1	4.8
3	1	2	2.4
4	3	1	10.8
5	1	3	3.6

(A) Rate = K[A][B]
(B) Rate = K[A]^2[B]
(C) Rate = K[A]
(D) Rate = K[B]
(E) Rate = K[A]^2[B]^2

37. A reaction occurred in which *A* reacted with a large excess of *B* to form *C*. The concentrations of the reactants were measured periodically and recorded in the chart below. Based on the data in the chart, which of the following statements is NOT true?

Time (Min)	[A] *M*	[B] *M*
0	0.50	6.00
10	0.36	6.00
20	0.25	6.00
30	0.18	6.00
40	0.13	6.00

(A) The reaction is first order in [A].
(B) The reaction is first order overall.
(C) The rate of the reaction is constant over time.
(D) The half-life of reactant [A] is 20 minutes.
(E) The graph of ln[A] will be a straight line.

38. A neutralization reaction between an acid and a metal hydroxide produces
(A) water and a salt
(B) hydrogen gas
(C) oxygen gas
(D) sodium hydroxide
(E) ammonia

39. What is the valence-electron configuration for Se^{2-}?
(A) $2s^22p^4$
(B) $2s^22p^6$
(C) $4s^24p^4$
(D) $4s^24p^6$
(E) $3s^23p^2$

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40. Of the following molecules, which has the largest dipole moment?
(A) HF
(B) HCl
(C) HBr
(D) HI
(E) HAt

41. How much heat is required to convert 100 g of water at 40°C to water vapor at 100°C? The heat of capacity of water is 4.184 J/g-°C, and the heat required to vaporize water is 2.26 kJ/g
(A) 227 kJ
(B) 418 kJ
(C) 226 kJ
(D) 25.1 kJ
(E) 251 kJ

42. When the equation $Al(NO_3)_3 + Na_2S \rightarrow Al_2S_3 + NaNO_3$ is balanced, the coefficients are
(A) 2, 3, 1, 6
(B) 2, 1, 3, 2
(C) 1, 1, 1, 1
(D) 4, 6, 3, 2
(E) 2, 3, 2, 3

43. Which of the following reactions is a redox reaction?
I. $Kr_2CrO_4 + BaCl_2 \rightarrow BaCrO_4 + 2KCl$
II. $Pb^{2+} + 2Br^- \rightarrow PbBr_2$
III. $Cu + S \rightarrow CuS$
(A) I
(B) II
(C) III
(D) I and III
(E) II and III

44. Which of the following xenon compounds is/are polar?
I. XeF_4
II. XeO_4
III. $XeOF_4$
(A) I
(B) II
(C) III
(D) I and III
(E) II and III

45. One edge of a cube is measured and found to be 13 cm. The volume of the cube in m^3 is
(A) 2.2×10^{-3}
(B) 2.2×10^{-6}
(C) 2.2
(D) 2.2×10^{3}
(E) 2.2×10^{6}

46. Which of the following is NOT a physical property of water?
(A) It is a liquid at room temperature.
(B) It can be decomposed into oxygen and hydrogen gases.
(C) It boils at 100°C at 1 atm pressure.
(D) It freezes at 0°C at 1 atm pressure.
(E) It has a density of 1.00 g/cm^3.

47. The formula of nitrobenzene is $C_6H_5NO_2$. The molecular mass of this compound is
(A) 107.11 amu
(B) 43.03 amu
(C) 109.10 amu
(D) 123.11 amu
(E) 3.06 amu

48. Using a periodic table, arrange the following atoms in order of increasing first ionization energy: Ne, Na, P, Ar, K.
(A) Ne < Na < P < Ar < K
(B) Na < Ne < P < K < Ar
(C) Ne < P < Na < K < Ar
(D) K < Na < P < Ar < Ne
(E) K = Na, P < Ne < Ar

49. Why are the atomic masses in the periodic table NOT integral numbers. (For example, carbon is listed as 12.01115 instead of as 12.00000.)
(A) Our technology does not allow for exact measurement of such a small quantity.
(B) Atoms gain and lose electrons easily, and that changes their masses significantly.
(C) Atomic masses listed in the periodic table are weighted averages of naturally occurring isotopes.
(D) Atomic masses are measured in real samples that are always contaminated with other elements.
(E) There is a theoretical uncertainty in the masses of atoms.

50. Both methane and ethane are made up of carbon and hydrogen. In methane, there are 12.0 g of carbon for every 4.00 g of hydrogen, a ratio of 3 : 1 by mass. In ethane, there are 24.0 g of carbon for every 6.00 g of hydrogen, a ratio of 4 : 1 by mass. This is a statement of the law of
(A) constant composition
(B) multiple proportions
(C) conservation of matter
(D) conservation of mass
(E) octaves

51. In which set of elements would all members be expected to have very similar chemical properties?
(A) O, S, Se
(B) N, O, F
(C) Na, Mg, K
(D) S, Se, Si
(E) Ne, Na, Mg

52. A chemist uses a cylinder with a piston and gas inlet valve. Consider the following change: Inject an additional gas through the gas inlet valve. What will be the consequences for the pressure of the gas and for the number of moles of gas present?
(A) The pressure of the gas will decrease, and the number of moles of gas present will decrease.
(B) The pressure of the gas will increase, and the number of moles of gas present will increase.
(C) The pressure of the gas will decrease, and the number of moles of gas present will increase.
(D) There will be no changes in the pressure of the gas or in the number of moles.
(E) The pressure of the number of moles of gas will stay the same, and the pressure of the gas will decrease.

53. ΔE is always positive when a system
(A) absorbs heat and does work
(B) gives off heat and does work
(C) absorbs heat and has work done on it
(D) gives off heat and has work done on it
(E) none of the above, since ΔE is always negative

54. Which of the following is NOT true about the Bohr model of the hydrogen atom?
(A) Electrons decay into the nucleus.
(B) The model cannot account for the ionization of an electron.
(C) An electron in a stable Bohr orbit does not emit radiation continuously.
(D) An electron may remain in an orbit indefinitely.
(E) The hydrogen atom absorbs radiant energy in multiples of $h\nu$.

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55. The standard cell potential (ΔE°_{cell}) of the reaction

$$Cl_2(g) + 2I^-(aq) \rightarrow 2Cl^-(aq) + I_2(s)$$

is +0.82 V. The value of ΔG° for the reaction is

(A) −24 kJ/mol
(B) +24 kJ/mol
(C) −160 kJ/mol
(D) +160 kJ/mol
(E) −50 kJ/mol

56. The primary source of the specificity of enzymes is

(A) their polarity, which matches that of their specific substrate
(B) their delocalized electron cloud
(C) their bonded transition metal, which is specific to the target substrate
(D) their locations within the cell
(E) their shape, which relates to the lock-and-key model

57. The rate law for a reaction is:

$$\text{rate} = k[A][B]^2.$$

Which of the following statements is NOT true?

(A) The reaction is first order in [A].
(B) The reaction is second order in [B].
(C) The reaction is second order overall.
(D) k is the reaction rate constant.
(E) If [B] is doubled, the reaction rate will increase by a factor of 4.

58. For the reaction

$$\text{heat} + C_2H_6(g) \rightarrow C_2H_4(g) + H_2(g)$$

ΔH° is +137 kJ/mol and ΔS° is +120 J/K · mol. This reaction is

(A) spontaneous at all temperatures
(B) spontaneous only at high temperatures
(C) spontaneous only at low temperatures
(D) nonspontaneous at all temperatures
(E) unreliable

59. Which of the following has the largest ionic radius?

(A) Be^{2+}
(B) Mg^{2+}
(C) Ca^{2+}
(D) Sr^{2+}
(E) Ba^{2+}

60. A 50.0-mL sample of an aqueous H_2SO_4 solution is titrated with a 0.375 M NaOH solution. The equivalence point is reached with 62.5 mL of the base. The concentration of H_2SO_4 is

(A) 0.234 M
(B) 0.469 M
(C) 0.150 M
(D) 0.300 M
(E) 0.938 M

61. The boiling point of water is known to be lower at high elevations. This is because

(A) water is more dense at high elevations
(B) hydrogen bonds are weaker at high elevations
(C) the heat of fusion is lower at high elevations
(D) the atmospheric pressure is higher at high elevations
(E) the atmospheric pressure is lower at high elevations

62. Given that a reaction is exothermic and has an activation energy of 50 kJ/mol, which of the following statements are correct?

I. The reverse reaction has an activation energy greater than 50 kJ/mol.
II. The reaction rate increases with temperature.
III. The reaction rate decreases with temperature.

(A) I
(B) II
(C) III
(D) I and II
(E) I and III

63. According to the ideal-gas equation, which of the following statements is true?
(A) If gases are mixed, the partial pressure of each lowers the partial pressure of the others.
(B) For Boyle's law to apply, a gas must be kept at constant pressure.
(C) The volume of a gas is not changed if it is heated from 0°C to 100°C and at the same volume if the pressure is increased from 750 torr to 850 torr.
(D) The volume of a gas doubles when the centigrade temperature doubles if all other variables are held constant.
(E) The volume of a gas decreases by a factor of 2 when the pressure is doubled if all other variables are held constant.

64. Which of the following statements is true under any condition for a reaction that is spontaneous at any temperature?
(A) ΔG and ΔH are negative, and ΔS is positive.
(B) ΔG and ΔH are positive, and ΔS is negative.
(C) ΔG and ΔS are positive, and ΔH is negative.
(D) ΔG, ΔH and ΔS are all positive.
(E) ΔG, ΔH and ΔS are all negative.

65. In an experiment, data was collected to analyze the density of an unknown solid. The data gathered included 7.50 grams as the mass of the sample and 2.5 milliliters as the volume of the sample. The density of the sample was then reported as how many grams per milliliter?
(A) 0.30
(B) 3.00
(C) 3.3
(D) 0.33
(E) 3.0

66. What is the oxidation state of xenon in XeO_4?
(A) +8
(B) +6
(C) +4
(D) +2
(E) 0

67. All of the following statements concerning the alkali metals are true EXCEPT
(A) they form ions that are soluble in water
(B) they form ions with a +1 oxidation state
(C) the electronegativity of alkali metals decreases as their atomic number increases
(D) the first ionization number of alkali metals decreases as their atomic number increases
(E) they are strong oxidizing agents

68. Which of the following sets of quantum numbers is NOT possible?

(A)	3	2	0	1/2
(B)	5	0	0	1/2
(C)	3	2	−2	−1/2
(D)	4	3	1	1/2
(E)	2	2	−1	1/2

69. Which of the following cannot be a reducing agent?
(A) Ag
(B) I^-
(C) Cl^-
(D) Fe^{3+}
(E) Cr^{3+}

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70. Alpha decay produces a new nucleus whose atomic number is
(A) 2 less and mass number is 2 less than the atomic number and mass number of the original nucleus
(B) 1 less and mass number is 2 less than the atomic number and mass number of the original nucleus
(C) 2 less and mass number is 4 less than the atomic number and mass number of the original nucleus
(D) 2 more and mass number is 4 more than the atomic number and mass number of the original nucleus
(E) 2 more and mass number is 2 less than the atomic number and mass number of the original nucleus

71. Which one of the following forms of radiation can penetrate the deepest into body tissue?
(A) Alpha
(B) Beta
(C) Gamma
(D) Positron
(E) Proton

72. Hydrocarbons containing carbon-carbon triple bonds are called
(A) alkanes
(B) aromatic hydrocarbons
(C) alkynes
(D) alkenes
(E) olefins

73. Which one of the following is NOT true about transition metals?
(A) They frequently have more than one common oxidation state.
(B) Their compounds are frequently colored.
(C) Their compounds frequently exhibit magnetic properties.
(D) They are found in the d-block of the periodic table.
(E) They typically have low melting points.

74. How is the reaction quotient used to determine whether a system is at equilibrium?
(A) The reaction quotient must be satisfied for equilibrium to be achieved.
(B) At equilibrium, the reaction quotient is undefined.
(C) The reaction is at equilibrium when $Q < K_{eq}$.
(D) The reaction is at equilibrium when $Q > K_{eq}$.
(E) The reaction is at equilibrium when $Q = K_{eq}$.

75. When sodium hydroxide is added to a solution of saturated calcium hydroxide, which of the following precipitates would you expect to form?
(A) Calcium
(B) Sodium
(C) Water
(D) Sodium hydroxide
(E) Calcium hydroxide

END OF SECTION I

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON THIS SECTION. DO NOT GO ON TO SECTION II UNTIL YOU ARE TOLD TO DO SO.