CHEMISTRY SUBJECT TEST 3

Note: For all questions involving solutions and/or chemical equations, assume that the system is in pure water unless otherwise stated.

Part A

Directions: Each set of lettered choices below refers to the numbered statements or questions immediately following it. Select the one lettered choice that best fits each statement or answers each question, 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 1–5 refer to the following.

(A) Carbon
(B) Nitrogen
(C) Oxygen
(D) Neon
(E) Argon

1. Is the third most abundant gas in Earth's atmosphere

2. At standard conditions, has an allotrophic form that is a good electrical conductor

3. Regardless of its electron configuration, it must always be paramagnetic when it's a single, neutrally charged atom

4. The key element delivered in soil fertilizer

5. Allotrope of this element is the primary absorber of UV solar radiation in Earth's atmosphere

Questions 6–9 refer to the following.

(A) Chemical pH indicator
(B) Acid/base buffer
(C) Anhydrous solution
(D) Hypotonic solution
(E) Supersaturated solution

6. A conjugate acid/base pair with differing spectral absorbencies

7. An example of a solution not in equilibrium

8. Term used in reference to an aqueous solution's osmotic pressure

9. Addition of water to this solution will not change $[H_3O^+]$

Questions 10–14 refer to the following.

(A) Standard voltaic potential
(B) Entropy
(C) Enthalpy
(D) Reaction rate
(E) Gibbs free energy

10. Increased with the addition of a catalyst

11. Abbreviated as “H”

12. A property that must decrease when a gas condenses into a liquid

13. Is always positive for a spontaneous chemical reaction

14. Is zero for a crystalline solid that is elementally pure at 0 K

Questions 15–19 refer to the following.

(A) Alkali metals
(B) Alkaline earth metals
(C) Noble gases
(D) Halogens
(E) Transition metals

15. The most unreactive family of elements

16. Form negative ions in an ionic bond

17. Consist of atoms that have valence electrons in a *d* subshell

18. Exist as diatomic molecules at room temperature

19. Members possess the lowest first ionization energy in their respective period

Questions 20–24 refer to the following.

(A) N_2

(B) KI

(C) CCl_4

(D) $AgNO_3$

(E) $CaCO_3$

20. A product of a neutralization of a strong acid with a strong base

21. A volatile covalent liquid at 25°C and 1 atm

22. Releases a gas with the addition of dilute acid

23. Forms a white precipitate when added to a solution of NaCl

24. Treatment of the dry solid with a mild oxidizing agent produces a purple solid

Questions 25–28 refer to the following.

(A) Gamma decay
(B) Nuclear fusion
(C) Alpha decay
(D) Positron emission
(E) Nuclear fission

25. Is the principle reaction responsible for the energy output of the sun

26. Is a nuclear process that results in no change in the mass number and atomic number of a nuclide

27. Responsible for most helium found on Earth

28. The nuclear process that transmutes uranium-238 into thorium-234

Questions 29–32 refer to the following.

(A) 0.1 *M* $MgCl_2$

(B) 0.1 *M* $HClO_4$

(C) 0.1 *M* NH_4OH

(D) 0.1 *M* KOH

(E) 0.1 *M* $LiNO_3$

29. Has a pH of 13

30. The solution with the lowest freezing point temperature

31. The solution with the highest boiling point temperature

32. Indicates a red flame when ionized with a Bunsen burner

PLEASE GO TO THE SPECIAL SECTION LABELED CHEMISTRY AT THE LOWER RIGHT-HAND CORNER OF THE ANSWER SHEET YOU ARE WORKING ON AND ANSWER QUESTIONS 101–116 ACCORDING TO THE FOLLOWING DIRECTIONS.

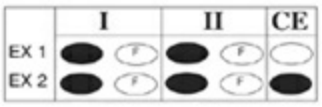
Part B

Directions: Each question below consists of two statements, I in the left-hand column and II in the right-hand column. For each question, determine whether statement I is true or false and whether statement II is true or false, and fill in the corresponding T or F ovals on your answer sheet. Fill in oval CE only if statement II is a correct explanation of statement I.

EXAMPLES:

	I		II
EX 1.	**H_2SO_4 is a strong acid**	**BECAUSE**	**H_2SO_4 contains sulfur.**
EX 2.	**An atom of oxygen is electrically neutral**	**BECAUSE**	**an oxygen atom contains an equal number of protons and electrons.**

SAMPLE ANSWERS



	I		II
101.	Transition metal compounds are often colored	BECAUSE	they frequently possess partially filled *d* orbitals.
102.	Chemical reactions slow down with lower temperature	BECAUSE	the energy barrier for the formation of products decreases with decreasing temperature.
103.	Exothermic reactions absorb heat	BECAUSE	breaking covalent bonds always requires energy.
104.	The solubility of gases in liquids does not depend upon pressure	BECAUSE	the vapor pressure of a substance is independent of external pressure.
105.	MgO has a high melting point	BECAUSE	highly charged ions result in strong ionic forces and high lattice energies.
106.	The ground state electron configuration orbitals of elemental Cu is [Ar] $4s^1 3d^{10}$	BECAUSE	completely half-filled and filled *d* bestow special electronic stabilization.
107.	Isotopes of a particular element have nearly identical chemical behavior	BECAUSE	they have identical electron configurations.
108.	In an electrochemical cell, the electrode that is the site of reduction is called the anode	BECAUSE	oxidation always occurs at the cathode.
109.	The addition of acid to a solution buffered to pH 7 slightly lowers the pH	BECAUSE	the addition of acids to any neutral solution always lowers the pH.
110.	Saltwater boils at a higher temperature than pure water	BECAUSE	the presence of salt increases the vapor pressure of water.
111.	BF_3 has a tetrahedral geometry	BECAUSE	the central B atom does not have a complete stable octet.
112.	Hydrogen peroxide, H_2O_2, is a good oxidizing agent	BECAUSE	the hydrogen in H_2O_2 has a +1 oxidation number.

113.	Hydrogen gas (H_2) is considered a perfectly ideal gas	BECAUSE	hydrogen atoms interact with each other via hydrogen bonds.
114.	Electrolysis of water requires the input of energy	BECAUSE	the products formed, H_2 and O_2, possess more chemical potential energy than H_2O.
115.	By mass, oxygen is the most abundant element in the human body	BECAUSE	it is principally found as O_2 in the bloodstream.
116.	LiOH is considered a strong base	BECAUSE	it undergoes neutralization reactions with acids.

RETURN TO THE SECTION OF YOUR ANSWER SHEET YOU STARTED FOR **CHEMISTRY** AND ANSWER QUESTIONS 33–69.

Part C

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.

33. Choose the answer below that accurately describes the correct molecular shape for the molecule $XeOF_4$.

(A) Tetrahedral
(B) Trigonal pyramidal
(C) Trigonal bipyramidal
(D) Square pyramidal
(E) Flat

34. For the radioactive atom ^{99}Tc, what is the correct number of protons and neutrons?

(A) 43 protons and 56 neutrons
(B) 43 protons and 99 neutrons
(C) 56 protons and 43 neutrons
(D) 56 protons and 99 neutrons
(E) Cannot be determined

35. Which one of the following acids is NOT strong?

(A) HCl
(B) HBr
(C) HNO_3
(D) H_3PO_4
(E) H_2SO_4

36. Identify the equation used to determine the amount of heat required to melt 10 grams of ice.

(A) $Q = mC_{sp}\Delta T$
(B) $Q = n\Delta H$

(C) $KE = \frac{1}{2}mv^2$

(D) $PE = mgh$

(E) $PV = nRT$

37. Identify the correct ground state electron configuration for Cr.

(A) [Ar] $3s^2 3d^4$

(B) [Ar] $3s^2 3d^5$

(C) [Ar] $4s^2 3d^5$

(D) [Ar] $4s^2 3d^4$

(E) [Ar] $4s^1 3d^5$

38. What is the hydroxide concentration for a solution with a pH of 10 at 25°C?

(A) 10^{-14} *M*

(B) 10^{-10} *M*

(C) 10^{-7} *M*

(D) 10^{-4} *M*

(E) 10^{-1} *M*

39. Five hundred milliliters of solution of 0.1 *M* NaBr has how many milligrams of bromine?

(A) 200 mg

(B) 400 mg

(C) 2,000 mg

(D) 4,000 mg

(E) 20,000 mg

40. According to the ideal gas law, what is the approximate volume that will be occupied by 0.5 mole of an ideal gas at 30°C and 3 atm pressure (gas constant R = 0.0821 L•atm/mol•K)?

(A) Less than 1 L

(B) 5 L

(C) 10 L

(D) 15 L

(E) More than 20 L

41. Given that $\Delta G = \Delta H - T\Delta S$, how is the spontaneity of an endothermic reaction expected to change with decreasing T?

(A) Becomes less spontaneous

(B) Becomes more spontaneous

(C) Does not change

(D) Decreases at first but then increases

(E) Insufficient information to make a conclusion

42. Identify the element with the greatest first ionization energy.

(A) Ce

(B) C

(C) Cl

(D) Ca

(E) Cs

43. Identify the molecule/ion with the greatest potential to act as a Lewis acid.

(A) CH_3^+

(B) CN^-

(C) NH_3

(D) BF_4^-

(E) CO_2

$$2\ Ca_3(PO_4)_2 + 6\ SiO_2 + 10\ C \rightarrow P_4 + \ldots CaSiO_3 + 10\ CO$$

44. Which coefficient balances the reaction given above?

(A) 2

(B) 4

(C) 5

(D) 6

(E) 8

45. A 100-milliliter solution containing $AgNO_3$ was treated with excess NaCl to completely precipitate the silver as AgCl. If 5.7 g AgCl was obtained, what was the concentration of Ag^+ in the original solution?

(A) 0.03 *M*

(B) 0.05 *M*

(C) 0.12 *M*

(D) 0.30 *M*

(E) 0.40 *M*

46. Identify which of the following statements is FALSE.

(A) The vapor pressure of a liquid decreases with increasing atmospheric pressure.

(B) The value of an equilibrium constant is dependent on temperature.

(C) The rate of a spontaneous reaction cannot be determined solely by its Gibbs free energy.

(D) During a phase transition, the temperature of a substance must be constant.

(E) The addition of a catalyst to a reaction at equilibrium has no net effect on the system.

47. Which of the following compounds would be expected to have the greatest lattice binding energy?

(A) $LiNO_3$

(B) LiF

(C) KI

(D) NH_4Br

(E) $CsNO_3$

48. The daughter nucleus formed when ^{18}F undergoes positron emission is

(A) ^{14}N

(B) ^{16}O

(C) ^{18}O

(D) ^{19}F

(E) ^{20}Ne

49. Which of the following reactions produces a yellow precipitate?

(A) $NaOH(aq) + HCl(aq) \rightarrow NaCl(s) + H_2O$

(B) $NaOH(aq) + BaCl(aq) \rightarrow BaOH(s) + NaCl(aq)$

(C) $Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow 2KNO_3(aq) + PbI_2(s)$

(D) $CuO(s) + Mg(s) \rightarrow Cu(s) + MgO(s)$

(E) $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

$$Zn(s)|ZnCl_2(aq)|Cl^-(aq)|Cl_2(g)|C(s)$$

50. In the electrochemical cell described by the cell diagram above, what reaction occurs at the anode?

(A) $Zn \rightarrow Zn^{2+} + 2e$

(B) $Zn^{2+} + 2e \rightarrow Zn$

(C) $Cl_2 + 2e \rightarrow 2Cl^-$

(D) $2Cl^- \rightarrow Cl_2 + 2e$

(E) $Zn + Cl_2 \rightarrow ZnCl_2$

51. Given the reaction $A \rightarrow B + C$, where ΔH_{rxn} is negative, what effect would increasing the temperature (at constant pressure) have on the system at equilibrium?

(A) No change

(B) Cannot be determined

(C) Shift to the right

(D) Shift to the left for $K < 1$ and to the right for $K > 1$

(E) Shift to the left

52. An unknown acid solution was presumed to be either HCl or H_2SO_4. Which one of the following salt solutions would produce a precipitate when added to H_2SO_4 but not when added to HCl?

(A) $LiNO_3$

(B) NH_4NO_3

(C) $CsNO_3$

(D) $Ba(NO_3)_2$

(E) $AgNO_3$

$$Ca_3(PO_4)_2(s) \leftrightharpoons 3\ Ca^{2+}(aq) + 2\ PO_4^{3-}(aq)$$

53. What is the equilibrium expression for the dissolution of $Ca_3(PO_4)_2$ where the above is true?

(A) $K_{sp} = [Ca^{2+}]^3[PO_4^{3-}]^2$

(B) $K_{sp} = [Ca^{2+}]^2[PO_4^{3-}]^3$

(C) $K_{sp} = [Ca^{2+}][PO_4^{3-}]/[Ca_3(PO_4)_2]$

(D) $K_{sp} = [Ca^{2+}]^3[PO_4^{3-}]^2/[Ca_3(PO_4)_2]$

(E) $K_{sp} = [Ca^{2+}]^2[PO_4^{3-}]^3/[Ca_3(PO_4)_2]$

54. Which of the following represents a conjugate acid/base pair?

(A) Na^+/Cl^-

(B) HCl/H^+

(C) H_2CO_3/CO_3^{2-}

(D) NH_3/NH_4^+

(E) K^+/OH^-

55. An unknown solution having a pH of 3.5 was titrated with 0.1 *M* NaOH. Analysis of the resulting titration curve showed a single equivalence point at pH 7. Therefore, which of the following could be the unknown solute in the initial solution?

(A) HF

(B) HCl

(C) LiOH

(D) NH_3

(E) H_2SO_4

56. Acid/base titration experiments could be used to determine all of the following directly EXCEPT

(A) the acid concentration of an acidic solution

(B) the alkalinity of a basic solution

(C) the pK_a of an unknown weak acid

(D) whether an unknown acid is monoprotic or polyprotic

(E) the molecular weight of an unknown acid or base

57. What is the correct term for the phase change from gas directly to solid?

(A) Deposition

(B) Sublimation

(C) Liquefaction

(D) Fusion

(E) Vaporization

58. What is the correct name for a straight-chained organic compound with the molecular formula C_3H_8?

(A) Methane

(B) Ethane

(C) Methylethane

(D) Propane

(E) Isopropane

59. If the pH of a solution is changed from 1 to 3 with the addition of an antacid, what percentage of $[H^+]$ was neutralized?

(A) 2%

(B) 10%

(C) 20%

(D) 90%

(E) 99%

60. Which of the following statements is the most accurate with regard to the significance of Avogadro's number, 6.02×10^{23}?

(A) It is the conversion factor between grams and atomic mass units.

(B) It is a universal physical constant just as the speed of light.

(C) It is the number of particles that is required to fill a 1-liter container.

(D) It is the inverse diameter of an H atom.

(E) It is the number of electrons in the universe.

Questions 61–64 refer to the following data at standard conditions.

	Appearance	Reactions with dilute HCl	Reaction with dilute HNO_3
Unknown metal #1	Dull gray solid with white oxide coating	Dissolved with bubbles of clear gas	Dissolved with bubbles of clear gas
Unknown metal #2	Solid; lustrous, smooth silver-gray surface	No reaction	Dissolved with bubbles of orange gas

61. Unknown metal #1 could be

(A) mercury
(B) copper
(C) zinc
(D) iron
(E) silver

62. Unknown metal #2 could be

(A) carbon
(B) copper
(C) zinc
(D) sodium
(E) silver

63. The addition of dilute HCl to unknown metal #1 produced a transparent gas. What is the likely identity of this gas?

(A) Cl_2
(B) H_2
(C) O_2
(D) CO_2
(E) NO_2

64. The addition of dilute HNO_3 to unknown metal #2 produced an orange gas. What is the likely identity of this gas?

(A) Cl_2

(B) H_2

(C) O_2

(D) CO_2

(E) NO_2

65. Which of the following solutions is the product of the neutralization reaction between 10 ml 0.2 *M* KOH and 10 ml 0.2 *M* HI?

(A) 0.1 *M* KI_3

(B) 0.1 *M* KI

(C) 0.2 *M* KI

(D) 0.4 *M* KI

(E) 0.4 *M* HOH

66. Which of the following is true regarding an Ne atom with a mass number of 20 and an O^{2-} ion with a mass number of 16?

(A) They contain the same number of protons.

(B) They contain the same number of neutrons.

(C) They contain the same number of protons plus neutrons.

(D) They are isoelectronic.

(E) They are isomers.

67. Which of the following statements is NOT correct regarding chemical catalysts?

(A) They are not consumed during the chemical reaction.

(B) They cannot make nonspontaneous reactions occur.

(C) They do not have to be the same phase as the reactant molecules.

(D) They shift equilibrated reactions to the product's side.

(E) Enzymes are biological catalysts.

68. Most elements are solids at 25°C and 1 atm pressure, the exception being the 11 elements that are gases and 2 that are liquids. What 2 elements are liquids?

(A) Hg and Br

(B) Hg and I

(C) Ag and Kr

(D) Au and Kr

(E) Pt and Co

69. A student conducted an experiment and obtained three values during three repetitive trials: 1.65, 1.68, 1.71. Later, the student discovered that the true value was 2.37. In contrast to the real value, the experimental results should be characterized as

(A) not accurate and not precise

(B) accurate but not precise

(C) not accurate but precise

(D) accurate and precise

(E) accurate, precise, but unreliable

STOP

If you finish before time is called, you may check your work on this section only. Do not turn to any other section in the test.