Practice Test 2

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

PART A

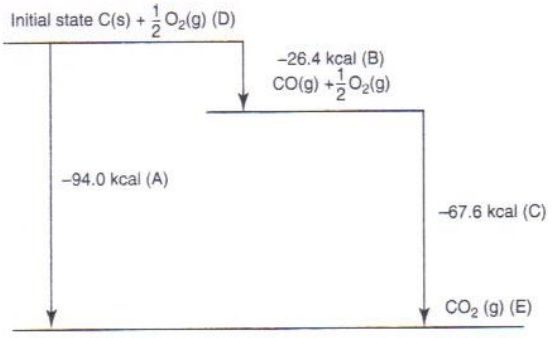
Directions: Every set of the given lettered choices below refers to the numbered statements or formulas immediately following it. Choose the one lettered choice that best fits each statement or formula and then fill in the corresponding oval on the answer sheet. Each choice may be used once, more than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

Questions 1–4

(A) Law of Definite Composition
(B) Nuclear fusion
(C) van der Waals forces
(D) Graham's Law of Diffusion (Effusion)
(E) Triple point

1. At a particular temperature and pressure, three states of a compound may coexist.
2. The combining of nuclei to release energy.
3. The ratio of the rate of movement of hydrogen gas compared with the rate of oxygen gas is 4 : 1.
4. The molecules of nitrous oxide and nitrogen dioxide differ by a multiple of the mass of one oxygen.

Questions 5–7 refer to the following diagram:



5. The ΔH of the reaction to form CO from $C + O_2$
6. The ΔH of the reaction to form CO_2 from $CO + O_2$
7. The ΔH of the reaction to form CO_2 from $C + O_2$

Questions 8–11

(A) Hydrogen bond
(B) Ionic bond
(C) Polar covalent bond
(D) Pure covalent bond
(E) Metallic bond

8. The type of bond between atoms of potassium and chloride in a crystal of potassium chloride
9. The type of bond between the atoms in a nitrogen molecule
10. The type of bond between the atoms in a molecule of CO_2 (electronegativity difference = 1)
11. The type of bond between the atoms of calcium in a crystal of calcium

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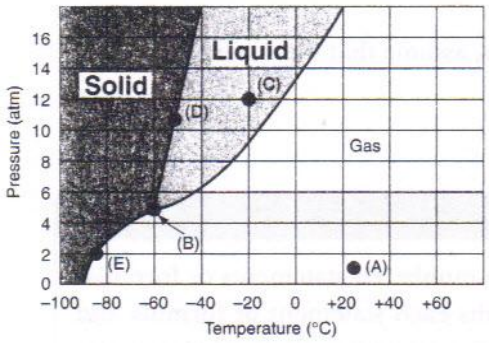
Questions 12–14 refer to the following phase diagram for CO_2:

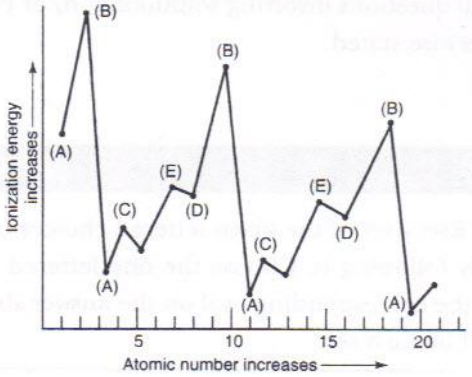


12. The point at which all three states of CO_2 can exist

13. The point at which CO_2 can exist only as a liquid

14. The point at which CO_2 can exist as a solid and a gas under 2 atmospheres of pressure

Questions 15–23 refer to the following graph, which shows the variation of the first ionization potential with respect to increasing atomic numbers:



15. The atoms likely to react with water to release hydrogen

16. Nonmetals that are all found in the gaseous state at STP

17. The noble gases

18. The alkali metals

19. The half-filled condition of the *p* orbitals

20. The filled *s* orbitals with the exception of helium

21. The beginning of pairing in the *p* orbitals

22. The most active metals

23. The filled *p* orbitals

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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.

24. All of the following involve a chemical change EXCEPT
    (A) the formation of HCl from H_2 and Cl_2
    (B) the color change when NO is exposed to air
    (C) the formation of steam from burning H_2 and O_2
    (D) the solidification of "Crisco" at low temperatures
    (E) the odor of NH_3 when NH_4Cl is rubbed together with $Ca(OH)_2$ powder

25. When most fuels burn, the products include carbon dioxide and
    (A) hydrocarbons
    (B) hydrogen
    (C) water
    (D) hydroxide
    (E) hydrogen peroxide

26. In the metric system, the prefix *kilo-* means
    (A) 10^0
    (B) 10^{-1}
    (C) 10^{-2}
    (D) 10^2
    (E) 10^3

27. How many atoms are in 1 mole of water?
    (A) 3
    (B) 54
    (C) 6.02×10^{23}
    (D) $2(6.02 \times 10^{23})$
    (E) $3(6.02 \times 10^{23})$

28. Which of the following atoms normally forms monoatomic molecules?
    (A) Cl
    (B) H
    (C) O
    (D) N
    (E) He

29. The shape of a PCl_3 molecule is described as
    (A) bent
    (B) trigonal planar
    (C) linear
    (D) trigonal pyramidal
    (E) tetrahedral

30. The complete loss of an electron of one atom to another atom with the consequent formation of electrostatic charges is referred to as
    (A) a covalent bond
    (B) a polar covalent bond
    (C) an ionic bond
    (D) a coordinate covalent bond
    (E) a pi bond between *p* orbitals

31. In the electrolysis of water, the cathode reaction is
    (A) $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^- + O_2(g)$
    (B) $2H_2O(\ell) \rightarrow \frac{1}{2}O_2(g) + 2H^+ + 2e^-$
    (C) $2OH^- + 2e^- \rightarrow O_2(g) + H_2(g)$
    (D) $2H^+ + 2e^- \rightarrow H_2(g)$
    (E) $2H_2O(\ell) + 4e^- \rightarrow O_2(g) + 2H_2(g)$

32. Which of the following particles has the LEAST mass?
    (A) alpha particle
    (B) beta particle
    (C) proton
    (D) neutron
    (E) gamma ray

33. If a radioactive element with a half-life of 100 years is found to have transmutated so that only 25% of the original sample remains, what is the age, in years, of the sample?
    (A) 25
    (B) 50
    (C) 100
    (D) 200
    (E) 400

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34. What is the pH of an acetic acid solution if the $[H_3O^+] = 1 \times 10^{-4}$ mole/liter?
(A) 1
(B) 2
(C) 3
(D) 4
(E) 5

35. The polarity of water is useful in explaining which of the following?
I. The solution process
II. The ionization process
III. The high conductivity of distilled water
(A) I only
(B) II only
(C) I and II only
(D) II and III only
(E) I, II, and III

36. When sulfur dioxide is bubbled through water, the solution will contain
(A) sulfurous acid
(B) sulfuric acid
(C) hyposulfuric acid
(D) persulfuric acid
(E) anhydrous sulfuric acid

37. Four grams of hydrogen gas at STP contain
(A) 6.02×10^{23} atoms
(B) 12.04×10^{23} atoms
(C) 12.04×10^{46} atoms
(D) 1.2×10^{22} molecules
(E) 12.04×10^{23} molecules

38. Analysis of a gas gave: C = 85.7% and H = 14.3%. If the formula mass of this gas is 42 atomic mass units, what are the empirical formula and the true formula?
(A) CH; C_4H_4
(B) CH_2; C_3H_6
(C) CH_3; C_3H_9
(D) C_2H_2; C_3H_6
(E) C_2H_4; C_3H_6

39. Which fraction would be used to correct a given volume of gas at 30°C to its new volume when it is heated to 60°C and the pressure is kept constant?
(A) $\frac{30}{60}$
(B) $\frac{60}{30}$
(C) $\frac{273}{333}$
(D) $\frac{303}{333}$
(E) $\frac{333}{303}$

40. What would be the predicted freezing point of a solution that has 684 grams of sugar (1 mol = 342 g) dissolved in 2,000 grams of water?
(A) −1.86°C
(B) −0.93°C
(C) −1.39°C
(D) −2.48°C
(E) −3.72°C

41. What is the approximate pH of a 0.005 M solution of H_2SO_4?
(A) 1
(B) 2
(C) 5
(D) 9
(E) 13

42. How many grams of NaOH are needed to make 100 grams of a 5% solution?
(A) 2
(B) 5
(C) 20
(D) 40
(E) 95

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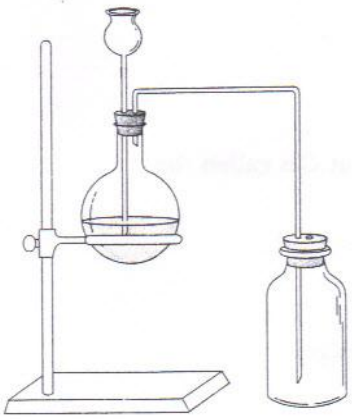
43. For the Haber process: $N_2 + 3H_2 \rightleftharpoons 2NH_3 +$ heat (at equilibrium), which of the following statements concerning the reaction rate is/are true?
    I. The reaction to the right will increase when pressure is increased.
    II. The reaction to the right will decrease when the temperature is increased.
    III. The reaction to the right will decrease when NH_3 is removed from the chamber.
    (A) I only
    (B) II only
    (C) I and II only
    (D) II and III only
    (E) I, II, and III

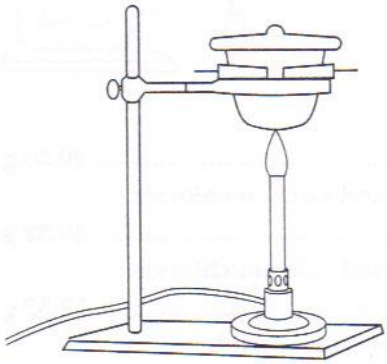
44. If you titrate 1 M H_2SO_4 solution against 50 milliliters of 1 M NaOH solution, what volume of H_2SO_4, in milliliters, will be needed for neutralization?
    (A) 10
    (B) 25
    (C) 40
    (D) 50
    (E) 100

45. How many grams of CO_2 can be prepared from 150 grams of calcium carbonate reacting with an excess of hydrochloric acid solution?
    (A) 11
    (B) 22
    (C) 33
    (D) 44
    (E) 66

Question 46 refers to the following diagram:



46. The diagram represents a setup that may be used to prepare and collect
    (A) NH_3
    (B) NO
    (C) H_2
    (D) SO_3
    (E) CO_2



47. The lab setup shown above was used for the gravimetric analysis of the empirical formula of Mg. In synthesizing MgO from a Mg strip in the crucible, which of the following is NOT true?
    (A) The initial strip of Mg should be cleaned.
    (B) The lid of the crucible should fit tightly to exclude oxygen.
    (C) The heating of the covered crucible should continue until the Mg is fully reacted.
    (D) The crucible, lid, and the contents should be cooled to room temperature before measuring their mass.
    (E) When the Mg appears to be fully reacted, the crucible lid should be partially removed and heating continued.

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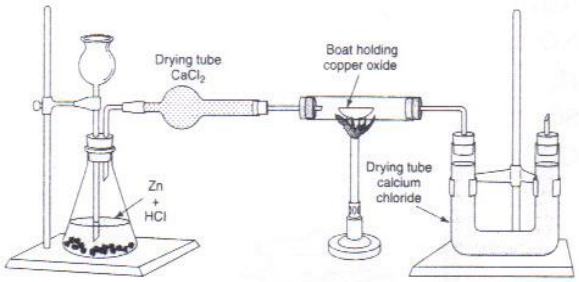
Questions 48–50 refer to the following experimental setup and data:



Recorded data:

Weight of U-tube	20.36 g
Weight of U-tube and calcium chloride before	39.32 g
Weight of U-tube and calcium chloride after	57.32 g
Weight of boat and copper oxide before	30.23 g
Weight of boat and copper oxide after	14.23 g
Weight of boat	5.00 g

48. What is the reason for the first $CaCl_2$ drying tube?
    (A) generate water
    (B) absorb hydrogen
    (C) absorb water that evaporates from the flask
    (D) decompose the water from the flask
    (E) act as a catalyst for the combination of hydrogen and oxygen

49. What conclusion can be derived from the data collected?
    (A) Oxygen was lost from the $CaCl_2$.
    (B) Oxygen was generated in the U-tube.
    (C) Water was formed from the reaction.
    (D) Hydrogen was absorbed by the $CaCl_2$.
    (E) CuO was formed in the decomposition.

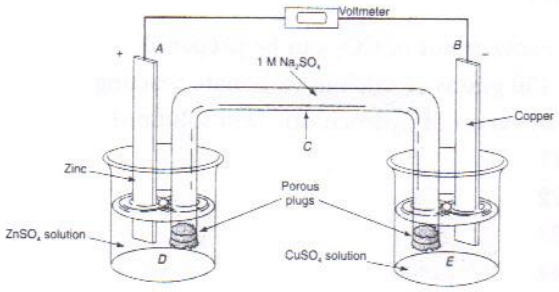
50. What is the ratio of the mass of water formed to the mass of hydrogen used in the formation of water?
    (A) 1 : 8
    (B) 1 : 9
    (C) 8 : 1
    (D) 9 : 1
    (E) 8 : 9

51. What is the mass, in grams, of 1 mole of $KAl(SO_4)_2 \cdot 12H_2O$?
    (A) 132
    (B) 180
    (C) 394
    (D) 474
    (E) 516

52. What mass of aluminum will be completely oxidized by 2 moles of oxygen at STP?
    (A) 18 g
    (B) 37.8 g
    (C) 50.4 g
    (D) 72.0 g
    (E) 100.8 g

53. In general, when metal oxides react with water, they form solutions that are
    (A) acidic
    (B) basic
    (C) neutral
    (D) unstable
    (E) colored

Questions 54–56 refer to the following diagram:



54. The oxidation reaction will occur at
    (A) *A*
    (B) *B*
    (C) *C*
    (D) *D*
    (E) *E*

55. The apparatus at *C* is called the
    (A) anode
    (B) cathode
    (C) salt bridge
    (D) ion bridge
    (E) osmotic bridge

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56. The standard potentials of the metals are:

$Zn^{2+} + 2e^- \rightleftharpoons Zn^0 \quad E^0 = -0.76$ volt

$Cu^0 \rightleftharpoons Cu^{2+} + 2e^- \quad E^0 = -0.34$ volt

What will be the voltmeter reading for this reaction?

(A) +1.10
(B) −1.10
(C) +0.42
(D) −0.42
(E) −1.52

57. How many liters of oxygen (STP) can be prepared from the decomposition of 213 grams of sodium chlorate (1 mol = 213 g)?

(A) 11.2
(B) 22.4
(C) 44.8
(D) 67.2
(E) 78.4

58. In this equation: $Al(OH)_3 + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$, the whole-number coefficients of the balanced equation are

(A) 1, 3, 1, 2
(B) 2, 3, 2, 6
(C) 2, 3, 1, 6
(D) 2, 6, 1, 3
(E) 1, 3, 1, 6

59. What is $\Delta H_{reaction}$ for the decomposition of 1 mole of sodium chlorate? (H_f^0 values: $NaClO_3(s) = -85.7$ kcal/mol, $NaCl(s) = -98.2$ kcal/mol, $O_2(g) = 0$ kcal/mol)

(A) −183.9 kcal
(B) −91.9 kcal
(C) +45.3 kcal
(D) +22.5 kcal
(E) −12.5 kcal

60. Isotopes of an element are related because which of the following is (are) the same in these isotopes?

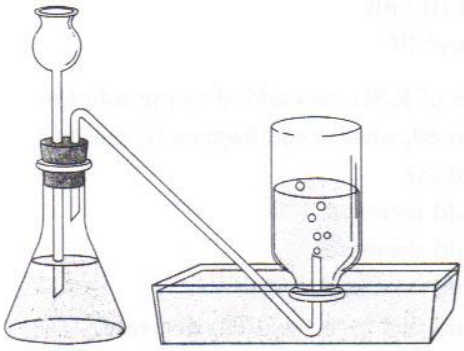
I. Atomic mass
II. Atomic number
III. Arrangement of orbital electrons

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

61. In the reaction of zinc with dilute HCl to form H_2, which of the following will increase the reaction rate?

I. Increasing the temperature
II. Increasing the exposed surface of zinc
III. Using a more active metal than zinc

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



62. The laboratory setup shown above can be used to prepare a

(A) gas lighter than air and soluble in water
(B) gas heavier than air and soluble in water
(C) gas soluble in water that reacts with water
(D) gas insoluble in water
(E) gas that reacts with water

63. In this reaction: $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$. If 4 moles of HCl are available to the reaction with an unlimited supply of $CaCO_3$, how many moles of CO_2 can be produced at STP?

(A) 1
(B) 1.5
(C) 2
(D) 2.5
(E) 3

64. A saturated solution of $BaSO_4$ at 25°C contains 3.9×10^{-5} mole/liter of Ba^{2+} ions. What is the K_{sp} of this salt?

(A) 3.9×10^{-5}
(B) 3.9×10^{-6}
(C) 2.1×10^{-7}
(D) 1.5×10^{-8}
(E) 1.5×10^{-9}

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65. Which of the following will definitely cause the volume of a gas to increase?
    I. Decreasing the pressure with the temperature held constant.
    II. Increasing the pressure with a temperature decrease.
    III. Increasing the temperature with a pressure increase.
    (A) I only
    (B) II only
    (C) I and III only
    (D) II and III only
    (E) I, II, and III

66. If 0.1 mole of K_2SO_4 was added to the solution in question 80, what would happen to the Ba^{2+} concentration?
    (A) It would increase.
    (B) It would decrease.
    (C) It would remain the same.
    (D) It would first increase, then decrease.
    (E) It would first decrease, then increase.

67. The number of oxygen atoms in 0.5 mole of $Al_2(CO_3)_3$ is
    (A) 4.5×10^{23}
    (B) 9.0×10^{23}
    (C) 3.6×10^{24}
    (D) 2.7×10^{24}
    (E) 5.4×10^{24}

Question 68 refers to a solution of 1 M acid, HA, with $K_a = 1 \times 10^{-6}$.

68. What is the H_3O^+ concentration? (Assume $[HA] = 1$, $[H_3O^+] = x[A^-] = x$.)
    (A) 1×10^{-5}
    (B) 1×10^{-4}
    (C) 1×10^{-2}
    (D) 1×10^{-3}
    (E) 0.9×10^{-3}

69. What is the percent dissociation of acetic acid in a 0.1 M solution if the $[H_3O^+]$ is 1×10^{-3} mole/liter?
    (A) 0.01%
    (B) 0.1%
    (C) 1.0%
    (D) 1.5%
    (E) 2.0%

STOP

IF YOU HAVE FINISHED BEFORE ONE HOUR IS UP, YOU MAY GO BACK TO CHECK YOUR WORK OR COMPLETE UNANSWERED QUESTIONS.

PART B

ON THE ACTUAL CHEMISTRY TEST, THE FOLLOWING TYPE OF QUESTION MUST BE ANSWERED ON A SPECIAL SECTION (LABELED "CHEMISTRY") AT THE LOWER LEFT-HAND CORNER OF PAGE 2 OF YOUR ANSWER SHEET. THESE QUESTIONS WILL BE NUMBERED BEGINNING WITH 101 AND MUST BE ANSWERED ACCORDING TO THE FOLLOWING DIRECTIONS.

Directions: Every question below contains two statements, I in the left-hand column and II in the right-hand column. For each question, decide if statement I is true or false and if 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.

Sample Answer Grid:

CHEMISTRY* Fill in oval CE only if II is a correct explanation of I.

	I		II		CE*
101.	(T)	(F)	(T)	(F)	( )

	I		II
101.	The structure of SO_3 is shown by using more than one structural formula	BECAUSE	SO_3 is very unstable and resonates between these possible structures.
102.	When the ΔG of a reaction at a given temperature is negative, the reaction occurs spontaneously	BECAUSE	when ΔG is negative, ΔH is also negative.
103.	One mole of CO_2 has a greater mass than 1 mole of H_2O	BECAUSE	the molecular mass of CO_2 is greater than the molecular mass of H_2O.
104.	Hydrosulfuric acid is often used in qualitative tests	BECAUSE	$H_2S(aq)$ reacts with many metallic ions to give colored precipitates.
105.	Crystals of sodium chloride go into solution in water as ions	BECAUSE	the sodium ion has a 1+ charge and the chloride ion has a 1− charge and they are hydrated by the water molecules.
106.	In an equilibrium reaction, if the concentration of the reactants is increased, the reaction will increase its forward rate	BECAUSE	when a stress is applied to a reaction in equilibrium, the equilibrium shifts in the direction that opposes the stress.
107.	The $\Delta H_{reaction}$ of a particular reaction can be arrived at by the summation of the $\Delta H_{reaction}$ values of two or more reactions that, added together, give the $\Delta H_{reaction}$ of the particular reaction	BECAUSE	Hess's Law conforms to the First Law of Thermodynamics, which states that the total energy of the universe is a constant.

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108. In a reaction that has both a forward and a reverse reaction, $A + B \rightleftharpoons AB$, when only A and B are introduced into a reacting vessel, the forward reaction rate is the highest at the beginning and begins to decrease from that point until equilibrium is reached	BECAUSE	the reverse reaction does not begin until equilibrium is reached.
109. At equilibrium, the forward reaction and reverse reaction stop	BECAUSE	at equilibrium, the reactants and products have reached the equilibrium concentrations.
110. The hydrid orbital form of carbon in acetylene is believed to be the *sp* form	BECAUSE	C_2H_2 is a linear compound with a triple bond between the carbons.
111. The weakest of the bonds between molecules are coordinate covalent bonds	BECAUSE	coordinate covalent bonds represent the weak attractive force of the electrons of one molecule for the positively charged nucleus of another.
112. A saturated solution is not necessarily concentrated	BECAUSE	*dilute* and *concentrated* are terms that relate only to the relative amount of solute dissolved in the solvent.
113. Lithium is the most active metal in the first group of the Periodic Table	BECAUSE	lithium has only one electron in the outer energy level.
114. The anions migrate to the cathode in an electrochemical reaction	BECAUSE	positively charged ions are attracted to the negatively charged cathode.
115. The atomic number of a neutral atom that has a mass of 39 and has 19 electrons is 19	BECAUSE	the number of protons in a neutral atom is equal to the number of electrons.
116. For an element with an atomic number of 17, the most probable oxidation number is +1	BECAUSE	the outer energy level of the halogen family has a tendency to add one electron to itself.

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