1984 Advanced Placement Exam Part I Multiple Choice

<u>Note:</u> *For all questions referring to solutions, assume that the solvent is water unless otherwise stated.*

<u>Directions:</u> 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 blacken the corresponding space on the answer sheet. A choice may be used once, more than once, or not at all in each set.

<u>Questions 1-3</u>

(A) F (B) S (C) Mg (D) Ar (E) Mn

1. Forms monatomic ions with 2– charge in solutions
2. Forms a compound having the formula KXO_4
3. Forms oxides that are common air pollutants and that yield acidic solution in water

<u>Questions 4–7</u>

(A) Hydrofluoric acid
(B) Carbon dioxide
(C) Aluminum hydroxide
(D) Ammonia
(E) Hydrogen peroxide

4. Is a good oxidizing agent
5. Is used to etch glass chemically
6. Is used extensively for the production of fertilizers
7. Has amphoteric properties

<u>Questions 8–9</u>

(A) A network solid with covalent bonding
(B) A molecular solid with zero dipole moment
(C) A molecular solid with hydrogen bonding
(D) An ionic solid
(E) A metallic solid

8. Solid ethyl alcohol, C_2H_5OH
9. Silicon dioxide, SiO_2

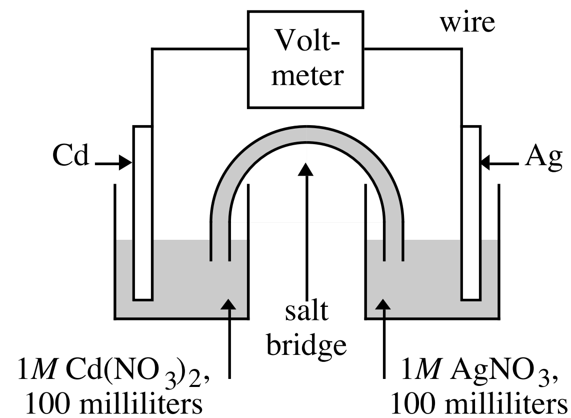
<u>Questions 10–13</u>

(A) CO_3^{2-} (B) $Cr_2O_7^{2-}$ (C) NH_4^+ (D) Ba^{2+} (E) Al^{3+}

Assume that you have an "unknown" consisting of an aqueous solution of a salt that contains one of the ions listed above. Which ion must be <u>absent</u> on the basis of each of the following observations of the "unknown"?

10. The solution is colorless
11. The solution gives no apparent reaction with dilute hydrochloric acid.
12. No odor can be detected when a sample of the solution is added drop by drop to a warm solution of sodium hydroxide.
13. No precipitate is formed when a dilute solution of H_2SO_4 is added to a sample of the solution.

<u>Question 14–17</u>



The spontaneous reaction that occurs when the cell above operates is $2\ Ag^+ + Cd_{(s)} \rightarrow 2\ Ag_{(s)} + Cd^{2+}$

(A) Voltage increases.
(B) Voltage decreases but remains at zero.
(C) Voltage becomes zero and remains at zero
(D) No change in voltage occurs
(E) Direction of voltage change cannot be predicted without additional information

Which of the above occurs for each of the following circumstances?

14. A 50–milliliter sample of a 2-molar $Cd(NO_3)_2$ solution is added to the left beaker.
15. The silver electrode is made larger.
16. The salt bridge is replaced by a platinum wire.
17. Current is allowed to flow for 5 minutes

<u>Directions:</u> Each of the questions or incomplete statements below is followed by five suggested answers or compilations. Select the one that is best in each case and then blacken the corresponding space on the answer sheet.

18.
<u>Hydrogen Halide</u>	<u>Normal Boiling Point, ˚C</u>
HF	+19

HCl	–85
HBr	–67
HI	–35

The liquefied hydrogen halides have the normal boiling points given above. The relatively high boiling point of HF can be correctly explained by which of the following?

(A) HF gas is more ideal.
(B) HF is the strongest acid.
(C) HF molecules have a smaller dipole moment.
(D) HF is much less soluble in water.
(E) HF molecules tend to form hydrogen bonds.

19. Which of the following represents a pair of isotopes?

		Atomic Number	Mass Number
(A)	I.	6	14
	II.	7	14
(B)	I.	6	7
	II.	14	14
(C)	I.	6	14
	II.	14	28
(D)	I.	7	13
	II.	7	14
(E)	I.	8	10
	II.	16	20

20. $...Mg_{(s)} + ...NO_3^-{}_{(aq)} + ...H^+{}_{(aq)} \rightarrow ...Mg^{2+}{}_{(aq)} + ...NH_4^+{}_{(aq)} + ...H_2O_{(l)}$

When the skeleton equation above is balanced and all coefficients reduced to their lowest whole-number terms, what is the coefficient for H^+?

(A) 4 (B) 6 (C) 8 (D) 9 (E) 10

21. When a sample of oxygen gas in a closed container of constant volume is heated until its absolute temperature is doubled, which of the following is also doubled?

(A) The density of the gas
(B) The pressure of the gas
(C) The average velocity of the gas molecules
(D) The number of molecules per cm^3
(E) The potential energy of the molecules

22. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$

Atoms of an element, X, have the electronic configuration shown above. The compound most likely formed with magnesium, Mg, is

(A) MgX (B) Mg_2X (C) MgX_2 (D) MgX_3 (E) Mg_3X_2

23. The density of an unknown gas is 4.20 grams per liter at 3.00 atmospheres pressure and 127˚C. What is the molecular weight of this gas? (R = 0.0821 liter–atm/mole–K)

(A) 14.6 (B) 46.0 (C) 88.0 (D) 94.1 (E) 138

24. The formula for potassium hexacyanoferrate (II)

is

(A) $K_4[Fe(CN)_6]$
(B) $K_3[Fe(CN)_6]$
(C) $K_2[Pt(CN)_4]$
(D) $K_2[Pt(CN)_6]$
(E) KCN

Questions 25–26

$$H_3AsO_4 + 3\ I^- + 2\ H_3O^+ \rightarrow H_3AsO_3 + I_3^- + H_2O$$

The oxidation of iodide ions by arsenic acid in acidic aqueous solution occurs according to the stoichiometry shown above. The experimental rate law of the reaction is:

$$\text{Rate} = k[H_3AsO_4]\ [I^-]\ [H_3O^+]$$

25. What is the order of the reaction with respect to I^-?
(A) 1
(B) 2
(C) 3
(D) 5
(E) 6

26. According to the rate law for the reaction, an increase in the concentration of hydronium ion has what effect on this reaction?
(A) The rate of reaction increases.
(B) The rate of reaction decreases.
(C) The value of the equilibrium constant increases.
(D) The value of the equilibrium constant decreases.
(E) Neither the rate nor the value of the equilibrium constant is changed.

27. The critical temperature of a substance is the
(A) temperature at which the vapor pressure of the liquid is equal to the external pressure
(B) temperature at which the vapor pressure of the liquid is equal to 760 mm Hg
(C) temperature at which the solid, liquid, and vapor phases are all in equilibrium
(D) temperature at which liquid and vapor phases are in equilibrium at 1 atmosphere
(E) lowest temperature above which a substance cannot be liquefied at any applied pressure

28. $2\ A_{(g)} + B_{(g)} / 2\ C_{(g)}$
When the concentration of substance B in the reaction above is doubled, all other factors being held constant, it is found that the rate of the reaction remains unchanged. The most probable explanation for this observation is that
(A) the order of the reaction with respect to substance B is 1
(B) substance B is not involved in any of the steps in the mechanism of the reaction
(C) substance B is not involved in the rate–determined step of the mechanism, but is

involved in subsequent steps

(D) substance B is probably a catalyst, and as such, its effect on the rate of the reaction does not depend on its concentration

(E) the reactant with the smallest coefficient in the balanced equation generally has little or no effect on the rate of the reaction

29. $Cu_{(s)} + 2\,Ag^+ \rightarrow Cu^{2+} + 2\,Ag_{(s)}$

If the equilibrium constant for the reaction above is 3.7×10^{15}, which of the following correctly describes the standard voltage, E°, and the standard free energy change, ΔG°, for this reaction?

(A) E° is positive and ΔG° is negative.
(B) E° is negative and ΔG° is positive.
(C) E° and ΔG° are both positive.
(D) E° and ΔG° are both negative.
(E) E° and ΔG° are both zero

30. When $^{214}_{84}Po$ decays, the emission consists consecutively of an α particle, then two β particles, and finally another α particle. The resulting stable nucleus is

(A) $^{206}_{83}Bi$ (C) $^{206}_{82}Pb$ (E) $^{210}_{81}Tl$
(B) $^{210}_{83}Bi$ (D) $^{208}_{82}Pb$

31. A 0.1–molar solution of which of the following ions is orange?

(A) $Fe(H_2O)_4{}^{2+}$ (D) $Zn(NH_3)_4{}^{2+}$
(B) $Cu(NH_3)_4{}^{2+}$ (E) $Cr_2O_7{}^{2-}$
(C) $Zn(OH)_4$

32. The net ionic equation for the reaction between silver carbonate and hydrochloric acid is

(A) $Ag_2CO_{3(s)} + 2\,H^+ + 2\,Cl^- \rightarrow 2\,AgCl_{(s)} + H_2O + CO_{2(g)}$
(B) $2\,Ag^+ + CO_3{}^{2-} + 2\,H^+ + 2\,Cl^- \rightarrow 2\,AgCl_{(s)} + H_2O + CO_{2(g)}$
(C) $CO_3{}^{2-} + 2\,H^+ \rightarrow H_2O + CO_{2(g)}$
(D) $Ag^+ + Cl^- \rightarrow AgCl_{(s)}$
(E) $Ag_2CO_{3(s)} + 2\,H^+ \rightarrow 2\,Ag^+ + H_2CO_3$

33. The pH of 0.1–molar ammonia is approximately

(A) 1 (B) 4 (C) 7 (D) 11 (E) 14

34. $\ldots CrO_2{}^- + \ldots OH^- \rightarrow \ldots CrO_4{}^{2-} + \ldots H_2O + \ldots e^-$

When the equation for the half–reaction above is balanced, what is the ratio of the coefficients $OH^-/CrO_2{}^-$?

(A) 1:1 (B) 2:1 (C) 3:1 (D) 4:1 (E) 5:1

35. The addition of an oxidizing agent such as chlorine water to a clear solution of an unknown

compound results in the appearance of a brown color. When this solution is shaken with the organic solvent, methylene dichloride, the organic solvent layer turns purple. The unknown compound probably contains

(A) K^+ (C) NO_3^- (E) Co^{2+}
(B) Br^- (D) I^-

36. $CuO_{(s)} + H_{2(g)} / Cu_{(s)} + H_2O_{(g)}$

$\Delta H = -2.0$ kilojoules

When the substances in the equation above are at equilibrium at pressure P and temperature T, the equilibrium can be shifted to favor the products by

(A) increasing the pressure by means of a moving piston at constant T
(B) increasing the pressure by adding an inert gas such as nitrogen
(C) decreasing the temperature
(D) allowing some gases to escape at constant P and T
(E) adding a catalyst

37. The molality of the glucose in a 1.0-molar glucose solution can be obtained by using which of the following?

(A) Volume of the solution
(B) Temperature of the solution
(C) Solubility of glucose in water
(D) Degree of dissociation of glucose
(E) Density of the solution

38. The radioactive decay of ${}^{14}_{6}C$ to ${}^{14}_{7}N$ occurs by the process of

(A) beta particle emission (D) electron capture
(B) alpha particle emission (E) neutron capture
(C) positron emission

39. Equal masses of three different ideal gases, X, Y, and Z, are mixed in a sealed rigid container. If the temperature of the system remains constant, which of the following statements about the partial pressure of gas X is correct?

(A) It is equal to $^1/_3$ the total pressure
(B) It depends on the intermolecular forces of attraction between molecules of X, Y, and Z.
(C) It depends on the relative molecular masses of X, Y, and Z.
(D) It depends on the average distance traveled between molecular collisions.
(E) It can be calculated with knowledge only of the volume of the container.

40. The geometry of the SO_3 molecule is best described as

(A) trigonal planar (D) bent
(B) trigonal pyramidal (E) tetrahedral
(C) square pyramidal

41. Which of the following molecules has the shortest bond length?

(A) N_2 (C) Cl_2 (E) I_2
(B) O_2 (D) Br_2

42. Metallic copper is heated strongly with concentrated sulfuric acid. The products of this reaction are

(A) $CuSO_{4(s)}$ and $H_{2(g)}$ only
(B) Cu^{2+}, $SO_{2(g)}$, and H_2O
(C) Cu^{2+}, $H_{2(g)}$, and H_2O
(D) $CuSO_{4(s)}$, $H_{2(g)}$, and $SO_{2(g)}$
(E) Cu^{2+}, $SO_{3(g)}$, and H_2O

43. The elements in which of the following have most nearly the same atomic radius?

(A) Be, B, C, N
(B) Ne, Ar, Kr, Xe
(C) Mg, Ca, Sr, Ba
(D) C, P, Se, I
(E) Cr, Mn, Fe, Co

44. What number of moles of O_2 is needed to produce 14.2 grams of P_4O_{10} from P? (Molecular weight P_4O_{10} = 284)

(A) 0.0500 mole
(B) 0.0625 mole
(C) 0.125 mole
(D) 0.250 mole
(E) 0.500 mole

45. The alkenes are compounds of carbon and hydrogen with the general formula C_nH_{2n}. If 0.561 gram of any alkene is burned in excess oxygen, what number of moles of H_2O is formed?

(A) 0.0400 mole
(B) 0.0600 mole
(C) 0.0800 mole
(D) 0.400 mole
(E) 0.800 mole

46. If 0.060 faraday is passed through an electrolytic cell containing a solution of In^{3+} ions, the maximum number of moles of In that could be deposited at the cathode is

(A) 0.010 mole
(B) 0.020 mole
(C) 0.030 mole
(D) 0.060 mole
(E) 0.18 mole

47. $CH_{4(g)} + 2\ O_{2(g)} \rightarrow CO_{2(g)} + 2\ H_2O_{(l)}$ $\qquad \Delta H^\circ = -889.1$ kJ

$\Delta H_f^\circ\ H_2O_{(l)} = -285.8$ kJ/mol
$\Delta H_f^\circ\ CO_{2(g)} = -393.3$ kJ/mol

What is the standard heat of formation of methane, $\Delta H_f^\circ\ CH_{4(g)}$, as calculated from the data above?

(A) –210.0 kJ/mole
(B) –107.5 kJ/mole
(C) –75.8 kJ/mole
(D) 75.8 kJ/mole
(E) 210.0 kJ/mole

48. Which of the following ions is the strongest Lewis acid?

(A) Na^+
(B) Cl^-
(C) CH_3COO^-
(D) Mg^{2+}
(E) Al^{3+}

49. Each of the following can act as both a Brönsted acid and a Brönsted base EXCEPT

(A) HCO_3^- (C) NH_4^+ (E) HS^-

(B) $H_2PO_4^-$ (D) H_2O

50. Two flexible containers for gases are at the same temperature and pressure. One holds 0.50 gram of hydrogen and the other holds 8.0 grams of oxygen. Which of the following statements regarding these gas samples is FALSE?

(A) The volume of the hydrogen container is the same as the volume of the oxygen container.

(B) The number of molecules in the hydrogen container is the same as the number of molecules in the oxygen container.

(C) The density of the hydrogen sample is less than that of the oxygen sample.

(D) The average kinetic energy of the hydrogen molecules is the same as the average kinetic energy of the oxygen molecules.

(E) The average speed of the hydrogen molecules is the same as the average speed of the oxygen molecules.

51. Pi (π) bonding occurs in each of the following species EXCEPT

(A) CO_2 (C) CN^- (E) CH_4

(B) C_2H_4 (D) C_6H_6

52. $3\ Ag_{(s)} + 4\ HNO_3 \rightarrow 3\ AgNO_3 + NO_{(g)} + 2\ H_2O$

The reaction of silver metal and dilute nitric acid proceeds according to the equation above. If 0.10 mole of powdered silver is added to 10. milliliters of 6.0–molar nitric acid, the number of moles of NO gas that can be formed is

(A) 0.015 mole (C) 0.030 mole (E) 0.090 mole

(B) 0.020 mole (D) 0.045 mole

53. Which, if any, of the following species is in the greatest concentration in a 0.100–molar solution of H_2SO_4 in water?

(A) H_2SO_4 molecules (C) HSO_4^- ions

(B) H_3O^+ ions (D) SO_4^{2-} ions

(E) All species are in equilibrium and therefore have the same concentrations.

54. Which of the following statements is always true about the phase diagram of any one–component system?
   (A) The slope of the curve representing equilibrium between the vapor and liquid phases is positive.
   (B) The slope of the curve representing equilibrium between the liquid and solid phases is negative.
   (C) The slope of the curve representing equilibrium between the liquid and solid phases is positive.
   (D) The temperature at the triple point is greater than the normal freezing point.
   (E) The pressure at the triple point is greater than 1 atmosphere.

55. At 20.˚C, the vapor pressure of toluene is 22 millimeters of mercury and that of benzene is 75 millimeters of mercury. An ideal solution, equimolar in toluene and benzene, is prepared. At 20.˚C, what is the mole fraction of benzene in the vapor in equilibrium with this solution?

(A) 0.23	(C) 0.50	(E) 0.83
(B) 0.29	(D) 0.77	

56. A cube of ice is added to some hot water in a rigid, insulated container, which is then sealed. There is no heat exchange with the surroundings. What has happened to the total energy and the total entropy when the system reaches equilibrium?

	Energy	Entropy
(A)	Remains constant	Remains constant
(B)	Remains constant	Decreases
(C)	Remains constant	Increases
(D)	Decreases	Increases
(E)	Increases	Decreases

57. For the reaction $A_{(g)}$ / $B_{(g)}$ + $C_{(g)}$, the equilibrium constant, K_p, is 2×10^{-4} at 25˚C. A mixture of the three gases at 25˚C is placed in a reaction flask and the initial pressures are $P_A = 21$ atmosphere, $P_B = 0.5$ atmosphere, and $P_C = 1$ atmosphere. At the instant of mixing, which of the following is true for the reaction as written?

(A) $\Delta G < 0$	(C) $\Delta S = 0$	(E) $\Delta G^\circ < 0$
(B) $\Delta G > 0$	(D) $\Delta G^\circ = 0$	

58. Which of the following represents the ground state electron configuration for the Mn^{3+} ion?
(Atomic number Mn = 25)
   (A) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^4$
   (B) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^5\ 4s^2$
   (C) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^2\ 4s^2$
   (D) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^8\ 4s^2$
   (E) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^3\ 4s^1$

59. When 70. milliliter of 3.0-molar Na_2CO_3 is added to 30. milliliters of 1.0-molar $NaHCO_3$ the resulting concentration of Na^+ is

(A) 2.0 M	(C) 4.0 M	(E) 7.0 M
(B) 2.4 M	(D) 4.5 M	

60. Which of the following has a zero dipole moment?

(A) HCN	(C) SO_2	(E) PF_5
(B) NH_3	(D) NO_2	

61. When a solution of potassium dichromate is added to an acidified solution of iron(II) sulfate, the products of the reaction are
   (A) $FeCr_2O_{7(s)}$ and H_2O
   (B) $FeCrO_{4(s)}$ and H_2O
   (C) Fe^{3+}, CrO_4^{2-}, and H_2O
   (D) Fe^{3+}, Cr^{3+}, and H_2O
   (E) $Fe_2(SO_4)_{3(s)}$, Cr^{3+} and H_2O

62. A student pipetted five 25.00–milliliter samples of hydrochloric acid and transferred each sample to an Erlenmeyer flask, diluted it with distilled water, and added a few drops of phenolphthalein to each. Each sample was then titrated with a sodium hydroxide solution to the appearance of the first permanent faint pink color. The following results were obtained.

Volumes of NaOH Solution
First Sample.................35.22 mL
Second Sample ....36.14 mL
Third Sample ....36.13 mL
Fourth Sample ....36.15 mL
Fifth Sample ....36.12 mL

Which of the following is the most probable explanation for the variation in the student's results?
   (A) The burette was not rinsed with NaOH solution
   (B) The student misread a 5 for a 6 on the burette when the first sample was titrated.
   (C) A different amount of water was added to the first sample.

(D) The pipette was not rinsed with the HCl solution.

(E) The student added too little indicator to the first sample.

63. Acid Acid Dissociation Constant, K_a

Acid	Acid Dissociation Constant, K_a
H_3PO_4	7×10^{-3}
$H_2PO_4^-$	8×10^{-8}
HPO_4^{2-}	5×10^{-13}

On the basis of the information above, a buffer with a pH = 9 can best be made by using

(A) pure NaH_2PO_4
(B) $H_3PO_4 + H_2PO_4^-$
(C) $H_2PO_4^- + PO_4^{2-}$
(D) $H_2PO_4^- + HPO_4^{2-}$
(E) $HPO_4^{2-} + PO_4^{3-}$

64. The net ionic equation for the reaction that occurs during the titration of nitrous acid with sodium hydroxide is

(A) $HNO_2 + Na^+ + OH^- \rightarrow NaNO_2 + H_2O$
(B) $HNO_2 + NaOH \rightarrow Na^+ + NO_2^- + H_2O$
(C) $H^+ + OH^- \rightarrow H_2O$
(D) $HNO_2 + H_2O \rightarrow NO_2^- + H_3O^+$
(E) $HNO_2 + OH^- \rightarrow NO_2^- + H_2O$

65. Which of the following species CANNOT function as an oxidizing agent?

(A) $Cr_2O_7^{2-}$
(B) MnO_4^-
(C) NO_3^-
(D) S
(E) I^-

66. Ca, V, Co, Zn, As

Gaseous atoms of which of the elements above are paramagnetic?

(A) Ca and As only
(B) Zn and As only
(C) Ca, V, and Co only
(D) V, Co, and As only
(E) V, Co, and Zn only

67. A student wishes to prepare 2.00 liters of 0.100–molar KIO_3 (molecular weight 214). The proper procedure is to weigh out

(A) 42.8 grams of KIO_3 and add 2.00 kilograms of H_2O
(B) 42.8 grams of KIO_3 and add H_2O until the final homogeneous solution has a volume of 2.00 liters
(C) 21.4 grams of KIO_3 and add H_2O until the final homogeneous solution has a volume of 2.00 liters
(D) 42.8 grams of KIO_3 and add 2.00 liters of H_2O
(E) 21.4 grams of KIO_3 and add 2.00 liters of H_2O

68. A 20.0–milliliter sample of 0.200–molar K_2CO_3 solution is added to 30.0 milliliters of 0.400–molar $Ba(NO_3)_2$ solution. Barium carbonate precipitates. The concentration of barium ion, Ba^{2+}, in solution after reaction is

(A) 0.150 M (B) 0.160 M (C) 0.200 M (D) 0.240 M (E) 0.267 M

69. What is the mole fraction of ethanol, C_2H_5OH, in an aqueous solution in which the ethanol concentration is 4.6 molal?

(A) 0.0046 (B) 0.076 (C) 0.083 (D) 0.20 (E) 0.72

70. One of the outermost electrons in a strontium atom in the ground state can be described by which of the following sets of four quantum numbers?

(A) 5, 2, 0, $^1/_2$
(B) 5, 1, 1, $^1/_2$
(C) 5, 1, 0, $^1/_2$
(D) 5, 0, 1, $^1/_2$
(E) 5, 0, 0, $^1/_2$

71. Which of the following reactions does NOT proceed significantly to the right in aqueous solutions?

(A) $H_3O^+ + OH^- \rightarrow 2\ H_2O$
(B) $HCN + OH^- \rightarrow H_2O + CN^-$
(C) $Cu(H_2O)_4{}^{2+} + 4\ NH_3 \rightarrow Cu(NH_3)_4{}^{2+} + 4\ H_2O$
(D) $H_2SO_4 + H_2O \rightarrow H_3O^+ + HSO_4^-$
(E) $H_2O + HSO_4^- \rightarrow H_2SO_4 + OH^-$

72. A compound is heated to produce a gas whose molecular weight is to be determined. The gas is collected by displacing water in a water–filled flask inverted in a trough of water. Which of the following is necessary to calculate the molecular weight of the gas, but does NOT need to be measured during the experiment?

(A) Mass of the compound used in the experiment
(B) Temperature of the water in the trough
(C) Vapor pressure of the water
(D) Barometric pressure
(E) Volume of water displaced from the flask

73. A 27.0–gram sample of an unknown hydrocarbon was burned in excess oxygen to form 88.0 grams of carbon dioxide and 27.0 grams of water. What is a possible molecular formula of the hydrocarbon?

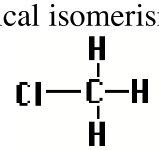
(A) CH_4 (B) C_2H_2 (C) C_4H_3 (D) C_4H_6 (E) C_4H_{10}

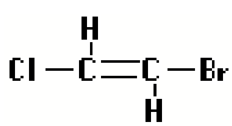
74. How many moles of NaF must be dissolved in 1.00 liter of a saturated solution of PbF_2 at 25˚C to reduce the $[Pb^{2+}]$ to 1×10^{-6} molar? (K_{sp} PbF_2 at 25˚C = 4.0×10^{-8})
(A) 0.020 mole (C) 0.10 mole (E) 0.40 mole
(B) 0.040 mole (D) 0.20 mole

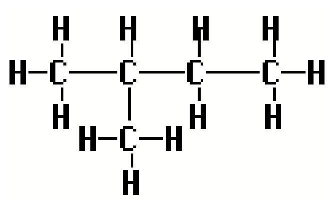
75. If the acid dissociation constant, K_a, for an acid HA is 8×10^{-4} at 25˚C, what percent of the acid is dissociated in a 0.50–molar solution of HA at 25˚C?
(A) 0.08% (C) 1% (E) 4%
(B) 0.2% (D) 2%

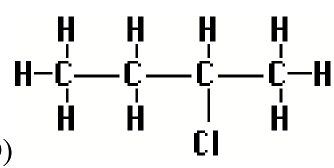
76. $HgO_{(s)} + H_2O$ / $HgI_4^{2-} + 2\ OH^-$
Consider the equilibrium above. Which of the following changes will increase the concentration of HgI_4^{2-} ?
(A) Increasing the concentration of OH^-
(B) Adding 6 M HNO_3
(C) Increasing the mass of HgO present
(D) Increasing the temperature
(E) Adding a catalyst

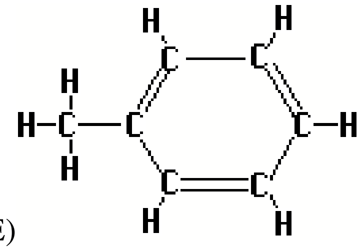
77. Which of the following compounds exhibits optical isomerism?


(A)


(B)


(C)


(D)


(E)

78. When the actual gas volume is <u>greater</u> then the volume predicted by the ideal gas law, the explanation lies in the fact that the ideal gas law does NOT include a factor for molecular.
(A) volume (C) velocity (E) shape
(B) mass (D) attractions

79. $5\ Fe^{2+} + MnO_4^- + 8\ H^+$ / $5\ Fe^{3+} + Mn^{2+} + 4\ H_2O$
In a titration experiment based on the equation above, 25.0 milliliters of an acidified Fe^{2+} solution requires 14.0 milliliters of standard 0.050–molar MnO_4^- solution to reach the equivalence point. The concentration of Fe^{2+} in the original solution is
(A) 0.0010 *M* (C) 0.028 *M* (E) 0.14 *M*
(B) 0.0056 *M* (D) 0.090 *M*

80. For which of the following molecules are resonance structures necessary to describe the bonding satisfactorily?
(A) H_2S (C) CO_2 (E) PF_3
(B) SO_2 (D) OF_2

81. What is the net ionic equation for the reaction that occurs when aqueous copper(II) sulfate is added to excess 6–molar ammonia?
(A) $Cu^{2+} + SO_4^{2-} + 2\ NH_4^+ + 2\ OH^- \rightarrow (NH_4)_2SO_4 + Cu(OH)_2$
(B) $Cu^{2+} + 4\ NH_3 + 4\ H_2O \rightarrow Cu(OH)_4^{2-} + 4\ NH_4^+$
(C) $Cu^{2+} + 2\ NH_3 + 2\ H_2O \rightarrow Cu(OH)_2 + 2\ NH_4^+$
(D) $Cu^{2+} + 4\ NH_3 \rightarrow Cu(NH_3)_4^{2+}$
(E) $Cu^{2+} + 2\ NH_3 + H_2O \rightarrow CuO + 2\ NH_4^+$

82. Step 1. $N_2H_2O_2 \rightleftarrows N_2HO_2^- + H^+$ (fast equilibrium)

Step 2. $N_2HO_2^- \rightarrow N_2O + OH^-$ (slow)

Step 3. $H^+ + OH^- \rightarrow H_2O$ (fast)

Nitramide, $N_2H_2O_2$, decomposes slowly in aqueous solution. This decomposition is believed to occur according to the reaction mechanism above. The rate law for the decomposition of nitramide that is consistent with this mechanism is given by which of the following?

(A) Rate = $k\,[N_2H_2O_2]$

(B) Rate = $k\,[N_2H_2O_2]\,[H^+]$

(C) $\text{Rate} = k\dfrac{[N_2H_2O_2]}{[H^+]}$

(D) $\text{Rate} = k\dfrac{[N_2H_2O_2]}{[N_2HO_2]}$

(E) Rate = $k\,[N_2H_2O_2]\,[OH^-]$

83. $NH_{3(g)} + 2\,CH_{4(g)} + {}^5/_2\,O_{2(g)} \rightleftarrows H_2NCH_2COOH_{(s)} + 3\,H_2O_{(l)}$

At constant temperature, ΔH, the change in enthalpy for the reaction above is approximately equal to

(A) $\Delta E - (^{11}/_2)\,RT$

(B) $\Delta E - (^{7}/_2)\,RT$

(C) $\Delta E + RT$

(D) $\Delta E + (^{7}/_2)\,RT$

(E) $\Delta E\,(^{11}/_2)\,RT$

84. Which of the following aqueous solutions has the highest boiling point?

(A) 0.10 M potassium sulfate, K_2SO_4

(B) 0.10 M hydrochloric acid, HCl

(C) 0.10 M ammonium nitrate, NH_4NO_3

(D) 0.10 M magnesium sulfate, $MgSO_4$

(E) 0.20 M sucrose, $C_{12}H_{22}O_{11}$

85. A sample of 9.00 grams of aluminum metal is added to an excess of hydrochloric acid. The volume of hydrogen gas produced at standard temperature and pressure is

(A) 22.4 liters

(B) 11.2 liters

(C) 7.46 liters

(D) 5.60 liters

(E) 3.74 liters

1984 AP Chemistry Exam – Multiple Choice Answers

Question #	Answer	% Correct	Question #	Answer	% Correct	Question #	Answer	% Correct
1.	B	78	30.	C	46	59.	D	38
2.	E	68	31.	E	46	60.	E	34
3.	B	74	32.	A	25	61.	D	10
4.	E	34	33.	D	44	62.	D	27
5.	A	62	34.	D	65	63.	D	32
6.	D	55	35.	D	40	64.	E	27
7.	C	29	36.	C	62	65.	E	38
8.	C	66	37.	E	54	66.	D	42
9.	A	56	38.	A	42	67.	B	64
10.	B	58	39.	C	54	68.	B	48
11.	A	23	40.	A	54	69.	B	24
12.	C	53	41.	A	49	70.	E	41
13.	D	46	42.	B	13	71.	E	45
14.	B	24	43.	E	48	72.	C	50
15.	D	52	44.	D	67	73.	D	44
16.	C	50	45.	A	59	74.	D	20
17.	B	45	46.	B	48	75.	E	38
18.	E	65	47.	C	38	76.	B	19
19.	D	87	48.	E	34	77.	D	17
20.	E	82	49.	C	63	78.	A	29
21.	B	75	50.	E	39	79.	E	29
22.	E	80	51.	E	56	80.	B	45
23.	B	75	52.	A	63	81.	D	29
24.	A	68	53.	B	55	82.	C	11
25.	A	61	54.	A	30	83.	A	16
26.	A	75	55.	D	39	84.	A	27
27.	E	67	56.	C	36	85.	B	30
28.	C	64	57.	B	32			
29.	A	51	58.	A	32			

average = 46.24 ± 18.08

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VERY EASY (80–100% correct), 3.5%

19. 20. 22.

EASY (60–79% correct), 22.4%

1. 2. 3. 5. 8. 18. 21. 23. 24. 25. 26. 27. 28. 34. 36.
44. 49. 52. 67.

MEDIUM DIFFICULTY (40–59% correct), 34.1%

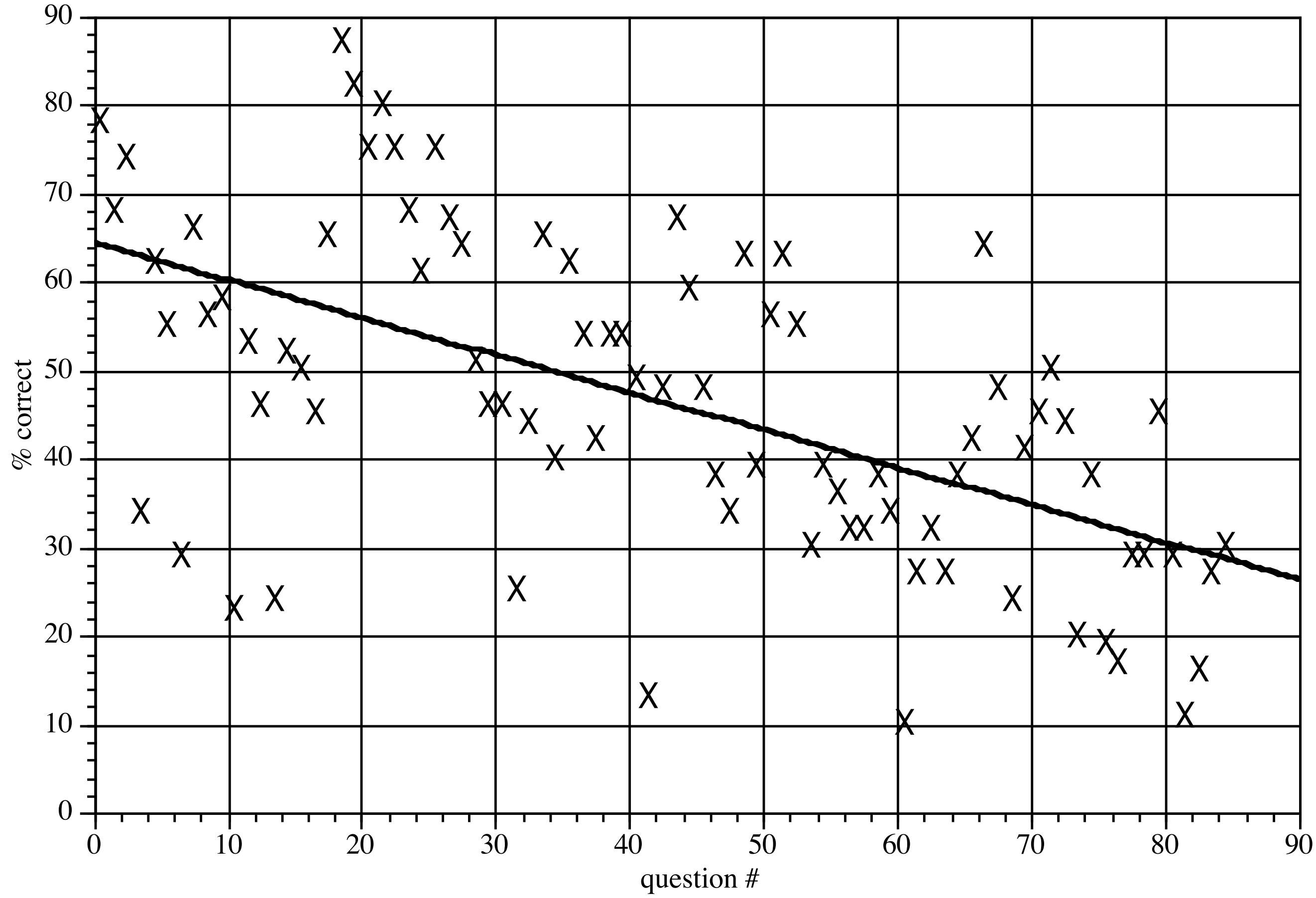
6. 9. 10. 12. 13. 15. 16. 17. 29. 30. 31. 33. 35. 37. 39.
40. 41. 43 45. 46. 51. 53. 66. 68. 70. 71. 72. 73. 80.

HARD (20–39% correct), 31.8%

4.	7.	11.	14.	32.	47.	48.	50.	54.	55.	56.	57.	58.	59.	60.
62.	63.	64.	65.	69.	74.	75.	78.	79.	81.	84.	85.			

VERY HARD (0–19% correct), 7.1%

42.	61.	76.	77.	82.	83.


90
80
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80
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question #