AP Chemistry: Solutions
Multiple Choice

59. When 70. milliliters 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   (B) 2.4 M   (C) 4.0 M   (D) 4.5 M   (E) 7.0 M

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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 fo KIO_3 and add 2.00 liters of H_2O

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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

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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

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15. The weight of H_2SO_4 (molecular weight 98.1) in 50.0 milliliters of a 6.00-molar solution is…

(A) 3.10 grams   (B) 12.0 grams   (C) 29.4 grams   (D) 294 grams   (E) 300. grams

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26. How many milliliters of 11.6-molar HCl must be diluted to obtain 1.0 liter of 3.0-molar HCl?

(A) 3.9 mL   (B) 35 mL   (C) 260 mL   (D) 1,000 mL   (E) 3,900 mL

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43. Which of the following does NOT behave as an electrolyte when it is dissolved in water?

(A) CH_3OH (B) K_2CO_3 (C) NH_4Br (D) HI   (E) Sodium acetate, CH_3COONa

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72. How many moles of solid $Ba(NO_3)_2$ should be added to 300. milliliters of 0.20-molar $Fe(NO_3)_3$ to increase the concentration of the NO_3^- ion to 1.0-molar? (Assume that the volume of the solution remains constant.)

(A) 0.060 mole   (B) 0.12 mole   (C) 0.24 mole   (D) 0.30 mole   (E) 0.40 mole

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47. Which of the following has the lowest conductivity?

(A) 0.1 M $CuSO_4$ (B) 0.1 M KOH   (C) 0.1 M $BaCl_2$ (D) 0.1 M HF   (E) 0.1 M HNO_3

28. Given that a solution is 5 percent sucrose by mass, what additional information is necessary to calculate the molarity of the solution?

I. The density of water   II. The density of the solution   III. The molar mass of sucrose

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

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53. If 87 grams of K_2SO_4 (molar mass 174 grams) is dissolved in enough water to make 250 milliliters of solution, what are the concentrations of the potassium and the sulfate ions?

	$[K^+]$	$[SO_4^{2-}]$
(A)	0.020 M	0.020 M
(B)	1.0 M	2.0 M
(C)	2.0 M	1.0 M
(D)	2.0 M	2.0 M
(E)	4.0 M	2.0 M

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33. A 1.0 L sample of an aqueous solution contains 0.10 mol of NaCl and 0.10 mol of $CaCl_2$. What is the minimum number of moles of $AgNO_3$ that must be added to the solution in order to precipitate all of the Cl^- as $AgCl_{(s)}$? (Assume that AgCl is insoluble.)

(A) 0.10 mol   (B) 0.20 mol   (C) 0.30 mol   (D) 0.40 mol   (E) 0.60 mol

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56. A yellow precipitate forms when 0.5 M $NaI_{(aq)}$ is added to a 0.5 M solution of which of the following ions?

(A) $Pb^{2+}_{(aq)}$ (B) $Zn^{2+}_{(aq)}$ (C) $CrO_4^{2-}_{(aq)}$ (D) $SO_4^{2-}_{(aq)}$ (E) $OH^-_{(aq)}$

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59. A 40.0 mL sample of 0.25 M KOH is added to 60.0 mL of 0.15 M $Ba(OH)_2$. What is the molar concentration of $OH^-_{(aq)}$ in the resulting solution? (Assume that the volumes are additive.)

(A) 0.10 M   (B) 0.19 M   (C) 0.28 M   (D) 0.40 M   (E) 0.55 M

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69. What is the final concentration of barium ions, $[Ba^{2+}]$, in solution when 100. mL of 0.10 M $BaCl_{2(aq)}$ is mixed with 100. mL of 0.050 M $H_2SO_{4(aq)}$?

(A) 0.00 M   (B) 0.012 M   (C) 0.025 M   (D) 0.075 M   (E) 0.10 M

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70. When 100 mL of 1.0 M Na_3PO_4 is mixed with 100 mL of 1.0 M $AgNO_3$, a yellow precipitate forms and $[Ag^+]$ becomes negligibly small. Which of the following is a correct listing of the ions remaining in solution in order of increasing concentration?

(A) $[PO_4^{3-}] < [NO_3^-] < [Na^+]$ (B) $[PO_4^{3-}] < [Na^+] < [NO_3^-]$ (C) $[NO_3^-] < [PO_4^{3-}] < [Na^+]$

(D) $[Na^+] < [NO_3^-] < [PO_4^{3-}]$ (E) $[Na^+] < [PO_4^{3-}] < [NO_3^-]$

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71. In a qualitative analysis for the presence of Pb^{2+}, Fe^{2+}, and Cu^{2+} ions in a aqueous solution, which of the following will allow the separation of Pb^{2+} from the other ions at room temperature?

(A) Adding dilute $Na_2S_{(aq)}$ solution   (B) Adding dilute $HCl_{(aq)}$ solution   (C) Adding dilute $NaOH_{(aq)}$ solution
(D) Adding dilute $NH_{3(aq)}$ solution   (E) Adding dilute $HNO_{3(aq)}$ solution

73. The volume of distilled water that should be added to 10.0 mL of 6.00 M HCl$_{(aq)}$ in order to prepare a 0.500 M HCl$_{(aq)}$ solution is approximately…

(A) 50.0 mL   (B) 60.0 mL   (C) 100. mL   (D) 110. mL   (E) 120. mL

Use the following answers for questions 10 - 13.

(A) CO$_3{}^{2-}$ (B) Cr$_2$O$_7{}^{2-}$ (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 absent 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$_2$SO$_4$ is added to a sample of the solution.

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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

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

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

(A) 0.10 M potassium sulfate, K$_2$SO$_4$ (B) 0.10 M hydrochloric acid, HCl

(C) 0.10 M ammonium nitrate, NH$_4$NO$_3$ (D) 0.10 M magnesium sulfalte, MgSO$_4$

(E) 0.20 M sucrose, C$_{12}$H$_{22}$O$_{11}$

27.

I. Difference in temperature between freezing point of solvent and freezing point of solvent and freezing point of solution

II. Molal freezing point depression constant, K$_f$, for solvent

In addition to the information above, which of the following gives the minimum data required to determine the molecular mass of a nonionic substance by the freezing point depression technique?

(A) No further information is necessary.   (B) Mass of solute   (C) Mass of solute and mass of solvent

(D) Mass of solute and volume of solvent   (E) Mass of solute, mass of solvent, and vapor pressure of solvent

28. Which of the following is probably true for a solid solute with a highly endothermic heat of solution when dissolved in water?

(A) The solid has a low lattice energy.

(B) As the solute dissolves, the temperature of the solution increases.

(C) The resulting solution is ideal.

(D) The solid is more soluble at higher temperatures.

(E) the solid has a high energy of hydration.

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71. A solution of toluene (molecular weight 92.1) in benzene (molecular weight 78.1) is prepared. The mole fraction of toluene in the solution is 0.100. What is the molality of the solution?

(A) $0.100\ m$ (B) $0.703\ m$ (C) $0.921\ m$ (D) $1.28\ m$ (E) $1.42\ m$

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14. Which of the following is lower for a 1.0-molar aqueous solution of <u>any</u> solute than it is for pure water?

(A) pH   (B) Vapor pressure   (C) Freezing point   (D) Electrical conductivity   (E) Absorption of visible light

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44. Which of the following solutions has the lowest freezing point?

(A) $0.20\ m\ C_6H_{12}O_6$, glucose   (B) $0.20\ m\ NH_4Br$ (C) $0.20\ m\ ZnSO_4$

(D) $0.20\ m\ KMnO_4$ (E) $0.20\ m\ MgCl_2$

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31. If the temperature of an aqueous solution of NaCl is increased from 20 °C to 90 °C, which of the following statements is true?

(A) The density of the solution remains unchanged.   (B) The molarity of the solution remains unchanged.

(C) The molality of the solution remains unchanged.   (D) The mole fraction of solute decreases.

(E) The mole fraction of solute increases.

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43. A sample of 61.8 g of H_3BO_3, a weak acid is dissolved in 1,000 g of water to make a 1.0-molal solution. Which of the following would be the best procedure to determine to molarity of the solution? (Assume no additional information is available.)

(A) Titration of the solution with standard acid   (B) Measurement of the pH with a pH meter

(C) Determination of the boiling point of the solution   (D) Measurement of the total volume of the solution

(E) Measurement of the specific heat of the solution

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75. Which of the following pairs of liquids forms the solution that is most ideal (most closely follows Raoult's law)?

(A) $C_8H_{18(l)}$ and $H_2O_{(l)}$ (B) $CH_3CH_2CH_2OH_{(l)}$ and $H_2O_{(l)}$

(C) $CH_3CH_2CH_2OH_{(l)}$ and $C_8H_{18(l)}$ (D) $C_6H_{14(l)}$ and $C_8H_{18(l)}$ (E) $H_2SO_{4(l)}$ and $H_2O_{(l)}$

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67. Substances X and Y that were in a solution were separated in the laboratory using the technique of fractional crystallization. This fractional crystallization is possible because substances X and Y have different…

(A) boiling points   (B) melting points   (C) densities   (D) crystal colors   (E) solubilities

35. A solution is made by dissolving a nonvolatile solute in pure solvent. Compared to the pure solvent, the solution…

(A) has a higher normal boiling point.
(B) has a higher vapor pressure.
(C) has the same vapor pressure.
(D) has a higher freezing point.
(E) is more nearly ideal.

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45. What is the mole fraction of ethanol, C_2H_5OH, in an aqueous solution that is 46 percent ethanol by mass? (The molar mass of C_2H_5OH is 46 g; the molar mass of H_2O is 18 g.)

(A) 0.25   (B) 0.46   (C) 0.54   (D) 0.67   (E) 0.75

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26. Approximately what mass of $CuSO_4·5H_2O$ (250 g mol^{-1}) is required to prepare 250 mL of 0.10 M copper (II) sulfate solution?

(A) 4.0 g   (B) 6.2 g   (C) 34 g   (D) 85 g   (E) 140 g

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38. A 0.10 M aqueous solution of sodium sulfate, Na_2SO_4, is a better conductor of electricity than a 0.10 M aqueous solution of sodium chloride, NaCl. Which of the following best explains this observation?

(A) Na_2SO_4 is more soluble in water than NaCl is.
(B) Na_2SO_4 has a higher molar mass than NaCl has.
(C) To prepare a given volume of 0.10 M solution, the mass of Na_2SO_4 needed is more than twice the mass of NaCl needed.
(D) More moles of ions are present in a given volume of 0.10 M Na_2SO_4 than in the same volume of 0.10 M NaCl.
(E) The degree of dissociation of Na_2SO_4 in solution is significantly greater than that of NaCl.

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39. On the basis of the solubility curves shown, the greatest percentage of which compound can be recovered by cooling a saturated solution of that compound from 90°C to 30°C ?

(A) NaCl

(B) KNO_3

(C) K_2CrO_4

(D) K_2SO_4

(E) $Ce_2(SO_4)_3$
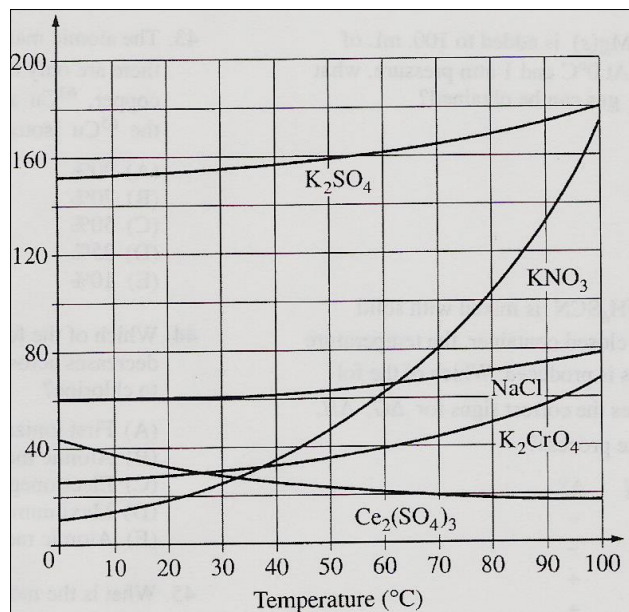
69. If 200. mL of 0.60 M $MgCl_{2(aq)}$ is added to 400. mL of distilled water, what is the concentration of $Mg^{2+}_{(aq)}$ in the resulting solution? (Assume volume are additive.)

(A) 0.20 M   (B) 0.30 M   (C) 0.40 M   (D) 0.60 M   (E) 1.2 M