Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

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| 1. | Which pure substance exhibits hydrogen bonding? |
| A) | HNF2 |
| B) | H2S |
| C) | B2H6 |
| D) | HBr |
| E) | CaH2 |

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| 2. | Rank the following molecules in order of increasing normal boiling point: CH3CH2OH, CH3CH2CH2OH, CH3CH2OCH3. |
| A) | lowest CH3CH2OCH3, CH3CH2OH, CH3CH2CH2OH highest. |
| B) | lowest CH3CH2OH, CH3CH2OCH3, CH3CH2CH2OH highest. |
| C) | lowest CH3CH2CH2OH, CH3CH2OCH3, CH3CH2OH highest. |
| D) | lowest CH3CH2CH2OH, CH3CH2OH, CH3CH2OCH3 highest. |
| E) | lowest CH3CH2OCH3, CH3CH2CH2OH, CH3CH2OH highest. |

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| 3. | Which one of the following decreases as the strength of the attractive intermolecular forces increases? |
| A) | The heat of vaporization. |
| B) | The normal boiling temperature. |
| C) | The extent of deviations from the ideal gas law. |
| D) | The sublimation temperature of a solid. |
| E) | The vapor pressure of a liquid. |

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| 4. | Which of the following pure substances has the lowest normal boiling point? |
| A) | NH3 |
| B) | H2Se |
| C) | H2Te |
| D) | H2O |
| E) | H2S |

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| 5. | Below is a phase diagram for a substance.Which line represents the vapor-pressure curve of the substance? |
| A) | M-N |
| B) | R-X |
| C) | X-Z |
| D) | S-X |
| E) | S-Z |

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| 6. | The critical point of CCl4 is 283°C and 45 atm pressure. Liquid CCl4 has a vapor pressure of 10.0 atm at 178°C. Which of the following statements must be true? |
| A) | The normal boiling point of CCl4 must be greater than 178°C. |
| B) | Liquid CCl4 can exist at temperatures greater than 283°C if the pressure is greater than 45 atm. |
| C) | The triple point of CCl4 must be less than 178°C. |
| D) | Liquid and solid can only be in equilibrium at one temperature—the freezing point. |
| E) | Vapor and liquid can only be in equilibrium at one temperature—the normal boiling point. |

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| 7. | What is the enthalpy of vaporization of a compound that has a vapor pressure of 173 mmHg at 269 K and 0.188 mmHg at 185 K? (*R* = 8.31 J/(K· mol)) |
| A) | 4.76 kJ/mol |
| B) | 0.585 kJ/mol |
| C) | 675 kJ/mol |
| D) | 33.6 kJ/mol |
| E) | 332 kJ/mol |

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| 8. | Which of the following processes is exothermic? |
| A) | sublimation |
| B) | vaporization |
| C) | melting |
| D) | fusion |
| E) | deposition |

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| 9. | Which of the following processes must exist in equilibrium with the evaporation process when a measurement of vapor pressure is made? |
| A) | fusion |
| B) | vaporization |
| C) | sublimation |
| D) | boiling |
| E) | condensation |

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| 10. | An unknown white solid melts at a low temperature. The solid is a nonelectrolyte. The solid is most likely a: |
| A) | ionic solid. |
| B) | covalent network solid. |
| C) | metallic solid. |
| D) | molecular solid. |
| E) | weak base. |

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| 11. | A compound containing carbon and nitrogen has a composition of 46.16% carbon and 53.84% nitrogen by mass. A solution prepared by dissolving 3.968 g of this compound in 50.00 g of carbon tetrachloride, CCl4, produces a solution that boils at 84.39°C. What is the molecular formula of the compound? (*Kb* for CCl4 is 5.03°C/*m*, and pure CCl4 has a freezing point of 76.72°C.) |
| A) | CN |
| B) | C2N2 |
| C) | CN2 |
| D) | C2N4 |
| E) | C3N3 |

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| 12. | What is the boiling-point change for a solution containing 0.382 mol of naphthalene (a nonvolatile, nonionizing compound) in 250. g of liquid benzene? (*Kb* = 2.53°C/m for benzene)  |
| A) | 3.87 °C |
| B) | 1.66 °C |
| C) | 6.62 °C |
| D) | 0.966 °C |
| E) | 0.242 °C |

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| 13. | What is the mole fraction of water in a solution that contains 7.4 mol of ethanol (C2H5OH) and 2.0 mol of water? |
| A) | 0.21 |
| B) | 0.79 |
| C) | 0.37 |
| D) | 0.27 |
| E) | 0.11 |

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| 14. | What is the molality of a solution that contains 79.4 g of 1,4-dichlorobenzene (C6H4Cl2) in 453 mL of carbon tetrachloride (CCl4)? The density of CCl4 is 1.60 g/mL. |
| A) | 0.110 *m* |
| B) | 1.91 *m* |
| C) | 0.746 *m* |
| D) | 0.184 *m* |
| E) | 0.175 *m* |

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| 15. | The volume of a 19.4% (by mass) solution is 170.1 mL. The density of the solution is 1.164 g/mL. What is the mass of solute in this solution? |
| A) | 28.3 g |
| B) | 38.4 g |
| C) | 160 g |
| D) | 198 g |
| E) | 1021 g |

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| 16. | Sparkling wine is bottled under a CO2 pressure of 4.2 atm. The solubility of CO2 at 4.2 atm is 0.69 g/100 g H2O. What is its solubility after the bottle is opened if the partial pressure of CO2 is 3.9  10-4 atm? |
| A) | 7.4  10-5 g/100 g H2O |
| B) | 6.4  10-5 g/100 g H2O |
| C) | 4.2  10-6 g/100 g H2O |
| D) | 1.6  10-5 g/100 g H2O |
| E) | 1.1  10-4 g/100 g H2O |

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| 17. | Suppose a small amount of a solid is added to water and, once equilibrium is reached, all the solid has dissolved. Which of the following statements is most likely to be true? |
| A) | The solution is supersaturated with solute. |
| B) | The solution is either unsaturated or supersaturated with solute. |
| C) | The solution is either saturated or supersaturated with solute. |
| D) | The solution is unsaturated with solute. |
| E) | The solution is saturated with solute. |

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| 18. | In general, which of the following types of solids would be the most soluble in carbon disulfide, CS2? |
| A) | ionic |
| B) | polar molecular |
| C) | nonpolar molecular |
| D) | network covalent |
| E) | metallic |

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| 19. | Which of the following is not a colligative property? |
| A) | osmotic pressure |
| B) | vapor pressure lowering |
| C) | freezing-point depression |
| D) | lattice energy |
| E) | boiling-point elevation |

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| 20. | A cucumber is placed in a concentrated salt solution. What is most likely to happen? |
| A) | Water will flow from the cucumber to the solution. |
| B) | Water will flow from the solution to the cucumber. |
| C) | Salt will flow into the cucumber. |
| D) | Salt will precipitate out. |
| E) | No change will occur. |

Clausius-Clapeyron Equation

ln P2 = ΔHvap  1 - 1

P1 R T1 T2

solubility

S2 = P2

S1 P1

Raoult’s Law

Psoln = Psolv · Xsolv

Psoln = PsolnO - ΔP

Boiling point elevation

Δ*Tb* = *Kbcm*

Freezing point depression

Δ*Tf* = *Kfcm*

**Answer Key**

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| 1. | A |
| 2. | A |
| 3. | E |
| 4. | E |
| 5. | C |
| 6. | C |
| 7. | D |
| 8. | E |
| 9. | E |
| 10. | D |
| 11. | B |
| 12. | A |
| 13. | A |
| 14. | C |
| 15. | B |
| 16. | B |
| 17. | D |
| 18. | C |
| 19. | D |
| 20. | A |