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

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| 1. | Which of the following correctly describes the equilibrium constant for the gas-phase reaction between H2 and O2 to form gaseous H2O? | |
| A) | *Kc* = |
| B) | *Kc* = |
| C) | *Kc* = |
| D) | *Kc* = |
| E) | *Kc =* [H2O] |

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| 2. | For the reaction Br2(*g*) + Cl2(*g*) 2BrCl(*g*), at equilibrium, it is found that the concentrations of Br2, Cl2, and BrCl are 0.237 *M*, 0.397 *M*, and 1.68 × 10–3 *M*, respectively. What is the value of *Kc*? | |
| A) | 1.79 × 10–2 |
| B) | 3.01 × 10–5 |
| C) | 3.32 × 104 |
| D) | 1.20 × 10–4 |
| E) | 5.59 × 101 |

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| 3. | Consider the following equilibrium:  C2H6(*g*) + C5H12(*g*) CH4(*g*) + C6H14(*g*); *Kp* = 9.57 at 500 K  Suppose 58.1 g each of CH4, C2H6, C5H12, and C6H14 are placed in a 50.0-L reaction vessel at 500 K. Which of the following statements is correct? | |
| A) | Because *Qc* = 1, the system is at equilibrium. |
| B) | Because *Qc* = 1, more products will be formed. |
| C) | Because *Qc* = 1, more reactants will be formed. |
| D) | Because *Qc* < *Kc*, more products will be formed. |
| E) | Because *Qc* > *Kc*, more reactants will be formed. |

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| 4. | Which of the following equilibria would not be affected by pressure changes at constant temperature? | |
| A) | CO(*g*) + ½O2(*g*) CO2(*g*) |
| B) | CaCO3(*s*) CaO(*s*) + CO2(*g*) |
| C) | 2Hg(*l*) + O2(*g*) 2HgO(*s*) |
| D) | CO2(*g*) + H2(*g*) CO(*g*) + H2O(*g*) |
| E) | 2H2(*g*) + O2(*g*) 2H2O(*l*) |

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| 5. | Which of the following statements is incorrect concerning the addition of a catalyst to an equilibrium reaction system? | |
| A) | The catalyst increases the rate of both the forward and the reverse reaction. |
| B) | If the reactants are capable of forming many different products, a catalyst may selectively speed up one reaction over another. |
| C) | The catalyst speeds up the attainment of equilibrium. |
| D) | The catalyst increases the yield of the products. |
| E) | The catalyst is not consumed in either the forward or the reverse reaction. |

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| 6. | Which of the following is true for a system whose equilibrium constant is relatively small? | |
| A) | It will take a short time to reach equilibrium. |
| B) | It will take a long time to reach equilibrium. |
| C) | The equilibrium lies to the left. |
| D) | The equilibrium lies to the right. |
| E) | Two of these are true. |

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| 7. | Consider the following equilibrium:  PCl3(*g*) + Cl2(*g*) PCl5(*g*); *H* = –92 kJ  The concentration of PCl3 at equilibrium may be increased by | |
| A) | increasing the pressure. |
| B) | adding Cl2 to the system. |
| C) | decreasing the temperature. |
| D) | the addition of neon. |
| E) | the addition of PCl5. |

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| 8. | Which of the following statements is incorrect? | |
| A) | An Arrhenius base is an electron-pair acceptor. |
| B) | An Arrhenius acid increases the concentration of hydronium ion. |
| C) | A Brønsted–Lowry base is a proton acceptor. |
| D) | A Brønsted–Lowry acid is a proton donor. |
| E) | Acids tend to be sour, and bases tend to be bitter. |

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| 9. | Which are the Brønsted–Lowry bases in the following equilibrium?  HCOO–(*aq*) + H2O(*l*) HCOOH(*aq*) + OH–(*aq*) | |
| A) | HCOO– and HCOOH |
| B) | HCOO– and OH– |
| C) | H2O and OH– |
| D) | H2O and HCOOH |
| E) | H2O, HCOOH, and OH– |

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| 10. | What is a conjugate acid–base pair for the following equilibrium?  H2O(*l*) + HPO42–(*aq*) H2PO4–(*aq*) + OH–(*aq*) | |
| A) | H2O is an acid and OH– is its conjugate base. |
| B) | H2O is an acid and HPO42– is its conjugate base. |
| C) | HPO42– is an acid and OH– is its conjugate base. |
| D) | HPO42– is an acid and H2PO4– is its conjugate base. |
| E) | HPO42– is an acid and H2O is its conjugate base. |

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| 11. | Which of the following species cannot act as a Lewis base? | |
| A) | S2– |
| B) | SH– |
| C) | Al3+ |
| D) | H2O |
| E) | H2S |

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| 12. | At 0°C, the ion-product constant of water, *K*w, is 1.23 × 10-15. What is the pH of pure water at 0°C? | |
| A) | 7.000 |
| B) | 7.555 |
| C) | 6.875 |
| D) | 7.455 |
| E) | none of these |

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| 13. | Which of the following expressions is not equivalent to pH? | |
| A) |  |
| B) | 14.0 – pOH |
| C) | –log [H+(*aq*)] |
| D) |  |
| E) | –log *Kw* |

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| 14. | What is the pH of a 0.020 *M* HClO4 solution? | |
| A) | 15.70 |
| B) | 1.70 |
| C) | 12.30 |
| D) | 10.09 |
| E) | 3.91 |

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| 15. | A solution has a pOH of 5.46. What is its hydroxide-ion concentration? | |
| A) | 2.0 × 10-4 *M* |
| B) | 4.3 × 10-3 *M* |
| C) | 2.9 × 10-9 *M* |
| D) | 3.5 × 10-6 *M* |
| E) | 5.5 *M* |

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| 16. | A solution has a pH value of 3.75. What is the pOH for this solution? | |
| A) | 10.25 |
| B) | 3.73 |
| C) | 7.00 |
| D) | 3.75 |
| E) | 1.78 |

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| 17. | The ionization constant of water at a temperature above 25°C is 2.3 × 10-14. What is the pH of pure water at this temperature?  2H2O(*l*) H3O+(*aq*) + OH–(*aq*) | |
| A) | 13.70 |
| B) | 6.82 |
| C) | 7.00 |
| D) | 7.82 |
| E) | 5.62 |

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| 18. | The titration curve shown below represents the titration of a weak base with a strong acid. Which point represents the equivalence point? | |
| A) | I |
| B) | II |
| C) | III |
| D) | IV |
| E) | V |

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| 19. | What is the pH at the equivalence point of the titration of a strong acid with a strong base? | |
| A) | 3.9 |
| B) | 4.5 |
| C) | 7.0 |
| D) | 8.2 |
| E) | none of these |

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| 20. | What is the hydrogen-ion concentration of a solution that is 0.015 *M* in acetic acid and 0.015 *M* in sodium acetate at 25°C? The acid-ionization constant of acetic acid is 1.8 x 10-5 at 25°C. | |
| A) | 1.8 × 10-7 *M* |
| B) | 1.8 × 10-6 *M* |
| C) | 1.8 × 10-5 *M* |
| D) | 1.8 × 10-4 *M* |
| E) | 1.8  10-3 *M* |

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| 21. | What will happen if a small amount of hydrochloric acid is added to a 0.1 *M* solution of HF? | |
| A) | The percent ionization of HF will increase. |
| B) | The percent ionization of HF will decrease. |
| C) | The percent ionization of HF will remain unchanged. |
| D) | *Ka* for HF will increase. |
| E) | *Ka* for HF will decrease. |

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| 22. | What is the pOH of a solution prepared by adding 0.417 g of ammonium chloride to 145 mL of water? *Kb* of NH3 is 1.8 × 10-5. | |
| A) | 7.00 |
| B) | 8.74 |
| C) | 3.01 |
| D) | 10.99 |
| E) | 5.26 |

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| 23. | Which of the following salts is most likely to form an aqueous solution having the pH shown in the figure below? | |
| A) | KCl |
| B) | Na2CO3 |
| C) | NH4Cl |
| D) | RbF |
| E) | Zn(NO3)2 |

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| 24. | Which of the following equilibria best represents the hydrolysis reaction that occurs in an aqueous solution of NH4Cl? | |
| A) | NH4+(*aq*) + Cl–(*aq*) NH4Cl(*s*) |
| B) | Cl–(*aq*) + H2O(*l*) HCl(*aq*) + OH–(*aq*) |
| C) | NH4+(*aq*) + OH–(*aq*) NH3(*aq*) + H2O(*l*) |
| D) | NH4+(*aq*)+ H2O(*l*) NH3(*aq*) + H3O+(*aq*) |
| E) | Cl–(*aq*)+ H3O+(*aq*) HCl(*aq*) + H2O(*l*) |

25. Calculate the pH for a titration of a 0.30 M KOH with 60 mL of a 0.25 M HNO3 @

a) 0mL

b) 25mL

c) 50mL

d) 75mL

26. Calculate the pH and the concentration of all species present in a 0.002 M HF solution using approximation and quadratic method:

HF + H2O(l) ↔ H3O+ + F- Ka = 3.5 x 10-