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

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| 1. | What is the solubility product expression for La2(CO3)3? | |
| A) | *Ksp* = [La2+]2[CO32–]3 |
| B) | *Ksp* = [2La3+][3CO32–] |
| C) | *Ksp* = [2La3+]2[3CO32–]3 |
| D) | *Ksp* = [La3+]2[CO32–]3 |
| E) | *Ksp* = [2La3+]2[CO32–]3 |

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| 2. | What is the correct mathematical expression for finding the molar solubility (*s*) of Sn(OH)2? | |
| A) | 2*s*2 = *Ksp* |
| B) | 2*s*3 = *Ksp* |
| C) | 108*s*5 = *Ksp* |
| D) | 4*s*3 = *Ksp* |
| E) | 8*s*3 = *Ksp* |

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| 3. | It is found that the concentration of Pb2+ in a saturated solution of lead(II) fluoride is 3.0  10–3 *M*. What is *Ksp* for PbF2? | |
| A) | 1.1  10–7 |
| B) | 2.8  10–8 |
| C) | 9.1  10–6 |
| D) | 1.3  10–9 |
| E) | 9.1  10–3 |

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| 4. | What is the molar solubility of silver (I) iodide at 25ºC? The solubility product constant for silver (I) iodide is 8.3  10–17 at 25ºC. | |
| A) | 8.3  10–17 *M* |
| B) | 4.2  10–17 *M* |
| C) | 4.8  10–5 *M* |
| D) | 2.7  10–6 *M* |
| E) | 9.1  10–9 *M* |

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| 5. | Rank the following metal sulfides in order of increasing molar solubility in water.   |  |  | | --- | --- | | Salt | *Ksp* | | CoS | 4  10–21 | | CuS | 6  10–36 | | FeS | 6  10–18 | | HgS | 1.6  10–52 | | MnS | 2.5  10–10 | | |
| A) | MnS < FeS < CoS < CuS < HgS |
| B) | FeS < HgS < CoS < CuS < MnS |
| C) | HgS < CuS < CoS < FeS < MnS |
| D) | CoS < CuS < FeS < HgS < MnS |
| E) | CuS < CoS < FeS < MnS < HgS |

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| 6. | In which of these solutions would silver (I) carbonate have the lowest molar solubility? For silver (I) carbonate, *Ksp* = 8.5  10–12. | |
| A) | pure water |
| B) | 0.1 *M* AgNO3 |
| C) | 0.01 *M* AgNO3 |
| D) | 0.1 *M* Na2CO3 |
| E) | 0.03 *M* H2CO3 |

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| 7. | For which of the following will precipitation be expected? | |
| A) | *Qc* > *Ksp* |
| B) | *Qc* < *Ksp* |
| C) | *Qc* = *Ksp* |
| D) | *Qc* = 1 |
| E) | *Ksp* = 1 |

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| 8. | What will happen if 0.1 mol of solid silver (I) nitrate is added to 1.0 L of a saturated solution of silver (I) chromate? For Ag2CrO4, *Ksp* = 2.4  10–12. | |
| A) | The AgNO3 will settle to the bottom without dissolving. |
| B) | The concentration of Ag+ in solution will not change. |
| C) | The concentration of CrO42– will increase. |
| D) | Some Ag2CrO4 will precipitate. |
| E) | Nothing will happen. |

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| 9. | In the sulfide scheme for qualitative analysis, the cations of Analytical Group IV are precipitated as phosphates or carbonates. Analytical Group IV consists of | |
| A) | alkali metals. |
| B) | alkaline earth elements. |
| C) | the halogens. |
| D) | transition metals having +2 ions. |
| E) | none of these |

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| 10. | What is the solubility (in g/L) of silver(I) iodide at 25ºC? The solubility product constant for silver(I) iodide is 8.3  10–17 at 25ºC. | |
| A) | 1.9  10–14 g/L |
| B) | 9.7  10–15 g/L |
| C) | 1.1  10–2 g/L |
| D) | 6.5  10–4 g/L |
| E) | 2.1  10–6 g/L |

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| 11. | According to the first law of thermodynamics, the energy of the universe is constant. Does this mean that Δ*E* is always equal to zero? | |
| A) | Yes, Δ*E* = 0 at all times, which is why *q* = -*w*. |
| B) | No, Δ*E* does not always equal zero, but this is due only to factors such as friction and heat. |
| C) | No, Δ*E* does not always equal zero because it refers to the system's internal energy, which is affected by heat and work. |
| D) | No, Δ*E* never equals zero because work is always being done on the system or by the system. |
| E) | No, Δ*E* never equals zero because energy is always flowing between the system and the surroundings. |

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| 12. | Which of the following is true for the sublimation of CO2(*s*)? | |
| A) | *S* > 0 and *H* > 0. |
| B) | *S* < 0 and *H* < 0. |
| C) | *S* < 0 and *H* > 0. |
| D) | *S* > 0 and *H* < 0. |
| E) | *S* = 0 and *H* = 0. |

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| 13. | Which of the following has the lowest entropy per mole? | |
| A) | liquid sodium at 100°C |
| B) | solid sodium at 30°C |
| C) | gaseous sodium at 900°C and 1 atm |
| D) | gaseous sodium at 900°C and 0.5 atm |
| E) | a solid solution of sodium in potassium at 30°C |

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| 14. | At the normal boiling point of benzene, *H*°vap = 30.7 kJ/mol and *S*°vap = 86.9 J/(mol · K). What is the normal boiling point of benzene? | |
| A) | 353 K |
| B) | 115 K |
| C) | 869 K |
| D) | 267 K |
| E) | 373 K |

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| 15. | Which of the following reactions has the smallest value of *S*° at 25°C? | |
| A) | C6H6(*s*)  C6H6(*l*) |
| B) | C6H6(*s*)  C6H6(*g*) |
| C) | C6H6(*l*) + Br2(*l*)  C6H5Br(*l*) + HBr(*g*) |
| D) | C6H6(*l*) + 9/2O2(*g*)  6CO(*g*) + 3H2O(*g*) |
| E) | C6H6(*l*) + 15/2O2(*g*)  6CO2(*g*) + 3H2O(*g*) |

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| 16. | What is the change in entropy when 0.894 g of water decomposes to form hydrogen gas and oxygen gas at 298 K?  2H2O(*l*)  2H2(*g*) + O2(*g*); *S*° = 326.3 J/K at 298 K | |
| A) | 292 J/K |
| B) | 32.4 J/K |
| C) | 16.2 J/K |
| D) | 8.10 J/K |
| E) | 0.109 J/K |

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| 17. | What is the thermodynamic quantity that provides the criterion for the spontaneity of a chemical reaction? | |
| A) | *S* |
| B) | *H* |
| C) | *U* |
| D) | *G* |
| E) | *T**S* |

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| 18. | For a reaction system that is at equilibrium, which of the following must always be true? | |
| A) | *G* = 0 |
| B) | *H* = 0 |
| C) | *U* = 0 |
| D) | *S* = 0 |
| E) | *q* = 0 |

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| 19. | Consder the following reaction:  3C(*s*) + 3H2(*g*)  C3H6(*g*); *H*° = 20.4 kJ; *S*° = –131.6 J/K at 298 K  What is the equilibrium constant at 298 K for this reaction? | |
| A) | 1.0 |
| B) | 3.5  10–11 |
| C) | 2.8  1010 |
| D) | 2.6  10–4 |
| E) | 1.3  10–7 |

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| 20. | For the reaction CaCO3(*s*)  CaO(*s*) + O2(*g*) at 1 atm pressure, the values of *H* and *S* are both positive, and the process is spontaneous at high temperatures. Which of the following statements about this reaction is true? | |
| A) | *G* at room temperature is negative. |
| B) | The process is exothermic at high temperatures and endothermic at room temperature. |
| C) | The change in entropy is the driving force for the reaction. |
| D) | The reverse reaction is nonspontaneous at room temperature. |
| E) | The reverse process is endothermic. |

**Answer Key**

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