

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) The thermodynamic quantity that expresses the degree of disorder in a system is _____.
- A) internal energy
B) heat flow
C) bond energy
D) entropy
E) enthalpy
- 2) Which one of the following statements is true about the equilibrium constant for a reaction if ΔG° for the reaction is negative?
- A) $K < 1$
B) $K = 0$
C) $K > 1$
D) $K = 1$
E) More information is needed.
- 3) For an isothermal process, $\Delta S =$ _____.
- A) q B) Tq_{rev} C) q_{rev}/T D) $q + w$ E) q_{rev}
- 4) The solubility of lead (II) chloride (PbCl_2) is 1.6×10^{-2} M. What is the K_{SP} of PbCl_2 ?
- A) 1.6×10^{-5} B) 4.1×10^{-6} C) 5.0×10^{-4} D) 1.6×10^{-2} E) 3.1×10^{-7}

Consider the following table of K_{SP} values.

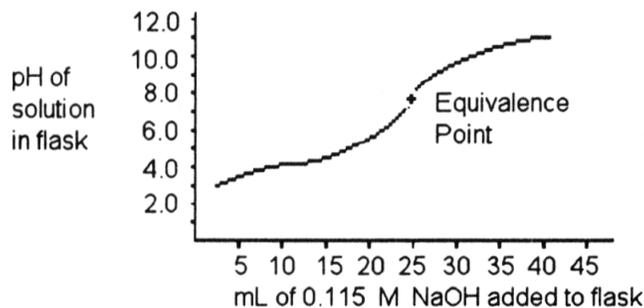
| Name | Formula | K_{SP} |
|-------------------|-------------------|-----------------------|
| Cadmium carbonate | CdCO_3 | 5.2×10^{-12} |
| Cadmium hydroxide | Cd(OH)_2 | 2.5×10^{-14} |
| Calcium fluoride | CaF_2 | 3.9×10^{-11} |
| Silver iodide | AgI | 8.3×10^{-17} |
| Zinc carbonate | ZnCO_3 | 1.4×10^{-11} |

- 5) Which compound listed below has the smallest molar solubility in water?
- A) AgI B) CdCO_3 C) Cd(OH)_2 D) ZnCO_3 E) CaF_2
- 6) Which compound listed below has the greatest molar solubility in water?
- A) CaF_2 B) CdCO_3 C) AgI D) ZnCO_3 E) Cd(OH)_2

- 7) ΔS is positive for the reaction _____.
- A) $2\text{Hg}(\text{l}) + \text{O}_2(\text{g}) \rightarrow 2\text{HgO}(\text{s})$
 B) $2\text{NO}_2(\text{g}) \rightarrow \text{N}_2\text{O}_4(\text{g})$
 C) $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$
 D) $\text{CO}_2(\text{g}) \rightarrow \text{CO}_2(\text{s})$
 E) $\text{BaF}_2(\text{s}) \rightarrow \text{Ba}^{2+}(\text{aq}) + 2\text{F}^{-}(\text{aq})$
- 8) The second law of thermodynamics can be given as _____.
- A) $\Delta E = q + w$
 B) $\Delta H^{\circ}_{\text{rxn}} = \sum n\Delta H^{\circ}_{\text{f}}(\text{products}) - \sum m\Delta H^{\circ}_{\text{f}}(\text{reactants})$
 C) $\Delta S = q_{\text{rev}}/T$ at constant temperature
 D) the entropy of a pure crystalline substance is zero at absolute zero
 E) for any spontaneous process, the entropy of the universe increases
- 9) The addition of hydrofluoric acid and _____ to water produces a buffer solution.
- A) NaF B) NaBr C) NaCl D) NaNO₃ E) HCl
- 10) What change will be caused by addition of a small amount of HCl to a solution containing fluoride ions and hydrogen fluoride?
- A) The concentration of hydronium ions will increase significantly.
 B) The fluoride ions will precipitate out of solution as its acid salt.
 C) The concentration of hydrogen fluoride will decrease and the concentration of fluoride ions will increase.
 D) The concentration of fluoride ion will decrease and the concentration of hydrogen fluoride will increase.
 E) The concentration of fluoride ions will increase as will the concentration of hydronium ions.
- 11) Calculate the pH of a solution prepared by dissolving 0.37 mol of formic acid (HCO₂H) and 0.23 mol of sodium formate (NaCO₂H) in water sufficient to yield 1.00 L of solution. The K_{a} of formic acid is 1.8×10^{-4} .
- A) 3.54 B) 2.30 C) 10.46 D) 3.95 E) 2.09
- 12) As a result of _____, we are able to measure absolute values of the entropy of a sample and are not forced to define relative values as we were when we defined enthalpies of formation, $\Delta H^{\circ}_{\text{f}}$.
- A) the third law of thermodynamics
 B) Hess's law
 C) the second law of thermodynamics
 D) reversibility
 E) the first law of thermodynamics
- 13) For which salt should the aqueous solubility be most sensitive to pH?
- A) CaF₂ B) CaBr₂ C) CaCl₂ D) Ca(NO₃)₂ E) CaI₂

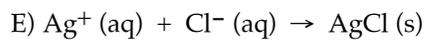
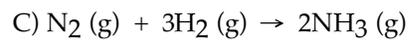
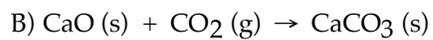
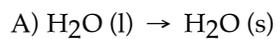
- 14) Which reaction produces a decrease in the entropy of the system?
- A) $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})$
 B) $\text{CO}_2(\text{s}) \rightarrow \text{CO}_2(\text{g})$
 C) $2\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}(\text{g})$
 D) $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g})$
 E) $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
- 15) Which of the following is a reversible process?
- A) freezing of water at -10°C and 1 atm
 B) melting of ice at 0°C and 1 atm
 C) freezing of water at -25°C and 1 atm
 D) melting of ice at 25°C and 1 atm
 E) evaporation of water at 25°C and 1 atm
- 16) Of the following, the entropy of _____ is the largest.
- A) $\text{HCl}(\text{s})$ B) $\text{HCl}(\text{g})$ C) $\text{HCl}(\text{l})$ D) $\text{HBr}(\text{g})$ E) $\text{HI}(\text{g})$
- 17) The first law of thermodynamics can be given as _____.
- A) the entropy of a pure crystalline substance at absolute zero is zero
 B) $\Delta E = q + w$
 C) for any spontaneous process, the entropy of the universe increases
 D) $\Delta S = q_{\text{rev}}/T$ at constant temperature
 E) $\Delta H^\circ_{\text{rxn}} = \sum n\Delta H^\circ_f(\text{products}) - \sum m\Delta H^\circ_f(\text{reactants})$
- 18) When a system is at equilibrium, _____.
- A) the forward and the reverse processes are both spontaneous
 B) both forward and reverse processes have stopped
 C) the process is not spontaneous in either direction
 D) the reverse process is spontaneous but the forward process is not
 E) the forward process is spontaneous but the reverse process is not
- 19) Which reaction produces an increase in the entropy of the system?
- A) $\text{CO}_2(\text{s}) \rightarrow \text{CO}_2(\text{g})$
 B) $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$
 C) $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$
 D) $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{s})$
 E) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$

- 20) If ΔG° for a reaction is greater than zero, then _____.
- A) $K > 1$
 - B) $K < 1$
 - C) $K = 1$
 - D) $K = 0$
 - E) More information is needed.
- 21) Of the following solutions, which has the greatest buffering capacity?
- A) 0.821 M HF and 0.217 M NaF
 - B) They are all buffer solutions and would all have the same capacity.
 - C) 0.821 M HF and 0.909 M NaF
 - D) 0.100 M HF and 0.217 M NaF
 - E) 0.121 M HF and 0.667 M NaF
- 22) Which one of the following processes produces a decrease in the entropy of the system?
- A) dissolution of solid KCl in water
 - B) boiling water to form steam
 - C) mixing of two gases into one container
 - D) melting ice to form water
 - E) freezing water to form ice
- 23) A solution containing which one of the following pairs of substances will be a buffer solution?
- A) RbCl, HCl
 - B) NaI, HI
 - C) CsF, HF
 - D) KBr, HBr
 - E) none of the above
- 24) The entropy of the universe is _____.
- A) continually decreasing
 - B) the same as the energy, E
 - C) continually increasing
 - D) constant
 - E) zero
- 25) Of the substances below, _____ will decrease the solubility of $\text{Pb}(\text{OH})_2$ in a saturated solution.
- A) HNO_3
 - B) $\text{Pb}(\text{NO}_3)_2$
 - C) H_2O_2
 - D) NaCl
 - E) NaNO_3

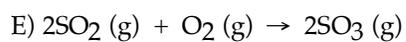
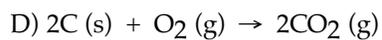
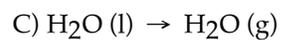
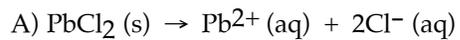


- 26) A 25.0-mL sample of a solution of an unknown compound is titrated with a 0.115 M NaOH solution. The titration curve above was obtained. The unknown compound is _____.
- a strong acid
 - a weak acid
 - a weak base
 - a strong base
 - neither an acid nor a base
- 27) In which of the following aqueous solutions would you expect AgCl to have the highest solubility?
- 0.020 KCl
 - 0.015 NaCl
 - 0.020 AgNO₃
 - 0.020 M BaCl₂
 - pure water
- 28) A reaction that is spontaneous as written _____.
- has an equilibrium position that lies far to the left
 - is also spontaneous in the reverse direction
 - will proceed without outside intervention
 - is very rapid
 - is very slow
- 29) The third law of thermodynamics can be given as _____.
- for any spontaneous process, the entropy of the universe increases
 - $\Delta E = q + w$
 - $\Delta S = q_{\text{rev}}/T$ at constant temperature
 - $\Delta H^{\circ}_{\text{rxn}} = \sum n\Delta H^{\circ}_{\text{f}}(\text{products}) - \sum m\Delta H^{\circ}_{\text{f}}(\text{reactants})$
 - the entropy of a pure crystalline substance at absolute zero is zero
- 30) In a spontaneous process, _____.
- the reverse process occurs at a higher rate than the forward process
 - the reverse process is also spontaneous
 - the path between reactants and products is reversible
 - forward and reverse processes occur at the same rate
 - the path between reactants and products is irreversible

31) ΔS is positive for the reaction _____.



32) ΔS is negative for the reaction _____.



Answer Key

Testname: 1412-3F.TST

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) D
- 2) C
- 3) C
- 4) A
- 5) A
- 6) A
- 7) E
- 8) E
- 9) A
- 10) D
- 11) A
- 12) A
- 13) A
- 14) A
- 15) B
- 16) E
- 17) B
- 18) C
- 19) A
- 20) B
- 21) C
- 22) E
- 23) C
- 24) C
- 25) B
- 26) B
- 27) E
- 28) C
- 29) E
- 30) E
- 31) D
- 32) E