1062-2nd Chem Exam-1070516(A)

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

1) For a given reaction, $\Delta S = +69.0$ J/mol·K, and the reaction is spontaneous at temperatures above the crossover temperature, 439 K. The value of ΔH = _____ kJ/mol, assuming that ΔH and ΔS do not vary with temperature.

A) 30.3 B) 1.57×10^{-4} C) 6.36×10^{-3} D) -1.57×10^{-4} E) -30.3

Answer: A

2) A reversible process is one that _____.

A) is spontaneous in both directions
B) must be carried out at low temperature
C) can be reversed with no net change in either system or surroundings
D) happens spontaneously
E) must be carried out at high temperature

Answer: C

3) A reaction that is not spontaneous at low temperature can become spontaneous at high temperature if ΔH is _____ and ΔS is _____.

A) +, + B) -, - C) +, - D) -, + E) +, 0

Answer: A

4) Consider a pure crystalline solid that is heated from absolute zero to a temperature above the boiling point of the liquid. Which of the following processes produces the greatest increase in the entropy of the substance?

A) heating the solid
B) vaporizing the liquid
C) melting the solid
D) heating the liquid
E) heating the gas

Answer: B

5) The standard Gibbs free energy of formation of _____ is zero.

(a) H_2O (l)
(b) Fe (s)
(c) I_2 (s)

A) (a) only
B) (b) only
C) (c) only
D) (b) and (c)
E) (a), (b), and (c)

Answer: D

6) Given the thermodynamic data in the table below, calculate the equilibrium constant (at 298 K) for the reaction:

$$2\,SO_2\,(g) + O_2\,(g) \rightleftharpoons 2\,SO_3\,(g)$$

Substance	$\Delta H_f°$ (kJ/mol)	S° (J/mol · K)
SO_2 (g)	-297	249
O_2 (g)	0	205
SO_3 (g)	-395	256

A) 1.06
B) 2.40×10^{24}
C) 1.95
D) 3.82×10^{23}
E) More data are needed.

Answer: B

7) The equilibrium constant for a reaction is 0.38 at 25 °C. What is the value of $\Delta G°$ (kJ/mol) at this temperature?
A) 200
B) 4.2
C) -4.2
D) 2.4
E) More information is needed.

Answer: D

8) The second law of thermodynamics states that _____.
A) $\Delta E = q + w$
B) the entropy of a pure crystalline substance is zero at absolute zero
C) $\Delta S = q_{rev}/T$ at constant temperature
D) for any spontaneous process, the entropy of the universe increases
E) $\Delta H°_{rxn} = \Sigma\, n\Delta H°_f$ (products) - $\Sigma\, m\Delta H°_f$ (reactants)

Answer: D

9) For the reaction

$$C_2H_6\,(g) \rightarrow C_2H_4\,(g) + H_2\,(g)$$

$\Delta H°$ is +137 kJ/mol and $\Delta S°$ is +120 J/K · mol. This reaction is _____.
A) spontaneous at all temperatures
B) nonspontaneous at all temperatures
C) spontaneous only at high temperature
D) spontaneous only at low temperature

Answer: C

10) The normal boiling point of methanol is 64.7 °C and the molar enthalpy of vaporization if 71.8 kJ/mol. The value of ΔS when 1.75 mol of CH_3OH (l) vaporizes at 64.7 °C is _____ J/K.
A) 372
B) 4.24×10^7
C) 1.94
D) 0.372
E) 1.94×10^3

Answer: A

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25 °C)

Substance	$\Delta H°_f$ (kJ/mol)	$\Delta G°_f$ (kJ/mol)	S (J/K-mol)
Carbon			
C (s, diamond)	1.88	2.84	2.43
C (s, graphite)	0	0	5.69
C_2H_2 (g)	226.7	209.2	200.8
C_2H_4 (g)	52.30	68.11	219.4
C_2H_6 (g)	-84.68	-32.89	229.5
CO (g)	-110.5	-137.2	197.9
CO_2 (g)	-393.5	-394.4	213.6
Hydrogen			
H_2(g)	0	0	130.58
Oxygen			
O_2 (g)	0	0	205.0
H_2O (l)	-285.83	-237.13	69.91

11) The value of $\Delta S°$ for the catalytic hydrogenation of acetylene to ethene,

$$C_2H_2\,(g) + H_2\,(g) \rightarrow C_2H_4\,(g)$$

is _____ J/K· mol.

A) +112.0 B) -18.6 C) -112.0 D) +550.8 E) +18.6

Answer: C

12) With thermodynamics, one cannot determine _____.

A) the extent of a reaction
B) the temperature at which a reaction will be spontaneous
C) the speed of a reaction
D) the direction of a spontaneous reaction
E) the value of the equilibrium constant

Answer: C

13) Of the following, the entropy of gaseous _____ is the largest at 25 °C and 1 atm.

A) Cl_2 B) O_3 C) F_2 D) I_2 E) Br_2

Answer: D

14) A solution containing which one of the following pairs of substances will be a buffer solution?

A) KBr, HBr
B) NaI, HI
C) CsF, HF
D) RbCl, HCl
E) none of the above

Answer: C

15) A solution is prepared by dissolving 0.23 mol of hydrofluoric acid and 0.27 mol of sodium fluoride in water sufficient to yield 1.00 L of solution. The addition of 0.05 mol of HCl to this buffer solution causes the pH to drop slightly. The pH does not decrease drastically because the HCl reacts with the _____ present in the buffer solution. The K_a of hydrofluoric acid is 1.36×10^{-3}.

A) fluoride ion
B) H_3O^+
C) hydrofluoric acid
D) H_2O
E) This is a buffer solution: the pH does not change upon addition of acid or base.

Answer: A

16) Which of the following could be added to a solution of sodium acetate to produce a buffer?

A) acetic acid or hydrochloric acid
B) sodium chloride or potassium acetate
C) potassium acetate only
D) acetic acid only
E) hydrochloric acid only

Answer: A

17) Of the following solutions, which has the greatest buffering capacity?

A) They are all buffer solutions and would all have the same capacity.
B) 0.821 M HF and 0.217 M NaF
C) 0.100 M HF and 0.217 M NaF
D) 0.821 M HF and 0.909 M NaF
E) 0.121 M HF and 0.667 M NaF

Answer: D

18) In which of the following aqueous solutions would you expect $PbCl_2$ to have the lowest solubility?

A) 0.015 M $PbNO_3$
B) 0.015 M NaCl
C) 0.020 M KCl
D) pure water
E) 0.020 M $BaCl_2$

Answer: E

19) A result of the common-ion effect is _____.

A) that ions such as K^+ and Na^+ are common ions, so that their values in equilibrium constant expressions are always 1.00
B) that common ions, such as Na^+ (aq), don't affect equilibrium constants
C) that some ions, such as Na^+ (aq), frequently appear in solutions but do not participate in solubility equilibria
D) that the selective precipitation of a metal ion, such as Ag^+, is promoted by the addition of an appropriate counterion (X^-) that produces a compound (AgX) with a very low solubility
E) that common ions precipitate all counter-ions

Answer: D

20) What is the solubility (in M) of $PbCl_2$ in a 0.15 M solution of HCl? The K_{sp} of $PbCl_2$ is 1.6×10^{-5}.

A) 7.1×10^{-4} B) 1.1×10^{-4} C) 2.0×10^{-3} D) 1.8×10^{-4} E) 1.6×10^{-5}

Answer: A

21) Calculate the pH of a solution prepared by dissolving 0.150 mol of benzoic acid and 0.300 mol of sodium benzoate in water sufficient to yield 1.00 L of solution. The K_a of benzoic acid is 6.30×10^{-5}.

A) 4.195 B) 2.516 C) 4.502 D) 10.158 E) 3.892

Answer: C

22) A 25.0 mL sample of an HCl solution is titrated with a 0.139 M NaOH solution. The equivalence point is reached with 25.3 mL of base. The concentration of HCl is _____ M.

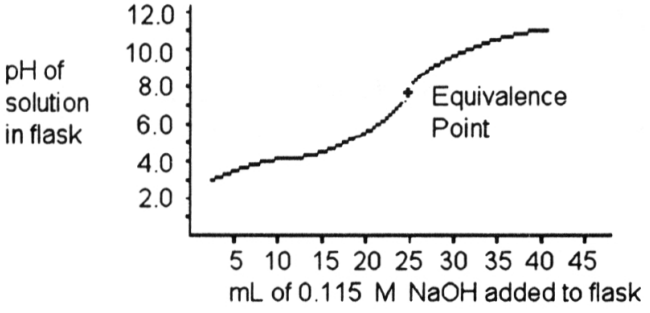
A) 0.0352 B) 11.7 C) 0.00352 D) 0.139 E) 0.141

Answer: E

23) A 25.0 mL sample of 0.723 M $HClO_4$ is titrated with a 0.27 M KOH solution. The H_3O^+ concentration after the addition of 80.0 mL of KOH is _____ M.

A) 4×10^{-2} B) 0.7 C) 1×10^{-7} D) 0.4 E) 3×10^{-13}

Answer: E



24) 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) a weak base
B) a strong acid
C) a strong base
D) a weak acid
E) neither an acid nor a base

Answer: D

25) The solubility of manganese (II) hydroxide ($Mn(OH)_2$) is 2.2×10^{-5} M. What is the K_{sp} of $Mn(OH)_2$?

A) 2.1×10^{-14} B) 1.1×10^{-14} C) 2.2×10^{-5} D) 4.8×10^{-10} E) 4.3×10^{-14}

Answer: E

26) Calculate the maximum concentration (in M) of silver ions (Ag^+) in a solution that contains 0.025 M of CO_3^{2-}. The K_{sp} of Ag_2CO_3 is 8.1×10^{-12}.

A) 1.4×10^{-6} B) 8.1×10^{-12} C) 2.8×10^{-6} D) 1.8×10^{-5} E) 3.2×10^{-10}

Answer: D

27) A solution of NaF is added dropwise to a solution that is 0.0144 M in Ba^{2+}. When the concentration of F^- exceeds _____ M, BaF_2 will precipitate. Neglect volume changes. For BaF_2, $K_{sp} = 1.7 \times 10^{-6}$.

A) 2.7×10^{-3} B) 5.9×10^{-5} C) 1.1×10^{-2} D) 1.2×10^{-4} E) 2.4×10^{-8}

Answer: C

28) Which one of the following is a Brønsted-Lowry acid?

A) HNO_2

B) $(CH_3)_3NH^+$

C) HF

D) CH_3COOH

E) all of the above

Answer: E

29) Which one of the following statements regarding K_W is false?

A) K_W changes with temperature.

B) K_W is known as the ion product of water.

C) The value of K_W shows that water is a weak acid.

D) pK_W is 14.00 at 25°C

E) The value of K_W is always 1.0×10^{-14}.

Answer: E

30) Classify the following compounds as weak acids (W) or strong acids (S):

hydrocyanic acid hydrofluoric acid phenol

A) W W W B) S W W C) W S W D) W S S E) S S S

Answer: A

31) HA is a weak acid. Which equilibrium corresponds to the equilibrium constant K_b for A^-?

A) $A^-(aq) + H_2O(l) \rightleftharpoons HA(aq) + OH^-(aq)$

B) $HA(aq) + H_2O(l) \rightleftharpoons H_2A^+(aq) + OH^-(aq)$

C) $A^-(aq) + H_3O^+(aq) \rightleftharpoons HA(aq) + H_2O(l)$

D) $A^-(aq) + OH^-(aq) \rightleftharpoons HOA^{2-}(aq)$

E) $HA(aq) + OH^-(aq) \rightleftharpoons H_2O(l) + H^+(aq)$

Answer: A

32) In which of the following aqueous solutions does the weak acid exhibit the lowest percentage ionization?

A) 0.01 M $HC_2H_3O_2$ ($K_a = 1.8 \times 10^{-5}$)

B) 0.01 M HF ($K_a = 6.8 \times 10^{-4}$)

C) 0.01 M HClO ($K_a = 3.0 \times 10^{-8}$)

D) 0.01 M HNO_2 ($K_a = 4.5 \times 10^{-4}$)

E) These will all exhibit the same percentage ionization.

Answer: C

33) Using the data in the table, which of the conjugate bases below is the weakest base?

Acid	K_a
HOAc	1.8×10^{-5}
$HC_7H_5O_2$	6.3×10^{-5}
HNO_2	4.5×10^{-4}
HF	6.8×10^{-4}

A) $C_7H_5O_2^-$
B) F^-
C) NO_2^-
D) OAc^-
E) OAc^- and $C_7H_5O_2^-$

Answer: B

34) Which of the following aqueous solutions has the lowest $[OH^-]$?
A) a 1×10^{-3} M solution of NH_4Cl
B) a 1×10^{-4} M solution of HNO_3
C) pure water
D) a solution with a pOH of 12.0
E) a solution with a pH of 3.0

Answer: D

35) Of the following substances, an aqueous solution of _____ will form basic solutions.

NH_4Cl $Cu(NO_3)_2$ K_2CO_3 NaF

A) NaF only
B) K_2CO_3, NH_4Cl
C) NaF, K_2CO_3
D) NH_4Cl, $Cu(NO_3)_2$
E) NH_4Cl only

Answer: C

36) What is the pH of an aqueous solution at 25.0 °C that contains 3.98×10^{-9} M hydroxide ion?
A) 9.00 B) 3.98 C) 8.40 D) 5.60 E) 7.00

Answer: D

37) The K_a for formic acid (HCO_2H) is 1.8×10^{-4}. What is the pH of a 0.10 M aqueous solution of sodium formate ($NaHCO_2$)?
A) 3.39 B) 5.63 C) 4.26 D) 11.64 E) 8.37

Answer: E

38) The pH of a 0.55 M aqueous solution of hypobromous acid, HBrO, at 25.0 °C is 4.48. What is the value of K_a for HBrO?

A) 3.3×10^{-5} B) 2.0×10^{-9} C) 6.0×10^{-5} D) 1.1×10^{-9} E) 3.0×10^{4}

Answer: B

39) A 7.0×10^{-3} M aqueous solution of $Ca(OH)_2$ at 25.0 °C has a pH of _____.

A) 11.85 B) 12.15 C) 7.1×10^{-13} D) 1.85 E) 1.4×10^{-2}

Answer: B

40) The base-dissociation constant of ethylamine ($C_2H_5NH_2$) is 6.4×10^{-4} at 25.0 °C. The $[H^+]$ in a 1.6×10^{-2} M solution of ethylamine is _____ M.

A) 3.2×10^{-3} B) 3.5×10^{-12} C) 11.46 D) 3.1×10^{-12} E) 2.9×10^{-3}

Answer: D