# 1012_2nd Exam_1020417

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

1) Choose the INCORRECT statement.
   A) The common ion in a mixture of a weak acid and a strong acid is the hydronium ion.
   B) A weak acid-strong base will produce a longer vertical section of a titration curve than will a strong acid-strong base.
   C) For an accurate titration, the end point needs to match the equivalence point.
   D) The pH of a buffer solution changes only slightly with addition of a small amount of acid or base.
   E) The pH of a buffer depends mainly on the $pK_a$ of the weak acid component of the buffer.

   Answer: B

2) How will addition of sodium chloride affect the pH of a HCl solution?
   A) It will lower the pH.
   B) It will raise the pH.
   C) The solution becomes hotter.
   D) The pH cannot be measured.
   E) The pH will not change.

   Answer: E

3) How will addition of sodium acetate to an acetic acid solution affect the pH?
   A) The pH will not change.
   B) The solution becomes hotter.
   C) The pH cannot be measured.
   D) It will lower the pH.
   E) It will raise the pH.

   Answer: E

4) A solution containing equimolar amounts of a weak acid with $K_a = 10^{-5}$ and its sodium salt has:
   A) pH dependent on concentration ratios
   B) pH < 7
   C) pH = 7
   D) pH dependent on the nature of the acid anion
   E) pH > 7

   Answer: B

5) What is the buffer range (for an effective 2.0 pH unit) for a benzoic acid/sodium benzoate buffer? [$K_a$ for benzoic acid is $6.3 \times 10^{-5}$]
   A) 4.7 - 6.7 B) 7.4 - 9.4 C) 5.3 - 7.3 D) 8.8 - 10.8 E) 3.2 - 5.2

   Answer: E

6) What factor governs the selection of an indicator for a neutralization titration?
   A) the final volume of the solution
   B) the molarity of the standard solution
   C) the pH at the stoichiometric (equivalence) point
   D) the volume of titrant
   E) the solubility of the indicator

   Answer: C

7) Phenol red indicator changes from yellow to red in the pH range from 6.6 to 8.0. State what color the indicator will assume in the following solution: 0.10 M $HC_2H_3O_2$ ( $K_a = 1.8 \times 10^{-5}$ ).

A) yellow
B) red-yellow mixture
C) red
D) The indicator is its original color.
E) There is not enough information to answer this question.

Answer: A

8) In the titration of 50.0 mL of 0.0200 M $C_6H_5COOH_{(aq)}$ with 0.100 M $NaOH_{(aq)}$, what is/are the major species in the solution after the addition of 5.0 mL of $NaOH_{(aq)}$?

A) $C_6H_5COO^-$ and $Na^+$
B) $C_6H_5COOH$, $OH^-$, and $Na^+$
C) $C_6H_5COOH$, $C_6H_5COO^-$, and $Na^+$
D) $C_6H_5COOH$
E) $H_3O^+$ and $OH^-$

Answer: C

9) Determine the $[F^-]$ of the solution with initial concentrations: [HF] = 1.296 M, [NaF] = 1.045 M. ( $K_a$ for HF is $6.6 \times 10^{-4}$ )

A) 2.344 M B) 0.251 M C) 1.046 M D) $5.3 \times 10^{-4}$ M E) $8.2 \times 10^{-4}$ M

Answer: C

10) 25 mL of 0.10 M HCl is titrated with 0.10 M NaOH. What is the pH at equivalence?

A) 7.0 B) 6.2 C) 7.5 D) 7.1 E) 8.6

Answer: A

11) 1.80 grams of an impure mixture containing $Na_2CO_3$ required 84.0 ml of 0.125 M $H_2SO_4$ for complete neutralization. What percent of the mixture is $Na_2CO_3$?

A) 120% B) 1.1% C) 62% D) 57% E) 31%

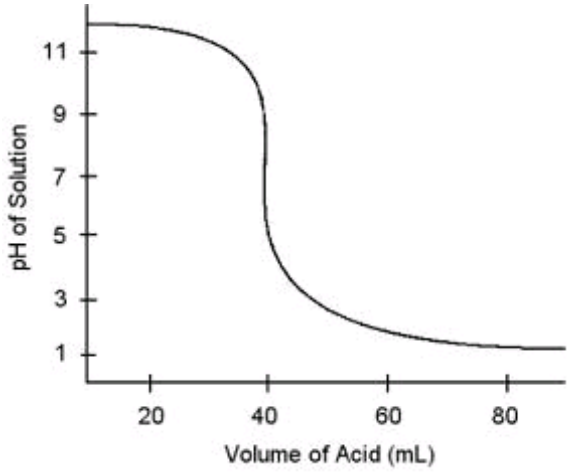
Answer: C

12) What is the pH of a 1.0 M solution of $Na_2CO_3$? ( For $H_2CO_3$: $K_{a1} = 4.4 \times 10^{-7}$, $K_{a2} = 4.7 \times 10^{-11}$ )

A) 12.2 B) 2.5 C) 5.8 D) 7.0 E) 10.3

Answer: A

13) Examine the titration curve shown below. Which of the following titrations could it represent?




A) titrating HCl by NaOH
B) titrating $Ca(OH)_2$ by HCl
C) titrating HCl by $NH_3$
D) titrating $H_2SO_4$ by NaOH
E) titrating $NH_3$ by HCl

Answer: B

Information for following three questions:
7.500 g of a weak acid HA ( $K_a = 2.5 \times 10^{-5}$) is added to distilled water to produce 500.0 mL of solution with $[H_3O^+] = 1.92 \times 10^{-3}$.

14) What is the initial concentration of the HA?
A) 0.150 M B) 0.500 M C) 0.250 M D) 0.100 M E) 0.040 M.

Answer: A

15) What is the molar mass of this weak acid?
A) 75 g/mol B) 750 g/mol C) 100 g/mol D) 252 g/mol E) 64 g/mold.

Answer: C

16) What is the freezing point of the solution ( density of the solution is 1.00 g/mL )? ( $K_f$ for $H_2O$ is 1.86 °C/m)
A) - 0.283 °C B) - 0.142 °C C) 0 °C D) 0.25 °C E) 100 °C

Answer: A

17) What is the $K_{sp}$ expression for magnesium phosphate, $Mg_3(PO_4)_2$?
A) $K_{sp} = [Mg^{2+}]^2[PO_4^{3-}]^3$
B) $K_{sp} = [Mg^{2+}][PO_4^{3-}]$
C) $K_{sp} = [Mg^{2+}]^3[PO_4^{3-}]$
D) $K_{sp} = [Mg^{2+}]^3[PO_4^{3-}]^2$
E) $K_{sp} = [Mg^{2+}]^3[PO_4^{3-}]^2/[Mg_3(PO_4)_2]$

Answer: D

18) Which of the following has the largest molar solubility?

A) $Mg(OH)_2$, $K_{sp} = 2 \times 10^{-11}$

B) $Fe(OH)_3$, $K_{sp} = 4 \times 10^{-38}$

C) $BaSO_4$, $K_{sp} = 1.1 \times 10^{-10}$

D) $Cr(OH)_2$, $K_{sp} = 6.3 \times 10^{-11}$

E) AgCl, $K_{sp} = 1.6 \times 10^{-10}$

Answer: D

19) A solution contains $[Ba^{2+}] = 5.0 \times 10^{-5}$ M, $[Ag^+] = 3.0 \times 10^{-5}$ M, and $[Zn^{2+}] = 2.0 \times 10^{-7}$ M. Sodium oxalate is slowly added so that $[C_2O_4^{2-}]$ increases.

| Salt | $BaC_2O_4$ | $ZnC_2O_4$ | $Ag_2C_2O_4$ |
|---|---|---|---|
| $K_{sp}$ | $1.5 \times 10^{-8}$ | $1.35 \times 10^{-9}$ | $1.1 \times 10^{-11}$ |

What is the concentration of the first cation to precipitate when the second cation just begins to precipitate?

A) $1.1 \times 10^{-11}$ B) $1.35 \times 10^{-9}$ C) $5.0 \times 10^{-5}$ D) $1.3 \times 10^{-6}$ E) $2.2 \times 10^{-6}$

Answer: E

20) Choose the compound that is LESS SOLUBLE in an acidic solution than in pure water.

A) FeS B) $C_6H_5COOH$ C) $Mg(CO_3)_2$ D) KCl E) $Ca(OH)_2$

Answer: B

21) Choose the compound that is most soluble in water.

A) HgS B) ZnS C) PbS D) SnS E) $K_2S$

Answer: E

22) In a qualitative cation analysis, the unknown ion is not precipitated by HCl, $H_2S$, or $CO_3^{2-}$. A flame test produced a violet flame. The unknown ion is _____.

A) $Fe^{2+}$ B) $Pb^{2+}$ C) $NH_4^+$ D) $K^+$ E) $Ag^+$

Answer: D

Information for following three questions:

$$AgCl_{(s)} \rightleftharpoons Ag^+_{(aq)} + Cl^-_{(aq)} \qquad K_{sp} = 1.8 \times 10^{-10} \text{ ( at 25 °C )}$$

$$Ag^+_{(aq)} + 2\,NH_{3(aq)} \rightleftharpoons [Ag(HN_3)_2^+]_{(aq)} \qquad K_f = 1.6. \times 10^{7} \text{ ( at 25 °C )}$$

23) What is the molar solubility of AgCl in pure water at 25 °C?

A) $3.2 \times 10^{-7}$ M B) $1.1 \times 10^{-9}$ M C) $1.8 \times 10^{-10}$ M D) $5.2 \times 10^{-2}$ M E) $1.3 \times 10^{-5}$ M

Answer: E

24) What is the molar solubility of AgCl in $1.0 \times 10^{-3}$ M $AgNO_3$ at 25 °C?

A) $1.8 \times 10^{-7}$ M B) $5.2 \times 10^{-6}$ M C) $6.6 \times 10^{-3}$ M D) $1.3 \times 10^{-5}$ M E) $1.8 \times 10^{-10}$ M

Answer: A

25) What is the molar solubility of AgCl in 0.100 M $NH_3$ 25 °C?

A) $2.0 \times 10^{-8}$ M B) $4.9 \times 10^{-3}$ M C) $1.8 \times 10^{-5}$ M D) $5.0 \times 10^{-6}$ M E) $3.3 \times 10^{-7}$ M

Answer: B

26) Choose the INCORRECT statement.

A) A zero $\Delta G$ means the system is at equilibrium.
B) A spontaneous reaction is one that must have a negative value of $\Delta H$.
C) If a process is spontaneous, the reverse process is nonspontaneous.
D) Entropy is related to the way in which the energy of a system is distributed among the available microscopic energy levels.
E) A nonspontaneous reaction can be made to occur by coupling it with a spontaneous reaction to form an overall spontaneous reaction.

Answer: B

27) Which of the following has the highest entropy?

A) 1 mole of liquid water at 30 °C
B) 1 mole of ice at -10 °C
C) 1 mole of water vapor at 100 °C
D) 1 mole of water vapor at 30 °C
E) 1 mole of water at 10 °C

Answer: C

28) Which of the following substances under equal conditions and in the same phase has the greatest molar entropy?

A) NO B) $N_2O_4$ C) $N_2O_3$ D) $NO_2$ E) $N_2O_5$

Answer: E

29) Order the following by increasing entropy.

$CO_{(g)}$, $COCl_{2(g)}$, $CO_{2(g)}$, $CaO_{(s)}$

A) $CO_2 < CO < CaO < COCl_2$
B) $CaO < CO < CO_2 < COCl_2$
C) $CO < CaO < COCl_2 < CO_2$
D) $CO_2 < CaO < COCl_2 < CO$
E) $COCl_2 < CO < CaO < CO_2$

Answer: B

30) A chemical reaction such as the following:

$2NH_{3(g)} \rightarrow N_{2(g)} + 3H_{2(g)} \quad \triangle H° = 92.22$ kJ

This means the reaction:

A) will be spontaneous at low temperature
B) is spontaneous at all temperatures
C) is not spontaneous at any temperature
D) will be spontaneous at high temperature

Answer: D

31) Consider the reaction: $3\ N_{2(g)} + 2\ O_{3(g)} \rightarrow 6\ NO_{(g)}$

| | | | |
|---|---|---|---|
| $\Delta H_f°$ | 0.00 | 142.26 | 90.37 kJ/mol |
| $S°$ | 191.5 | 237.7 | 210.6 J/mol K |

What is $\Delta G°_{rxn}$ for this reaction in kJ at 500 K?

A) $-1.00 \times 10^5$ kJ
B) 93 kJ
C) 151 kJ
D) 441 kJ
E) 365 kJ

Answer: C

32) Consider the reaction at 25 °C:

$$AgI_{(s)} \rightleftharpoons Ag^{+}_{(aq)} + I^{-}_{(aq)}$$

| | | | | |
|---|---|---|---|---|
| $\triangle G_f^\circ$ | -66.19 | 77.11 | -51.57 | kJ/mol |

What is $K_{sp}$ for AgI at 25 °C? ( R = 8.3145 J $mol^{-1}$ $K^{-1}$ )

A) $3.2 \times 10^{-12}$ B) $4.7 \times 10^{3}$ C) $8.5 \times 10^{-17}$ D) 0.96 E) $1.2 \times 10^{16}$

Answer: C

33) If the enthalpy of vaporization of chloromethane, $CH_3Cl$, is 21.5 kJ/mol at the normal boiling point, 249 K, calculate $\triangle S^\circ_{vap}$.

A) 86.3 J $mol^{-1}$ $K^{-1}$
B) 896 J $mol^{-1}$ $K^{-1}$
C) 5.35 J $mol^{-1}$ $K^{-1}$
D) 11.6 J $mol^{-1}$ $K^{-1}$
E) 252. J $mol^{-1}$ $K^{-1}$

Answer: A

34) Which of the following statements must be true for the entropy of a pure solid to be zero?

I. The temperature must be 0 K.
II. The solid must be crystalline, not amorphous.
III. The solid must be perfectly ordered.
IV. The solid must be an element.

A) I and II B) I C) I, II, III, and IV D) I, II, and III

Answer: D

35) Calculate $\Delta S^\circ$ for the formation of <u>one</u> mole of solid sodium bromide from the elements at 25°C.

| Species | $S^\circ$, J/(K · mol) |
|---|---|
| NaBr (*s*) | 86.8 |
| Na (*s*) | 51.3 |
| $Br_2$ (*l*) | 152.2 |

A) -116.7 J/K B) 86.8 J/K C) -40.6 J/K D) -81.2 J/K

Answer: C

36) Which of the following is zero at 25 °C?

A) $\Delta G^\circ_f$ for $H_2O_{(l)}$ B) $S^\circ$ for $H_2O_{(l)}$ C) $S^\circ$ for $N_{2(g)}$ D) $\Delta G^\circ_f$ for $N_{2(g)}$

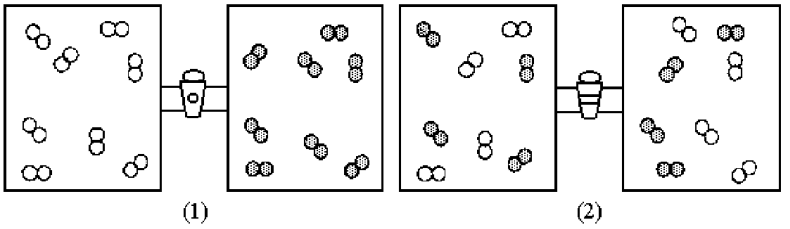
Answer: D

37) For the reaction $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$, $\Delta H^\circ_f$ = +57.2 kJ/mol and $K_p$ = 0.113 at 25 °C. Estimate the $K_p$ at 56 °C. ( R = 8.3145 J $mol^{-1}$ $K^{-1}$ )

A) $2.35 \times 10^{-6}$ B) 1.00 C) $6.57 \times 10^{5}$ D) 0.415

Answer: B

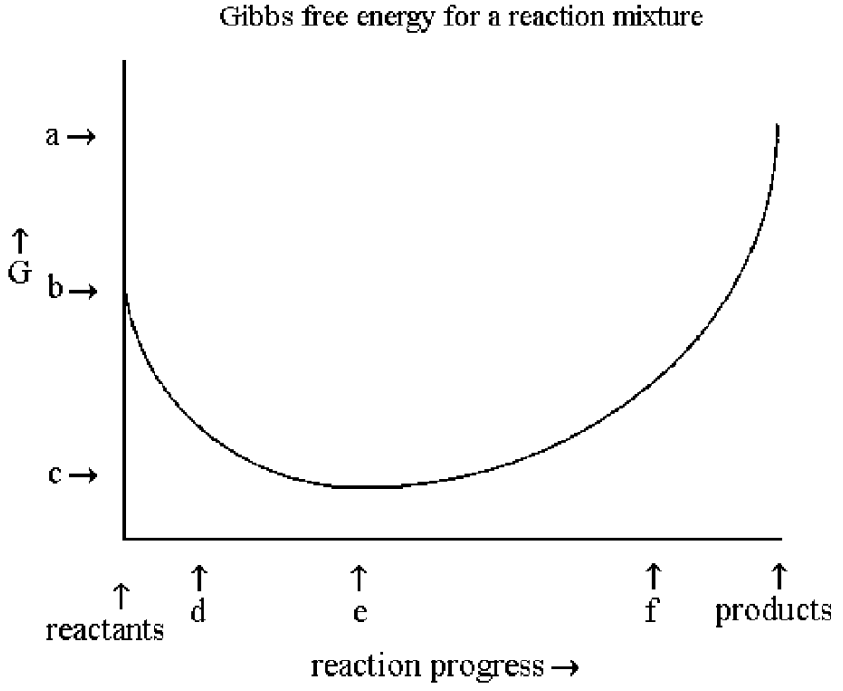
38) In figure (1) below oxygen molecules, represented by unshaded spheres, and chlorine molecules, represented by shaded spheres, are in separate compartments. Figure (2) shows the equilibrium state of the system after the stopcock separating the two compartments is opened. Assuming the oxygen and the chlorine behave as ideal gases, what are the signs (+, -, or 0) of $\Delta H$, $\Delta S$, and $\Delta G$ for this process?




A) $\Delta H = 0, \Delta S = +, \Delta G = -$
B) $\Delta H = -, \Delta S = +, \Delta G = -$
C) $\Delta H = +, \Delta S = -, \Delta G = +$
D) $\Delta H = 0, \Delta S = -, \Delta G = +$

Answer: A

Information for following two questions:




39) According to the diagram, the forward reaction is
A) spontaneous at d, at equilibrium at e, and nonspontaneous at f.
B) nonspontaneous at d, at equilibrium at e, and spontaneous at f.
C) nonspontaneous at d and e, and spontaneous at f.
D) spontaneous at d, e, and f.

Answer: A

40) According to the diagram,
A) $\Delta G°$ is positive and the equilibrium composition is rich in reactants.
B) $\Delta G°$ is negative and the equilibrium composition is rich in products.
C) $\Delta G°$ is negative and the equilibrium composition is rich is reactants.
D) $\Delta G°$ is positive and the equilibrium composition is rich in products.

Answer: A