113-2 Semester General Chemistry Midterm Exam(B)-20250409

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

1) At equilibrium, _____.
   A) the rate constants of the forward and reverse reactions are equal
   B) all chemical reactions have ceased
   C) the rates of the forward and reverse reactions are equal
   D) the value of the equilibrium constant is 1
   E) the limiting reagent has been consumed

   Answer: C

2) The value of K_{eq} for the following reaction is 0.25:

   $$SO_2\,(g) + NO_2\,(g) \rightleftharpoons SO_3\,(g) + NO\,(g)$$

   The value of K_{eq} at the same temperature for the reaction below is _____.

   $$2SO_2\,(g) + 2NO_2\,(g) \rightleftharpoons 2SO_3(g) + 2NO\,(g)$$

   A) 16 B) 0.50 C) 0.063 D) 0.12 E) 0.25

   Answer: C

3) Which of the following expressions is the correct equilibrium-constant expression for the reaction below?

   $$(NH_4)_2Se\,(s) \rightleftharpoons 2NH_3\,(g) + H_2Se\,(g)$$

   A) $1 / [(NH_4)_2Se]$
   B) $[NH_3][H_2Se] / [(NH_4)_2Se]$
   C) $[NH_3]^2[H_2Se]$
   D) $[(NH_4)_2Se] / [NH_3]^2[H_2Se]$
   E) $[NH_3]^2[H_2Se] / [(NH_4)_2Se]$

   Answer: C

4) Consider the following reaction at equilibrium:

   $$2CO_2\,(g) \rightleftharpoons 2CO\,(g) + O_2\,(g) \qquad \Delta H° = -514\ kJ$$

   Le Châtelier's principle predicts that adding O_2 (g) to the reaction container will _____.
   A) increase the partial pressure of CO_2 (g) at equilibrium
   B) increase the value of the equilibrium constant
   C) decrease the partial pressure of CO_2 (g) at equilibrium
   D) decrease the value of the equilibrium constant
   E) increase the partial pressure of CO (g) at equilibrium

   Answer: A

5) Phosphorous trichloride and phosphorous pentachloride equilibrate in the presence of molecular chlorine according to the reaction:

$$PCl_3\,(g) + Cl_2\,(g) \rightarrow PCl_5\,(g)$$

An equilibrium mixture at 450 K contains
P_{PCl_3} = 0.224 atm,
P_{Cl_2} = 0.284 atm, and
P_{PCl_5} = 4.24 atm. What is the value of K_p at this temperature?

A) 1.50×10^{-2} B) 2.70×10^{-1} C) 3.74 D) 66.7 E) 8.36

Answer: D

6) Dinitrogen tetroxide partially decomposes according to the following equilibrium:

$$N_2O_4\,(g) \rightarrow 2NO_2\,(g)$$

A 1.000-L flask is charged with 9.20×10^{-3} mol of N_2O_4. At equilibrium, 5.98×10^{-3} mol of N_2O_4 remains. K_{eq} for this reaction is _____.

A) 0.183
B) 2.96×10^{-5}
C) 6.94×10^{-3}
D) 0.197
E) 0.212

Answer: C

7) Given the following reaction at equilibrium, if $K_c = 5.84 \times 10^5$ at 230.0 °C, K_p = _____.

$$2NO\,(g) + O_2\,(g) \rightleftharpoons 2NO_2\,(g)$$

A) 6.44×10^5 B) 3.67×10^{-2} C) 1.41×10^4 D) 2.41×10^7 E) 2.40×10^6

Answer: C

8) Consider the following reaction at equilibrium:

$$2NH_3\,(g) \rightleftharpoons N_2\,(g) + 3H_2\,(g)$$

Le Châtelier's principle predicts that the moles of H_2 in the reaction container will increase with _____.

A) a decrease in the total volume of the reaction vessel (T constant)
B) a decrease in the total pressure (T constant)
C) some removal of NH_3 from the reaction vessel (V and T constant)
D) an increase in total pressure by the addition of helium gas (V and T constant)
E) addition of some N_2 to the reaction vessel (V and T constant)

Answer: B

9) A Brønsted-Lowry base is defined as a substance that _____.

A) increases $[H^+]$ when placed in H_2O

B) acts as a proton donor

C) increases $[OH^-]$ when placed in H_2O

D) acts as a proton acceptor

E) decreases $[H^+]$ when placed in H_2O

Answer: D

10) Of the acids in the table below, _____ is the strongest acid.

Acid	K_a
HOAc	1.8×10^{-5}
$HCHO_2$	1.8×10^{-4}
HClO	3.0×10^{-8}
HF	6.8×10^{-4}

A) HOAc

B) HF

C) $HCHO_2$

D) HClO

E) HOAc and $HCHO_2$

Answer: B

11) The pH of an aqueous solution at 25.0 °C is 10.40. What is the molarity of H^+ in this solution?

A) 2.5×10^{-4} B) 1.0×10^{-13} C) 3.60 D) 2.5×10^{10} E) 4.0×10^{-11}

Answer: E

12) A 8.0×10^{-3} M aqueous solution of $Ca(OH)_2$ at 25.0 °C has a pH of _____.

A) 6.3×10^{-13} B) 1.6×10^{-2} C) 11.90 D) 1.80 E) 12.20

Answer: E

13) The K_a of hypochlorous acid (HClO) is 3.0×10^{-8} at 25.0 °C. Calculate the pH of a 0.0335 M hypochlorous acid solution.

A) 3.02 B) 4.50 C) -3.02 D) 9.50 E) 6.52

Answer: B

14) Calculate the pH of a 0.250 M aqueous solution of NH_3. The K_b of NH_3 is 1.77×10^{-5}.

A) 2.08 B) 11.32 C) 2.68 D) 11.92 E) 8.95

Answer: B

15) K_b for NH_3 is 1.8×10^{-5}. What is the pH of a 0.35 M aqueous solution of NH_4Cl at 25.0 °C?

A) 11.23 B) 4.85 C) 2.60 D) 9.15 E) 11.40

Answer: B

16) Of the following, which is the strongest acid?

A) $HClO_4$ B) $HClO_2$ C) HIO D) $HClO_3$ E) HClO

Answer: A

17) Which of the following could be added to a solution of acetic acid to prepare a buffer?
A) sodium hydroxide only
B) sodium acetate only
C) hydrofluoric acid or nitric acid
D) sodium acetate or sodium hydroxide
E) nitric acid only

Answer: D

18) Calculate the pH of a solution that is 0.310 M in sodium formate ($NaHCO_2$) and 0.190 M in formic acid (HCO_2H). The K_a of formic acid is 1.77×10^{-4}.

A) 13.79 B) 3.532 C) 10.04 D) 4.975 E) 3.958

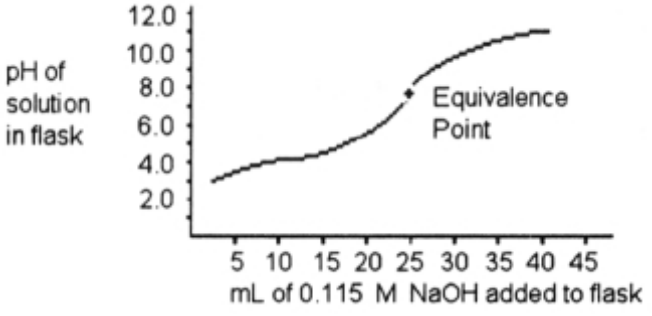
Answer: E

19) Calculate the percent ionization of formic acid (HCO_2H) in a solution that is 0.152 M in formic acid. The K_a of formic acid is 1.77×10^{-4}.

A) 3.44 B) 0.0180 C) 2.74×10^{-5} D) 0.581 E) 8.44

Answer: A

20)



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

Answer: A

21) 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) 1.1×10^{-2} B) 2.4×10^{-8} C) 5.9×10^{-5} D) 1.2×10^{-4} E) 2.7×10^{-3}

Answer: A

22) What is the molar solubility of manganese carbonate ($MnCO_3$) in water? The solubility-product constant for $MnCO_3$ is 5.0×10^{-10} at 25 °C.

A) 3.2×10^{-5} B) 9.30 C) 2.2×10^{-5} D) 1.0×10^{-9} E) 2.5×10^{-10}

Answer: C

23) *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}

Which compound listed below has the greatest molar solubility in water?

A) $CdCO_3$ B) CaF_2 C) $ZnCO_3$ D) $Cd(OH)_2$ E) AgI

Answer: B

24) A 25.0 mL sample of 0.723 M $HClO_4$ is titrated with a 0.273 M KOH solution. The H_3O^+ concentration after the addition of 50.0 mL of KOH is _____ M.

A) 0.0587
B) 0.273
C) 0.430
D) 0.0181
E) none of the above

Answer: A

25) Which one of the following is least soluble in water?

A) CH_3CH_2OH
B) $CH_3CH_2CH_2CH_2CH_2OH$
C) CH_3OH
D) $CH_3CH_2CH_2OH$
E) $CH_3CH_2CH_2CH_2OH$

Answer: B

26) Calculate the molality of a 10.0% (by mass) aqueous solution of hydrochloric acid (HCl).

A) 2.74 m
B) 3.05 m
C) 0.274 m
D) 4.33 m
E) The density of the solution is needed to solve the problem.

Answer: B

27) Calculate the mole fraction of nitric acid of a 17.5% (by mass) aqueous solution of nitric acid (HNO_3).

A) 0.278 B) 3.37 C) 0.0607 D) 0.0572 E) 1.75

Answer: D

28) The concentration of CO_2 in a soft drink bottled with a partial pressure of CO_2 of 4.0 atm over the liquid at 25 °C is 1.2×10^{-1} M. The Henry's law constant for CO_2 at this temperature is _____.

A) 3.0×10^{-2} mol/L-atm
B) 4.5×10^{-3} mol/L-atm
C) 2.3×10^{-2} mol/L-atm
D) 5.6×10^{-3} mol/L-atm
E) More information is needed to solve the problem.

Answer: A

29) A 1.35 m aqueous solution of compound X had a boiling point of 101.4 °C. Which one of the following could be compound X? The boiling point elevation constant for water is 0.52 °C/m.

A) Na_3PO_4
B) $CaCl_2$
C) $C_6H_{12}O_6$
D) KCl
E) CH_3CH_2OH

Answer: D

30) A solution contains 15 ppm of benzene. The density of the solution is 1.00 g/mL. This means that _____.

A) the solution is 15% by mass of benzene
B) there are 15 mg of benzene in 1.0 g of this solution
C) 1.0 g of the solution contains 15×10^{-6} g of benzene
D) 100 g of the solution contains 15 g of benzene
E) 1.0 L of the solution contains 15 g of benzene

Answer: C

31) The osmotic pressure of a solution formed by dissolving 80.0 mg of aspirin ($C_9H_8O_4$) in 0.250 L of water at 25 °C is _____ atm.(R = 0.08206 L-atm/K-mol)

A) 43.5 B) 4.41 C) 0.0435 D) 7.83 E) 3.65×10^{-3}

Answer: C

32) A solution is prepared by dissolving 24.7 g of $CaCl_2$ in 375 g of water. The density of the resulting solution is 1.05 g/mL. The concentration of $CaCl_2$ is _____% by mass.

A) 6.49 B) 0.0618 C) 0.0649 D) 6.18 E) 6.24

Answer: D

33) At elevated temperatures, dinitrogen pentoxide decomposes to nitrogen dioxide and oxygen:

$$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$$

When the rate of formation of O_2 is 2.2×10^{-4} M/s, the rate of decomposition of N_2O_5 is _____ M/s.

A) 2.8×10^{-4} B) 1.1×10^{-4} C) 5.5×10^{-4} D) 4.4×10^{-4} E) 2.2×10^{-4}

Answer: D

34) - 35) *The data in the table below were obtained for the reaction:*

$$2\ ClO_2\ (aq) + 2\ OH^-\ (aq) \rightarrow ClO_3^-\ (aq) + ClO_2^-\ (aq) + H_2O\ (1)$$

Experiment Number	$[ClO_2]$ (M)	$[OH^-]$ (M)	Initial Rate (M/s)
1	0.060	0.030	0.0248
2	0.020	0.030	0.00276
3	0.020	0.090	0.00828

34) What is the order of the reaction with respect to ClO_2?

A) 0 B) 3 C) 2 D) 1 E) 4

Answer: C

35) What is the magnitude of the rate constant for the reaction?

A) 713 B) 230 C) 115 D) 1.15×10^4 E) 4.6

Answer: B

36) The reaction

$$CH_3\text{-}N{\equiv}C \rightarrow CH_3\text{-}C{\equiv}N$$

At 230.3 °C, $k = 6.29 \times 10^{-4}\ s^{-1}$. If $[CH_3{-}N{\equiv}C]$ is 1.00×10^{-3} initially, $[CH_3{-}N{\equiv}C]$ is _____ after 1.000×10^3 s.

A) 2.34×10^{-4} B) 4.27×10^{-3} C) 1.88×10^{-3} D) 5.33×10^{-4} E) 1.00×10^{-6}

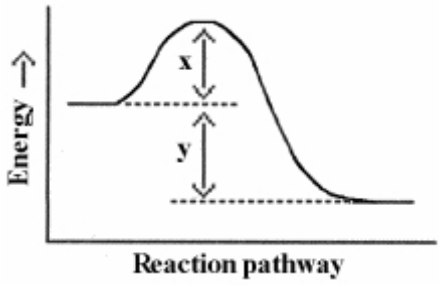
Answer: D

37) A compound decomposes by a first-order process. If 25.0% of the compound decomposes in 60.0 minutes, the half-life of the compound is _____.

A) 65 minutes B) 120 minutes C) 145 minutes D) 198 minutes E) 180 minutes

Answer: C

38) Which energy difference in the energy profile below corresponds to the activation energy for the forward reaction?



A) x B) y C) x + y D) y - x E) x - y

Answer: A

39) A possible mechanism for the overall reaction

$$Br_2\,(g) + 2NO\,(g) \rightarrow 2NOBr\,(g)$$

is

$$NO\,(g) + Br_2\,(g) \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} NOBr_2\,(g) \qquad \text{(fast)}$$

$$NOBr_2\,(g) + NO\,(g) \xrightarrow{k_2} 2NOBr \qquad \text{(slow)}$$

The rate law for formation of NOBr based on this mechanism is rate = _____.

A) $k_1[NO]^{1/2}$

B) $(k_2k_1/k^{-1})[NO][Br_2]^2$

C) $k_1[Br_2]^{1/2}$

D) $(k_1/k^{-1})^2[NO]^2$

E) $(k_2k_1/k^{-1})[NO]^2[Br_2]$

Answer: E

40) A particular first-order reaction has a rate constant of $1.35 \times 10^2\ s^{-1}$ at 25.0 °C. What is the magnitude of k at 75.0°C if E_a = 60.2 kJ/mol? (R = 8.3145 J/K-mol)

A) 4.43×10^3 B) 1.35×10^2 C) 2.71×10^6 D) 2.44×10^4 E) 471

Answer: A