# 1102-1st Midterm Exam_03/30/22_(A)

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

*The data in the table below were obtained for the reaction:*

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

| 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 |

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

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

Answer: D

2) A reaction was found to be third order in A. Increasing the concentration of A by a factor of 3 will cause the reaction rate to _____.

A) remain constant
B) triple
C) increase by a factor of 9
D) increase by a factor of 27
E) decrease by a factor of the cube root of 3

Answer: D

*The peroxydisulfate ion* ($S_2O_8^{2-}$) *reacts with the iodide ion in aqueous solution via the reaction:*

$$S_2O_8^{2-}\,(aq) + 3I^- \rightarrow 2SO_4\,(aq) + I_3^-\,(aq)$$

*An aqueous solution containing* 0.050 M *of* $S_2O_8^{2-}$ *ion and* 0.072 M *of* $I^-$ *is prepared, and the progress of the reaction followed by measuring* $[I^-]$. *The data obtained is given in the table below.*

| Time (s) | 0.000 | 400.0 | 800.0 | 1200.0 | 1600.0 |
|---|---|---|---|---|---|
| $[I^-]$ (M) | 0.072 | 0.057 | 0.046 | 0.037 | 0.029 |

3) The average rate of disappearance of $I^-$ between 400.0 s and 800.0 s is _____ M/s.

A) $3.6 \times 10^4$ B) $1.4 \times 10^{-5}$ C) $2.6 \times 10^{-4}$ D) $2.8 \times 10^{-5}$ E) $5.8 \times 10^{-5}$

Answer: D

4) For the elementary reaction

$$NO_3 + CO \rightarrow NO_2 + CO_2$$

the molecularity of the reaction is _____, and the rate law is rate = _____.

A) 4, $k[NO_3][CO][NO_2][CO_2]$

B) 4, $k[NO_2][CO_2]/[NO_3][CO]$

C) 2, $k[NO_3][CO]/[NO_2][CO_2]$

D) 2, $k[NO_3][CO]$

E) 2, $k[NO_2][CO_2]$

Answer: D

5) A second-order reaction has a half-life of 18 s when the initial concentration of reactant is 0.71 M. The rate constant for this reaction is _____ $M^{-1}s^{-1}$.

A) 18 B) 1.3 C) $2.0 \times 10^{-2}$ D) $3.8 \times 10^{-2}$ E) $7.8 \times 10^{-2}$

Answer: E

6) The half-life of a first-order reaction is 13 min. If the initial concentration of reactant is 0.085 M, it takes _____ min for it to decrease to 0.055 M.

A) 3.6 B) 8.2 C) 8.4 D) 11 E) 0.048

Answer: B

7) 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=8.314 J/mol•K

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

Answer: D

8) Which one of the following substances would be the most soluble in $CCl_4$?

A) $C_{10}H_{22}$ B) NaCl C) $CH_3CH_2OH$ D) $H_2O$ E) $NH_3$

Answer: A

9) A solution is prepared by dissolving 13.0 g of $NH_3$ in 250.0 g of water. The density of the resulting solution is 0.974 g/mL. The mole fraction of $NH_3$ in the solution is _____.

A) 0.0520 B) 0.940 C) 0.922 D) 0.0522 E) 16.8

Answer: D

10) Which of the following liquids will have the lowest freezing point?

A) pure $H_2O$

B) aqueous $FeI_3$ (0.030 m)

C) aqueous glucose (0.050 m)

D) aqueous NaI (0.030 m)

E) aqueous $CoI_2$ (0.030 m)

Answer: B

11) Calculate the molality of a 25.4% (by mass) aqueous solution of phosphoric acid ($H_3PO_4$).

A) 4.45 m
B) 25.4 m
C) 3.47 m
D) 2.59 m
E) The density of the solution is needed to solve the problem.

Answer: C

12) A solution is prepared by dissolving calcium chloride in water and diluting to 500.0 mL. If this solution contains 44 ppm chloride ions, the concentration of calcium ions is _____ ppm.

A) 88 B) 11 C) 500 D) 44 E) 22

Answer: E

13) The vapor pressure of pure water at 25 °C is 23.8 torr. What is the vapor pressure (torr) of water above a solution prepared by dissolving 18.0 g of glucose (a nonelectrolyte, MW = 180.0 g/mol) in 95.0 g of water?

A) 23.4 B) 23.8 C) 0.451 D) 0.443 E) 24.3

Answer: A

14) A solution is prepared by dissolving 15.0 g of $NH_3$ in 250.0 g of water. The density of the resulting solution is 0.974 g/mL. The molarity of $NH_3$ in the solution is _____.

A) 3.24 B) 0.882 C) 60.0 D) 3.53 E) 0.00353

Answer: A

15) Which one of the following solutes has a limiting van't Hoff factor (i) of 3 when dissolved in water?

A) $KNO_3$ B) $CH_3OH$ C) sucrose D) $CCl_4$ E) $Na_2SO_4$

Answer: E

16) A solution is prepared by dissolving 0.60 g of nicotine (a nonelectrolyte) in water to make 12 mL of solution. The osmotic pressure of the solution is 7.55 atm at 25 °C. The molecular weight of nicotine is _____ g/mol. R=0.0821 atm•L/mol•K

A) 160 B) 43 C) 50 D) 0.60 E) 28

Answer: A

17) The solubility of Ar in water at 25 °C is $1.6 \times 10^{-3}$ M when the pressure of the Ar above the solution is 1.0 atm. The solubility of Ar at a pressure of 2.5 atm is _____ M.

A) $1.6 \times 10^{3}$ B) $4.0 \times 10^{-3}$ C) $1.6 \times 10^{-3}$ D) $6.4 \times 10^{-4}$ E) $7.5 \times 10^{-2}$

Answer: B

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

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

A) $[SO_2] / [SO_3]$
B) $[SO_3] / [SO_2][O_2]$
C) $[SO_3]^2 / [SO_2]^2[O_2]^2$
D) $[SO_3]^2 / [SO_2]^2[O_2]$
E) $[SO_3] / [SO_2][O_2]^2$

Answer: D

19) In which of the following reactions would increasing pressure at constant temperature change the concentrations of reactants and products, based on Le Châteliers principle?

A) $N_2O_4\,(g) \rightleftharpoons 2NO_2\,(g)$

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

C) $2N_2\,(g) + O_2\,(g) \rightleftharpoons 2N_2O\,(g)$

D) $N_2\,(g) + 2O_2\,(g) \rightleftharpoons 2NO_2\,(g)$

E) all of the above

Answer: E

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

$$CO_2\,(s) + H_2O\,(l) \rightleftharpoons H^+\,(aq) + HCO_3^-\,(aq)$$

A) $[H^+][HCO_3^-]$

B) $[H^+][HCO_3^-] / [CO_2][H_2O]$

C) $[H^+][HCO_3^-] / [CO_2]$

D) $[CO_2] / [H^+][HCO_3^-]$

E) $[CO_2][H_2O] / [H^+][HCO_3^-]$

Answer: A

21) $K_p = 0.0198$ at 721 K for the reaction

$$2HI\,(g) \rightleftharpoons H_2\,(g) + I_2\,(g)$$

In a particular experiment, the partial pressures of $H_2$ and $I_2$ at equilibrium are 0.763 and 0.863 atm, respectively. The partial pressure of HI is _____ atm.

A) 5.77 B) 0.0130 C) 33.3 D) 0.114 E) 7.87

Answer: A

22) Consider the following equilibrium.

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

The equilibrium cannot be established when _____ is/are placed in a 1.0-L container.

A) 0.75 mol $SO_2$ (g)

B) 1.0 mol $SO_3$ (g)

C) 0.25 mol $SO_2$ (g) and 0.25 mol $O_2$ (g)

D) 0.50 mol $O_2$ (g) and 0.50 mol $SO_3$ (g)

E) 0.25 mol of $SO_2$ (g) and 0.25 mol of $SO_3$ (g)

Answer: A

23) Consider the following chemical reaction:

$$H_2\,(g) + I_2\,(g) \rightleftharpoons 2HI\,(g)$$

At equilibrium in a particular experiment, the concentrations of $H_2$, $I_2$, and HI were 0.15 M, 0.033 M, and 0.55 M, respectively. The value of $K_{eq}$ for this reaction is _____.

A) 0.0090 B) 5.1 C) 23 D) 111 E) 61

Answer: E

24) The value of $K_{eq}$ for the equilibrium

$$H_2\,(g) + I_2\,(g) \rightleftharpoons 2\,HI\,(g)$$

is 794 at 25 °C. What is the value of $K_{eq}$ for the equilibrium below?

$$1/2\,H_2\,(g) + 1/2\,I_2\,(g) \rightleftharpoons HI\,(g)$$

A) 397 B) 0.0013 C) 0.035 D) 1588 E) 28

Answer: E

25) Given the following reaction at equilibrium, if $K_c = 5.54 \times 10^5$ at 230.0 °C, $K_p$ = _____.
R=0.0821 atm•L/mol•K

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

A) $2.28 \times 10^6$ B) $3.67 \times 10^{-2}$ C) $6.44 \times 10^5$ D) $1.34 \times 10^4$ E) $2.99 \times 10^7$

Answer: D