1072-1st Chem Exam-1080327 (A)

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

1) Ammonium nitrate (NH_4NO_3; molar mass = 80.04 g/mol) dissolves readily in water even though the dissolution is endothermic by 26.4 kJ/mol. The solution process is spontaneous because _____.
   A) of the increase in enthalpy upon dissolution of this strong electrolyte
   B) osmotic properties predict this behavior
   C) of the decrease in enthalpy upon addition of the solute
   D) the vapor pressure of the water decreases upon addition of the solute
   E) of the increase in disorder upon dissolution of this strong electrolyte

   Answer: E

2) Which of the following choices has the compounds correctly arranged in order of increasing solubility in water? (least soluble to most soluble)
   A) $CH_3OH < CH_4 < LiF$
   B) $LiF < NaNO_3 < CHCl_3$
   C) $CH_4 < NaNO_3 < CHCl_3$
   D) $CCl_4 < CHCl_3 < NaNO_3$
   E) $CH_3OH < Cl_4 < CHCl_3$

   Answer: D

3) Calculate the mole fraction of HCl (molar mass = 36.46 g/mol) in a 10.0% (by mass) aqueous solution.
   A) 0.00111 B) 0.0344 C) 0.0520 D) 0.0548 E) 0.122

   Answer: C

4) A solution contains 15 ppm of benzene (molar mass = 78.1 g/mol). The density of the solution is 1.00 g/mL. This means that _____.
   A) 100 g of the solution contains 15 g 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) 1.0 L of the solution contains 15 g of benzene
   E) the solution is 15% by mass of benzene

   Answer: C

5) A 0.100 m solution of which one of the following solutes will have the highest vapor pressure?
   A) $Ca(ClO_4)_2$ B) $Al(ClO_4)_3$ C) NaCl D) $KClO_4$ E) sucrose

   Answer: E

6) On a clear day at sea level, with a temperature of 25 °C, the partial pressure of N_2 in air is 0.78 atm and the concentration of nitrogen in water is 5.3×10^{-4} M. When the partial pressure of N_2 is _____ atm, the concentration in water is 1.1×10^{-3} M.
   A) 0.63 B) 1.0 C) 0.78 D) 1.6 E) 2.1

   Answer: D

7) A solution is prepared by dissolving 16.2 g of benzene (C_6H_6) in 282 g of carbon tetrachloride (CCl_4). The concentration of benzene in this solution is _____ molal. The molar masses of C_6H_6 and CCl_4 are 78.1 g/mol and 154 g/mol, respectively.

A) 7.36×10^{-4} B) 0.0543 C) 5.43 D) 0.102 E) 0.736

Answer: E

8) Calculate the freezing point of a solution containing 5.0 grams of KCl (molar mass = 74.55 g/mol) and 550.0 grams of water. The molal-freezing-point-depression constant (K_f) for water is 1.86 °C/m.

A) -0.45 °C B) 1.23 °C C) +0.23 °C D) -0.23 °C E) +0.45 °C

Answer: A

9) The osmotic pressure of a solution formed by dissolving 25.0 mg of aspirin ($C_9H_8O_4$; molar mass = 180.158 g/mol) in 0.250 L of water at 25 °C is _____ atm.

A) 1.38 B) 2.45 C) 0.0136 D) 1.14×10^{-3} E) 13.6

Answer: C

10) The solubility of $MnSO_4$ monohydrate in water at 20 °C is 70.0 g per 100.0 mL of water. A solution at 20 °C that is 4.22 *M* in $MnSO_4$ monohydrate is best described as a(n) _____ solution. The formula weight of $MnSO_4$ monohydrate is 168.97 g/mol.

A) solvated
B) unsaturated
C) hydrated
D) supersaturated
E) saturated

Answer: D

11) The molarity of urea in a solution prepared by dissolving 16 g of urea (molar mass = 60.0 g/mol) in 39 g of H_2O is _____ M. The density of the solution is 1.3 g/mL.

A) 0.16 B) 6.3 C) 3.7 D) 0.11 E) 6.8

Answer: B

12) The vapor pressure of pure ethanol at 60 °C is 0.459 atm. Raoult's Law predicts that a solution prepared by dissolving 10.0 mmol naphthalene (nonvolatile) in 90.0 mmol ethanol will have a vapor pressure of _____ atm.

A) 0.367 B) 0.498 C) 0.790 D) 0.413 E) 0.0918

Answer: D

13) A solution containing 10.0 g of an unknown liquid (nonelectrolyte) and 90.0 g water has a freezing point of -3.33 °C. Given K_f = 1.86°C/m for water, the molar mass of the unknown liquid is _____ g/mol.

A) 619 B) 161 C) 62.1 D) 69.0 E) 333

Answer: C

14) A compound decomposes by a first-order process. If 17.0% of the compound decomposes in 60.0 minutes, the half-life of the compound is _____.

A) 223 minutes B) 198 minutes C) 181 minutes D) 141 minutes E) 325 minutes

Answer: A

15) The following reaction is second order in [A] and the rate constant is 0.039 $M^{-1}s^{-1}$:

$$A \rightarrow B$$

The concentration of A was 0.30 M at 23 s. The initial concentration of A was _____ M.

A) 2.4 B) 3.7 C) 1.2×10^{-2} D) 0.41 E) 0.27

Answer: D

16) As the temperature of a reaction is increased, the rate of the reaction increases because the _____.

A) reactant molecules collide less frequently and with greater energy per collision
B) reactant molecules collide less frequently
C) reactant molecules collide more frequently with less energy per collision
D) reactant molecules collide more frequently and with greater energy per collision
E) activation energy is lowered

Answer: D

17) The reaction

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

is a second-order reaction with a rate constant of 0.80 $M^{-1}s^{-1}$ at 11 °C. If the initial concentration of NOBr is 0.0440 M, the concentration of NOBr after 7.0 seconds is _____.

A) 0.0324 M B) 0.0480 M C) 0.0402 M D) 0.0276 M E) 0.0353 M

Answer: E

18) Determine the rate law and the value of k for the following reaction using the data provided.

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

$[S_2O_8^{2-}]_i$ (M)	$[I^-]_i$ (M)	Initial Rate ($M^{-1}s^{-1}$)
0.30	0.42	4.54
0.44	0.42	6.65
0.44	0.21	3.33

A) Rate = 120 $M^{-2}s^{-1}\ [S_2O_8^{2-}]^2[I^-]$
B) Rate = 23 $M^{-1/2}s^{-1}\ [S_2O_8^{2-}][I^-]^{1/2}$
C) Rate = 195 $M^{-3}s^{-1}\ [S_2O_8^{2-}]^2[I^-]^2$
D) Rate = 36 $M^{-1}s^{-1}\ [S_2O_8^{2-}][I^-]$
E) Rate = 86 $M^{-2}s^{-1}\ [S_2O_8^{2-}][I^-]^2$

Answer: D

19) A reaction is found to have an activation energy of 108 kJ/mol. If the rate constant for this reaction is $4.60 \times 10^{-6}\ s^{-1}$ at 275 K, what is the rate constant at 366 K?

A) $5.4 \times 10^{-5}\ s^{-1}$
B) $1.9 \times 10^{-4}\ s^{-1}$
C) $12\ s^{-1}$
D) $0.58\ s^{-1}$
E) $1.7\ s^{-1}$

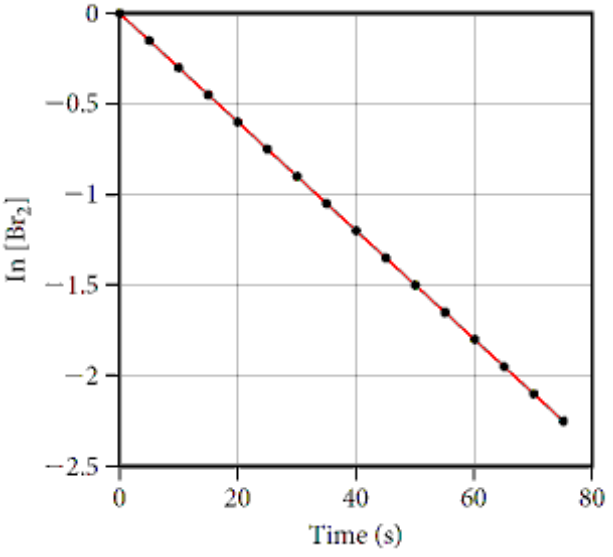
Answer: D

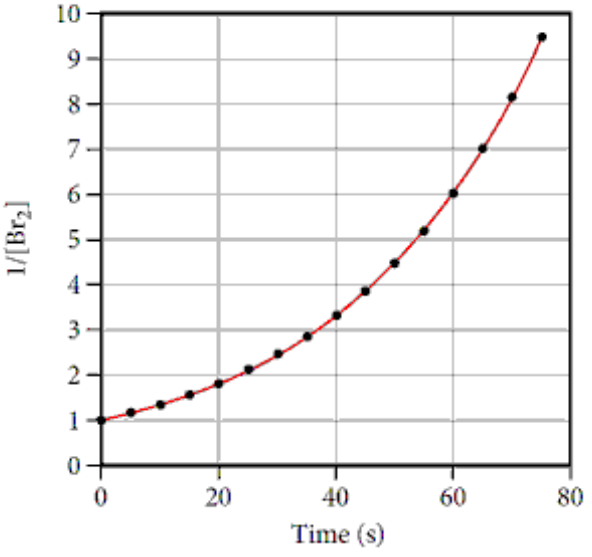
20) Which of the following statements is TRUE?

A) A catalyst raises the activation energy of a reaction.
B) Rate constants are temperature dependent.
C) The addition of a homogeneous catalyst does not change the activation energy of a given reaction.
D) The rate constant does not depend on the activation energy for a reaction where the products are lower in energy than the reactants.
E) None of the above are true.

Answer: B

21) The decomposition of Br_2 was followed as a function of time; two different plots of the data are shown here. Determine the order and rate constant for the reaction.





A) second order; 22.2 $M^{-1} \cdot s^{-1}$
B) first order; 33.3 s^{-1}
C) second order; 0.045 $M^{-1} \cdot s^{-1}$
D) first order; 0.030 s^{-1}

Answer: D

22) 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) 2, k[NO_3][CO]
B) 2, k[NO_2][CO_2]
C) 4, k[NO_3][CO][NO_2][CO_2]
D) 2, k[NO_3][CO]/[NO_2][CO_2]
E) 4, k[NO_2][CO_2]/[NO_3][CO]

Answer: A

23) Which substance in the reaction below either appears or disappears the fastest?

$$4NH_3 + 7O_2 \rightarrow 4NO_2 + 6H_2O$$

A) NO_2
B) O_2
C) H_2O
D) NH_3
E) The rates of appearance/disappearance are the same for all of these.

Answer: B

24) The decomposition of N_2O_5 in solution in carbon tetrachloride proceeds via the reaction

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

The reaction is first order and has a rate constant of $4.82 \times 10^{-3}\ s^{-1}$ at 64 °C. If the reaction is initiated with 0.058 mol in a 1.00-L vessel, how many moles remain after 151 s?

A) 0.055 B) 0.028 C) 12 D) 0.060 E) 2.0×10^3

Answer: B

25) Given the following balanced equation, determine the rate of reaction with respect to [Cl_2].

If the rate of Cl_2 loss is 4.24×10^{-2} M/s, what is the rate of formation of NO?

$$2\ NO(g) + Cl_2(g) \rightarrow 2\ NOCl(g)$$

A) 4.24×10^{-2} M/s
B) 1.61×10^{-2} M/s
C) 8.48×10^{-2} M/s
D) 2.12×10^{-2} M/s
E) 1.06×10^{-1} M/s

Answer: C

26) Which of the following represents the equation for a zero-order half-life?

A) $t_{1/2} = \frac{[A]_o}{k}$

B) $t_{1/2} = \frac{0.693}{k}$

C) $t_{1/2} = \frac{1}{[A]_o}$

D) $t_{1/2} = \frac{2k}{[A]_o}$

E) $t_{1/2} = \frac{[A]_o}{2k}$

Answer: E

27) Given the following proposed mechanism, predict the rate law for the overall reaction.

$2NO_2 + Cl_2 \rightarrow 2NO_2Cl$ (overall reaction)

Mechanism

$NO_2 + Cl_2 \rightarrow NO_2Cl + Cl$ slow

$NO_2 + Cl \rightarrow NO_2Cl$ fast

A) Rate = $k[NO_2][Cl_2]$

B) Rate = $k[NO_2]^2[Cl_2]^2$

C) Rate = $k[NO_2Cl][Cl]^2$

D) Rate = $k[NO_2Cl]^2$

E) Rate = $k[NO_2][Cl]$

Answer: A

28) The equilibrium-constant expression depends on the _____ of the reaction.

A) stoichiometry and mechanism

B) stoichiometry

C) temperature

D) mechanism

E) the quantities of reactants and products initially present

Answer: B

29) The expression for K_p for the reaction below is _____.

$$4CuO\,(s) + CH_4\,(g) \rightleftharpoons CO_2\,(g) + 4Cu\,(s) + 2H_2O\,(g)$$

A) $\dfrac{P_{CO_2} P_{H_2O}{}^2}{P_{CH_4}}$

B) $\dfrac{[Cu]\, P_{CO_2} P_{H_2O}{}^2}{[CuO]^4 P_{CH_4}}$

C) $\dfrac{P_{CH_4}}{P_{H_2O}{}^2 P_{CO_2}}$

D) $\dfrac{P_{CO_2} P_{H_2O}{}^2}{P_{CuO}}$

E) $\dfrac{P_{CH_4}}{P_{CO_2} P_{H_2}{}^2}$

Answer: A

30) Consider the following reaction:

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

A reaction mixture initially contains 0.86 atm NO and 0.86 atm SO_3. Determine the equilibrium pressure of NO_2 if K_p for the reaction at this temperature is 0.0118.

A) 0.85 atm B) 0.084 atm C) 0.048 atm D) 0.012 atm E) 0.78 atm

Answer: B

31) The equilibrium constant for the gas phase reaction

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

is $K_{eq} = 2.80 \times 10^2$ at 999 K. At equilibrium, _____.

A) reactants predominate
B) only products are present
C) only reactants are present
D) products predominate
E) roughly equal amounts of products and reactants are present

Answer: D

32) Of the following equilibria, only _____ will shift to the left in response to a decrease in volume.

A) $2\,SO_3\,(g) \rightleftharpoons 2\,SO_2\,(g) + O_2\,(g)$
B) $H_2\,(g) + Cl_2\,(g) \rightleftharpoons 2\,HCl\,(g)$
C) $N_2\,(g) + 3\,H_2\,(g) \rightleftharpoons 2\,NH_3\,(g)$
D) $4\,Fe\,(s) + 3\,O_2\,(g) \rightleftharpoons 2\,Fe_2O_3\,(s)$
E) $2HI\,(g) \rightleftharpoons H_2\,(g) + I_2\,(g)$

Answer: A

33) Consider the following reaction at equilibrium:

$$2NH_3\,(g) \rightleftharpoons N_2\,(g) + 3H_2\,(g) \quad \Delta H° = +92.4\ kJ$$

Le Châtelier's principle predicts that adding N_2 (g) to the system at equilibrium will result in _____.

A) removal of all of the H_2 (g)
B) a decrease in the concentration of H_2 (g)
C) an increase in the value of the equilibrium constant
D) a lower partial pressure of N_2
E) a decrease in the concentration of NH_3 (g)

Answer: B

34) A reaction vessel is charged with hydrogen iodide, which partially decomposes to molecular hydrogen and iodine:

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

When the system comes to equilibrium at 425 °C, P_{HI} = 0.708 atm, and $P_{H_2} = P_{I_2}$ = 0.0960 atm. The value of K_p at this temperature is _____.

A) 54.3
B) 1.30×10^{-2}
C) 1.84×10^{-2}
D) 6.80×10^{-2}
E) K_p cannot be calculated for this gas reaction when the volume of the reaction vessel is not given.

Answer: C

35) The equilibrium constant (K_p) for the interconversion of PCl_5 and PCl_3 is 0.0121:

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

A vessel is charged with PCl_5, giving an initial pressure of 0.123 atm. At equilibrium, the partial pressure of PCl_3 is _____ atm.

A) 0.0455 B) 0.0782 C) 0.0908 D) 0.0330 E) 0.123

Answer: D

36) Given the following reaction at equilibrium at 450.0 °C:

$$CaCO_3\,(s) \rightleftharpoons CaO\,(s) + CO_2\,(g)$$

If pCO_2 = 0.0135 atm, K_c = _____.

A) 0.0821 B) 135 C) 8.01 D) 2.27×10^{-4} E) 0.801

Answer: D

37) At elevated temperatures, molecular hydrogen and molecular bromine react to partially form hydrogen bromide:

$$H_2\,(g) + Br_2\,(g) \rightleftharpoons 2HBr\,(g)$$

A mixture of 0.682 mol of H_2 and 0.440 mol of Br_2 is combined in a reaction vessel with a volume of 2.00 L. At equilibrium at 700 K, there are 0.556 mol of H_2 present. At equilibrium, there are _____ mol of Br_2 present in the reaction vessel.

A) 0.000 B) 0.126 C) 0.440 D) 0.314 E) 0.556

Answer: D

38) 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 the equilibrium partial pressure of CO (g) can be maximized by carrying out the reaction _____.

A) at high temperature and high pressure
B) at high temperature and low pressure
C) at low temperature and low pressure
D) at low temperature and high pressure
E) in the presence of solid carbon

Answer: C

39) 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) 0.035 C) 1588 D) 0.0013 E) 28

Answer: E

40) In the coal-gasification process, carbon monoxide is converted to carbon dioxide via the following reaction:

$$CO\,(g) + H_2O\,(g) \rightleftharpoons CO_2\,(g) + H_2\,(g)$$

In an experiment, 0.35 mol of CO and 0.40 mol of H_2O were placed in a 1.00-L reaction vessel. At equilibrium, there were 0.16 mol of CO remaining. K_{eq} at the temperature of the experiment is _____.

A) 0.93 B) 1.1 C) 1.0 D) 5.5 E) 0.75

Answer: B