1012_1st Exam_1020320

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

1) What is the main difference between a Pt catalyst and an enzyme catalyst?
   A) A Pt catalyst is always a homogeneous catalyst.
   B) The enzyme causes a faster reaction.
   C) The Pt catalyst causes a faster reaction.
   D) An enzyme has greater substrate specificity.
   E) A Pt catalyst is an enzyme.

   Answer: D

2) If increasing the concentration of A in a chemical reaction causes no increase in the rate of the reaction, then we may say:
   A) A is a catalyst
   B) the reaction rate is second order in [A]
   C) the reaction rate is zero order in [A]
   D) the reaction rate is first order in [A]
   E) A is not involved in the reaction

   Answer: C

3) A factor that decreases the activation energy for a reaction:
   I) decreases the rate constant
   II) increases the rate constant
   III) has no effect on the rate constant
   IV) makes the product yield increase
   V) might be a catalyst

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

   Answer: C

4) For the second order reaction A → products, the following data are obtained:

   [A] = 1.512 M, t = 0 min
   [A] = 1.490 M, t = 1.0 min
   [A] = 1.469 M, t = 2.0 min

   What is the concentration of [A] in the experiment after 4.0 min for the reaction?

   A) 1.61 M B) 1.43 M C) 1.37 M D) 1.40 M E) 1.35 M

   Answer: B

5) In a second order reaction:
   I) the sum of the exponents in the rate law is equal to two.
   II) at least one of the exponents in the rate law is a two.
   III) the half-life is not constant.
   IV) the half-life is constant.
   V) k can be expressed as $M^{-2}s^{-1}$ or $M^{-2}min^{-1}$.

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

   Answer: B

6) Given that the equilibrium concentrations of $[N_2] = 0.035$ M, $[C_2H_2] = 0.057$ M, and $[HCN] = 6.8 \times 10^{-4}$ M, find the value of the equilibrium constant expression for the reaction:

$$N_2(g) + C_2H_2(g) \rightleftharpoons 2\ HCN$$

A) 4300 B) 2.3×10^{-4} C) 3.4×10^{-1} D) 6.8×10^{-1} E) 2.9

Answer: B

7) What is the $[HPO_4^{-2}]$ of a solution labeled "0.10 M Phosphoric Acid"?

$[K_{a1} = 7.1 \times 10^{-3}; K_{a2} = 6.3 \times 10^{-8}; K_{a3} = 4.2 \times 10^{-13}]$

A) 4.2×10^{-13} M
B) 1.6×10^{-9} M
C) 1.6×10^{-16} M
D) 6.3×10^{-8} M
E) 7.1×10^{-3} M

Answer: D

8) The rate constant for a first-order reaction is $k = 0.00073\ s^{-1}$. Determine the percent of reactant that has decomposed after 500 s.

A) 31% B) 69% C) 37% D) 43% E) 57%

Answer: A

9) For the reaction: $2NO_2(g) \rightarrow 2NO(g) + O_2(g)$ concentration-time data are:

t(s)	$[NO_2]$	$\ln[NO_2]$	$\frac{1}{[NO_2]}$
0.00	2.000	0.300	0.500
0.40	1.467	0.166	0.682
0.80	1.076	0.032	0.929
1.20	0.789	-0.103	1.267
1.60	0.579	-0.237	1.727
2.00	0.424	-0.373	2.358

What is the order of the reaction with respect to $[NO_2]$?

A) first B) third C) second D) zero E) 2 + 2

Answer: A

10) Write the equilibrium constant expression for the following reaction:

$6\ CO_2(g) + 6\ H_2O(l) \rightleftharpoons C_6H_{12}O_6(s) + 6\ O_2(g)$

A) $K_c = \dfrac{[O_2]^6}{[CO_2]^6}$

B) $K_c = \dfrac{[C_6H_{12}O_6]}{[H_2O]^6[CO_2]^6}$

C) $K_c = \dfrac{[CO_2]^6}{[C_6H_{12}O_6]}$

D) $K_c = \dfrac{[CO_2]^6[H_2O]^6}{[O_2]^6}$

E) $K_c = \dfrac{[O_2]}{[CO_2]}$

Answer: A

11) Choose the INCORRECT statement.

A) A reversible chemical reaction is one in which equilibrium is never established due to the constant decomposition of the products.
B) When the rate of the reverse reaction equals the rate of the forward reaction, equilibrium has been established.
C) Chemical equilibrium is a dynamic equilibrium.
D) A certain amount of energy, called the activation energy, must be available if a reaction is to take place.
E) Changes in temperature will change the value of an equilibrium constant.

Answer: A

12) What is the pH of a 0.475 M solution of sodium nitrite? *K*a (nitrous acid) = 7.2×10^{-4}

A) 5.59 B) 8.58 C) 12.27 D) 8.41 E) 5.42

Answer: D

13) 0.75 mol of N_2 and 1.20 mol of H_2 are placed in a 3.0 liter container. When the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2\ NH_3(g)$ reaches equilibrium, $[H_2] = 0.100$ M. Which of the following is true?

A) $[NH_3] = 0.150$ M
B) $[NH_3] = 0.200$
C) $[N_2] = 0.650$ M
D) $[N_2] = 0.250$
E) $[NH_3] = [H_2] = 0.05$ M

Answer: B

14) Equilibrium constant *K* is constant except when one varies the:

A) concentration of the products
B) temperature of the reaction
C) concentrations of the reactants
D) partial pressures of the reactants
E) *K* always remains constant

Answer: B

15) Choose the INCORRECT statement.
A) The rate-determining step is always the first step.
B) An elementary process is a step in the mechanism.
C) A bimolecular process is one involving a collision of two molecules.
D) A unimolecular process is one in which a single molecule dissociates.
E) A reaction mechanism is a step-by-step detailed description of a chemical reaction.

Answer: A

16) List the following acids in order of increasing strength:
H_3PO_4 H_2SO_4 $HClO_4$
A) $HClO_4 < H_3PO_4 < H_2SO_4$
B) $H_2SO_4 < H_3PO_4 < HClO_4$
C) $HClO_4 < H_2SO_4 < H_3PO_4$
D) $H_3PO_4 < H_2SO_4 < HClO_4$
E) $H_2SO_4 < HClO_4 < H_3PO_4$

Answer: D

17) Consider the following reversible reaction:
$POCl_3(g) \rightleftharpoons POCl(g) + Cl_2(g)$ $K_c = 0.450$
The following initial amounts of reactants and products were mixed: $[POCl_3] = 0.750$ M, $[POCl] = 0.550$ M, and $[Cl_2] = 0.150$ M. What is the equilibrium concentration of POCl?
A) 0.360 M B) 0.395 M C) 0.155 M D) 0.945 M E) 0.740 M

Answer: E

18) In the reaction $C_4H_9Cl(aq) + H_2O(l) \rightarrow C_4H_9OH(aq) + HCl(aq)$ the concentration of the reactant changes from 0.0562 M to 0.0431 M in 85 sec. What is the average rate of decomposition over this interval?
A) 0.0154 M
B) 1.54×10^{-4} M/s
C) 1.54×10^{-4} moles/s
D) 0.0154 M/s
E) 1.54×10^{-4} moles

Answer: B

19) List the following acids in order of increasing strength:
HBrO HIO HClO
A) HClO < HIO < HBrO
B) HClO< HBrO < HIO
C) HBrO < HIO < HClO
D) HIO < HBrO < HClO
E) HIO < HClO < HBrO

Answer: D

20) If one mole of $Ba(OH)_2$ is added to enough water to make 10 liters of solution, the pH of the resulting solution is _____.
A) 13.0 B) 1.0 C) 12.5 D) 0.7 E) 13.3

Answer: E

21) CO_2 acts as an acid in the reaction $CaO(s) + CO_2 \rightleftharpoons CaCO_3(s)$ because it _____.

A) reacts with a metal
B) is a proton donor
C) is an electron-pair acceptor
D) turns blue litmus red
E) is a gas containing a non-metal

Answer: C

22) Choose the Brønsted-Lowry acids and bases in the following equation:

$$HSO_4^- + C_2H_3O_2^- \rightleftharpoons HC_2H_3O_2 + SO_4^{2-}$$

A) acids SO_4^{2-}, $C_2H_3O_2^-$ bases HSO_4^-, $HC_2H_3O_2$
B) acids SO_4^{2-}, $HC_2H_3O_2$ bases HSO_4^-, $C_2H_3O_2^-$
C) acids HSO_4^-, $C_2H_3O_2^-$ bases $HC_2H_3O_2$, SO_4^{2-}
D) acids HSO_4^-, SO_4^{2-} bases $HC_2H_3O_2$, $C_2H_3O_2^-$
E) acids HSO_4^-, $HC_2H_3O_2$ bases SO_4^{2-}, $C_2H_3O_2^-$

Answer: E

23) For the following compound, predict whether the solution is acidic, basic or neutral and why:

A) basic because NH_4Cl is the salt of a weak acid
B) basic because NH_4Cl is a weak base
C) acidic because NH_4Cl is a strong acid
D) acidic because NH_4Cl is the salt of a weak base
E) neutral because there is no hydrolysis

Answer: D

24) A solution has pOH of -0.47. This means that:

A) the solution has a pH of 13.53
B) the solution has an $[OH^-] = 0.34$ M
C) The solution has an $[H^+] = 2.95$ M
D) the solution has an $[OH^-] = 2.95$ M
E) the solution has an $[OH^-]$ greater than 10.0 M

Answer: D

25) In the reaction $BF_3 + NH_3 \rightleftharpoons F_3B{:}NH_3$, BF_3 acts as:

A) a Lewis base
B) an Arrhenius acid
C) an Arrhenius base
D) a Lewis acid
E) a Brønsted acid

Answer: D

26) Which of the following situations involves a heterogeneous catalysis?

A) The catalyst is in two different phases of matter.
B) The catalyst changes phases during the reaction.
C) The catalyst is present in a different phase of matter than are the reactants and products.
D) The reactants and products are different phases of matter in a catalyzed reaction.
E) The catalyst, reactants, and products are all different phases of matter.

Answer: C

27) Data for the reaction A + B → C are given below. Find the rate constant for this system.

Experiment	[A], M	[B], M	Initial rate, M/s
1	0.030	0.060	2.5×10^{-5}
2	0.030	0.020	2.5×10^{-5}
3	0.060	0.060	10.0×10^{-5}

A) 2.8×10^{-2} Ms^{-1}
B) 1.7×10^{-3} Ms^{-1}
C) 2.8×10^{-2} $M^{-1}s^{-1}$
D) 1.7×10^{-3} $M^{-1}s^{-1}$
E) 2.8×10^{-2} $M^{2}s^{-1}$

Answer: C

28) In the following reversible reaction the Brønsted acids are _____.

$HCO_3^-(aq) + OH^-(aq) \rightleftharpoons CO_3^{2-}(aq) + H_2O$

A) HCO_3^- and H_2O
B) HCO_3^- and CO_3^{2-}
C) OH^- and H_2O
D) OH^- and CO_3^{2-}
E) H_2O and CO_3^{2-}

Answer: A

29) Consider the following reaction at a certain temperature.

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

When the initial concentration of $SO_3(g)$ is 0.128 M, the concentration of oxygen gas at equilibrium is found to be 0.0130 M. Calculate K_c for this reaction.

A) 1.47×10^{-3} B) 8.45×10^{-4} C) 7.64×10^{-5} D) 1.62×10^{-2}

Answer: B

30) For the reaction: $3\ Fe(s) + 4\ H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4\ H_2(g)$ what is the effect of adding Fe(s)?

A) There is no change.
B) The reaction shifts to the right.
C) The K_p is decreased.
D) The K_p is doubled.
E) The reaction shifts to the left.

Answer: A

31) In the Arrhenius equation, $\ln k = -E_a/RT + \ln A$, the symbol A denotes:

A) a constant that represents the frequency of collisions with the proper orientation and other steric conditions favorable for a reaction
B) the absolute temperature
C) the initial concentration of A
D) the activation energy
E) the rate constant

Answer: A

32) For the reaction: $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$ at the time when N_2O_5 is being consumed at a rate of -1.2×10^{-4} M/s, what is the rate at which O_2 is being formed?

A) 4.8×10^{-4} M/s
B) 2.4×10^{-4} M/s
C) 6.0×10^{-5} M/s
D) 1.2×10^{-4} M/s
E) 3.0×10^{-5} M/s

Answer: C

33) 0.375 g of a monoprotic acid (mm = 245 g/mol) is dissolved in water to produce 25.0 mL of a solution with pH = 3.28. Determine the ionization constant of the acid.

A) 2.3×10^{-2} B) 4.5×10^{-3} C) 4.5×10^{-6} D) 8.56×10^{-3} E) 7.4×10^{-5}

Answer: C

34) For the reaction: $C_2H_4Br_2 + 3KI \rightarrow C_2H_4 + 2KBr + KI_3$

Initial rate data at 60°C are:

$[C_2H_4Br_2]$, M	[KI], M	$\Delta[KI_3]/\Delta t$ (M min)
0.500	1.80	0.269
0.500	7.20	1.08
1.50	1.80	0.807

The rate law is _____.

A) rate = $k[C_2H_4Br_2]$
B) rate = $k[KI]$
C) rate = $k[KI][C_2H_4Br_2]^2$
D) rate = $k[KI]^2$
E) rate = $k[KI][C_2H_4Br_2]$

Answer: E

35) Which species in the following reaction acts as a Lewis acid?

$$CuSO_4(s) + 4NH_3(aq) \rightleftharpoons [Cu(NH_3)_4]^{2+}(aq) + SO_4^{2-}(aq)$$

A) NH_3
B) SO_4^{2-}
C) $[Cu(NH_3)_4]^{2+}(aq)$
D) Cu^{2+}
E) $[Cu(NH_3)_4]^{2+}(aq)$ and SO_4^{2-}

Answer: D

36) Which of the following statements is true about the reaction $2A \rightarrow B + C$ which is first order in A and first order overall?

A) The rate of formation of C is twice the rate of reaction of A.
B) The rate of the reaction will decrease at higher concentrations of B and C.
C) The time required for one half of A to react is directly proportional to the quantity of A.
D) The rate of formation of B is the same as the rate of reaction of A.
E) The initial rate doubles with doubling of initial concentration of A.

Answer: E

37) A saturated aqueous solution of calcium hydroxide has a pH of 12.25. What is the $[Ca^{2+}]$ of such a solution?

A) 5.6×10^{-13} B) 0.018 C) 8.9×10^{-3} D) 2.3×10^{-5} E) 0.035

Answer: C

38) Which of the following has no effect on the rate of a reaction?

A) activation energy
B) presence of a catalyst
C) temperature of reactants
D) value of $\Delta H°$
E) concentrations of reactants

Answer: D

39) Consider the following reaction.

$$C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$$

At equilibrium at a certain temperature, $[H_2O(g)] = 0.12$ M, and $[CO(g)] = [H_2(g)] = 1.2$ M. If suddenly these concentrations are increased by 0.50 M, which of the following is true?

A) $K_c = 4.66$ B) Since K_c does not change, nothing happens.
C) more products are formed D) more $H_2O(g)$ will be formed

Answer: C

40) For the reaction: $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$ the rate law is:

$$\frac{\Delta[O_2]}{\Delta t} = k[N_2O_5]$$

At 300 K, the half-life is 2.50×10^4 seconds and the activation energy is 103.3 kJ/mol. What is the half-life at 310 K?

A) 9.51×10^4 s B) 6.57×10^3 s C) 2.49×10^4 s D) 9.51×10^6 s E) 1.87×10^{-1} s

Answer: B

41) Calculate rate constant k for a first order reaction with a half-life of 75.0 min.

A) 1.33×10^{-2} min^{-1}
B) 9.24×10^{-3} min^{-1}
C) 2.67×10^{-2} min^{-1}
D) 52.0 min^{-1}
E) 1.54×10^{-4} min^{-1}

Answer: B

42) For $2\ NO_2(g) \rightleftharpoons N_2O_4(g)$, $K_c = [N_2O_4]/[NO_2]^2$. At equilibrium there are 0.0270 mol N_2O_4 and 0.450 mol NO_2 in a 50.0-L container. What is K_c?

A) 0.133 B) 6.81 C) 0.00267 D) 6.67 E) 2.45

Answer: D

43) In the equilibrium system described by: $PO_4^{3-}(aq) + H_2O(l) \rightleftharpoons HPO_4^{2-}(aq) + OH^-(aq)$ Brønsted-Lowry theory would designate:

A) PO_4^{3-} as amphiprotic

B) H_2O and OH^- as a conjugate pair

C) HPO_4^{2-} and OH^- as the acids

D) PO_4^{3-} and H_2O as the bases

E) HPO_4^{2-} and H_2O as a conjugate pair

Answer: B

44) Consider the reaction:

$$CH_4(g) + 4\,Cl_2(g) \rightleftharpoons CCl_4(l) + 4\,HCl(g) \quad \Delta H° = -398 \text{ kJ/mol}$$

The equilibrium is displaced to the right if:

A) some carbon tetrachloride is removed

B) the pressure is lowered

C) the temperature is raised

D) some hydrogen chloride is added

E) some chlorine gas is removed

Answer: A

45) What is the pH of a 0.375 M solution of benzoic acid? $K_a = 6.3 \times 10^{-5}$

A) 8.9 B) 11.7 C) 5.1 D) 2.3 E) 0.43

Answer: D

46) For the reaction:

$$3\,Fe(s) + 4\,H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4\,H_2(g)$$

write the expression for K_p.

A) $\dfrac{[Fe_3O_4][H_2]}{[Fe][H_2O]}$

B) $\dfrac{[Fe_3O_4]\,P(H_2)}{[Fe]\,P(H_2O)}$

C) $\dfrac{P(H_2)^4}{P(H_2O)^4}$

D) $\dfrac{[Fe_3O_4][H_2]^4}{[Fe][H_2O]^4}$

E) $\dfrac{P(H_2)}{P(H_2O)}$

Answer: C

47) For the following chemical equilibrium, $K_p = 4.6 \times 10^{-14}$ at 25°C, find the value of K_c for this reaction at 25°C. R =0.0831 bar L / K mol

$$2\ Cl_2(g) + 2\ H_2O(g) \rightleftharpoons 4\ HCl(g) + O_2(g)$$

A) $K_c = 1.1 \times 10^{-12}$
B) $K_c = 2.2 \times 10^{-14}$
C) $K_c = 4.6 \times 10^{-14}$
D) $K_c = 9.4 \times 10^{-14}$
E) $K_c = 1.9 \times 10^{-15}$

Answer: E

48) For the reaction: $CH_4(g) + 2H_2O(g) \rightleftharpoons CO_2(g) + 4H_2(g)$ $\Delta H° = +190$ kJ add $H_2(g)$:
A) the reaction reacts to the left
B) the reaction reacts to the right
C) the $\Delta H°$ increases
D) the temperature increases
E) there is no change in equilibrium position

Answer: A

49) For the reaction $CO(g) + 3\ H_2(g) \rightleftharpoons H_2O(g) + CH_4(g)$, $K_c = 190$ at 1000 K. If a vessel is filled with these gases such that the initial concentrations are [CO] = 0.036 M, $[H_2] = 0.045$, $[H_2O] = 0.020$, and $[CH_4] = 0.031$, in which direction will a reaction occur and why?
A) toward products because $Q/Kc = 4.1$
B) toward products because $Q/Kc = 0.38$
C) toward reactants because $Q/Kc = 61$
D) toward reactants because $Q/Kc = 0.24$
E) it is at equilibrium because Q/Kc = 1

Answer: E

50) A saturated aqueous solution of calcium hydroxide is approximately 0.13% calcium hydroxide, by mass, and has a density of 1.02 g ml^{-1}. What is the pH of such a solution?
A) 12.25 B) 12.75 C) 13.00 D) 12.55 E) 11.95

Answer: D