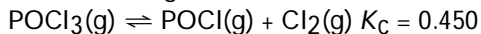# 1002_1st Exam_1010321

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

1) Consider the following reaction:

$$POCl_3(g) \rightleftharpoons POCl(g) + Cl_2(g) \quad K_c = 0.450$$

A sample of pure $POCl_3(g)$ was placed in a reaction vessel and allowed to decompose according to the above reaction. At equilibrium, the concentrations of $POCl(g)$ and $Cl_2(g)$ were each 0.150 M. What was the initial concentration of $POCl_3(g)$?

   A) 0.633 M   B) 0.225 M   C) 0.350 M   D) 0.200 M   E) 0.483 M

Answer: D

2) Which statement is INCORRECT
   A) The activated complex will be the highest on the energy profile.
   B) In an endothermic reaction, activation energy is usually greater than the enthalpy.
   C) If the forward reaction is exothermic, the reverse will be endothermic.
   D) Activation energy is the same for forward and reverse reaction.
   E) An activated complex has higher energy than any molecule contributing to it.

Answer: D

3) Which indication of relative acid strengths is INCORRECT?
   A) $HCl > HF$
   B) $HClO_2 > HClO$
   C) $CH_3CO_2H > CH_3CH_2OH$
   D) $H_2SO_3 > HNO_3$
   E) $H_2SO_4 > H_2SO_3$

Answer: D

4) Consider the equilibrium system: $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ for which $K_p = 0.1134$ at 25°C and $\Delta H°_{rxn} = 58.03$ kJ/mol. Assuming that the total pressure inside the container is 10 atm at equilibrium and that initially only N_2O_4 was present inside the container, compute P_{N_2O} at equilibrium.

   A) 7.98 atm   B) 1.01 atm   C) 1.12 atm   D) 8.88 atm   E) 8.99 atm

Answer: B

5) What is the pH of a 0.563 M solution of ethylammonium bromide? K_b (ethylammonia) $= 4.3 \times 10^{-4}$
   A) 5.32   B) 8.58   C) 5.44   D) 8.68   E) 1.79

Answer: C

6) What is the pH of a 0.253 M solution of ammonium chloride? K_b (NH_3) $= 1.2 \times 10^{-5}$
   A) 2.7   B) 11.3   C) 4.8   D) 9.9   E) 9.2

Answer: C

7) For a reaction Rate $= k[A][B]^2$, what factor will keep k unchanged?
   A) adding catalyst   B) adding inhibitor
   C) increasing [A]   D) raising temperature

Answer: C

8) 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) 6.67   B) 0.133   C) 0.00267   D) 6.81   E) 2.45

Answer: A

9) For the reaction: $C_2H_4Br_2 + 3 KI \rightarrow C_2H_4 + 2 KBr + KI_3$, when the rate of reaction is 2.0×10^{-5}, what is the rate of appearance of C_2H_4?

   A) 0.67×10^{-5} B) 6.0×10^{-5} C) 2.0×10^{-5} D) 4.0×10^{-5} E) 1.0×10^{-5}

Answer: C

10) 0.653 g of a monoprotic acid (mm = 157 g/mol) is dissolved in water to produce 50.0 mL of a solution with pH = 2.13. Determine the ionization constant of the acid.

   A) 8.9×10^{-2} B) 3.6×10^{-6} C) 3.9×10^{-2} D) 6.6×10^{-4} E) 7.9×10^{-3}

Answer: D

11) For the reaction $2 NO(g) \rightleftharpoons N_2O_4(g)$ K_p equals _____.

   A) K_c/RT B) K_c C) RT/K_c D) $K_c(RT)$ E) $K_c(RT)^2$

Answer: A

12) What is the $[K^+]$ of a solution prepared by dissolving 0.140 g of potassium hydroxide in sufficient pure water to prepare 250.0 ml of solution?

   A) 10^{-4} M   B) 10^{-8} M   C) 10^{-12} M   D) 10^{-2} M   E) 10^{-5} M
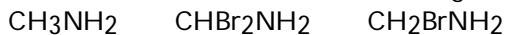
Answer: D

13) Given the following initial rate data, calculate the specific rate constant.

Experiment	$[A]_o$, M	$[B]_o$, M	Initial rate, M/s
1	5.1×10^{-4}	0.35×10^{-4}	3.4×10^{-8}
2	5.1×10^{-4}	0.70×10^{-4}	6.8×10^{-8}
3	5.1×10^{-4}	0.18×10^{-4}	1.7×10^{-8}
4	1.0×10^{-3}	0.35×10^{-4}	6.8×10^{-8}
5	1.5×10^{-3}	0.35×10^{-4}	10.2×10^{-8}

   A) 3.6 M^2s^{-1}
   B) 3.6 M^2s^{-1}
   C) 1.9 M^2/s^2
   D) 1.1×10^8 M^2/s^2
   E) 1.9 $M^{-1.}s^{-1}$

Answer: E

14) What is the indication of the relative base strengths of the following bases?

        CH_3NH_2 $CHBr_2NH_2$ CH_2BrNH_2

  A) $CH_2BrNH_2 > CHBr_2NH_2 > CH_3NH_2$

  B) $CHBr_2NH_2 > CH_3NH_2 > CH_2BrNH_2$

  C) $CHBr_2NH_2 > CH_2BrNH_2 > CH_3NH_2$

  D) $CH_2BrNH_2 > CH_3NH_2 > CHBr_2NH_2$

  E) $CH_3NH_2 > CH_2BrNH_2 > CHBr_2NH_2$

Answer: E

15) What is the order of reaction for the following reaction: Rate = $k[A]^{-1/2} [B]^{1/2}$?

  A) 1/2 order

  B) zero order

  C) -1/2 order

  D) second order

  E) first order

Answer: B

16) For which of the following reactions does $K_p = K_c$?

  A) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ B) $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$

  C) $H_2(g) + I_2(s) \rightleftharpoons 2HI(g)$ D) $3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$

Answer: D

17) List the following acids in order of increasing strength:

        $HClO_2$ $HClO_3$ $HClO_4$

  A) $HClO_3 < HClO_2 < HClO_4$

  B) $HClO_4 < HClO_2 < HClO_3$

  C) $HClO_4 < HClO_3 < HClO_2$

  D) $HClO_2 < HClO_3 < HClO_4$

  E) $HClO_2 < HClO_4 < HClO_3$

Answer: D

18) What is the rate law for the following mechanism?

        $N_2O + NO \rightarrow N_2ONO$ (Slow)

        $N_2ONO \rightarrow N_2 + NO_2$ (Fast)
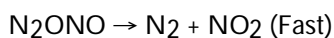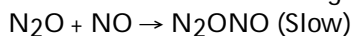
  A) Rate = $k[N_2][NO_2]$

  B) Rate = $k[NO]$

  C) Rate = $k[N_2ONO]$

  D) Rate = $k[N_2O][NO]$

  E) Rate = $k[N_2O]$

Answer: D

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

   Answer: B

20) For $CO_2(g)$ + $H_2(g)$ ⇌ $CO(g)$ + $H_2O(g)$, K_c = $[CO][H_2O]/[CO_2][H_2]$, if there are 1.43 mols each of CO and H_2, 0.572 mol H_2 and 4.572 mols CO_2, in a 4.0 L container at equilibrium, what is K_c?
     A) 0.782   B) 0.137   C) 1.28   D) 0.547   E) 2.34

   Answer: A

21) Which of the following statements is INCORRECT?
     A) In a zero order reaction the rate remains constant throughout the reaction.
     B) For a first order reaction ln $[A]_t/[A]_0$ = kt.
     C) Half-life in a first order reaction is constant.
     D) Radioactive decay is a first order reaction.
     E) In gaseous reactions [A] can be expressed as concentration or as pressure.

   Answer: B

22) 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 rate constant, k, for the reaction?
     A) 2.2×10^{-2} M^{-1} min^{-1}
     B) 1.0×10^{-2} M^{-1} min^{-1}
     C) 3.6×10^{-3} M^{-1} min^{-1}
     D) 9.7×10^{-3} M^{-1} min^{-1}
     E) 1.4×10^{-2} M^{-1} min^{-1}

   Answer: D

23) A mixture containing 0.392 M A(g) and 0.452 M B(g) is allowed to come to equilibrium at 300 K. The reaction 3 A(g) + 2 B(g) ⇌ C(g) + D(g) occurs. At equilibrium, [C] = 0.00128 M. What is the value of K_c?
     A) 7.19×10^6 B) 1.39×10^{-4} C) 9.24×10^{-6} D) 1.36×10^2 E) 7.35×10^{-3}
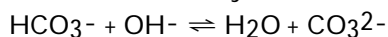
   Answer: B

24) Which of the following keep the equilibrium position unchanged?
     A) pressure change
     B) temperature decrease
     C) temperature
     D) concentration change
   E) homogeneous catalyst
   Answer: E C   E

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

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

    A) acids HCO_3^-, H_2O bases OH^-, CO_3^{2-}
    B) acids H_2O, CO_3^{2-} bases HCO_3^-, OH^-
    C) acids H_2O, OH^- bases HCO_3^-, CO_3^{2-}
    D) acids HCO_3^-, OH^- bases CO_3^{2-}, H_2O
    E) acids OH^-, CO_3^{2-} bases HCO_3^-, H_2O

Answer: A

26) 4.000 mol chlorine and 2.000 mol bromine were placed in a 50.0 L container and kept at 293 K until equilibrium was achieved for the reaction:

$$Br_2(l) + Cl_2(g) \rightleftharpoons 2BrCl(g)$$
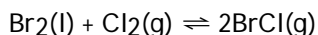
At the point of equilibrium there were 82.63 g of $Br_2(l)$. Compute the value of K_C for this reaction.

    A) 0.0699   B) 3.50   C) 0.699   D) 0.849   E) 0.0849

Answer: A

27) At 35°C, $K_p = 0.315$ for the reaction $N_2O_4(g) \rightleftharpoons 2 NO_2(g)$, if the initial pressure of $NO_2(g)$ in a container is 3.00 atm, what is the equilibrium pressure of $N_2O_4(g)$?

    A) 0.685 atm   B) 0.471 atm   C) 0.315 atm   D) 1.19 atm   E) 1.88 atm

Answer: D

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

Answer: C

29) Which of the following is FALSE for a second order reaction?

    A) $1/[A]_t - 1/[A]_0 = kt$.
    B) If $1/[A]$ versus time is a straight line, the reaction is second order.
    C) Each successive half-life is 4 times as long as the previous.
    D) The slope of $1/[A]_t$ versus time is k.
    E) $t_{1/2} = 1/k[A]_0$.

Answer: C

30) Write the equilibrium expression K_c for the reaction:

sodium sulfite(aq) + chloric acid (aq) $\rightleftharpoons$ sodium chlorite(aq) + sulfur dioxide(g) + water(l).

A) $\dfrac{[NaClO_3]^2}{[Na_2SO_3][HClO_3]^2}$

B) $\dfrac{[NaClO_3][SO_2][H_2O]}{[Na_2SO_3][HClO_3]}$

C) $\dfrac{[NaClO_3][SO_2]}{[Na_2SO_3][HClO_3]}$

D) $\dfrac{[NaClO_3]^2[SO_2]}{[Na_2SO_3][HClO_3]^2}$

E) $\dfrac{[NaClO_3]^2[SO_2][H_2O]}{[Na_2SO_3][HClO_3]^2}$

Answer: D

31) What is the pH of a 0.250 M solution of formic acid? $K_a = 1.8 \times 10^{-4}$

A) 0.60   B) 5.4   C) 2.2   D) 11.8   E) 8.6

Answer: C

32) Substance A decomposes by a first-order reaction. Starting initially with [A] = 2.00 M, after 150 min [A] = 0.50 M. For this reaction what is $t_{1/2}$?

A) 75.0 min   B) 300 min   C) 150 min   D) 37.5 min   E) 15.0 min

Answer: A

33) The concept of an acid not limited to H+ or species containing one or more protons is inherent in:

A) both the Arrhenius and the Brønsted-Lowry theories
B) both the Brønsted-Lowry and the Lewis theories
C) only the Brønsted-Lowry theory
D) only the Arrhenius theory
E) only the Lewis theory

Answer: E

34) Which of the following lowers the activation energy of a reaction?

A) adding reactants
B) removing products
C) adding a catalyst
D) raising the temperature
E) lowering the temperature

Answer: C

35) Which of the following is a logical inference from the fact that a 0.10 molar solution of potassium acetate, $KC_2H_3O_2$, is less alkaline than a 0.10 molar solution of potassium cyanide, KCN?

A) 0.10 M potassium acetate is more concentrated than 0.10 M potassium cyanide.
B) Hydrocyanic acid is less soluble in water than acetic acid.
C) Acetic acid is a weaker acid than hydrocyanic acid.
D) Hydrocyanic acid is a weaker acid than acetic acid.
E) Cyanides are less soluble than acetates.

Answer: D

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

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

   Answer: A

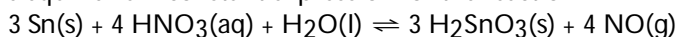37) For the reaction: $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$ the rate law is:

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

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

   A) 1.05×10^{-4} s^{-1}

   B) 7.29×10^{-6} s^{-1}

   C) 3.70×10^{-5} s^{-1}

   D) 2.78×10^{-5} s^{-1}

   E) 7.29×10^{-8} s^{-1}

   Answer: ~~B~~ | 1020318   A |

38) Write the equilibrium constant expression for the reaction:

   $3\ Sn(s) + 4\ HNO_3(aq) + H_2O(l) \rightleftharpoons 3\ H_2SnO_3(s) + 4\ NO(g)$

   A) $K_C = \dfrac{[NO]^4}{[HNO_3]^4}$

   B) $K_C = \dfrac{[H_2SnO_3]^3[NO]^4}{[HNO_3]^4}$

   C) $K_C = \dfrac{[H_2SnO_3]^3[NO]^4}{[Sn]^3[HNO_3]^4}$

   D) $K_C = \dfrac{[H_2SnO_3]^3[NO]^4}{[Sn]^3[HNO_3]^4[H_2O]}$

   E) $K_C = \dfrac{[H_2SnO_3][NO]^-}{[Sn][H_2O][HNO_3]}$

   Answer: A

39) Define rate law
   A) A theoretical equation that describes how the rate of reaction depends on temperature, orientation and number of collisions.
   B) A theoretical equation that describes how the rate of reaction depends on the concentration of reactants.
   C) An experimentally determined equation that describes how the rate of reaction depends on the concentration of reactants.
   D) An experimentally determined equation that describes how the rate of reaction depends on temperature, orientation and number of collisions.

   Answer: C

40) Consider the reaction:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \quad \Delta H° = -196.6 \text{ kJ/mol}$$
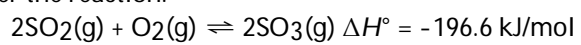
The equilibrium is displaced to the left if:
  A) the temperature is raised
  B) some sulfur trioxide is removed
  C) some sulfur dioxide is added
  D) the pressure is raised
  E) the temperature is lowered

Answer: A