CHEM-1212
Spring 2016
Second Examination
Form A

Multiple Choice - Choose the BEST Answer

1. Which of the following reactions best illustrates the protonation of water and the deprotonation of carbonic acid?

A) $H_2O(l) + H_2CO_3^-(aq) \rightleftharpoons HCO_3^-(aq) + OH^-(aq)$
B) $H_2O(l) + H_2CO_3(aq) \rightleftharpoons HCO_3^-(aq) + OH^-(aq)$
C) $H_2O(l) + H_2CO_3(aq) \rightleftharpoons HCO_3^-(aq) + H_3O^+(aq)$
D) $H_2O(l) + H_2CO_3(aq) \rightleftharpoons H_2CO_3^+(aq) + OH^-(aq)$
E) $H_2O(l) + H_2CO_3(aq) \rightleftharpoons CO_3^{2-}(aq) + H_3O^+(aq)$

2. Which species are present in an aqueous solution of a weak base?

I. the weak base
II. OH^-
III. H_3O^+
IV. the conjugate acid of the weak base
V. H_2O

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

3. Which of the following equations best shows H_2O acting as a base?

A) $HS^-(aq) + H_2O(l) \rightleftharpoons S^{2-}(aq) + H_3O^+(aq)$
B) $HS^-(aq) + H_2O(l) \rightleftharpoons H_2S(aq) + OH^-(aq)$
C) $HS^-(aq) + OH^-(aq) \rightleftharpoons S^{2-}(aq) + H_2O(l)$
D) $H_2S(aq) + OH^-(aq) \rightleftharpoons HS^-(aq) + H_2O(l)$
E) In all of the previous equations, H_2O is acting as an acid.

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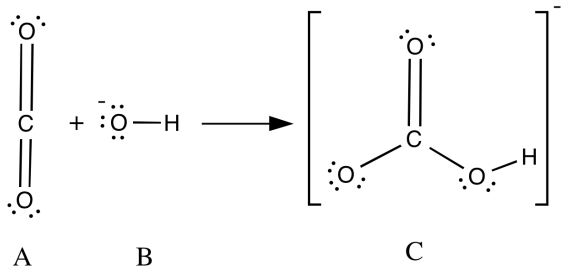
4. The figure below is a reaction between CO_2 and OH^-. Which of the following statements is true about the reaction shown below?



I. Species A acts as an Arrhenius acid
II. Species A donates an electron pair to species B
III. Species B accepts an electron pair from species A
IV. Species B acts as a Brønsted-Lowry base
V. Species A acts as a Brønsted-Lowry acid

A) I only
B) IV and V only
C) II and III only
D) I, II, III, IV and V are all correct.
E) None of the statements I-V are true

5. What is the pH of a 0.300 *M* HCN(aq) solution? The K_a of hydrocyanic acid is 4.9×10^{-10}.

A) pH = 0.52
B) pH = 1.21
C) pH = 4.92
D) pH = 9.08
E) Not enough information is given.

6. Which statement is true regarding the relative acid strengths of HOCl and HOBr?

A) HOBr is a weaker acid than HOCl due to the greater electronegativity of the chlorine atom as compared to bromine making the O-H bond weaker in HBrO.
B) HOBr is a weaker acid than HOCl because the H-Br bond is weaker than the H-Cl bond due to the radius of the chlorine atom being smaller than that of bromine.
C) HOCl is a weaker acid than HOBr because the bond between hydrogen and bromine is very week due to the greater electronegativity of bromine than chlorine.
D) HOCl is a weaker acid than HOBr because the H-Br bond is weaker than the H-Cl bond due to the radius of the chlorine atom being smaller than that of bromine.
E) HOBr is a weaker acid than HOCl due to the greater electronegativity of the chlorine atom as compared to the bromine atom making the O-H bond weaker in HOCl.

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7. Using the following table, which answer choice is the strongest acid?

Formula	K_b
$(CH_3)_2NH$	5.4×10^{-4}
N_2H_4	8.9×10^{-7}
NH_3	1.8×10^{-5}

A) NH_3
B) N_2H_4
C) $(CH_3)_2NH$
D) $(CH_3)_2NH_2^+$
E) $N_2H_5^+$

8. An aqueous solution of which of the following will have a pH = 7.00 when it is produced in a neutralization reaction?

A) $Fe(NO_3)_3$
B) NH_4Cl
C) $AlCl_3$
D) Na_2CO_3
E) $KClO_4$

9. $H_2CO_3(aq)$ has an $K_{a1} = 4.3 \times 10^{-7}$ and an $K_{a2} = 5.6 \times 10^{-11}$. Which of the following are true about $H_2CO_3(aq)$ at equilibrium?

A) At equilibrium, the relative concentrations of the following are: $[H_2CO_3] = [HCO_3^-] = [CO_3^{2-}]$ due to $K_{a1} >>> K_{a2}$.
B) At equilibrium the relative concentrations of the following are: $[H_2CO_3] << [HCO_3^-] = [CO_3^{2-}]$ because the equilibriums are very product favored.
C) At equilibrium the relative concentrations of the following are: $[H_2CO_3] = [HCO_3^-] << [CO_3^{2-}]$ because the only the first deprotonation occurs.
D) At equilibrium the relative concentrations of the following are: $[H_2CO_3] >> [HCO_3^-] >> [CO_3^{2-}]$ because the equilibriums are very reactant favored.
E) At equilibrium the relative concentrations of the following are: $[H_2CO_3] >> [HCO_3^-] = [CO_3^{2-}]$ because the only the first deprotonation occurs.

10. Natural or "unpolluted" rain has a pH of 5.6. By what factor has the concentration of $H_3O^+(aq)$ changed in acid rain with a pH of 3.6?

A) increased by a factor of 2.0
B) increased by a factor of 100
C) increased by a factor of 0.2
D) decreased by a factor of 0.2
E) decreased by a factor of 100

Multiple Choice - Choose the BEST Answer

11. What is the net ionic reaction for potassium hydroxide reacting with hydrocyanic acid?

$KOH(aq) + HCN(aq) \rightleftharpoons KCN(aq) + H_2O(l)$

A) $K^+(aq) + OH^-(aq) + H^+(aq) + CN^-(aq) \rightleftharpoons K^+(aq) + CN^-(aq) + H_2O(l)$
B) $K^+(aq) + OH^-(aq) + HCN(aq) \rightleftharpoons K^+(aq) + CN^-(aq) + H_2O(l)$
C) $OH^-(aq) + H^+(aq) \rightleftharpoons H_2O(l)$
D) $OH^-(aq) + HCN(aq) \rightleftharpoons CN^-(aq) + H_2O(l)$
E) $KOH(aq) + HCN(aq) \rightleftharpoons KCN(aq) + H_2O(l)$

12. A buffer contains equal amounts of a weak base and its conjugate acid. It has a pH = 9.26. Which answer option is a reasonable value for the pH after the addition of a small amount of strong base?

A) pH = 3.16
B) pH = 7.00
C) pH = 9.02
D) pH = 9.45
E) pH = 13.67

13. If a small amount of a strong base is added to a buffer solution made up of a weak base, B, and the chloride salt of its conjugate acid, the pH of the buffer solution does not change appreciable because

A) no reaction occurs
B) the K_b of B changes
C) the strong base reacts with B to produce BH^+ which is a weak acid.
D) the strong base reacts with H_2O to produce BH^+ which is a weak base.
E) the strong base reacts with BH^+ to produce B, which is a weak base.

14. Equal volumes of the aqueous solutions below are mixed. Which mixture results in a buffer?

A) 0.10 *M* HBr(aq) with 0.10 *M* KOH(aq)
B) 0.10 *M* CH_3NH_2(aq) with 0.10 *M* HCl(aq)
C) 0.080 *M* NaOH(aq) with 0.10 *M* CH_3COOH (aq)
D) 0.10 *M* CH_3COOH(aq) with 0.10 *M* HCOOH(aq)
E) 0.080 *M* HClO(aq) with 0.10 *M* KOH(aq)

15. A buffer contains a weak acid, HA and its conjugate base, A^-. The weak acid has a $pK_a = 3.52$, and the buffer currently has a pH = 4.25. Which of the following statement(s) is(are) true?

A) $[HA] > [A^-]$
B) $[HA] < [A^-]$
C) $[HA] = [H_2O]$
D) $[HA] = [OH^-]$
E) $[OH^-] = [H_3O^+]$

Multiple Choice - Choose the BEST Answer

16. What is the pH of a solution prepared by dissolving 3.6 g of $NaHCO_3$ and 5.3 g Na_2CO_3 in enough water to produce 0.20 L of solution. The equilibrium constants for carbonic acid are $K_{a1} = 4.3 \times 10^{-7}$ and $K_{a2} = 5.6 \times 10^{-11}$.

A) 6.31
B) 6.37
C) 6.43
D) 10.25
E) 10.32

17. When there is an increase in the concentration of CO_2 in the ocean, which of the following statements are true? Use the following equations as needed to answer the question.

1. $CO_2(aq) + H_2O(l) \rightleftharpoons H_2CO_3(aq)$ $K = 1.7 \times 10^{-3}$
2. $H_2CO_3(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + HCO_3^-(aq)$ $K_{a1} = 4.3 \times 10^{-7}$
3. $HCO_3^-(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + CO_3^{2-}(aq)$ $K_{a2} = 5.6 \times 10^{-11}$
4. $Ca^{2+}(aq) + 2\ HCO_3^-(aq) \rightleftharpoons CaCO_3(s) + CO_2(aq) + H_2O(l)$

A) As the concentration of $CO_2(aq)$ increases, the amount of $CaCO_3(s)$ decreases
B) The deprototonation of H_2CO_3 is greater than the deprotonation of HCO_3^-.
C) The CO_2 in water is used to form $H_2CO_3(aq)$
D) As the concentration of $CO_2(aq)$ in the ocean increases, the pH of the system decreases.
E) All of the previous statements are true.

18. A 50.0 mL sample of 0.250 *M* NH_3 ($K_b = 1.8 \times 10^{-5}$) is titrated with 0.500 *M* HNO_3. What is the pH of the solution after 12.5 mL of acid was added?

A) pH = 4.78
B) pH = 7.00
C) pH = 9.14
D) pH = 9.22
E) pH = 9.26

19. A solution contains 0.150 *M* Pb^{2+}. Chloride ions are added to the solution. What concentration is necessary to precipitate $PbCl_2$ at 25°C? ($K_{sp} = 1.2 \times 10^{-5}$)?

A) a concentration less than 8.0×10^{-5} mol/L
B) a concentration equal to 8.0×10^{-5} mol/L
C) a concentration greater than 8.0×10^{-2} mol/L
D) a concentration less than 8.9×10^{-3} mol/L
E) a concentration greater than 8.9×10^{-3} mol/L

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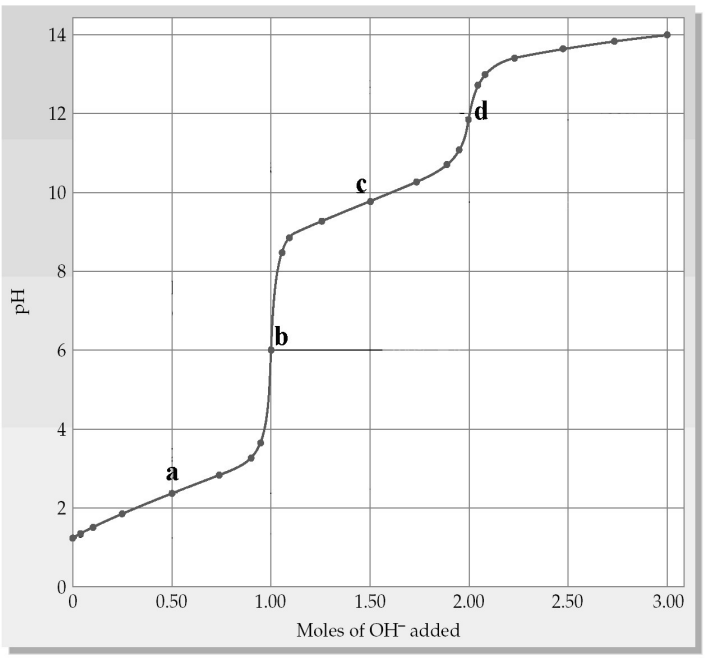
20. The following plot shows a titration curve for the titration of 1.00 L of 1.00 *M* diprotic acid H_2A with NaOH. Which point on the plot (a-d) best represents the HA^-/A^{2-} buffer region?



A) Point a
B) Point b
C) Point c
D) Point d
E) This buffer region does not exist on the titration curve above.

21. A 25.0 mL sample of 0.500 *M* HCO_2H (K_a = 1.8 x 10^{-4}) is titrated with 0.350 *M* NaOH. What is the pH of the solution after 40.0 mL of base was added?

A) 4.11
B) 4.66
C) 9.89
D) 11.18
E) 12.36

22. Which form of the exam do you have?

A) A
B) B