
Acid-Base Equilibria - (Lectures 1 & 2)

Round One - Warm Up

1) According to the Arrhenius concept, an acid is a substance that _____.

- A) is capable of donating one or more H^+
- B) causes an increase in the concentration of H^+ in aqueous solutions
- C) can accept a pair of electrons to form a coordinate covalent bond
- D) reacts with the solvent to form the cation formed by autoionization of that solvent
- E) tastes bitter

Answer: B

2) A Brønsted-Lowry base is defined as a substance that _____.

- A) increases $[H^+]$ when placed in H_2O
- B) decreases $[H^+]$ when placed in H_2O
- C) increases $[OH^-]$ when placed in H_2O
- D) acts as a proton acceptor
- E) acts as a proton donor

Answer: D

3) A Brønsted-Lowry acid is defined as a substance that _____.

- A) increases K_a when placed in H_2O
- B) decreases $[H^+]$ when placed in H_2O
- C) increases $[OH^-]$ when placed in H_2O
- D) acts as a proton acceptor
- E) acts as a proton donor

Answer: E

4) Which one of the following is a Brønsted-Lowry acid?

- A) $(CH_3)_3NH^+$
- B) CH_3COOH
- C) HF
- D) HNO_2
- E) all of the above

Answer: E

5) A substance that is capable of acting as both an acid and as a base is _____.

- A) autosomal
- B) conjugated
- C) ambiprotic
- D) saturated
- E) miscible

Answer: C

6) Which one of the following is a Brønsted-Lowry base?

- A) $(CH_3)_3N$
- B) CH_3COOH
- C) HF
- D) HNO_2
- E) none of the above

Answer: A

Lecture 2 7) The molar concentration of hydronium ion in pure water at $25^\circ C$ is _____.

- A) 0.00
- B) 1.0×10^{-7}
- C) 1.0×10^{-14}
- D) 1.00
- E) 7.00

Answer: B

Lecture 2 8) The molar concentration of hydroxide ion in pure water at $25^\circ C$ is _____.

- A) 1.00
- B) 0.00
- C) 1.0×10^{-14}
- D) 1.0×10^{-7}
- E) 7.00

Answer: D

Lecture 2 9) The magnitude of K_w indicates that _____.

- A) water autoionizes very slowly
- B) water autoionizes very quickly
- C) water autoionizes only to a very small extent
- D) the autoionization of water is exothermic

Answer: C

Lecture 2 10) Which one of the following statements regarding K_w is false?

- A) pK_w is 14.00 at 25 °C.
- B) The value of K_w is always 1.0×10^{-14} .
- C) K_w changes with temperature.
- D) The value of K_w shows that water is a weak acid.
- E) K_w is known as the ion product of water.

Answer: B

Lecture 2 11) The hydride ion, H^- , is a stronger base than the hydroxide ion, OH^- . The product(s) of the reaction of hydride ion with water is/are _____.

- A) H_3O^+ (aq)
- B) OH^- (aq) + H_2 (g)
- C) OH^- (aq) + $2H^+$ (aq)
- D) no reaction occurs
- E) H_2O_2 (aq)

Answer: B

12) Of the following acids, _____ is a strong acid.

- A) HNO_2
- B) H_2CO_3
- C) HNO_3
- D) $HClO$
- E) HF

Answer: C

13) Of the following acids, _____ is not a strong acid.

- A) HNO_2
- B) H_2SO_4
- C) HNO_3
- D) $HClO_4$
- E) HCl

Answer: A

14) Of the following, _____ is a weak acid.

- A) HF
- B) HCl
- C) HBr

- D) HNO_3
- E) $HClO_4$

Answer: A

Lecture 2 15) Which one of the following is the weakest acid?

- A) HF ($K_a = 6.8 \times 10^{-4}$)
- B) $HClO$ ($K_a = 3.0 \times 10^{-8}$)
- C) HNO_2 ($K_a = 4.5 \times 10^{-4}$)
- D) HCN ($K_a = 4.9 \times 10^{-10}$)
- E) Acetic acid ($K_a = 1.8 \times 10^{-5}$)

Answer: D

Lecture 2 16) Of the acids in the table below, _____ is the strongest acid.

Acid	K_a
HOAc	1.8×10^{-5}
$HCHO_2$	1.8×10^{-4}
$HClO$	3.0×10^{-8}
HF	6.8×10^{-4}

- A) HOAc
- B) $HCHO_2$
- C) $HClO$
- D) HF
- E) HOAc and $HCHO_2$

Answer: D

Lecture 2 17) The K_a of hypochlorous acid ($HClO$) is 3.0×10^{-8} at 25 °C. What is the percent ionization of hypochlorous acid in a 0.015 M aqueous solution of $HClO$ at 25 °C?

- A) 4.5×10^{-8}
- B) 14
- C) 2.1×10^{-5}
- D) 0.14
- E) 1.4×10^{-3}

Answer: D

18) Classify the following compounds as weak acids (W) or strong acids (S):

benzoic acid nitric acid acetic acid

A) W W W

- B) S S S
C) S W W
D) W S S
E) W S W

Answer: E

19) Classify the following compounds as weak acids (W) or strong acids (S):

hydrocyanic acid hydrofluoric acid phenol

- A) W W W
B) S S S
C) S W W
D) W S S
E) W S W

Answer: A

20) Classify the following compounds as weak acids (W) or strong acids (S):

nitrous acid hydrochloric acid
hydrofluoric acid

- A) W W W
B) S S S
C) S W W
D) W S S
E) W S W

Answer: E

21) Classify the following compounds as weak acids (W) or strong acids (S):

hypochlorous acid perchloric acid chloric acid

- A) W S S
B) S S S
C) S W W
D) W W W
E) W S W

Answer: A

22) Ammonia is a _____.

- A) weak acid
B) strong base
C) weak base
D) strong acid
E) salt

Answer: C

Lecture 2 23) HA is a weak acid. Which equilibrium corresponds to the equilibrium constant K_b for A^- ?

- A) $HA(aq) + H_2O(l) \rightleftharpoons H_2A^+(aq) + OH^-(aq)$
B) $A^-(aq) + H_3O^+(aq) \rightleftharpoons HA(aq) + H_2O(l)$
C) $HA(aq) + OH^-(aq) \rightleftharpoons H_2O(l) + H^+(aq)$
D) $A^-(aq) + H_2O(l) \rightleftharpoons HA(aq) + OH^-(aq)$
E) $A^-(aq) + OH^-(aq) \rightleftharpoons HOA^{2-}(aq)$

Answer: D

Lecture 2 24) A^- is a weak base. Which equilibrium corresponds to the equilibrium constant K_a for HA?

- A) $HA(aq) + H_2O(l) \rightleftharpoons H_2A^+(aq) + OH^-(aq)$
B) $A^-(aq) + H_3O^+(aq) \rightleftharpoons HA(aq) + H_2O(l)$
C) $HA(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + A^-(aq)$
D) $A^-(aq) + H_2O(l) \rightleftharpoons HA(aq) + OH^-(aq)$
E) $A^-(aq) + OH^-(aq) \rightleftharpoons HOA^{2-}(aq)$

Answer: C

25) Classify the following compounds as weak bases (W) or strong bases (S):

ammonia fluoride ion sodium hydroxide

- A) W W S
B) S S S
C) S W W
D) W S S
E) W S W

Answer: A

26) Classify the following compounds as weak bases (W) or strong bases (S):

Methylamine carbonate ion potassium hydroxide

- A) W W S
B) S S S
C) S W W
D) W S S
E) W S W

Answer: A

Lecture 2 27) Using the data in the table, which of the conjugate bases below is the strongest base?

Acid	K_a
HOAc	1.8×10^{-5}
HC ₇ H ₅ O ₂	6.3×10^{-5}
HNO ₂	4.5×10^{-4}
HF	6.8×10^{-4}

- A) OAc⁻
- B) C₇H₅O₂⁻
- C) NO₂⁻
- D) F⁻
- E) OAc⁻ and C₇H₅O₂⁻

Answer: A

Lecture 2 28) Using the data in the table, which of the conjugate bases below is the weakest base?

Acid	K_a
HOAc	1.8×10^{-5}
HC ₇ H ₅ O ₂	6.3×10^{-5}
HNO ₂	4.5×10^{-4}
HF	6.8×10^{-4}

- A) OAc⁻
- B) C₇H₅O₂⁻
- C) NO₂⁻
- D) F⁻
- E) OAc⁻ and C₇H₅O₂⁻

Answer: D

Lecture 2 29) Using the data in the table, which of the conjugate bases below is the strongest base?

Acid	K_a
HOAc	1.8×10^{-5}
HCHO ₂	1.8×10^{-4}
HCIO	3.0×10^{-8}
HF	6.8×10^{-4}

- A) OAc⁻
- B) CHO₂⁻
- C) ClO⁻
- D) F⁻
- E) OAc⁻ and CHO₂⁻

Answer: C

Lecture 2 30) Using the data in the table, which of the conjugate bases below is the weakest base?

Acid	K_a
HOAc	1.8×10^{-5}
HCHO ₂	1.8×10^{-4}
HCIO	3.0×10^{-8}
HF	6.8×10^{-4}

- A) OAc⁻
- B) CHO₂⁻
- C) ClO⁻
- D) F⁻
- E) OAc⁻ and CHO₂⁻

Answer: D

Lecture 2 31) Using the data in the table, which of the conjugate acids below is the strongest acid?

Base	K_b
ClO ⁻	3.3×10^{-7}
CO ₃ ⁻²	1.8×10^{-4}
HS ⁻	1.8×10^{-7}
NH ₂ CH ₃	4.4×10^{-4}

- A) HCIO
- B) HCO₃⁻
- C) H₂S
- D) NH₃CH₃⁺
- E) H₂S and HCIO

Answer: C

Lecture 2 32) Using the data in the table, which of the conjugate acids below is the weakest acid?

Base	K_b
ClO ⁻	3.3×10^{-7}
CO ₃ ⁻²	1.8×10^{-4}
HS ⁻	1.8×10^{-7}
NH ₂ CH ₃	4.4×10^{-4}

- A) HCIO
- B) HCO₃⁻
- C) H₂S
- D) NH₃CH₃⁺
- E) H₂S and HCIO

Answer: D

Lecture 2 33) Using the data in the table, which of the conjugate acids below is the strongest acid?

Base	K_b
NH_3	1.8×10^{-5}
$\text{C}_5\text{H}_5\text{N}$	1.7×10^{-9}
H_2NOH	1.1×10^{-8}
NH_2CH_3	4.4×10^{-4}

- A) NH_4^+
- B) $\text{C}_5\text{H}_5\text{NH}^+$
- C) H_3NOH^+
- D) NH_3CH_3^+
- E) NH_4^+ and NH_3CH_3^+

Answer: B

Lecture 2 34) Using the data in the table, which of the conjugate acids below is the weakest acid?

Base	K_b
NH_3	1.8×10^{-5}
$\text{C}_5\text{H}_5\text{N}$	1.7×10^{-9}
H_2NOH	1.1×10^{-8}
NH_2CH_3	4.4×10^{-4}

- A) NH_4^+
- B) $\text{C}_5\text{H}_5\text{NH}^+$
- C) H_3NOH^+
- D) NH_3CH_3^+
- E) NH_4^+ and NH_3CH_3^+

Answer: D

Lecture 2 35) Which of the following ions will act as a weak base in water?

- A) OH^-
- B) Cl^-
- C) NO_3^-
- D) ClO^-
- E) None of the above will act as a weak base in water.

Answer: D

Lecture 2 36) Which of the following ions will act as a weak base in water?

- A) HS^-
- B) F^-
- C) NO_2^-
- D) ClO^-
- E) All of the above will act as a weak base in water.

Answer: E

Lecture 2 37) Which of the following aqueous solutions has the highest $[\text{OH}^-]$?

- A) a solution with a pH of 3.0
- B) a 1×10^{-4} M solution of HNO_3
- C) a solution with a pOH of 12.0
- D) pure water
- E) a 1×10^{-3} M solution of NH_4Cl

Answer: D

Lecture 2 38) Which of the following aqueous solutions has the lowest $[\text{OH}^-]$?

- A) a solution with a pH of 3.0
- B) a 1×10^{-4} M solution of HNO_3
- C) a solution with a pOH of 12.0
- D) pure water
- E) a 1×10^{-3} M solution of NH_4Cl

Answer: C

Lecture 2 39) A 0.0035 M aqueous solution of a particular compound has $\text{pH} = 2.46$. The compound is _____.

- A) a weak base
- B) a weak acid
- C) a strong acid
- D) a strong base
- E) a salt

Answer: C

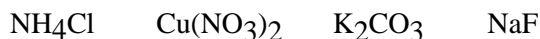
Lecture 2 40) Of the following substances, an aqueous solution of _____ will form basic solutions.

NaHS $\text{Cu}(\text{NO}_3)_2$ KHCO_3 NaF

- A) NaHS , $\text{Cu}(\text{NO}_3)_2$
- B) KHCO_3 , NaHS
- C) NaF only
- D) NaF , KHCO_3
- E) NaHS , KHCO_3 and NaF

Answer: E

Lecture 2 41) Of the following substances, an aqueous solution of _____ will form basic solutions.



- A) NH_4Cl , $\text{Cu}(\text{NO}_3)_2$
- B) K_2CO_3 , NH_4Cl
- C) NaF only
- D) NaF , K_2CO_3
- E) NH_4Cl only

Answer: D

Lecture 2 42) Of the compounds below, a 0.1 M aqueous solution of _____ will have the highest pH.

- A) KCN , K_a of $\text{HCN} = 4.0 \times 10^{-10}$
- B) NH_4NO_3 , K_b of $\text{NH}_3 = 1.8 \times 10^{-5}$
- C) NaOAc , K_a of $\text{HOAc} = 1.8 \times 10^{-5}$
- D) NaClO , K_a of $\text{HClO} = 3.2 \times 10^{-8}$
- E) NaHS , K_b of $\text{HS}^- = 1.8 \times 10^{-7}$

Answer: A

Lecture 2 43) A 0.1 M solution of _____ has a pH of 7.0.

- A) Na_2S
- B) KF
- C) NaNO_3
- D) NH_4Cl
- E) NaF

Answer: C

Lecture 2 44) Which of the following acids will be the strongest?

- A) H_2SO_4
- B) HSO_4^-
- C) H_2SO_3
- D) H_2SeO_4
- E) HSO_3^-

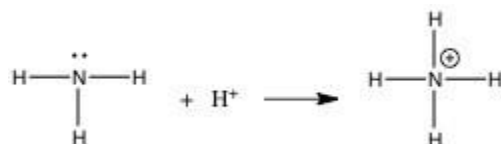
Answer: A

Lecture 2 45) Of the following, which is the strongest acid?

- A) HClO
- B) HClO_3
- C) HClO_2
- D) HClO_4
- E) HIO

Answer: D

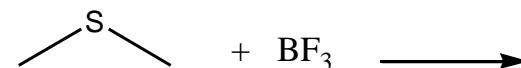
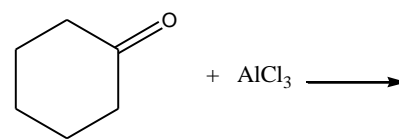
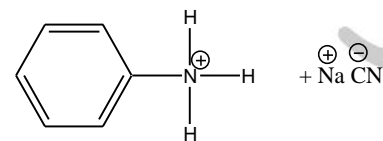
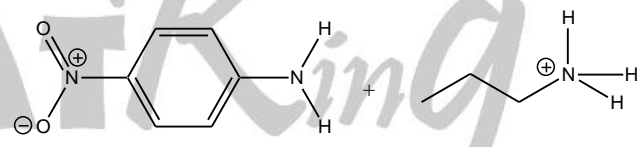
46) In the gas phase reaction below, NH_3 is acting as a(n) _____ base but not as a(n) _____ base.



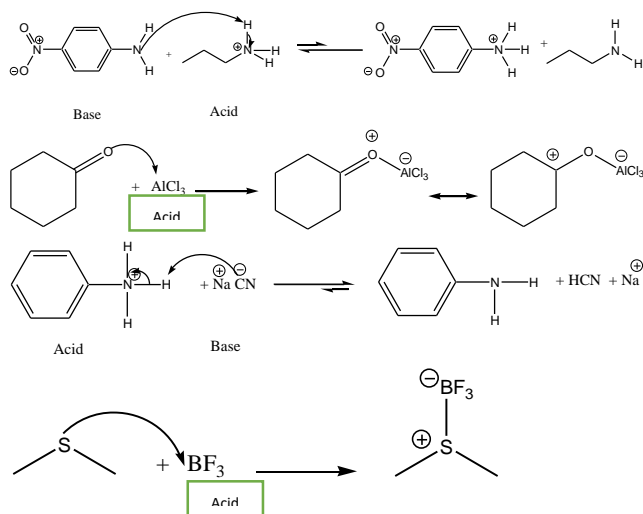
- A) Arrhenius, Brønsted-Lowry
- B) Brønsted-Lowry, Lewis
- C) Lewis, Arrhenius
- D) Lewis, Brønsted-Lowry
- E) Arrhenius, Lewis

Answer: C

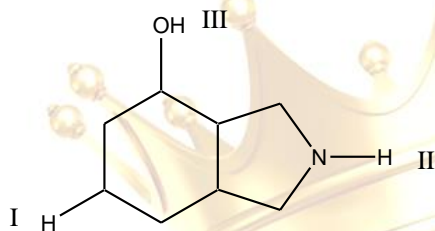
47) For the following reactions identify the acid and the base and predict the products.



Answers:



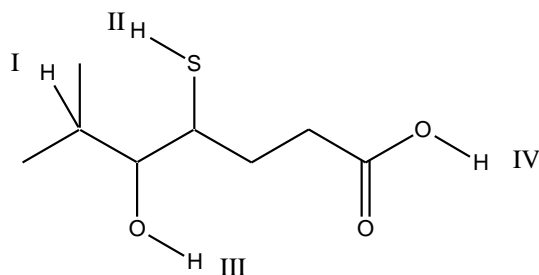
- 48) Rank the following protons in decreasing order (most to least) of acidity.



- A) II>III>I
B) I>II>III
C) III>I>II
D) III>II>I
E) None of these

Answer: D

- 49) Which of the indicated protons is most acidic?



- A) I
B) II
C) III
D) IV
E) All of these

Answer: D

Round Two: Let's Do More

- 1) What is the conjugate acid of NH_3 ?

- A) NH_3
B) NH_2^+
C) NH_3^+
D) NH_4^+
E) NH_4OH

Answer: D

- 2) What is the conjugate acid of CO_3^{2-} ?

- A) CO_2^{2-}
B) HCO_2^{2-}
C) H_2CO_3
D) HCO_3^-
E) none of the above

Answer: D

- 3) The conjugate base of HSO_4^- is _____.

- A) OH^-
B) H_2SO_4
C) SO_4^{2-}
D) HSO_4^+
E) H_3SO_4^+

Answer: C

- 4) The conjugate base of H_2PO_4^- is _____.

- A) PO_4^{3-}
B) H_2PO_4
C) H_3PO_4
D) HPO_4^{2-}
E) none of the above

Answer: D

- 5) The conjugate acid of HSO_4^- is _____.

- A) SO_4^{2-}
B) H_2SO_4
C) HSO_4^+
D) H^+
E) HSO_3^+

Answer: B

6) The conjugate acid of CH_3NH_2 is _____.

- A) CH_3NH_2
- B) CH_3NH_3^+
- C) CH_3NH_2^+
- D) CH_3NH^+
- E) none of the above

Answer: B

7) What is the conjugate base of OH^- ?

- A) O_2
- B) O^-
- C) H_2O
- D) O^{2-}
- E) H_3O^+

Answer: D

8) What is the pH of an aqueous solution at 25.0°C that contains 3.98×10^{-9} M hydronium ion?

- A) 8.400
- B) 5.600
- C) 9.000
- D) 3.980
- E) 7.000

Answer: A

9) What is the pOH of an aqueous solution at 25.0°C that contains 3.98×10^{-9} M hydronium ion?

- A) 8.400
- B) 5.600
- C) 9.000
- D) 3.980
- E) 7.000

Answer: B

10) What is the pH of an aqueous solution at 25.0°C that contains 3.98×10^{-9} M hydroxide ion?

- A) 8.40
- B) 5.60
- C) 9.00
- D) 3.98
- E) 7.00

Answer: B

11) What is the pOH of an aqueous solution at 25.0°C that contains 3.98×10^{-9} M hydroxide ion?

- A) 8.40
- B) 5.60
- C) 9.00
- D) 3.98
- E) 7.00

Answer: A

12) Calculate the pOH of a solution at 25.0°C that contains 1.94×10^{-10} M hydronium ions.

- A) 1.94
- B) 4.29
- C) 7.00
- D) 14.0
- E) 9.71

Answer: B

13) Calculate the pH of a solution at 25.0°C that contains 1.94×10^{-10} M hydronium ions.

- A) 1.94
- B) 4.29
- C) 7.00
- D) 14.0
- E) 9.71

Answer: E

14) Calculate the concentration (in M) of hydronium ions in a solution at 25.0°C with a pOH of 4.223.

- A) 5.98×10^{-5}
- B) 1.67×10^{-10}
- C) 1.67×10^4
- D) 5.99×10^{-19}
- E) 1.00×10^{-7}

Answer: B

15) Calculate the concentration (in M) of hydroxide ions in a solution at 25.0°C with a pOH of 4.223.

- A) 5.98×10^{-5}
- B) 1.67×10^{-10}
- C) 1.67×10^4
- D) 5.99×10^{-19}
- E) 1.00×10^{-7}

Answer: A

16) An aqueous solution contains 0.100 M NaOH at 25.0 °C. The pH of the solution is _____.

- A) 0.100
- B) 1.00
- C) 13.00
- D) 7.00
- E) -1.00

Answer: C

17) An aqueous solution contains 0.150 M HCl at 25.0 °C. The pH of the solution is _____.

- A) 0.150
- B) 1.00
- C) 13.00
- D) 7.00
- E) 0.82

Answer: E

Lecture 2 18) HZ is a weak acid. An aqueous solution of HZ is prepared by dissolving 0.020 mol of HZ in sufficient water to yield 1.0 L of solution. The pH of the solution was 4.93 at 25.0 °C. The K_a of HZ is _____.

- A) 1.2×10^{-5}
- B) 6.9×10^{-9}
- C) 1.4×10^{-10}
- D) 9.9×10^{-2}
- E) 2.8×10^{-12}

Answer: B

Lecture 2 19) The pH of a 0.55 M aqueous solution of hypobromous acid, HBrO, at 25.0 °C is 4.48. What is the value of K_a for HBrO?

- A) 2.0×10^{-9}
- B) 9.1×10^{-10}
- C) 6.0×10^{-5}
- D) 3.3×10^{-5}
- E) 3.0×10^4

Answer: A

Lecture 2 20) The pH of a 0.25 M aqueous solution of hydrofluoric acid, HF, at 25.0 °C is 2.03. What is the value of K_a for HF?

- A) 2.0×10^{-9}
- B) 1.1×10^{-9}
- C) 6.0×10^{-5}
- D) 3.5×10^{-4}
- E) none of the above

Answer: D

Lecture 2 21) The pH of a 0.60 M aqueous solution of formic acid, HCHO₂, at 25.0 °C is 1.98. What is the value of K_a for formic acid?

- A) 2.0×10^{-5}
- B) 1.8×10^{-4}
- C) 6.0×10^{-5}
- D) 3.5×10^{-4}
- E) none of the above

Answer: B

Lecture 2 22) A 0.15 M aqueous solution of the weak acid HA at 25.0 °C has a pH of 5.35. The value of K_a for HA is _____.

- A) 3.0×10^{-5}
- B) 1.8×10^{-5}
- C) 7.1×10^{-9}
- D) 1.3×10^{-10}
- E) 3.3×10^4

Answer: D

Lecture 2 23) The K_a of hypochlorous acid (HClO) is 3.00×10^{-8} . What is the pH at 25.0 °C of an aqueous solution that is 0.0200 M in HClO?

- A) +2.45
- B) -2.45
- C) -9.22
- D) +9.22
- E) +4.61

Answer: E

Lecture 2 24) The K_a of acetic acid (HC₂H₃O₂) is 1.8×10^{-5} . What is the pH at 25.0 °C of an aqueous solution that is 0.100 M in acetic acid?

- A) +2.87
- B) -2.87
- C) -11.13
- D) +11.13
- E) +6.61

Answer: A

Lecture 2 25) The acid-dissociation constants of sulfurous acid (H₂SO₃) are $K_{a1} = 1.7 \times 10^{-2}$ and $K_{a2} = 6.4 \times 10^{-8}$ at 25.0 °C. Calculate the pH of a 0.163 M aqueous solution of sulfurous acid.

- A) 4.53
- B) 1.28
- C) 1.86
- D) 6.21
- E) 2.93

Answer: B

Lecture 2 26) The acid-dissociation constants of phosphoric acid (H_3PO_4) are $K_{a1} = 7.5 \times 10^{-3}$, $K_{a2} = 6.2 \times 10^{-8}$, and $K_{a3} = 4.2 \times 10^{-13}$ at 25.0°C . What is the pH of a 2.5 M aqueous solution of phosphoric acid?

- A) 1.82
- B) 0.40
- C) 2.51
- D) 0.86
- E) 0.13

Answer: D

Lecture 2 27) The pH of a 0.55 M aqueous solution ammonia, NH_3 , at 25.0°C is 11.50. What is the value of K_b for NH_3 ?

- A) 2.0×10^{-9}
- B) 1.1×10^{-9}
- C) 6.0×10^{-6}
- D) 1.8×10^{-5}
- E) none of the above

Answer: D

Lecture 2 28) A 0.15 M aqueous solution of the weak base B at 25.0°C has a pH of 8.88. The value of K_b for B is _____.

- A) 3.0×10^{-5}
- B) 1.8×10^{-5}
- C) 3.9×10^{-10}
- D) 1.3×10^{-11}
- E) none of the above

Answer: C

Lecture 2 29) The pH of a 0.30 M solution of a weak acid is 2.67. What is the K_a for this acid?

- A) 2.1×10^{-4}
- B) 4.4×10^{-4}
- C) 1.5×10^{-4}
- D) 6.6×10^{-4}
- E) none of the above

Answer: E

Lecture 2 30) Z^- is a weak base. An aqueous solution of NaZ is prepared by dissolving 0.350 mol of NaZ in sufficient water to yield 1.0 L of solution. The pH of the solution was 8.93 at 25.0°C . The K_b of Z^- is _____.

- A) 1.2×10^{-5}
- B) 6.9×10^{-9}
- C) 2.1×10^{-10}
- D) 9.9×10^{-2}
- E) 2.8×10^{-12}

Answer: C

Lecture 2 31) The pH of a 0.10 M solution of a weak base is 9.82. What is the K_b for this base?

- A) 2.1×10^{-4}
- B) 4.4×10^{-8}
- C) 8.8×10^{-8}
- D) 6.6×10^{-4}
- E) 2.0×10^{-5}

Answer: B

Lecture 2 32) Determine the pH of a 0.35 M aqueous solution of CH_3NH_2 (methylamine). The K_b of methylamine is 4.4×10^{-4} .

- A) 10.00
- B) 3.86
- C) 12.09
- D) 1.96
- E) 13.24

Answer: C

Lecture 2 33) An aqueous solution contains 0.050 M of methylamine. The concentration of hydroxide ion in this solution is _____ M. K_b for methylamine is 4.4×10^{-4} .

- A) 0.050
- B) 2.2×10^{-5}
- C) 1.1×10^{-3}
- D) 4.5×10^{-3}
- E) 9.7×10^{-3}

Answer: D

Lecture 2 34) An aqueous solution contains 0.050 M of methylamine. The concentration of H^+ in this solution is _____ M. K_b for methylamine is 4.4×10^{-4} .

- A) 0.050
- B) 2.2×10^{-13}
- C) 2.9×10^{-13}
- D) 4.5×10^{-13}
- E) 2.2×10^{-12}

Answer: E

Lecture 2 35) The acid-dissociation constant, K_a , for gallic acid is 4.57×10^{-3} . What is the base-dissociation constant, K_b , for the gallate ion?

- A) 4.57×10^{-3}
- B) 2.19×10^{-12}
- C) 5.43×10^{-5}
- D) 7.81×10^{-6}
- E) 2.19×10^2

Answer: B

Lecture 2 36) The base-dissociation constant, K_b , for pyridine, C_5H_5N , is 1.4×10^{-9} . The acid-dissociation constant, K_a , for the pyridinium ion, $C_5H_5NH^+$, is _____.

- A) 1.0×10^{-7}
- B) 1.4×10^{-23}
- C) 7.1×10^{-4}
- D) 1.4×10^{-5}
- E) 7.1×10^{-6}

Answer: E

Lecture 2 37) The K_a for HCN is 4.9×10^{-10} . What is the value of K_b for CN^- ?

- A) 2.0×10^{-5}
- B) 4.0×10^{-6}
- C) 4.9×10^4
- D) 4.9×10^{-24}
- E) 2.0×10^9

Answer: A

Lecture 2 38) K_a for HF is 7.0×10^{-4} . K_b for the fluoride ion is _____.

- A) 2.0×10^{-8}
- B) 1.4×10^{-11}
- C) 7.0×10^{-18}
- D) 7.0×10^{-4}
- E) 1.4×10^3

Answer: B

Lecture 2 39) K_a for HCN is 4.9×10^{-10} . What is the pH of a 0.068 M aqueous solution of sodium cyanide?

- A) 0.74
- B) 2.96
- C) 11.07
- D) 13.24
- E) 7.00

Answer: C

Lecture 2 40) K_a for HX is 7.5×10^{-12} . What is the pH of a 0.15 M aqueous solution of NaX?

- A) 7.97
- B) 1.96
- C) 6.00
- D) 8.04
- E) 12.10

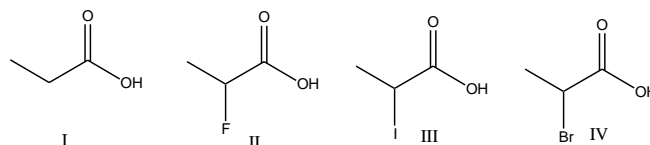
Answer: E

Lecture 2 41) The pH of a 0.15 M aqueous solution of NaZ (the sodium salt of HZ) is 10.7. What is the K_a for HZ?

- A) 1.6×10^{-6}
- B) 6.0×10^{-9}
- C) 8.9×10^{-4}
- D) 1.3×10^{-12}
- E) 3.3×10^{-8}

Answer: B

42) Which of the following is most acidic?



Answer: II

Round 3

1) The conjugate base of NH_3 is _____.

- A) NH_2^-
- B) NH_4^+
- C) NH_2OH
- D) H_3O^+
- E) OH^-

Answer: A

2) The conjugate base of H_2PO_4^- is _____.

- A) H_3PO_4
- B) HPO_4^{2-}
- C) PO_4^{3-}
- D) H_3O^+
- E) OH^-

Answer: B

3) In acidic solution, _____.

- A) $[\text{H}_3\text{O}^+] > [\text{OH}^-]$
- B) $[\text{H}_3\text{O}^+] = [\text{OH}^-]$
- C) $[\text{H}_3\text{O}^+] < [\text{OH}^-]$
- D) $[\text{OH}^-] > 7.00$
- E) $[\text{H}_3\text{O}^+] = 0\text{M}$

Answer: A

4) Which solution below has the highest concentration of hydroxide ions?

- A) $\text{pH} = 12.5$
- B) $\text{pH} = 11$
- C) $\text{pH} = 8.3$
- D) $\text{pH} = 6.0$
- E) $\text{pH} = 3.0$

Answer: A

5) Which solution below has the highest concentration of hydronium ions?

- A) $\text{pH} = 3.0$
- B) $\text{pH} = 10$
- C) $\text{pH} = 7.0$
- D) $\text{pH} = 6.4$
- E) $\text{pH} = 11.2$

Answer: A

6) An aqueous solution at 25.0°C contains $[\text{H}^+] = 0.085\text{ M}$. What is the pH of the solution?

- A) 1.07
- B) -1.07
- C) 13.0
- D) 0.0850
- E) 1.20×10^{-13}

Answer: A

Lecture 2 7) The pH of an aqueous solution at 25.0°C is 10.55. What is the molarity of H^+ in this solution?

- A) 2.8×10^{-11}
- B) 3.5×10^{-4}
- C) 3.45
- D) 1.1×10^{-13}
- E) 3.5×10^{10}

Answer: A

Lecture 2 8) Calculate the molarity of hydroxide ion in an aqueous solution that has a pOH of 3.00.

- A) 1.0×10^{-3}
- B) 11.00
- C) 1.0×10^{-11}
- D) 3.0×10^{-14}
- E) 1.1×10^{-13}

Answer: A

9) What is the pH of an aqueous solution at 25.0°C in which $[\text{H}^+]$ is 0.0015 M ?

- A) 6.50
- B) 2.82
- C) -2.82
- D) -6.50
- E) none of the above

Answer: B

10) What is the pOH of an aqueous solution at 25.0°C in which $[\text{H}^+]$ is 0.0050 M ?

- A) 8.70
- B) 11.70
- C) -11.70
- D) -8.70
- E) none of the above

Answer: B

11) What is the pH of an aqueous solution at 25.0 °C in which $[\text{OH}^-]$ is 0.0030 M?

- A) 5.81
- B) -11.48
- C) 2.52
- D) -2.52
- E) 11.48

Answer: C

12) What is the pOH of an aqueous solution at 25.0 °C in which $[\text{OH}^-]$ is 0.0010 M?

- A) 11.00
- B) -3.00
- C) 3.00
- D) -11.00
- E) 6.91

Answer: C

Lecture 2 13) What is the concentration (in M) of hydronium ions in a solution at 25.0 °C with pH = 4.146?

- A) 4.15
- B) 9.85
- C) 1.40×10^{-10}
- D) 7.15×10^{-5}
- E) none of the above

Answer: D

Lecture 2 14) What is the concentration (in M) of hydroxide ions in a solution at 25.0 °C with pH = 4.282?

- A) 4.28
- B) 9.72
- C) 1.92×10^{-10}
- D) 5.22×10^{-5}
- E) none of the above

Answer: C

15) An aqueous solution contains 0.10 M HNO_3 . The solution is _____.

- A) acidic
- B) basic
- C) neutral
- D) very dilute
- E) highly colored

Answer: A

Lecture 2 16) Which solution will be the most basic?

- A) 0.10 M $\text{Ba}(\text{OH})_2$
- B) 0.10 M KOH
- C) 0.10 M H_2O
- D) 0.10 M CH_3OH
- E) All solutions have equal basicity.

Answer: A

17) A 1.0×10^{-2} M aqueous solution of $\text{Ca}(\text{OH})_2$ at 25.0 °C has a pH of _____.

- A) 12.30
- B) 1.70
- C) 2.0×10^{-2}
- D) 5.0×10^{-13}
- E) 12.00

Answer: A

18) What is the pH of a 0.020 M aqueous solution of barium hydroxide?

- A) 12.60
- B) 12.30
- C) 1.70
- D) 10.41
- E) 1.40

Answer: A

19) What is the pOH of a 0.030 M solution of barium hydroxide?

- A) 12.78
- B) 12.48
- C) 1.52
- D) 1.22
- E) 10.41

Answer: D

20) Hydrochloric acid is a strong acid. This means that _____.

- A) HCl dissociates completely to $\text{H}^+(\text{aq})$ and $\text{Cl}^-(\text{aq})$ when it dissolves in water
- B) HCl does not dissociate at all when it is dissolved in water
- C) HCl produces a gaseous product when it is neutralized
- D) HCl cannot be neutralized by a weak base
- E) aqueous solutions of HCl contain equal concentrations of $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$

Answer: A

Lecture 2 21) The acid-dissociation constant at 25.0 °C for hypochlorous acid (HClO) is 3.0×10^{-8} . At equilibrium, the molarity of H_3O^+ in a 0.066 M solution of HClO is _____.

- A) 4.4×10^{-5}
- B) 0.066
- C) 2.2×10^{-10}
- D) 4.35
- E) 1.18

Answer: A

Lecture 2 22) In which of the following aqueous solutions does the weak acid exhibit the highest percentage ionization?

- A) 0.01 M H_2SO_3 ($K_a = 1.4 \times 10^{-2}$)
- B) 0.01 M HCN ($K_a = 6.2 \times 10^{-10}$)
- C) 0.01 M H_2CO_3 ($K_a = 4.5 \times 10^{-7}$)
- D) 0.01 M $\text{HC}_3\text{H}_5\text{O}_2$ ($K_a = 1.3 \times 10^{-5}$)
- E) 0.01 M HOCl ($K_a = 3.5 \times 10^{-8}$)

Answer: A

Lecture 2 23) In which of the following aqueous solutions does the weak acid exhibit the lowest percentage ionization?

- A) 0.01 M HCN ($K_a = 6.2 \times 10^{-10}$)
- B) 0.01 M H_2CO_3 ($K_a = 4.5 \times 10^{-7}$)
- C) 0.01 M HNO_2 ($K_a = 4.0 \times 10^{-4}$)
- D) 0.01 M HCHO_2 ($K_a = 1.8 \times 10^{-4}$)
- E) 0.01 M HOCl ($K_a = 3.5 \times 10^{-8}$)

Answer: A

Lecture 2 24) The K_a of hypochlorous acid (HClO) is 3.0×10^{-8} at 25.0 °C. Calculate the pH of a 0.0385 M hypochlorous acid solution.

- A) 3.05
- B) 9.53
- C) 4.47
- D) 6.52
- E) -3.05

Answer: C

Lecture 2 25) The K_a of hydrofluoric acid (HF) at 25.0 °C is 6.8×10^{-4} . What is the pH of a 0.45 M aqueous solution of HF?

- A) 4.05
- B) 1.76
- C) 3.64
- D) 0.35
- E) 1.01

Answer: B

Lecture 2 26) The K_a of hydrazoic acid (HN_3) is 1.9×10^{-5} at 25.0 °C. What is the pH of a 0.15 M aqueous solution of HN_3 ?

- A) 0.82
- B) 1.95
- C) 5.23
- D) 2.77
- E) -3.46

Answer: D

Lecture 2 27) The base-dissociation constant of ethylamine ($\text{C}_2\text{H}_5\text{NH}_2$) is 6.4×10^{-4} at 25.0 °C. The $[\text{H}^+]$ in a 1.4×10^{-2} M solution of ethylamine is _____ M.

- A) $3.7 \times 4.9 \times 10^{-12}$
- B) 2.7×10^{-3}
- C) 3.3×10^{-12}
- D) 3.0×10^{-3}
- E) 11.43

Answer: A

Lecture 2 28) Calculate the pH of a 0.500 M aqueous solution of NH_3 . The K_b of NH_3 is 1.77×10^{-5} .

- A) 8.95
- B) 11.47
- C) 2.53
- D) 13.17
- E) 2.23

Answer: B

Lecture 2 29) A 0.1 M aqueous solution of _____ will have a pH of 7.0 at 25.0 °C.

LiF RbBr NaClO₄ NH₄Cl

- A) RbBr and NaClO₄
- B) LiF and RbBr
- C) NaClO₄ only
- D) LiF only
- E) NH₄Cl only

Answer: A

Lecture 2 30) An aqueous solution of _____ will produce a basic solution.

- A) Na₂SO₃
- B) RbBr
- C) Mg(ClO₄)₂
- D) NH₄NO₃
- E) KNO₃

Answer: A

Lecture 2 31) An aqueous solution of _____ will produce an acidic solution.

- A) NH₄I
- B) KBr
- C) Sr(ClO₄)₂
- D) K₂CO₃
- E) NaNO₃

Answer: A

Lecture 2 32) An aqueous solution of _____ will produce a neutral solution.

- A) LiNO₃
- B) NaNO₂
- C) KF
- D) Rb₂CO₃
- E) NH₄NO₃

Answer: A

Lecture 2 33) The acid-dissociation constant of hydrocyanic acid (HCN) at 25.0 °C is 4.9×10^{-10} . What is the pH of an aqueous solution of 0.050 M sodium cyanide (NaCN)?

- A) 11.00
- B) 3.00
- C) 7.22
- D) 2.5×10^{-7}
- E) 2.5×10^{-11}

Answer: A

Lecture 2 34) Calculate the pOH of a 0.0727 M aqueous sodium cyanide solution at 25.0 °C. K_b for CN⁻ is 4.9×10^{-10} .

- A) 9.33
- B) 10.00
- C) 5.22
- D) 1.14
- E) 8.78

Answer: C

Lecture 2 35) Calculate the pH of a 0.0727 M aqueous sodium cyanide solution at 25.0 °C. K_b for CN⁻ is 4.9×10^{-10} .

- A) 9.33
- B) 10.00
- C) 5.22
- D) 1.14
- E) 8.78

Answer: E

Lecture 2 36) Determine the pH of a 0.15 M aqueous solution of KF. For hydrofluoric acid, $K_a = 7.0 \times 10^{-4}$.

- A) 0.82
- B) 5.83
- C) 8.17
- D) 5.01
- E) 1.17

Answer: C

Lecture 2 37) Determine the pOH of a 0.10 M aqueous solution of KF. For hydrofluoric acid, $K_a = 7.0 \times 10^{-4}$.

- A) 1.00
- B) 5.92
- C) 8.08
- D) 5.01
- E) 1.58

Answer: B

Lecture 2 38) Calculate the pH of 0.726 M anilinium hydrochloride ($\text{C}_6\text{H}_5\text{NH}_3\text{Cl}$) solution in water, given that K_b for aniline is 3.83×10^{-4} .

- A) 1.78
- B) 12.22
- C) 5.36
- D) 8.64
- E) 12.42

Answer: C

Lecture 2 39) Calculate the pOH of 0.606 M anilinium hydrochloride ($\text{C}_6\text{H}_5\text{NH}_3\text{Cl}$) solution in water, given that K_b for aniline is 3.83×10^{-4} .

- A) 1.82
- B) 12.18
- C) 5.40
- D) 8.60
- E) 12.42

Answer: D

Lecture 2 40) K_b for NH_3 is 1.8×10^{-5} . What is the pH of a 0.40 M aqueous solution of NH_4Cl at 25.0 °C?

- A) 2.57
- B) 11.43
- C) 9.18
- D) 4.82
- E) 11.23

Answer: D

Lecture 2 41) K_b for NH_3 is 1.8×10^{-5} . What is the pOH of a 0.20 M aqueous solution of NH_4Cl at 25.0 °C?

- A) 2.72
- B) 11.28
- C) 9.02
- D) 4.98
- E) 11.23

Answer: C

Lecture 2 42) The K_a for formic acid (HCO_2H) is 1.8×10^{-4} . What is the pH of a 0.20 M aqueous solution of sodium formate (NaHCO_2)?

- A) 11.64
- B) 5.48
- C) 3.39
- D) 8.52
- E) 4.26

Answer: D

43) Of the following, which is the strongest acid?

- A) HIO_4
- B) HIO_3
- C) HIO_2
- D) HIO
- E) The acid strength of all of the above is the same.

Answer: A

Lecture 2 44) Of the following, which is the weakest acid?

- A) HPO_3^-
- B) H_3PO_4
- C) H_2PO_4^-
- D) HPO_4^-
- E) The acid strength of all of the above is the same.

Answer: A

45) Tryptophan, an essential amino acid, is important in the synthesis of the neurotransmitter serotonin in the body. It has the following structure. Circle the three most acidic protons in tryptophan.

