Bronsted-Lowry Acid Base Model

Activity 1: Fundamental Concepts

Question Group 1

Question 1

The Bronsted-Lowry model defines acids and bases in terms of their tendency to donate or accept a proton. Which statement below best describes what the model means by "proton"?

A proton is a hydrogen ion (H^+).
A proton is a hydrogen atom (H).
A proton is a hydroxide ion (OH^-).
A proton is a hydronium ion (H_3O^+).
A proton is a positively-charged electron.

Question Group 2

Question 2

Which statement describes the Bronsted-Lowry definition of an acid and a base?

An acid is a proton donor and a base is a proton acceptor.
An acid is a proton acceptor and a base is a proton donor.
An acid is a proton donor and a base is an electron donor.
An acid is a proton acceptor and a base is an electron acceptor.
An acid is a proton donor and a base is an electron acceptor.

Question Group 3

Question 3

Which statement describes the reaction that occurs when a Bronsted-Lowry acid dissolves in water?

The acid donates a proton to water to produce the hydronium ion (H_3O^+).
The acid donates a proton to water to produce the hydroxide ion (H_3O^+).
The acid donates a proton to water to produce the hydroxide ion (OH^-).
The acid accepts a proton from water to produce the hydronium ion (H_3O^+).
The acid accepts a proton from water to produce the hydroxide ion (OH^-).

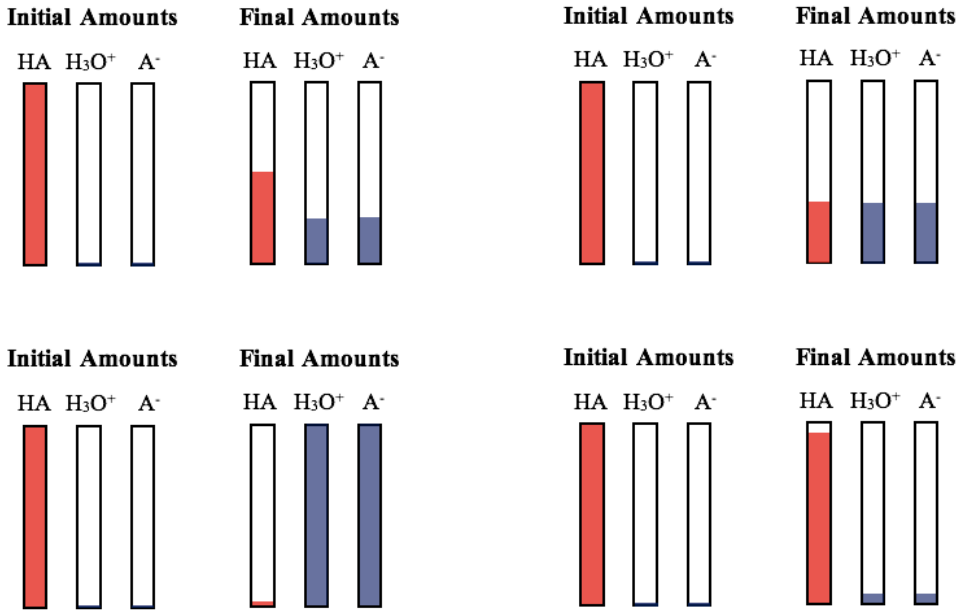
Question Group 4
Question 4
Which statement describes the hydronium and the hydroxide ions?

The hydronium ion is H_3O^+ and the hydroxide ion is OH^-.
The hydronium ion is H_3O^+ and the hydroxide ion is H_3O^-.
The hydronium ion is H^+ and the hydroxide ion is OH^-.
The hydronium ion is OH^+ and the hydroxide ion is OH^-.
The hydronium ion is OH^- and the hydroxide ion is H_3O^+.

Question Group 5
Question 5
Which statement describes the reaction that occurs when a Bronsted-Lowry base dissolves in water?

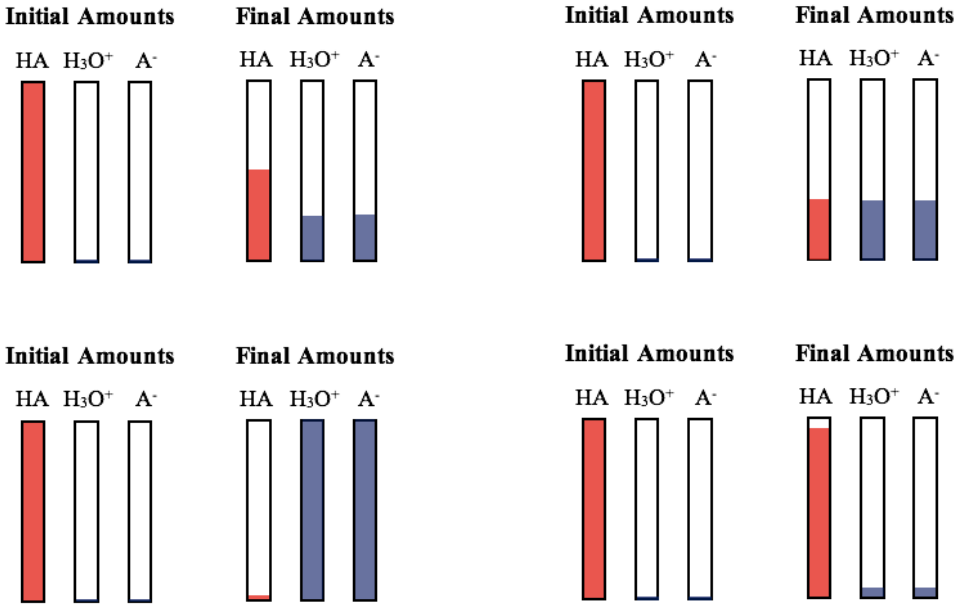
The base accepts a proton from water to produce the hydroxide ion (OH^-).
The base accepts a proton from water to produce the hydronium ion (H_3O^+).
The base donates a proton to water to produce the hydroxide ion (OH^-).
The base donates a proton to water to produce the hydronium ion (H_3O^+).
The base donates a proton to water to produce the hydroxide ion (H_3O^+).

Question Group 6
Question 6
Weak acids are different than strong acids. Strong acids completely dissociate in water. Weak acids, having the generic formula HA, only partially dissociate in water. Which bar chart describes this weak acid behavior? (The bar charts represent final amounts of chemicals present in water after dissociation.)



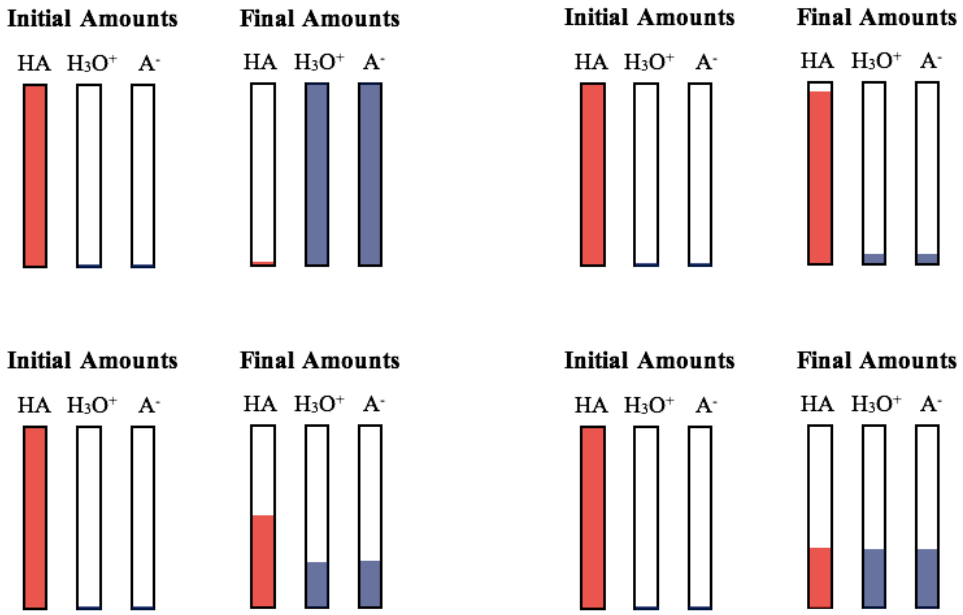
Question 7

Weak acids are different than strong acids. Strong acids completely dissociate in water. Weak acids, having the generic formula HA, only partially dissociate in water. Which bar chart describes this weak acid behavior? (The bar charts represent final amounts of chemicals present in water after dissociation.)



Question 8

Weak acids are different than strong acids. Strong acids completely dissociate in water. Weak acids, having the generic formula HA, only partially dissociate in water. Which bar chart describes this weak acid behavior? (The bar charts represent final amounts of chemicals present in water after dissociation.)



Activity 2: Conjugate Acid-Base Pairs
Question Group 7
Question 9
Consider the following acid-base reaction.

$$HBr_{(aq)} + H_2O_{(l)} \rightarrow Br^-_{(aq)} + H_3O^+_{(aq)}$$

Which species is acting as the proton donor in this reaction?
HBr
H_2O
Br^-
H_3O^+

Which species is acting as the proton acceptor in this reaction?
HBr
H_2O
Br^-
H_3O^+

Idenitfy the two sets of conjugate acid-base pairs.
HBr and H_2O
Br^- and H_3O^+
HBr and Br^-
H_2O and H_3O^+
HBr and H_3O^+
H_2O and Br^-

Question 10
Consider the following acid-base reaction.

$$HCl_{(aq)} + H_2O_{(l)} \rightarrow Cl^-_{(aq)} + H_3O^+_{(aq)}$$

Which species is acting as the proton donor in this reaction?
HCl
H_2O
Cl^-
H_3O^+

Which species is acting as the proton acceptor in this reaction?
HCl
H_2O
Cl^-
H_3O^+

Idenitfy the two sets of conjugate acid-base pairs.
HCl and H_2O
Cl^- and H_3O^+
HCl and Cl^-
H_2O and H_3O^+
H_2O and Cl^-
HCl and H_3O^+

Question Group 8
Question 11
Consider the following acid-base reaction.

$$HCN_{(aq)} + H_2O_{(l)} \rightarrow CN^-_{(aq)} + H_3O^+_{(aq)}$$

Which species is acting as the proton donor in this reaction?
HCN
H_2O
CN^-
H_3O^+

Which species is acting as the proton acceptor in this reaction?
HCN
H_2O
CN^-
H_3O^+

Idenitfy the two sets of conjugate acid-base pairs.
HCN and H_2O
CN^- and H_3O^+
HCN and CN^-
H_2O and H_3O^+
HCN and H_3O^+
H_2O and CN^-

Question 12
Consider the following acid-base reaction.

$$HClO_{3(aq)} + H_2O_{(l)} \rightarrow ClO_3^-{}_{(aq)} + H_3O^+{}_{(aq)}$$

Which species is acting as the proton donor in this reaction?
$HClO_3$
H_2O
ClO_3^-
H_3O^+

Which species is acting as the proton acceptor in this reaction?
$HClO_3$
H_2O
ClO_3^-
H_3O^+

Idenitfy the two sets of conjugate acid-base pairs.
$HClO_3$ and H_2O
ClO_3^- and H_3O^+
$HClO_3$ and ClO_3^-
H_2O and H_3O^+
$HClO_3$ and H_3O^+
H_2O and ClO_3^-

Question Group 9
Question 13
Consider the following acid-base reaction.

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$$

Which species is acting as the proton donor in this reaction?
NH_3
H_2O
NH_4^+
OH^-

Which species is acting as the proton acceptor in this reaction?
NH_3
H_2O
NH_4^+
OH^-

Idenitfy the two sets of conjugate acid-base pairs.
NH_3 and H_2O
NH_4^+ and OH^-
NH_3 and NH_4^+
H_2O and OH^-
NH_3 and OH^-
H_2O and NH_4^+

Question 14
Consider the following acid-base reaction.

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow C_5H_5NH^+_{(aq)} + OH^-_{(aq)}$$

Which species is acting as the proton donor in this reaction?
C_5H_5N
H_2O
$C_5H_5NH^+$
OH^-

Which species is acting as the proton acceptor in this reaction?
C_5H_5N
H_2O
$C_5H_5NH^+$
OH^-

Idenitfy the two sets of conjugate acid-base pairs.
C_5H_5N and H_2O
$C_5H_5NH^+$ and OH^-
C_5H_5N and $C_5H_5NH^+$
H_2O and OH^-
C_5H_5N and OH^-
H_2O and $C_5H_5NH^+$

Question Group 10
Question 15
When an acid donates a proton to another substance, it turns into its **conjugate base**. And when a base accepts a proton from another substance, it turns into its **conjugate acid.**

If $HC_2H_3O_2$ acts as an acid, then what is its conjugate base?
H_2O
H_3O^+
OH^-
$HC_2H_3O_2^+$
$HC_2H_3O_2^-$
$H_2C_2H_3O_2^+$
$H_2C_2H_3O_2^-$
$C_2H_3O_2^-$
$C_2H_3O_2^+$

If CH_3NH_2 acts as a base, then what is its conjugate acid?
H_2O
H_3O^+
OH^-
$CH_3NH_2^+$
$CH_3NH_2^-$
CH_3NH^+
CH_3NH^-
$CH_3NH_3^-$
$CH_3NH_3^+$

Question 16
When an acid donates a proton to another substance, it turns into its **conjugate base**. And when a base accepts a proton from another substance, it turns into its **conjugate acid.**

If $HClO_2$ acts as an acid, then what is its conjugate base?
H_2O
H_3O^+
OH^-
$HClO_2^+$
$HClO_2^-$
$H_2ClO_2^+$
$H_2ClO_2^-$
ClO_2^+
ClO_2^-

If $C_2H_5NH_2$ acts as a base, then what is its conjugate acid?
H_2O
H_3O^+
OH^-
$C_2H_5NH_2^+$
$C_2H_5NH_2^-$
$C_2H_5NH_3^+$
$C_2H_5NH_3^-$
$C_2H_5NH^+$
$C_2H_5NH^-$

Question Group 11
Question 17
When an acid donates a proton to another substance, it turns into its **conjugate base**. And when a base accepts a proton from another substance, it turns into its **conjugate acid.**

If HNO_3 acts as an acid, then what is its conjugate base?
H_2O
H_3O^+
OH^-
HNO_3^+
HNO_3^-
$H_2NO_3^+$
$H_2NO_3^-$
NO_3^+
NO_3^-

If $(CH_3)_3N$ acts as a base, then what is its conjugate acid?
H_2O
H_3O^+
OH^-
$(CH_3)_3N^+$
$(CH_3)_3N^-$
$(CH_3)_2CH_2N^+$
$(CH_3)_2CH_2N^-$
$(CH_3)_3NH^-$
$(CH_3)_3NH^+$

Question 18
When an acid donates a proton to another substance, it turns into its **conjugate base**. And when a base accepts a proton from another substance, it turns into its **conjugate acid.**

If $HClO_4$ acts as an acid, then what is its conjugate base?
H_2O
H_3O^+
OH^-
$HClO_4^+$
$HClO_4^-$
$H_2ClO_4^+$
$H_2ClO_4^-$
ClO_4^+
ClO_4^-

If $C_6H_5NH_2$ acts as a base, then what is its conjugate acid?
H_2O
H_3O^+
OH^-
$C_6H_5NH_2^+$
$C_6H_5NH_2^-$
$C_6H_5NH_3^+$
$C_6H_5NH_3^-$
$C_6H_5NH^-$
$C_6H_5NH^+$

Question Group 12
Question 19
When an acid donates a proton to another substance, it turns into its **conjugate base**. And when a base accepts a proton from another substance, it turns into its **conjugate acid.**

If HSO_4^- acts as an acid, then what is its conjugate base?
H_2O
H_3O^+
OH^-
HSO_4
HSO_4^{2-}
H_2SO_4
$H_2SO_4^{2-}$
SO_4
SO_4^{2-}

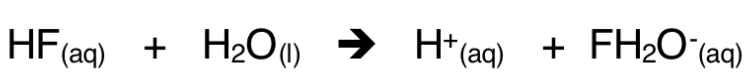
If HSO_4^- acts as a base, then what is its conjugate acid?
H_2O
H_3O^+
OH^-
HSO_4
HSO_4^{2-}
H_2SO_4
$H_2SO_4^{2-}$
SO_4
SO_4^{2-}

Question 20
When an acid donates a proton to another substance, it turns into its **conjugate base**. And when a base accepts a proton from another substance, it turns into its **conjugate acid.**

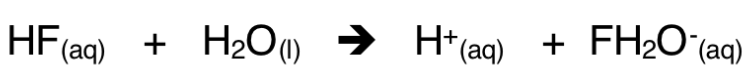
If $HC_2O_4^-$ acts as an acid, then what is its conjugate base?
H_2O
H_3O^+
OH^-
HC_2O_4
$HC_2O_4^{2-}$
$H_2C_2O_4$
$H_2C_2O_4^{2-}$
C_2O_4
$C_2O_4^{2-}$

If $HC_2O_4^-$ acts as a base, then what is its conjugate acid?
H_2O
H_3O^+
OH^-
HC_2O_4
$HC_2O_4^{2-}$
$H_2C_2O_4$
$H_2C_2O_4^{2-}$
C_2O_4
$C_2O_4^{2-}$

Activity 3: Acid and Base Dissociation Equations
Question Group 13
Question 21
Identify the dissociation equation for the dissociation of the weak acid hydrofluoric acid (HF) in water.



Question 22
Identify the dissociation equation for the dissociation of the weak acid hydrofluoric acid (HF) in water.



Question 23
Identify the dissociation equation for the dissociation of the weak acid hydrofluoric acid (HF) in water.

$$HF_{(aq)} + H_2O_{(l)} \rightarrow H_2F^+_{(aq)} + OH^-_{(aq)}$$

$$HF_{(aq)} + H_2O_{(l)} \rightarrow F^+_{(aq)} + H_3O^-_{(aq)}$$

$$HF_{(aq)} + H_2O_{(l)} \rightarrow H^+_{(aq)} + FH_2O^-_{(aq)}$$

$$HF_{(aq)} + H_2O_{(l)} \rightarrow H^+_{(aq)} + FOH^-_{(aq)}$$

$$HF_{(aq)} + H_2O_{(l)} \rightarrow F^-_{(aq)} + H_3O^+_{(aq)}$$

Question Group 14
Question 24
Identify the dissociation equation for the dissociation of the weak acid nitrous acid (HNO_2) in water.

$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow NO_2^+_{(aq)} + H_3O^-_{(aq)}$$

$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow NO_2^-_{(aq)} + H_3O^+_{(aq)}$$

$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow H_2NO_2^+_{(aq)} + OH^-_{(aq)}$$

$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow H^+_{(aq)} + OHNO_2^-_{(aq)}$$

$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow HN^+_{(aq)} + H_2O_3^-_{(aq)}$$

Question 25
Identify the dissociation equation for the dissociation of the weak acid nitrous acid (HNO_2) in water.

$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow H^+_{(aq)} + OHNO_2^-{}_{(aq)}$$

$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow H_2NO_2^+{}_{(aq)} + OH^-_{(aq)}$$

$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow NO_2^-{}_{(aq)} + H_3O^+_{(aq)}$$

$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow HN^+_{(aq)} + H_2O_3^-{}_{(aq)}$$

$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow NO_2^+{}_{(aq)} + H_3O^-_{(aq)}$$

Question 26
Identify the dissociation equation for the dissociation of the weak acid nitrous acid (HNO_2) in water.

$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow NO_2^+{}_{(aq)} + H_3O^-_{(aq)}$$

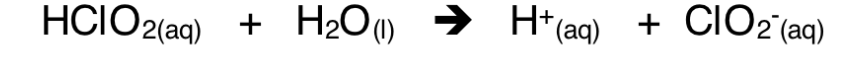
$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow H_2NO_2^+{}_{(aq)} + OH^-_{(aq)}$$

$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow H^+_{(aq)} + OHNO_2^-{}_{(aq)}$$

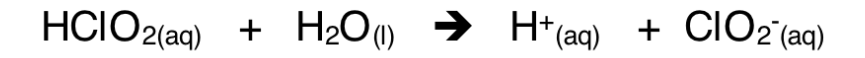
$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow HN^+_{(aq)} + H_2O_3^-{}_{(aq)}$$

$$HNO_{2(aq)} + H_2O_{(l)} \rightarrow NO_2^-{}_{(aq)} + H_3O^+_{(aq)}$$

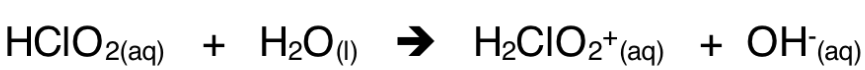
Question Group 15
Question 27
Identify the dissociation equation for the dissociation of the weak acid chlorous acid ($HClO_2$) in water.

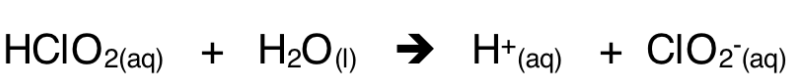


Question 28
Identify the dissociation equation for the dissociation of the weak acid chlorous acid ($HClO_2$) in water.



Question 29
Identify the dissociation equation for the dissociation of the weak acid chlorous acid ($HClO_2$) in water.





Question Group 16
Question 30
Identify the dissociation equation for the dissociation of the weak acid carbonic acid (H_2CO_3) in water.

Question 31
Identify the dissociation equation for the dissociation of the weak acid carbonic acid (H_2CO_3) in water.

$$H_2CO_{3(aq)} + H_2O_{(l)} \rightarrow H_3CO_3^{+}{}_{(aq)} + OH^{-}{}_{(aq)}$$

$$H_2CO_{3(aq)} + H_2O_{(l)} \rightarrow 2\,H^{+}{}_{(aq)} + CO_3^{2-}{}_{(aq)}$$

$$H_2CO_{3(aq)} + H_2O_{(l)} \rightarrow CO_3^{2-}{}_{(aq)} + H_4O^{2+}{}_{(aq)}$$

$$H_2CO_{3(aq)} + H_2O_{(l)} \rightarrow HCO_3^{-}{}_{(aq)} + H_3O^{+}{}_{(aq)}$$

$$H_2CO_{3(aq)} + H_2O_{(l)} \rightarrow H_2^{+}{}_{(aq)} + CO_3OH^{-}{}_{(aq)}$$

Question 32
Identify the dissociation equation for the dissociation of the weak acid carbonic acid (H_2CO_3) in water.

$$H_2CO_{3(aq)} + H_2O_{(l)} \rightarrow H_2^{+}{}_{(aq)} + CO_3OH^{-}{}_{(aq)}$$

$$H_2CO_{3(aq)} + H_2O_{(l)} \rightarrow CO_3^{2-}{}_{(aq)} + H_4O^{2+}{}_{(aq)}$$

$$H_2CO_{3(aq)} + H_2O_{(l)} \rightarrow 2\,H^{+}{}_{(aq)} + CO_3^{2-}{}_{(aq)}$$

$$H_2CO_{3(aq)} + H_2O_{(l)} \rightarrow H_3CO_3^{+}{}_{(aq)} + OH^{-}{}_{(aq)}$$

$$H_2CO_{3(aq)} + H_2O_{(l)} \rightarrow HCO_3^{-}{}_{(aq)} + H_3O^{+}{}_{(aq)}$$

Question Group 17
Question 33
Identify the dissociation equation for the dissociation of the weak base ammonia (NH_3) in water.

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_2^-{}_{(aq)} + H_3O^+{}_{(aq)}$$

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_2^-{}_{(aq)} + H_3O^+{}_{(aq)}$$

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$$

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow H_3O^+{}_{(aq)} + NOH^-{}_{(aq)}$$

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_3O^+{}_{(aq)} + OH^-{}_{(aq)}$$

Question 34
Identify the dissociation equation for the dissociation of the weak base ammonia (NH_3) in water.

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow H_3O^+{}_{(aq)} + NOH^-{}_{(aq)}$$

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_2^-{}_{(aq)} + H_3O^+{}_{(aq)}$$

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_2^-{}_{(aq)} + H_3O^+{}_{(aq)}$$

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$$

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_3O^+{}_{(aq)} + OH^-{}_{(aq)}$$

Question 35
Identify the dissociation equation for the dissociation of the weak base ammonia (NH_3) in water.

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_3O^+_{(aq)} + OH^-_{(aq)}$$

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + NOH^-_{(aq)}$$

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_2^-{}_{(aq)} + H_3O^+_{(aq)}$$

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_2^-{}_{(aq)} + H_3O^+_{(aq)}$$

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_4^+{}_{(aq)} + OH^-_{(aq)}$$

Question Group 18
Question 36
Identify the dissociation equation for the dissociation of the weak base pyridine (C_5H_5N) in water.

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow C_5H_5NH^+_{(aq)} + OH^-_{(aq)}$$

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + C_5H_5NOH^-_{(aq)}$$

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow C_5H_5NH^-_{(aq)} + H_3O^+_{(aq)}$$

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow C_5H_6^+{}_{(aq)} + NOH^-_{(aq)}$$

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow C_5H_4N^-_{(aq)} + H_3O^+_{(aq)}$$

Question 37
Identify the dissociation equation for the dissociation of the weak base pyridine (C_5H_5N) in water.

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow C_5H_5NH^-_{(aq)} + H_3O^+_{(aq)}$$

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow C_5H_5NH^+_{(aq)} + OH^-_{(aq)}$$

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + C_5H_5NOH^-_{(aq)}$$

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow C_5H_4N^-_{(aq)} + H_3O^+_{(aq)}$$

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow C_5H_6^+{}_{(aq)} + NOH^-_{(aq)}$$

Question 38
Identify the dissociation equation for the dissociation of the weak base pyridine (C_5H_5N) in water.

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + C_5H_5NOH^-_{(aq)}$$

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow C_5H_5NH^-_{(aq)} + H_3O^+_{(aq)}$$

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow C_5H_6^+{}_{(aq)} + NOH^-_{(aq)}$$

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow C_5H_5NH^+_{(aq)} + OH^-_{(aq)}$$

$$C_5H_5N_{(aq)} + H_2O_{(l)} \rightarrow C_5H_4N^-_{(aq)} + H_3O^+_{(aq)}$$