4-5-18 Friday

Chapter: 10
"Acids, Bases And Salts"
Self-Assessment Exercise 10.1:

Q: Identify Bronsted acids and bases in the following reactions.

(i) $H_2SO_4 + H_2O \rightleftharpoons HSO_4^- + H_3O^+$

Since H_2SO_4 becomes HSO_4^- after donating a proton so it is Bronsted acid while H_2O become H_3O^+ after accepting a proton so it is Bronsted ~~alkali~~ Base.

(ii) $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

- **Bronsted Acid:**

In the above reaction, CH_3COOH is converted to CH_3COO^- by donating a proton, so CH_3COOH is an acid.

- **Bronsted Base:**

Because H_2O accepts the proton that CH_3COOH donates and forms H_3O^+, H_2O is base.

(iii) $H_2S + NH_3 \rightleftharpoons NH_4^+ + HS^-$

- **Bronsted Acid:**

In above reaction, H_2S is converted to HS^- by donating a proton, so H_2S is an acid.

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- **Bronsted Base:**

Because NH_3 accepts the proton that H_2S donates and form NH_4^+, NH_3 is a base.

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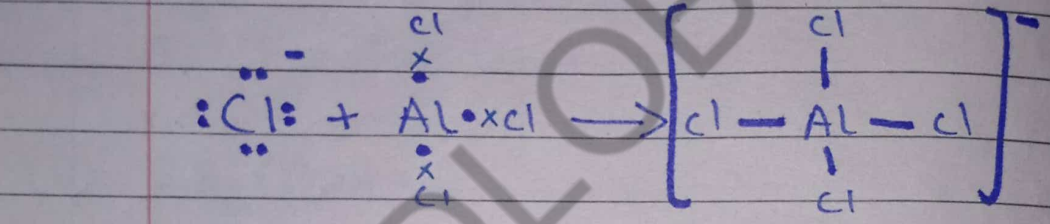
Chapter: 10

"Acids, Bases And Salts"

Self. Assessment Exercise: 10.2

Q1: Identify Lewis acid and lewis base in the following examples:

(i) $Cl^- + AlCl_3 \longrightarrow [AlCl_4]^-$



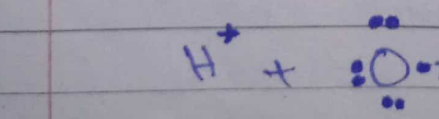
- **Lewis Acid:**

$AlCl_3$ has incomplete octet. It has six electrons (3 electron pairs), so it needs an electron pair to complete its octet and is an electron pair acceptor. $AlCl_3$ is lewis acid.

- **Lewis Base:**

Cl^- has a lone pair so it is an electron pair donor. Cl^- is a lewis base.

(ii) $H^+ + OH^- \longrightarrow H_2O$



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- **Lewis Acid:**

H^+ has incomplete duplet. It has no electrons so it needs a pair of electrons to complete its duplet. It is an electron pair acceptor and is a lewis acid.

- **Lewis Base:**

OH^- has a lone pair on O-atom. So it is electron pair donor. OH^- is lewis base.

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Chapter: 10
"Acids, Bases And Salts"

Self. Assessment Exercise: 10.3

1. A soft drink has $[H^+] = 3 \times 10^{-3}$ M. Is the drink acidic, neutral or basic?

$$[H^+] = 3 \times 10^{-3} M$$
$$= 3 \times 10^{-3} > 1 \times 10^{-7}$$

The solution is acidic as the concentration of H^+ ions is greater than 1×10^{-7}.

---

2. Ordinary vinegar is approximately 1M CH_3COOH. Concentration of H^+ in it is 4.2×10^{-3} M. Is vinegar acidic, basic or neutral?

$$[H^+] = 4.2 \times 10^{-3} M$$
$$= 1 \times 10^{-7} < 4.2 \times 10^{-3}$$

The solution is acidic as concentration of H^+ ions is greater than 1×10^{-7}.

---

3. A student determines the $[OH^-]$ of milk of magnesia, and obtains a value of 4.2×10^{-3} M. Is the solution acidic, basic or neutral?

$[OH^-] = 4.2 \times 10^{-3} M$

$[H^+] = ?$

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$K_w = [H^+][OH^-]$

$\frac{K_w}{[OH^-]} = [H^+]$

$\frac{1 \times 10^{-4}}{4.2 \times 10^{-3}} = [H^+]$

$0.238 \times 10^{-4+3} = [H^+]$

$0.24 \times 10^{-11} = [H^+]$

$0.24 \times 10^{-11} < 1.0 \times 10^{-7}$

The solution is **basic** as the concentration of H^+ ions is less than 1×10^{-7}.

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Chapter: 10

Acids, Bases And Salts

Review Exercise:

Q5: Identify Bronsted-Lowery acids or bases in the following reactions:

(i) $HNO_3 + H_2O \rightarrow H_3O^+ + NO_3^-$

- **Bronsted Acid:**

According to Bronsted-Lowery concept, all those substances which donate proton is acid. As in above equation, HNO_3 donates proton and is converted to H_3O^+, it is an acid.

- **Bronsted Base:**

According to Bronsted-Lowery concept, all those substances which accept proton are bases. As in above equation H_2O accepts proton and is converted to H_3O^+, it acts as Bronsted base.

(ii) $NH_3 + HNO_3 \longrightarrow NH_4NO_3$

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- **Bronsted Acid:**

According to Bronsted-lowery concept, all those substances which donate protons are acids. As in above equation HNO_3 donates proton and is converted to NO_3, it acts as an acid.

- **Bronsted Base:**

According to Bronsted-Lowery concept, all those substances which accept proton are bases. As in above equation NH_3 accepts proton and is converted to NH_4^+, it acts as Bronsted base.

Q6: Identify Lewis acid and Lewis base in the following reactions

(i) $F^- + BF_3 \rightarrow [BF_4]^-$

- **Lewis Base:**

According to lewis concept bases are electron pair donor. So in above equation F^- (Flouride ion) has lone pair of electron so it will donate this lone pair acts as lewis base.

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- **Lewis Acid:**

According to lewis concept, acids are electron pair acceptor. So in above equation in BF_3, Bron is electron deficient and will accept a pair of electrons and act as lewis acid.

(ii) $H^+ + NH_3 \longrightarrow [NH_4]^+$

- **Lewis Base:**

According to lewis concept, base is an electron pair donor. So in above equation in NH_3, N has a lone pair of electrons and it will donate this lone pair and act as lewis acid. base

- **Lewis base:**

According to lewis concept, acids are electron pair acceptor so in above equation H^+ is electron deficient and will accept a pair of electrons and act as lewis acid.

(iii) $NH_3 + AlCl_3 \longrightarrow [H_3N - AlCl_3]$

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- **Lewis Base:**

According to lewis concept, bases are ~~either~~ electron pair donor. So in above equation NH_3, N has a lone pair of electrons and it will donate this lone pair and act as lewis base.

- **Lewis Acid:**

According to lewis concept, acids are electron pair acceptors. So in the above equation, in $AlCl_3$, Al is electron deficient and will accept a pair of electrons and act as lewis acid.

Q14. Write equations showing the ionization of the following as Arrehenius acids:

(a) $HI_{(aq)}$

$$HI \xrightleftharpoons{H_2O} H_2^+ + I_2^-$$

HI ionizes in water to produce H^+ ions and is thus Arrehenius acid.

(b) $HNO_{2\,(aq)}$

$$HNO_2 \rightleftharpoons H^+ + NO_2^-$$

HNO_2 ionizes in water and produces H^+ ions and is thus Arrehenius acid.

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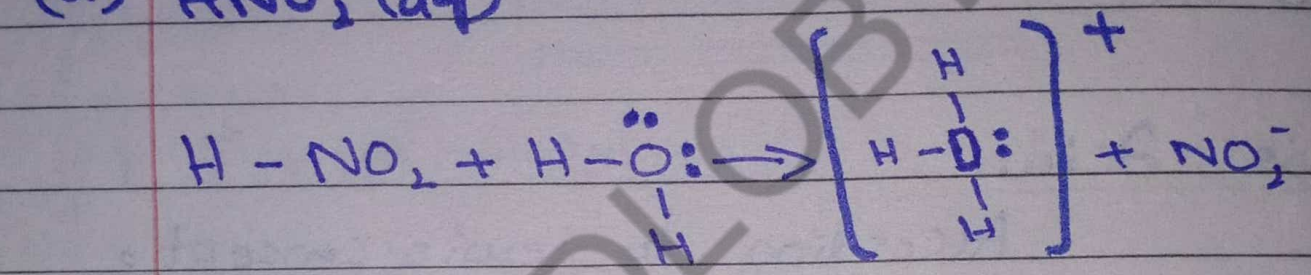
15. Write equations showing the ionization of the following as Bronsted-Lowery acids:

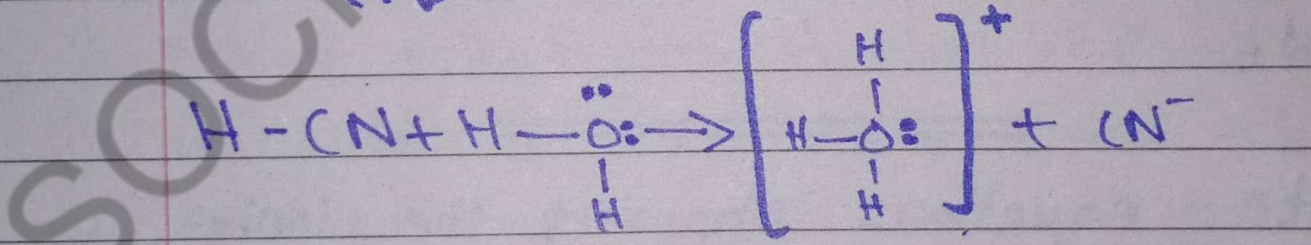
According to Bronsted-Lowery concept, acids are proton donors.

(a) $HNO_2(aq)$



So in above equations, HNO_2 is acid.

(b) $HCN_{(aq)}$



As HCN is proton donor, it is Bronsted acid.

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Chapter: 10

ACIDS, BASES AND SALTS

Review Exercise:

Q7. Classify the following solutions as acidic, basic or neutral.

(i) A solution that has hydrogen ion concentration 1.0×10^{-3} M.

As

$$1.0 \times 10^{-3} \text{ M} > 1.0 \times 10^{-7} \text{ M}$$

So a solution that has hydrogen ion concentration 1.0×10^{-3} M is acidic. ✓

(ii) A solution that has hydrogen ion concentration 1.0×10^{-10} M.

As

$$[H^+] = 1.0 \times 10^{-10} \text{ M} < 1 \times 10^{-7} \text{ M}$$

So the solution that has hydrogen ion concentration 1.0×10^{-10} M is basic. ✓

(iii) A solution that has hydroxyl ion concentration 1.0×10^{-3} M

$$[OH^-] = 1.0 \times 10^{-3} \text{ M}$$

$$K_w = [H^+][OH^-]$$

$$\frac{K_w}{[OH^-]} = [H^+]$$

$$[H^+] = \frac{1 \times 10^{-14}}{1 \times 10^{-3}}$$

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$[H^+] = 1 \times 10^{-14+3}$

$[H^+] = 1 \times 10^{-11}$ M

As:

1×10^{-11} M < 1×10^{-7} M

So the solution that contain 1×10^{-3} M hydroxyl ions is basic

(iv) A solution that has hydroxyl ion concentration 1.0×10^{-10} M.

$[OH^-] = 1 \times 10^{-10}$ M

$K_w = [H^+][OH^-]$

$\frac{K_w}{[OH^-]} = [H^+]$

$[H^+] = \frac{K_w}{[OH^-]}$

$[H^+] = \frac{1 \times 10^{-14}}{1 \times 10^{-10}}$

$[H^+] = 1 \times 10^{-14+10}$

$[H^+] = 1 \times 10^{-4}$ M

As:

1×10^{-4} M > 1×10^{-7} M

So solution that contain 1×10^{-10} M of hydroxyl (hydrogen) ions is acidic.

Q10: Identify Bronsted acids and Bronsted bases in the following reactions.

(i) $HS^-_{(aq)} + H_2O_{(l)} \rightleftharpoons S^{-2}_{(aq)} + H_3O^+_{(aq)}$

- **Bronsted Acid:**

According to Bronsted-Lowery concept, an acid is a proton donor. In the above reaction H_2S acts as an acid because it donates a proton and become HS^-.

- **Bronsted Base:**

According to Bronsted-Lowery concept, a base is a proton acceptor. In the above reaction NH_3 acts as a base because it accepts proton and form NH_4^+.

(ii) $HCO_3^-(g) + H_2O(l) \rightleftharpoons CO_3^{-2}(aq) + H_3O^+(aq)$

- **Bronsted Acid:**

According to Bronsted-Lowery concept, an acid is proton donor. So in the above e reaction HCO_3^- acts as an acid because it donates a proton and form CO_3^{-2}.

- **Bronsted Base:**

According to Bronsted-Lowery concept, a base is proton acceptor. In the above reaction, H_2O acts as base because it accepts a proton to form H_3O^+.

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Q12. Identify lewis acids and Lewis bases in the following reactions.

(i) $B(OH)_{3(s)} + OH^-_{(aq)} \rightarrow B(OH)^-_{4\,(aq)}$

- **Lewis acid:**

According to lewis concept, an acid is electron pair acceptor. In the above reaction $B(OH)_3$ acts as an acid because it accepts a pair of electrons.

- **Lewis Base:**

According to lewis concept, a base is electron pair donor. In the above reaction OH^- acts as per base because it donates a pair of electrons.

(ii) $Cu^{+2}_{(aq)} + 4NH_{3\,(aq)} \rightarrow [Cu(NH_3)_4]^{+2}_{(aq)}$

- **Lewis Acid:**

According to lewis concept, an acid is electron pair acceptor. In the above reaction Cu^{+2} acts as acid because it accepts an ~~attid~~ electron pair.

- **Lewis Base:**

According to lewis concepts, a base is electron pair donor. In the above

reaction NH_3 acts as base because it donates a pair of electrons.

QB: Classify water as proton donor or proton acceptor.

Amphoteric Substances:

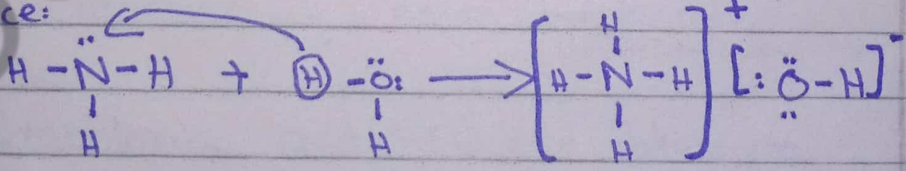
Substance that react with acids and bases are called amphoteric substances.

Nature of Water:

In some cases water accepts a proton and in some cases it donates a proton. This means that water behaves like an acid as well as a base so it is amphoteric in nature.

Water as Acid:

Ammonia is a gas at room temperature. When it reacts with water, following reaction takes place:



In the above reaction, water acts as an acid because it donates a proton.

Water as Base:

Consider the following example:

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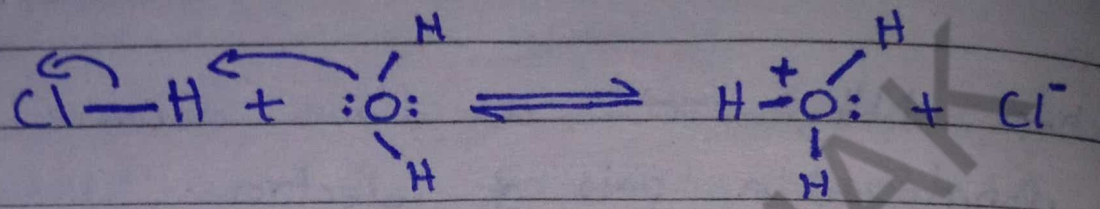

In the above reaction H_2O acts as a base because it accepts a proton which is a base according to Bronsted-Lowery concept.

28-May-2018 Monday

Chapter: 10
"Acids, Salts and Bases"

Self. Assessment Exercise: 10.5

1. Hydroxides such as $Mg(OH)_2$ called milk of magnesia is used as antacid. It neutralizes excess stomach acid (HCl). Write complete and balanced chemical equation for this neutralization reaction?

Magnesium hydroxide + Hydro-chloric acid → Magnesium chlorid + water

$Mg(OH)_2 + HCl \rightarrow MgCl_2 + H_2O$

$Mg(OH)_2$ contain 2 OH and hydro-chloric acid contain one H, so multiply 2 with HCl:

$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + H_2O$

The reaction is now balanced.

---

2. Hydrochloric acid (HCl) and Potassium hydroxide (KOH) react and produce potassium chloride. Write complete and balanced chemical equation for this neutralization reaction?

Hydrochloric acid + Potassium hydroxide → Potassium chloride + water

$HCl + KOH \rightarrow KCl + H_2O$

Since the number of H and OH are same, so the reaction is already balanced.

Q3: Balance following neutralization reactions.

(i) $H_2SO_{4(aq)} + NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + H_2O_{(l)}$

Since the number of H atoms and OH are same but the number of Na-atoms are not same so multiply NaOH by 2.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + H_2O$$

The reaction is balanced now.

(ii) $H_3PO_{4(aq)} + NaOH_{(aq)} \rightarrow Na_3PO_4 + H_2O_{(l)}$

Since the number of H-atoms and OH are not same but Multiply NaOH and H_2O by 3.

$$H_3PO_4 + 3NaOH \rightarrow Na_3PO_4 + 3H_2O$$

The reaction is balanced now.

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Review Exercise:

Q3: Ammonium hydroxide and nitric acid react and produce ammonium nitrate and water. Write balanced chemical equation for this neutralization reaction.

Ammonium hydroxide + Nitric acid → Ammonium nitrate + water

$NH_4OH + HNO_3 \rightarrow NH_4NO_3 + H_2O$

Since number of OH and H-atoms are equal, the reaction equation is balanced.

Q4: Write balanced chemical equation for the following neutralization reactions.

(i) Sulphuric acid + Magnesium hydroxide → magnesium sulphate + water

$H_2SO_4 + Mg(OH)_2 \rightarrow MgSO_4 + H_2O$

Since the number of H-atoms is not equal, multiply H_2O by 2.

$H_2SO_4 + Mg(OH)_2 \rightarrow MgSO_4 + 2H_2O$

The equation is balanced now.

(ii) Sulphuric acid + Sodium hydroxide → sodium sulphate + water

$$H_2SO_4 + NaOH \longrightarrow Na_2SO_4 + H_2O$$

Since the number of H-atoms and Na-atoms is not equal to balance the equation, multiply NaOH and H_2O by 2.

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$$

The equation is balanced now.

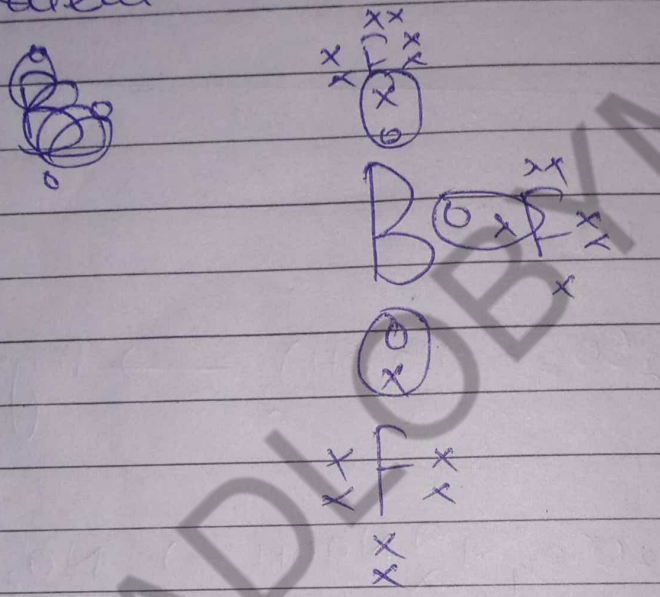
(iii) Hydrochloric acid + calcium hydroxide → calcium chloride + water

$$2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O$$

Since the number of H-atoms and Cl-atoms is not equal to balance the equation, multiply HCl by 2.

Qno2 (v) Lewis Acid.

According to lewis acid is a substance which accepts a pair of election to form co-ordinate Covalent bond.



As Boron belongs to group III-A it has three electons in its outer most shell, it will share three electons with flourine through covalent bond, so there will be total six electons in outermost shell of Boron, to complete its octet it needs two electons. So 'B' has Tendency to accept a pair of an electon to form co-ordinate covalent bond.
So it is a lewis acid.

Q no 3

Ammonium hydroxide + nitric acid reacts → Ammonium nitrate and water.

$$NH_4OH + HNO_3 \rightarrow NH_4NO_3 + H_2O$$

(Q no 3) (i)

$$H_2SO_4 + Mg(OH)_2 \rightarrow MgSO_4 + 2H_2O$$

(ii) $H_2OSO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

(iii) $2HCl \rightarrow Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O$