Acid, Bases and Salts

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8.1:
Characteristics of Acid and Bases

Acids:
Acids are a type of species that donate protons(proton donors). They have unique characteristics and reactions with other chemical species. Let us first take a look at their physical and chemical properties.

Physical properties of Acids:

1) Corrosive
2) Sour
3) Can burn the nose when inhaled
4) Can conduct electricity when in solution

Indicator	Color
Universal	Red up to orange
Litmus	Red
Methyl orange	red
Phenolphthalein	Colorless

Chemical properties of Acids:

1) Proton donor
2) pH lower than 7
3) Turns damp blue litmus paper red

Here are the following reactions you need to be familiar with regards to Acids:

1) Acid + Metal $\longrightarrow$ Salt + H_2

2) Acid + Base $\longrightarrow$ Salt + H_2O

3) Acid + Metal Carbonate $\longrightarrow$ Salt + CO_2 + H_2O

A crucial concept to understand is **why acids only have their acidic properties when dissolved in water.** Take an example of HCl but in gaseous state. This compound has no acidic properties. Its called hydrogen chloride. However, when dissolved in water, it has a pH lower than 7.

This is because when it dissolves in water, the H^+ ions dissolve in water. The higher concentration of this ion, the more acidic the solution.

This is why pH stands for power of hydrogen. The higher concentration of H^+ ions, the more

acidic it is.

Another crucial concept to understand is the difference of a concentrated acid and a strong acid.

Strong acid complete dissociates/ionizes in water whereas a weak acid partially ionizes in water. An example of a strong acid is HCl whereas an example of a weak acid is CH_3COOH.

Hence, the strength of an acid affects pH, not the concentration.
However, do take note that 1M of an acid, regardless of its strength, will neutralize 1M of base, regardless of its strength as well.

Extra info: The more number of H an acid has, the stronger it is.
Hence,
$HCl < H_2SO_4 < H_3PO_4$

Bases and Alkalis:
Bases are a type of a species which receives proton (proton acceptor).They have unique characteristics and reactions with other chemical species. Let us first take a look at their physical and chemical properties.

Physical properties of Bases:

1) Bitter
2) Slippery
3) Can conduct electricity when in solution

Indicator	Color
Universal	Blue up to purple
Litmus	Blue
Methyl orange	Yellow
Phenolphthalein	Pink

Chemical properties of Bases:

1) pH higher than 7
2) Turns damp red litmus paper blue
3) Proton acceptor

Bases have very similar concepts to that of acids with respect to their strength and concentration.

Bases than can dissolve in water are called alkalis. Alkalis dissociate in water. This solution contains OH^- ions.

Hence, similarly, strong alkalis complete dissociate in water whereas weak alkalis partially dissociate in water.

Here are the following reactions you need to be familiar with regards to Bases:

1) Acid + Base ⟶ Salt + H_2O

2) Base + ammonium compound ⟶ Salt + ammonia + water

Bases can be used to control the acidity of soils. When soils get to acidic, crops die. Hence, small amounts of bases is spread across the soil to neutralize the acidity.

Bases such as CaO, $Ca(OH)_2$ and $CaCO_3$ are used. More often than not, $CaCO_3$ is used as it is insoluble and hence would not be washed away. Not to mention, the other 2 may raise the pH above 7.

8.2:
Types of oxides

We have acidic, basic, amphoteric and neutral oxides.

Metals are usually classified as basic oxides whereas non metals are classified as acidic oxides.

Amphoteric oxides are oxides that can exhibit both basic and acidic properties.

Examples of amphoteric oxides are Al2O3 , ZnO and PbO.
Examples of neutral oxides are N_2O,NO and CO.

$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$
$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

When dealing with questions such as this in a exam, it is **absolutely crucial to show the reaction and give an example when answering these questions.** For example, if the question is "How do you differentiate an amphoteric from an basic oxide?"

You give an example of basic oxide and show the reaction of a basic oxide with an acid. State that it cannot react with a base.

Then, you give an example of amphoteric oxide and show the reaction of the amphoteric oxide with both base and acid.

8.3:

Preparation of Salts

Before we start looking at how we prepare salts, let us first understand how do we determine whether or not a salt is soluble in water(universal solvent).

SPANE CHS

All Sodium, Potassium, Ammonium, Nitrate and Ethanoate salts are soluble

All carbonate salts are insoluble except sodium, potassium and ammonium

All halide salts are soluble except $PbCl_2$ and AgCl

All sulfate salts are soluble except $CaSO_4$, $BaSO_4$ and $PbSO_4$

It is also useful to know that group 1 and 2 metals form white coloured oxides

As seen above, there are 2 types of salts:

1) Soluble
2) Insoluble

Each type requires specific methods. Let us first start with soluble.

Method to prepare soluble salts:

1) Acid + alkali (titration)
2) Acid + base
3) Acid + carbonate
4) Acid + metal

Each method has its own strengths and weaknesses. For the 4th metal, it would not work on very unreactive metals such as that of lead, copper etc.

Each method have very similar steps. The key points I would like to point out would be:

1) If you want an anhydrous salt, leave it in the oven. Otherwise, heat until crystallization point and leave in RTP
2) Never ever have acid as the reactant in excess. The other reactant should always be the one in excess
3) To not if all acid has reacted, look for cues such as bubbling has stopped, no effervescence formed (if reacted with carbonate) or the solid, whether metal or insoluble alkali(base) stops dissolving in the acid
4) When undergoing titration process, the first part requires you to add an indicator as you would never know when both has completely reacted. Always remember to note down

the values and repeat the experiment without the indicator

For insoluble salts, there is only one method and that is precipitation.

Let us say we would like to obtain $PbCl_2$

We first need to **react 2 soluble salts.** These 2 salts would then undergo double displacement. It will look something like this

$2NaCl + Pb(NO_3)_2 \rightarrow PbCl_2 + 2NaNO_3$

When choosing your reactants, always make sure the cation and anion are found in separate species. Here, Pb^{2+} comes from $Pb(NO_3)_2$ whereas Cl^- comes from NaCl.

A trick I like to use is remember that all sodium and nitrate salts are soluble. Hence, I would just add an anion behind sodium and a cation in from of nitrate.

When preparing insoluble salts, always rinse with distilled water to remove soluble impurities before drying it in the oven.

8.4:
Identification of Ions and Gases

Notes on Qualitative Analysis.pdf.pdf

Exam tips:

1) Remember how to obtain soluble and insoluble salts
2) Understand which reactant must be in excess, why and how to spot the limiting reactant has been used up
3) Memorize SPANE CHS
4) Identification of ions and gases may feel like a pain in the ass but at least 3 marks will be allocated for it
5) Understand why $CaCO_3$ is preferred in bring the pH of soil up
6) Understand how acids and bases have their respective properties