



Ratna Sagar

RATNA SAGAR

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BYWORD

E-LIVE

Education, Our Mission



ICSE

Living Science

Chemistry

Class 10

Chapter-8 Study of Compounds-
Hydrogen Chloride

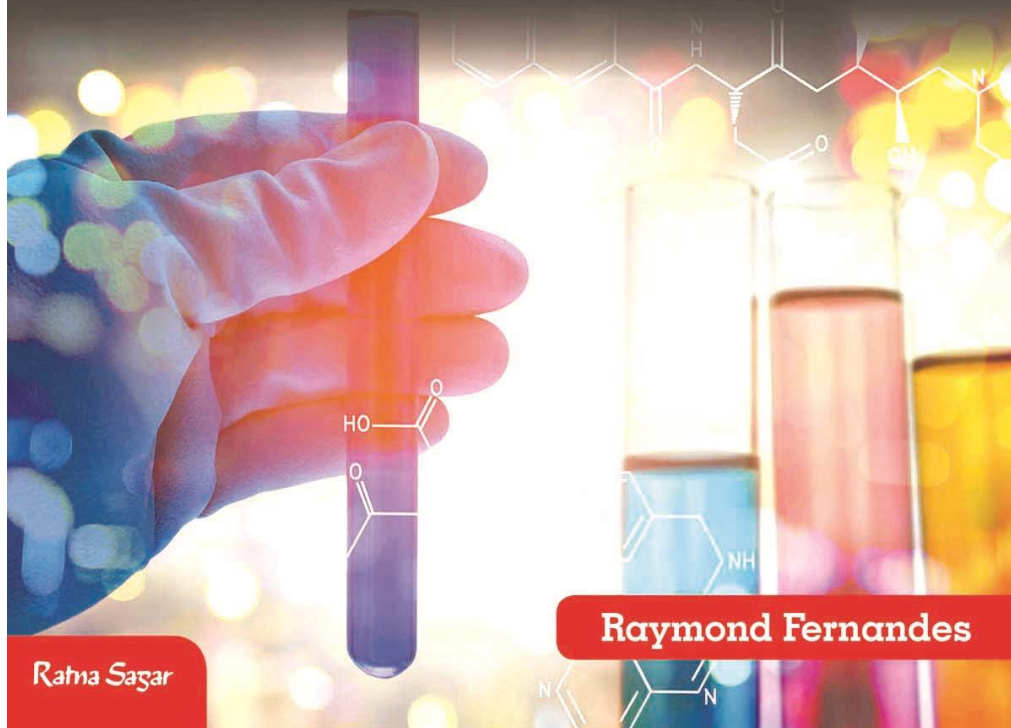


As per the latest ICSE syllabus

10



Living Science CHEMISTRY



Raymond Fernandes

Rama Sagar

EDUCATION, OUR MISSION



LEARNING OBJECTIVES

Hydrogen Chloride Gas

- ❖ Preparation of hydrogen chloride gas
- ❖ Laboratory preparation of hydrogen chloride gas
- ❖ Physical properties of hydrogen chloride gas
- ❖ Chemical properties of hydrogen chloride gas

Hydrochloric Acid

- ❖ Preparation of hydrochloric acid
- ❖ Physical properties of hydrochloric acid
- ❖ Chemical properties of hydrochloric acid
- ❖ Tests for hydrochloric acid
- ❖ Uses of hydrochloric acid

Important characteristics of hydrogen chloride gas

Molecular formula: HCl

Molecular mass: 36.5 u

Vapour density: 18.25

Nature: Acidic in nature

Solubility: Highly soluble in water

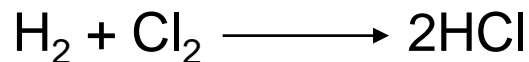
Common name: Spirit of salts



Preparation of hydrogen chloride gas

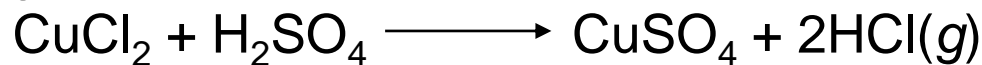
1. By the direct combination of hydrogen and chlorine

In the presence of diffused sunlight, hydrogen combines with chlorine to form hydrogen chloride gas.



2. By the reaction of metallic chlorides with concentrated H_2SO_4

When metallic chlorides react with concentrated sulphuric acid, hydrogen chloride gas is liberated.



Laboratory preparation of hydrogen chloride gas

In the laboratory, hydrogen chloride gas is prepared by the action of concentrated sulphuric acid on common salt, sodium chloride.

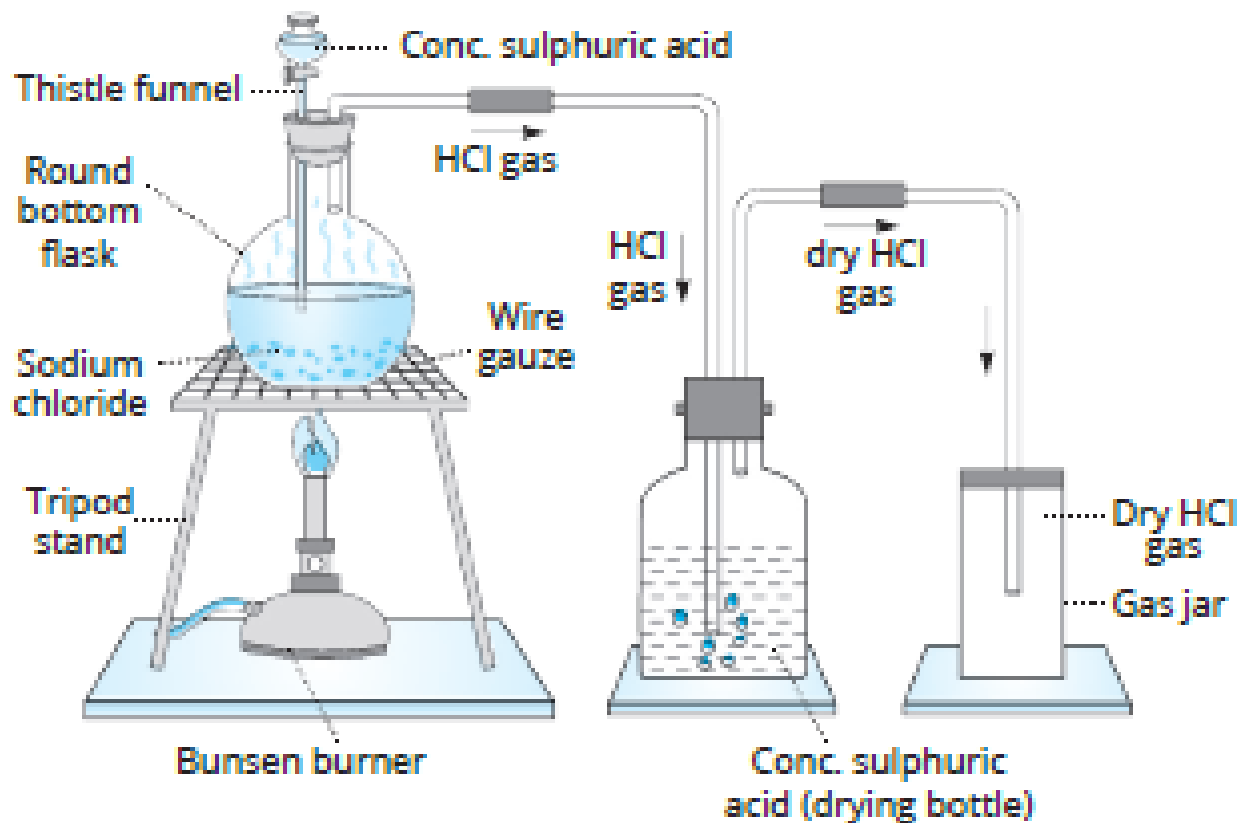
Reactants: Sodium chloride and sulphuric acid

Sodium chloride is preferred only for laboratory preparation of hydrogen chloride gas because it is cheap and easily available. Concentrated H_2SO_4 is used because it is **less volatile** in nature and therefore it can displace a more volatile acid from its corresponding salt.



Reaction: The reaction takes place at a temperature of 200°C as follows:
$$\text{NaCl}(s) + \text{H}_2\text{SO}_4(l) \xrightarrow{<200^{\circ}\text{C}} \text{NaHSO}_4(aq) + \text{HCl}(g)$$

Procedure: Sodium chloride is taken in a round bottom flask and concentrated sulphuric acid is added dropwise to it through the thistle funnel. The flask is heated gently to about 200°C to initiate the reaction.



Preparation of HCl gas from NaCl and H_2SO_4



Physical properties of hydrogen chloride gas

- 1. Colour:** Colourless gas
- 2. Smell:** Pungent with choking smell. If inhaled, it corrodes the delicate membrane of the respiratory tract.
- 3. Taste:** Sour in taste
- 4. Density:** Its vapour density is 18.25 and that of air is 14.4. Hence, it is 1.28 times heavier than air.
- 5. Solubility:** Highly soluble in water. HCl gas fumes in moist air and forms droplets of HCl acid.

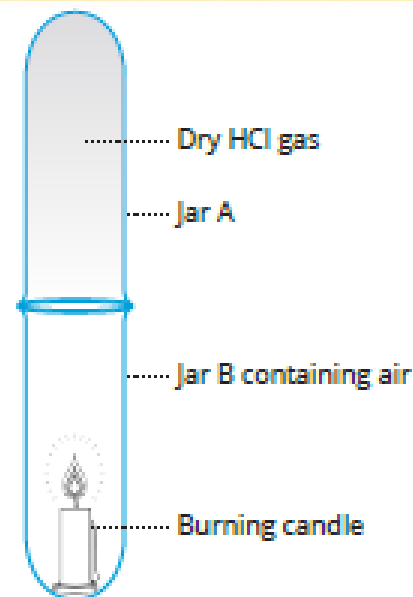
The solubility increases on decreasing the temperature.

- 6. Liquefaction of gas:** Liquefies at 10°C and 40 atmospheric pressure. On further cooling, liquid hydrogen chloride solidifies to a white solid which melts at -113°C .
- 7. Boiling point:** Liquid hydrogen chloride boils at -33°C .



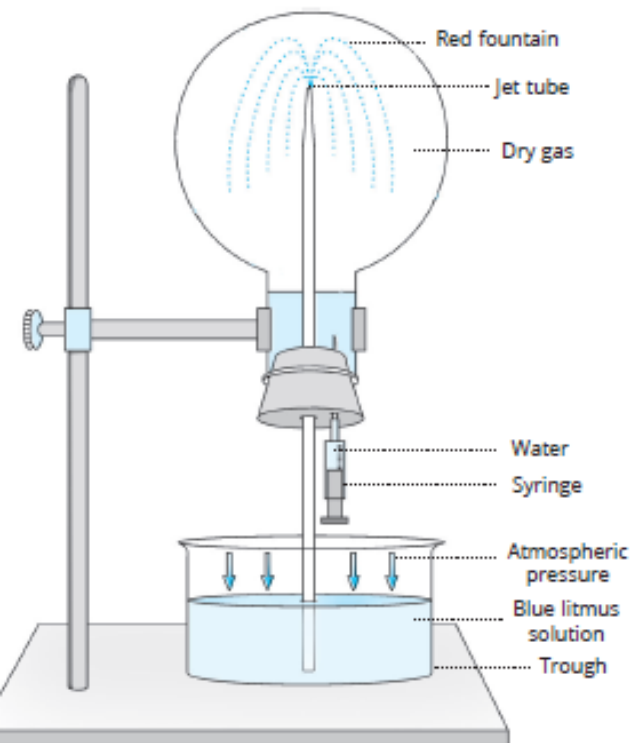
Experiment to show that hydrogen chloride gas is heavier than air

The burning candle gets extinguished because HCl gas being heavier than air displaces air from jar B. It shows that Hydrogen chloride (HCl) gas is heavier than air.



Experiment to demonstrate high solubility of hydrogen chloride gas.

When the syringe is squeezed, the water entering the flask dissolves almost the entire hydrogen chloride gas, thus creating a partial vacuum. This happens because hydrogen chloride gas dissolves rapidly in water. The vacuum draws up the litmus solution, which spurts into the round bottom flask and turns red when it comes in contact with the undissolved hydrogen chloride gas.





Chemical properties of hydrogen chloride gas

1. Combustion

Hydrogen chloride gas is neither combustible nor does it support combustion. It extinguishes a burning candle.

2. Action on indicators

Action on indicators is studied only with moist hydrogen chloride gas. The hydronium ions formed when hydrogen chloride gas is dissolved in water are responsible for the colour changes in the indicators.

3. Thermal dissociation

When heated above 500°C , less than 0.5% of hydrogen chloride gas dissociates to hydrogen and chlorine.

4. Reaction with ammonia

Hydrogen chloride gas reacts with ammonia to form dense white fumes of ammonium chloride.

5. Reaction with metals

Metals react with hydrogen chloride gas at high temperature to form their respective chlorides and liberate hydrogen.



Hydrochloric Acid

Hydrogen chloride gas when dissolved in water produces hydrochloric acid. Hence, hydrochloric acid is a solution of hydrogen chloride in water. The formation of hydronium ions, by HCl is responsible for the acidic character. Hydrochloric acid is a good conductor of electricity.

Preparation of hydrochloric acid

To prepare hydrochloric acid, hydrogen chloride gas is dissolved in water. But it cannot be prepared by directly dissolving HCl gas in water by dipping the delivery tube carrying HCl gas in water. The difficulty encountered in doing so is that hydrogen chloride gas dissolves rapidly in water, thus causing back suction.

Back suction

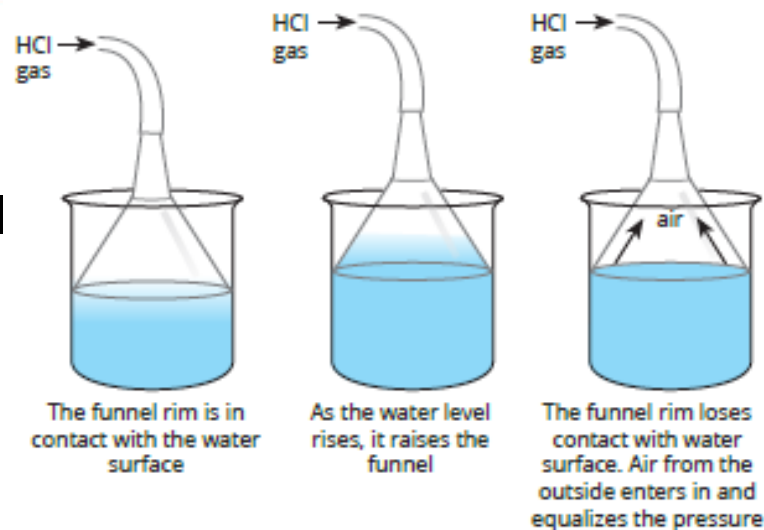
Hydrogen chloride gas is highly soluble in water. When the delivery tube containing hydrogen chloride gas is directly immersed in water, its rate of dissolution in water is higher than its rate of formation. This creates a partial vacuum inside the delivery tube resulting in low pressure.

To balance this low pressure, the air from outside exerts pressure on the water in a beaker and hence, forces it up through the delivery tube in the flask. As a result, water is sucked back. This effect is called **back suction**.



Prevention of back suction: It is prevented by using the funnel arrangement. The main advantage of this arrangement is that the funnel provides a large surface area which aids in preventing back suction.

Funnel arrangement for the preparation of hydrochloric acid.



Physical properties of hydrochloric acid

- 1. Colour:** Pure hydrochloric acid is colourless liquid but commercially available acid is slightly yellow in colour due to the presence of ferric chloride as an impurity.
- 2. Taste and odour:** It has a sour taste like most acids and has a slightly pungent odour.
- 3. Nature:** It is highly corrosive in nature.
- 4. Solubility:** It is highly soluble in water.
- 5. Boiling point:** Hydrochloric acid solution forms a constant boiling mixture at around 110°C . Beyond this temperature, the acid cannot be concentrated by distillation. It is volatile and when exposed to air it fumes, that is, loses hydrogen chloride.



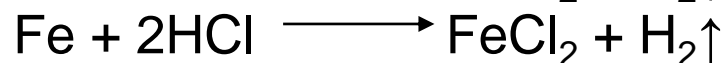
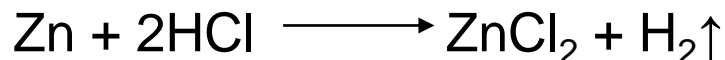
Chemical properties of hydrochloric acid

Reaction with dilute hydrochloric acid

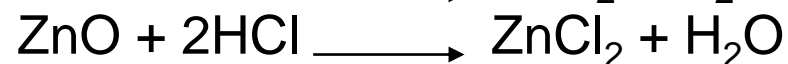
Dilute hydrochloric acid behaves like a typical acid.

1. Acidic Nature: Hydrochloric acid is a strong acid. It dissolves in water to generate the hydronium ion. Due to the presence of hydronium ions, it shows acidic properties.

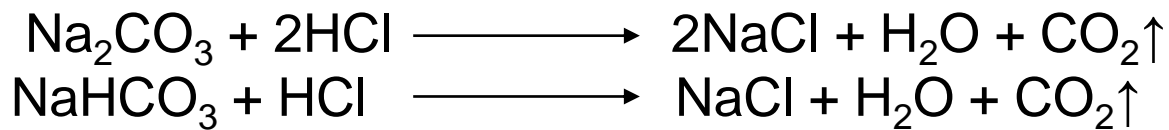
2. Reaction with active metals: It reacts with active metals which are placed above hydrogen in the metal reactivity series. Hydrochloric acid reacts with active metals to form metal chlorides and liberates hydrogen gas.



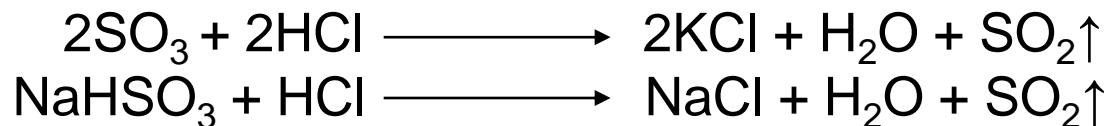
3. Reaction with bases, i.e. oxides and hydroxides of metals: Hydrochloric acid neutralizes oxides and hydroxides of metals to form their corresponding salts and water.



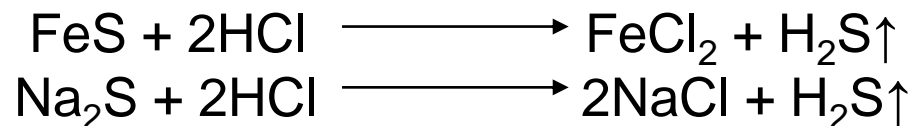
4. Reaction with carbonates and bicarbonates: Hydrochloric acid reacts with metal carbonates and bicarbonates to give the corresponding metal chloride and liberate carbon dioxide.



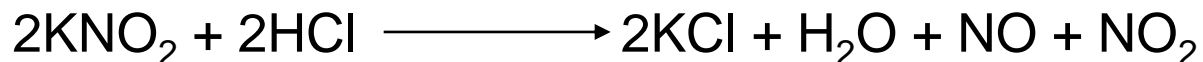
5. Reaction with sulphites and bisulphites: Hydrochloric acid reacts with metallic sulphites and bisulphites to give metal chloride and liberate sulphur dioxide.



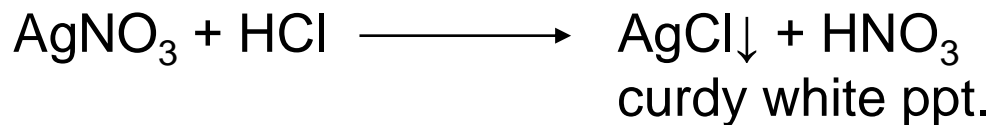
6. Reaction with sulphides: Hydrochloric acid reacts with metallic sulphides to form metal chloride and liberates hydrogen sulphide.



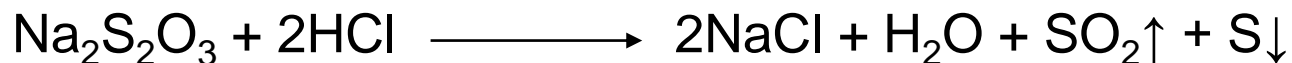
7. Reaction with metallic nitrites: Hydrochloric acid reacts with metallic nitrites on warming to form respective metallic chlorides and oxides of nitrogen.



8. Reaction with nitrates: Normally, hydrochloric acid does not react with nitrates. However, hydrochloric acid reacts with soluble salts of silver and lead like AgNO_3 and $\text{Pb}(\text{NO}_3)_2$ to form their respective insoluble salts in the form of precipitates.

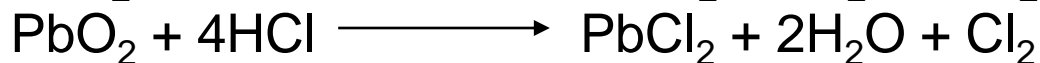
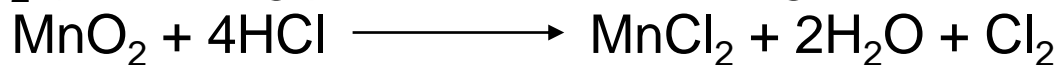


9. Reaction with sodium thiosulphate: Dilute hydrochloric acid reacts with sodium thiosulphate to form sodium chloride, liberate sulphur dioxide gas and sulphur.

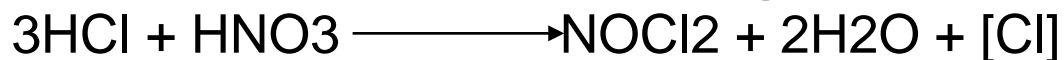


Reactions for concentrated hydrochloric acid

1. Reaction with oxidizing agents: Concentrated hydrochloric acid reduces strong oxidizing agents like MnO_2 , PbO_2 , Pb_3O_4 , KMnO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$, CaOCl_2 (bleaching powder) and in turn gets oxidized to chlorine.



2. Reaction with concentrated nitric acid (aqua regia formation): When concentrated hydrochloric acid is mixed with concentrated nitric acid in the ratio of 3 : 1, it forms a mixture called **aqua regia**.



3 parts 1 part

nitrosyl
chloride

nascent
chlorine



Tests for hydrochloric acid

1. It possesses a characteristic irritating pungent smell.
2. A glass rod dipped in ammonia solution gives dense white fumes with hydrochloric acid.
3. Hydrochloric acid forms a curdy white precipitate with silver nitrate solution. The precipitate is insoluble in nitric acid but soluble in ammonium hydroxide.
4. Concentrated hydrochloric acid when reacts with manganese dioxide liberates greenish-yellow chlorine gas. The liberated gas turns starch iodide paper blueblack

Uses of hydrochloric acid

Hydrochloric acid is used

1. in the manufacture of drugs, dyes and paints.
2. in the manufacture of silver chloride for photography.
3. in the manufacture of glucose from starch.
4. in cleaning of metal surfaces before galvanizing, painting, electroplating, soldering, etc. For cleaning the metal surface,
5. in the preparation of aqua regia.
6. in the extraction of glue from bones.
7. in removing rust from iron sheets.



SUMMARY

1. Preparation of hydrogen chloride gas

- By the synthesis of hydrogen and chlorine



- By reacting metallic chlorides with concentrated H_2SO_4



2. Laboratory preparation of hydrogen chloride

- By the action of conc. H_2SO_4 on NaCl below 200°C .



- ### 3. Properties of hydrogen chloride gas:
- HCl gas is colourless, pungent smelling, sour in taste, heavier than air, highly soluble in water and acidic in nature.

- ### 4. Preparation of hydrochloric acid:
- Hydrochloric acid is prepared by dissolving hydrogen chloride gas through funnel arrangement. Funnel arrangement is used because it

- a. prevents back suction of water.
- b. provides large surface area for the absorption of HCl gas.

The HCl obtained from funnel arrangement contains 36% by mass of hydrochloric acid.

- ### 5. Acidic nature of hydrochloric acid:
- HCl is a strong monobasic acid and produces hydronium ions when dissolved in water.



- ### 6. Uses of hydrochloric acid:
- It is used in manufacture of drugs, dyes, paints, in tanning industry and as a laboratory reagent.

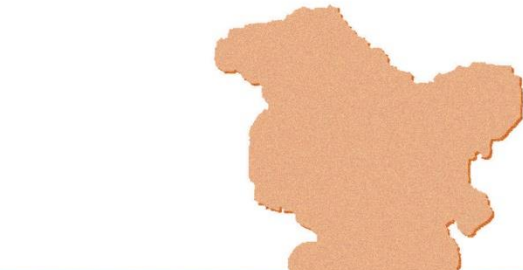


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