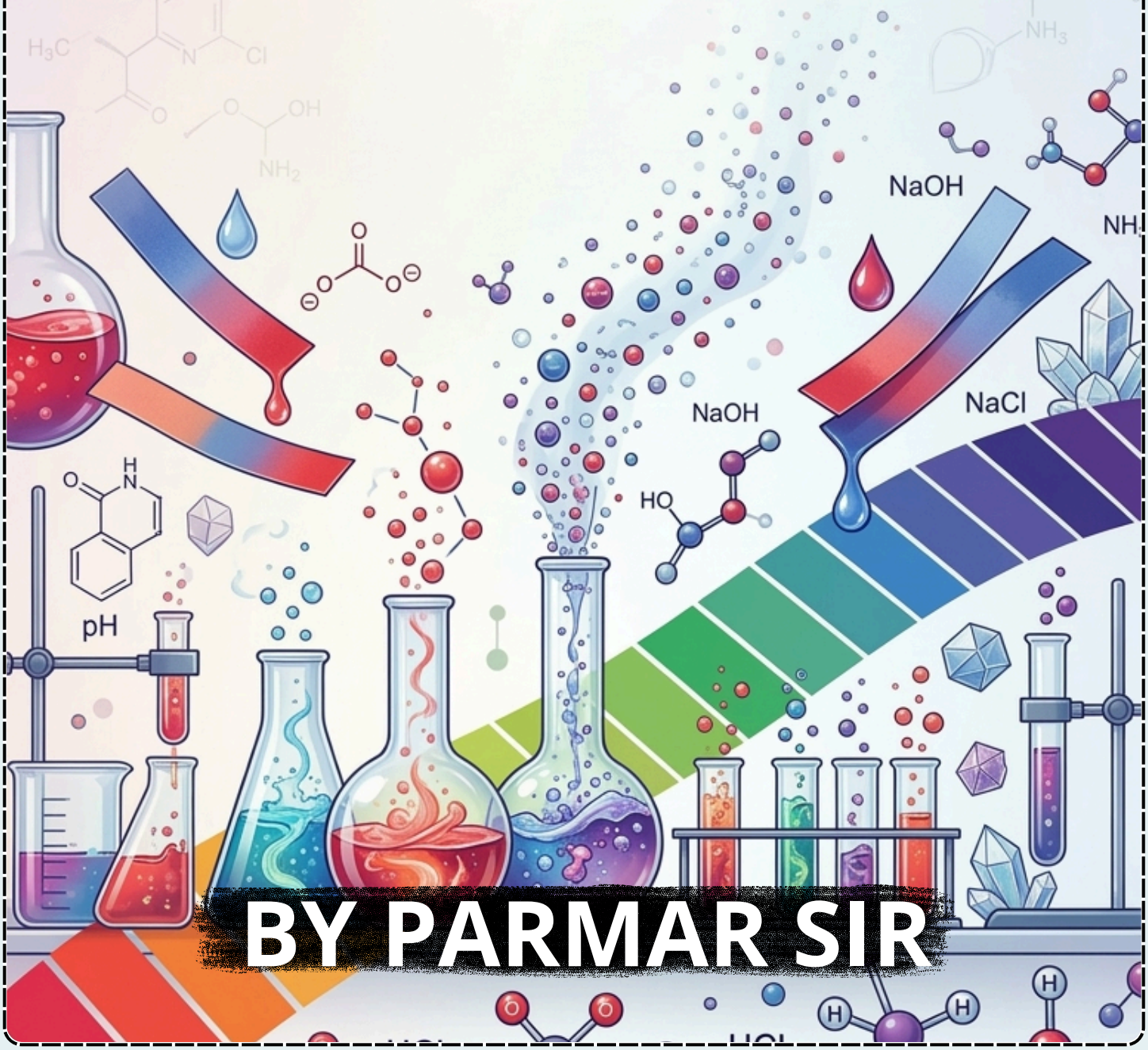
PARMAR SSC

ACID, BASE AND SALT

Lecture - 7



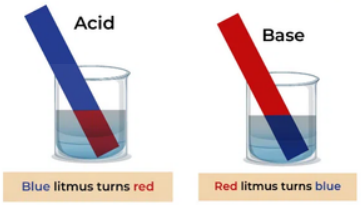
BY PARMAR SIR

Acid

- An acid is any hydrogen-containing substance that is capable of donating a proton (hydrogen ion → H^+) to another substance.
- Acids are usually identified by their sour taste.
- An acid turns blue litmus paper red.

Base

- A base is a molecule or ion able to accept a hydrogen ion from an acid.
- A base turns red litmus paper blue.



Litmus is a purple dye, which changes its colour when interacted with acid or base.

Acid–Base Indicators

1 Natural Indicators

- Natural indicators are substances, often derived from plants, that change color in the presence of acids or bases, indicating their acidic or basic nature.
- Eg.

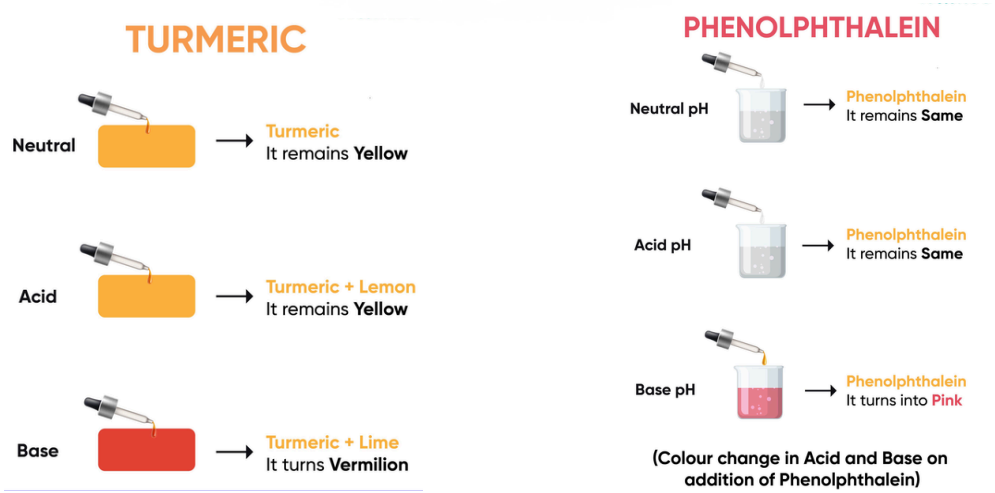
1. **Litmus:** It is extracted from Lichen (Thallophyte).
2. **Turmeric:** It is a natural dye Curcumin is present in it.
3. **Coloured petals:** Coloured petals of Hydrangea, Petunia, Geranium, Red Cabbage, China Rose, etc.

2 Synthetic Indicator

- Synthetic indicators are acid-base indicators that are man-made or synthesized in a laboratory.
- Eg.

1. **Phenolphthalein:** It is colourless in acidic solutions but turns pink in basic solutions.
2. **Methyl Orange:** It is red in acidic solutions and yellow in basic solutions.

Indicators



Indicator	Acid	Base
Litmus	Blue to Red	Red to Blue
Turmeric	Remains yellow	Turn to reddish brown
Phenolphthalein	Colourless	Pink
Methyl orange	Red	Yellow (a bit orangey)

Olfactory Indicators

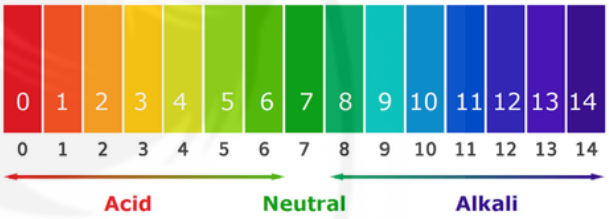
- An olfactory indicator is a substance whose smell changes based on whether it is mixed with an acid or base.
- **Eg.** Vanilla, Onion, Clove, etc.





Universal Indicators

- A universal indicator is a mixture of different types of indicators that exhibits different coloration at different levels.
- It is used to detect the acidic or basic nature of a substance or a solution.



ORGANIC ACIDS

Acid	Sources
Acetic Acid	Vinegar
Citric Acid	Citrus Fruits (lemon, orange)
Tartaric Acid	Tamarind, Grapes, Kaccha Mango
Oxalic Acid	Tomato, Spinach
Lactic Acid	Curd
Ascorbic Acid	Citrus Fruits, Amla
Methanoic/Formic Acid	Ant Sting, Nettle Sting
Butyric Acid	Rancid Butter
Stearic Acid	Oil/Fats
Malic Acid	Apple, Banana
Lauric Acid	Coconut milk
Erucic Acid	Mustard oil

MINERAL ACIDS

- A mineral acid or an inorganic acid is any acid derived from an inorganic compound that dissociates to produce hydrogen ions (H^+) in water.

Acid	Sources
Sulphuric Acid (king of chemical)	Oil of Vitriol
Nitric Acid	Explosives
Hydrochloric Acid	Gastric Juice
Boric Acid	Antiseptic
Carbonic Acid	Soda Water
Phosphoric Acid	Fertilizers

BASE

Base	Used In
Calcium Hydroxide	Lime Water
Ammonium Hydroxide	Window Cleaner
Sodium/Potassium Hydroxide	Soap
Magnesium Hydroxide	Milk of Magnesia

Chemical Properties of Acids and Bases

1. Reaction with Metals

- When acids react with metals, they typically produce a salt and hydrogen gas, while some metals like zinc and aluminium also react with bases to form a salt and hydrogen gas.

Acid + Metal → Salt + Hydrogen gas

Burns with a pop sound

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2\ (g)$$

$$Zn + NaOH \rightarrow Na_2ZnO_2 + H_2\ (g)$$

2. Reaction of Metal Carbonate and Metal Hydrogen Carbonate with Acids

- When acids react with metal carbonates or metal hydrogen carbonates, they produce salt, carbon dioxide gas, and water.

Metal Carbonate OR Metal Bicarbonate + Acid → Salt + CO_2 + H_2O

$$Na_2CO_3 / NaHCO_3 + HCl \rightarrow NaCl + CO_2 + H_2O$$

Test of Carbon Dioxide

- Carbon Dioxide (CO_2) turns lime water milky because the carbon dioxide reacts with the calcium hydroxide $Ca(OH)_2$ in the lime water, forming an insoluble white precipitate of calcium carbonate ($CaCO_3$).

$$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$$

Turns lime water milky.

Further:

- If excess CO_2 is passed through the milky lime water, the milkiness disappears because calcium carbonate reacts with more CO_2 and water to form soluble calcium bicarbonate.

$$CaCO_3(s) + CO_2(g) + H_2O(l) \rightarrow Ca(HCO_3)_2(aq)$$

milkiness disappears

Acid/Base in Water Solution

Conduction of Electricity

- Aqueous solutions of acids and bases conduct electricity because they contain charged particles (ions) that can move and carry an electric current, which is due to the dissociation of acids into H^+ ions and bases into OH^- ions.
- Distilled water, alcohol and glucose do not conduct electricity.
- All bases do not dissolve in water.
  Eg. copper (II) oxide.
- An alkali is a base that dissolves in water.
- All alkali are bases, but all bases are not alkali.

Dilution of Acids

- While diluting an acid, it's safer to add acid to water slowly and with constant stirring than to add water to an acid. Adding water to acid can cause an extreme exothermic reaction that produces a large amount of heat which can cause the solution to boil, splatter, and cause burns.



Neutralization Reaction

- A neutralization reaction is a type of acid-base reaction where an acid reacts with a base to form salt and water to release heat (exothermic reaction), essentially "cancelling out" each other's acidic or basic properties.
- Neutralization reaction is a type of double displacement reaction.

$$\text{Acid} + \text{Base} \rightarrow \text{Salt} + \text{Water} + \text{Heat}$$

$$\text{Metal oxide} + \text{Acid} \rightarrow \text{Salt} + H_2O$$

Basic

$$\text{Non-metal oxide} + \text{Base} \rightarrow \text{Salt} + H_2O$$

Acidic

Strong Acid + Weak Base → Salt (Acidic) + H_2O

$Al(OH)_3 + HCl \rightarrow AlCl_3$ (Acidic salt) + H_2O

Weak Acid + Strong Base → Salt (Basic) + H_2O

$CH_3COOH + NaOH \rightarrow CH_3COONa$ (basic salt) + H_2O

Strong Acid + Strong Base → Salt (neutral) + H_2O

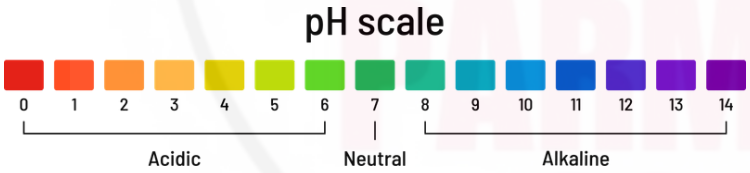
$NaOH + HCl \rightarrow NaCl$ (neutral salt) + H_2O

Weak Acid + Weak Base → Salt (neutral) + H_2O

$CH_3COOH + NH_4OH \rightarrow CH_3COONH_4$ (neutral) + H_2O

pH Scale

- "p" stands for "Potenz" means "Power" in German language.
- pH scale was developed by Lauritz Sorensen (a Danish chemist).
- It is a universal indicator (a mixture of several indicators) and a logarithmic scale.
- It shows different colour at different hydrogen ion concentration.
- It measures H^+ ion concentration.



$$pH = -\log [H^+]$$

Importance of pH Scale in Everyday Life

- Human body works in a narrow pH range of 7-7.8.
- pH scale is used in treatment of soil (Quick lime/CaO, Slaked lime is added to acidic soil).
- When soil is too basic, then gypsum is added to treat it.
- Antacids like $Mg(OH)_2$ - Milk of Magnesia, baking soda, aluminium hydroxide is used to treat indigestion when stomach produces too much HCl.
- pH levels help in self-defence in plants and animals.

Important pH Values

- **Gastric juice: 1.6**
- **Lemon: 2**
- **Milk: 6.4**
- **Blood: 7.4 (slightly alkaline)**
- **Saliva: 6.5**
- **Milk of Magnesia: 10**
- **NaOH: 14**

1. **Bee sting:** It contains methanoic acid/formic acid (causes burning sensation when it comes in contact with skin).
   - **Remedy:** A mild base like Calamine lotion (contains Zinc carbonate) is applied.

2. **Nettle plant leaves:** Sting of the hair of the nettle leaves contain methanoic acid.
   - **Remedy:** The juice of dock leaves is applied due to its basic properties which relieves the burning or stinging sensation.

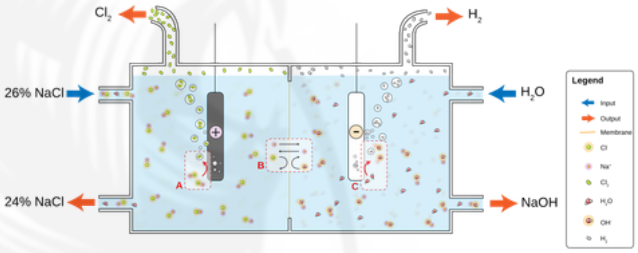
- Acid rain occurs when pH of the rainwater drops below 5.6 (contains sulphur dioxide (SO_2) + nitrogen oxides).
- Tooth decay starts when the pH value is less than 5.5.

Chlor-Alkali Process

- The chlor-alkali process is an industrial method that uses electrolysis to produce chlorine, hydrogen, and sodium hydroxide (caustic soda).
- An aqueous solution of sodium chloride (NaCl) or brine is passed through an electrolytic cell. An electric current is passed through the solution. Chlorine gas (Chlor) and sodium hydroxide (Alkali) solution are produced.

$$2NaCl\ (aq) + 2H_2O \rightarrow 2NaOH\ (aq) + Cl_2\ (g) + H_2\ (g)$$

At Cathode *At Anode* *At Cathode*



Bleaching Powder

- Its chemical formula is $CaOCl_2$ (calcium oxychloride/calcium hypochlorite).
- It is commonly known as Chlorinated Lime.
- It is produced by the action of chlorine on dry Slaked Lime ($Ca(OH)_2$).

$$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$$

Slaked Lime/Lime Water

Uses of Bleaching Powder

- It is used for bleaching cotton and linen clothes in textile industries.
- It is used for bleaching wood pulp in paper industries.
- It is used in laundry.
- It is used as an oxidising agent in chemical industry.
- It is used as an disinfectant for cleaning drinking water

Baking Soda

- Its chemical formula is $NaHCO_3$ (sodium bicarbonate).
- Sodium chloride, water, carbon dioxide, and ammonia react to produce sodium bicarbonate ($NaHCO_3$) and ammonium chloride (NH_4Cl).

$$NaCl + H_2O + CO_2 + NH_3 \rightarrow NaHCO_3 + NH_4Cl$$

Sublime compound

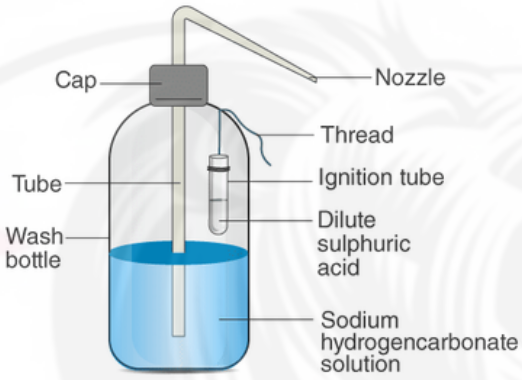
- The preparation of sodium bicarbonate ($NaHCO_3$) from NaCl, NH_3, CO_2, and H_2O is known as the Solvay Process.

When Baking Soda is Heated

- When baking soda is heated, it undergoes a decomposition reaction, breaking down into sodium carbonate (Na_2CO_3), water (H_2O), and carbon dioxide (CO_2).

Uses of Baking Soda

- It is used to make tasty, crispy pakora and used in faster cooking.
- It is used to make baking powder = mixture of baking soda + mild edible acid (eg,. Tartaric Acid).
- It is used as antacids (substances which neutralise stomach acidity).
- It is used in soda-acid fire extinguisher (Dilute H_2SO_4 + $NaHCO_3$).



Making a soda-acid fire extinguisher

- When the fire extinguisher's knob is turned, the sulfuric acid and sodium bicarbonate react to produce carbon dioxide gas.

Washing Soda

- Its chemical formula is $Na_2CO_3 \cdot 10H_2O$ (hydrated sodium carbonate).

$$NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$
$$Na_2CO_3 + 10\ H_2O \rightarrow Na_2CO_3 \cdot 10H_2O$$

Uses of Washing Soda

- It is used in glass, soap and paper industries.
- It is used in manufacturing of borax ($Na_2B_4O_7 \cdot 10H_2O$).
- It is used as a cleaning agent.
- It is used in removing permanent hardness of water.

Hard water

- It is a type of water that contains high levels of calcium and magnesium minerals.

Heavy water (D_2O)

- It is a type of water that contains a higher concentration of deuterium (a heavy isotope of hydrogen) than regular water.

Plaster of Paris

- On heating Gypsum at 373 K, it loses water molecules and form Plaster of Paris ($CaSO_4 \cdot 1/2H_2O$ – Calcium Sulphate Hemihydrate).
- It is a white powder and on mixing with water, it changes to Gypsum.

$$CaSO_4 \cdot 1/2H_2O + 1\frac{1}{2}H_2O \rightarrow CaSO_4 \cdot 2H_2O$$

(Plaster of Paris) *(Gypsum)*

Uses of Plaster of Paris

- It is used to support fractured bones, forming a hard cast that immobilizes the injured limb while it heals.
- It is used for making toys, decorative materials, smooth surface of walls, etc.

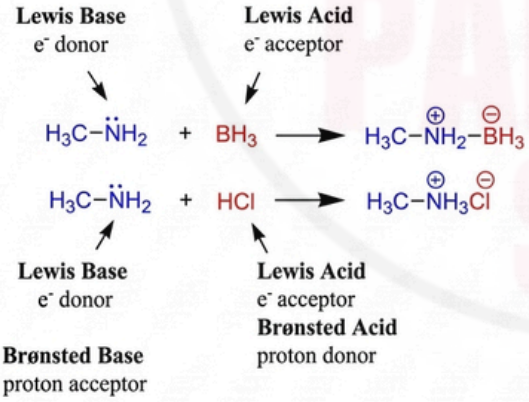




Some Other Salts

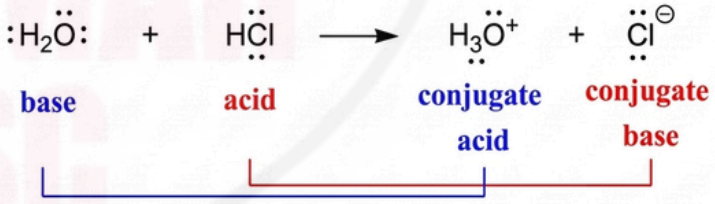
- **Blue vitriol**: $CuSO_4 \cdot 5H_2O$ (it can be used to relieve mouth ulcers)
- **Green vitriol**: $FeSO_4 \cdot 7H_2O$
- **White vitriol**: $ZnSO_4 \cdot 7H_2O$
- **Mohr's Salt**: $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$
- **Alum**: $KAl(SO_4)_2 \cdot 12H_2O$
- **Epsom salt**: $MgSO_4 \cdot 7H_2O$

Any Base is a Lewis Base and Any Acid is a Lewis Acid



Not every Base is a Brønsted Base and Any Acid is a Brønsted Acid

Conjugate Acid and Conjugate Base



*In acid-base reactions, the **acid** is converted into its **conjugate base**, and the **base** is converted into its **conjugate acid**.*

Brønsted–Lowry Theory

- **Acid:** Substances that donate a proton (H^+).
- **Base:** Substances that accept a proton (H^+).

Conjugate Pairs

- When an acid donates a proton (H^+), the remaining part becomes its conjugate base.
- Similarly, when a base accepts a proton (H^+), it becomes its conjugate acid.

Rule:

- If an acid is strong, its conjugate base will be weak.
- If an acid is weak, its conjugate base will be strong.



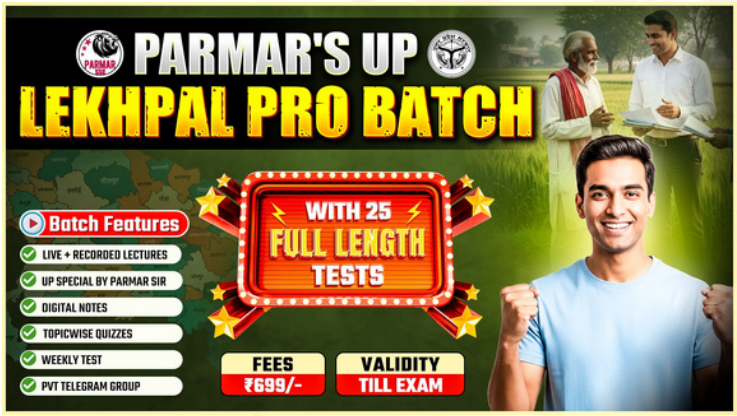


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