

GPAT

2027-28



PHARMACEUTICAL ANALYSIS

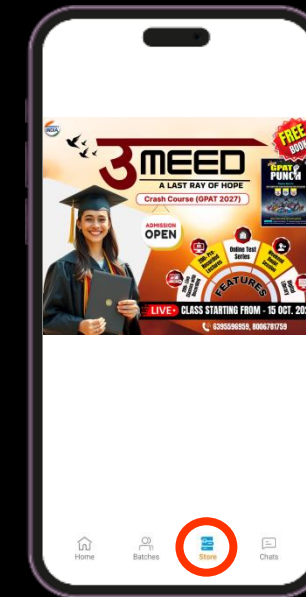
CLASS- 20

ACID-BASE TITRATION

UPDATED QUESTIONS TILL GPAT 2026

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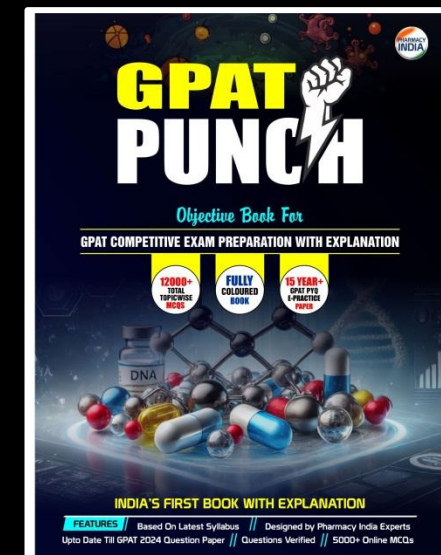


01.

As per Brønsted–Lowry concept, an acid is defined as:

[GPAT-2024]

- (a) Electron pair donor
- (b) Any substance or molecule that can donate a proton
- (c) Electron pair acceptor
- (d) Any substance or molecule that can accept a proton



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01.

As per Brønsted–Lowry concept, an acid is defined as:

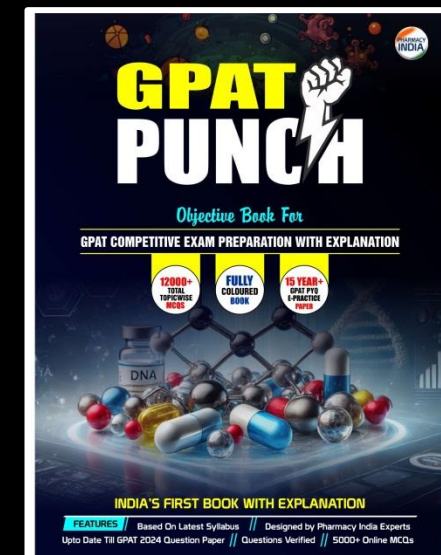
[GPAT-2024]

(a) Electron pair donor

(b) Any substance or molecule that can donate a proton

(c) Electron pair acceptor

(d) Any substance or molecule that can accept a proton



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Explanation:

According to the Brønsted–Lowry theory, an acid is a proton donor. A proton refers to an H^+ ion. When an acid donates H^+ , it forms its conjugate base. A Brønsted–Lowry base, in contrast, accepts a proton. Thus, proton donation is the defining property of a Brønsted–Lowry acid.



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02.

Match the following buffer systems with their appropriate pH ranges:

[GPAT-2022]

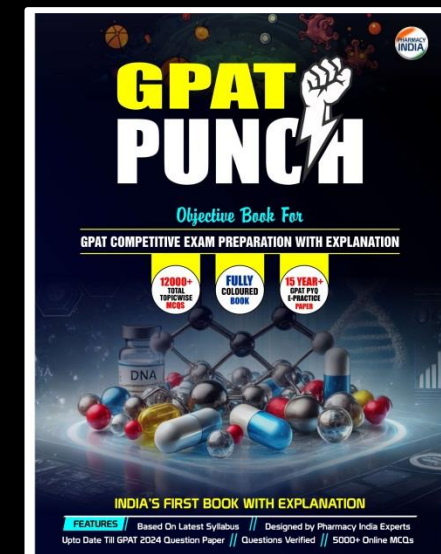
1. HCl and KCl	—	P. 8.0–10.0
2. HCl and potassium hydrogen phthalate	—	Q. 0.2–4.0
3. NaOH and potassium hydrogen phthalate	—	R. 4.2–5.8
4. H_3BO_3 , NaOH and KCl	—	S. 1.2–2.2

(a) 1-S, 2-Q, 3-R, 4-P

(b) 1-Q, 2-S, 3-P, 4-R

(c) 1-R, 2-P, 3-Q, 4-S

(d) 1-P, 2-R, 3-S, 4-Q



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02.

Match the following buffer systems with their appropriate pH ranges:

[GPAT-2022]

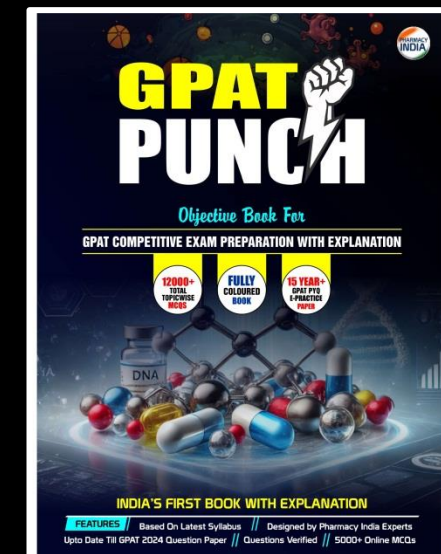
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(a) 1-S, 2-Q, 3-R, 4-P

(b) 1-Q, 2-S, 3-P, 4-R

(c) 1-R, 2-P, 3-Q, 4-S

(d) 1-P, 2-R, 3-S, 4-Q



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Explanation:

HCl and KCl are used for the strongly acidic range of about pH 1.2–2.2. HCl with potassium hydrogen phthalate covers approximately pH 0.2–4.0. NaOH with potassium hydrogen phthalate is useful around pH 4.2–5.8. Boric acid, NaOH and KCl provide an alkaline buffer system around pH 8–10. Different buffer combinations are therefore selected according to the required pH range.



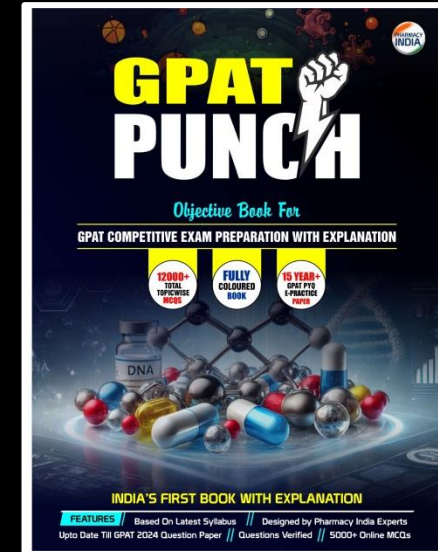
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03. In a universal indicator, a pH of 7 is shown by which colour? [GPAT-2018]

- (a) Yellow
- (b) Green
- (c) Blue
- (d) Pink



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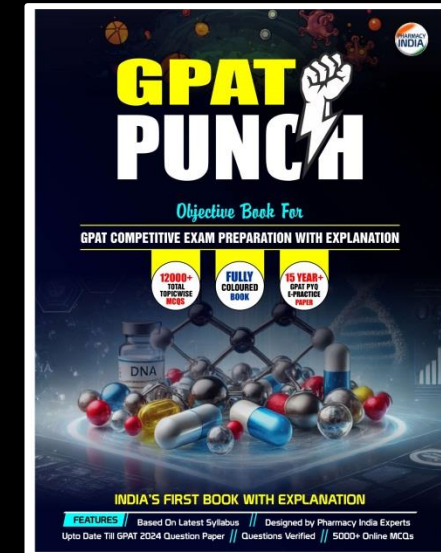
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(a) Yellow

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(c) Blue

(d) Pink



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Explanation:

A solution having pH 7 is considered neutral at ordinary conditions. Universal indicator shows a characteristic green colour at neutrality. Acidic solutions produce colours ranging from red to yellow. Alkaline solutions generally produce blue to violet colours. Therefore, green indicates a pH around 7.



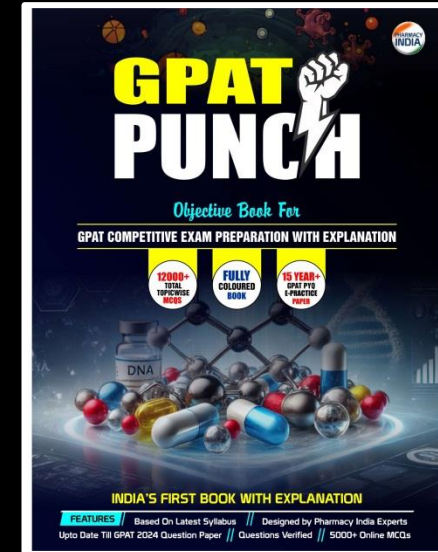
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04. What is the colour of methyl orange in an acidic medium?

- (a) Red
- (b) Orange
- (c) Yellow
- (d) Blue



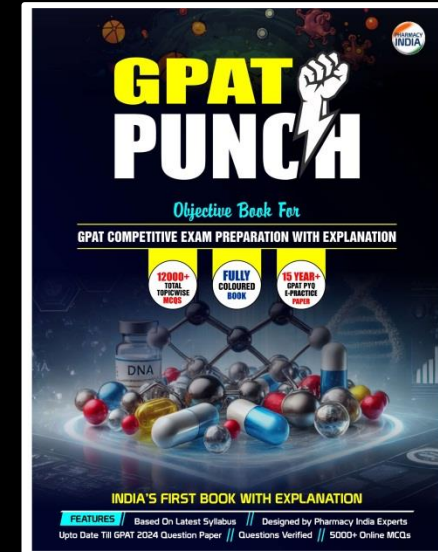
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- (a) Red
- (b) Orange
- (c) Yellow
- (d) Blue



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Explanation:

Methyl orange is an acid–base indicator commonly used in acidic endpoint titrations. In strongly acidic solution, its protonated form is red. During its transition range, the colour appears orange. In alkaline solution, its colour becomes yellow.



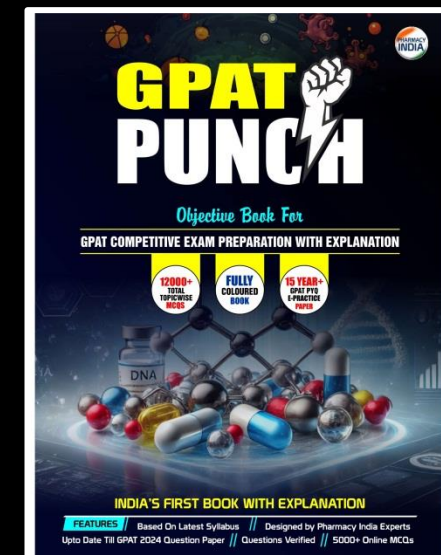
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05.

Why does the titration of boric acid become possible after addition of glycerol? [GPAT-2011]

- (a) Boric acid is converted into boronic acid
- (b) A stronger monoprotic complex containing tetracoordinate boron is formed
- (c) Boric acid becomes a tribasic acid
- (d) Two boric acid molecules form an anhydride



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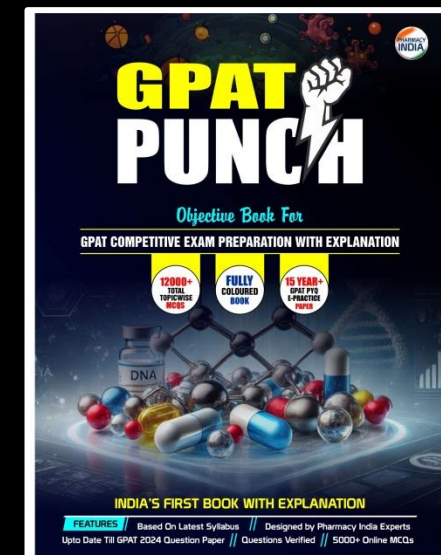
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Explanation:

Boric acid is a very weak acid and cannot be titrated sharply with NaOH using phenolphthalein alone. Glycerol interacts with boric acid through its neighbouring hydroxyl groups. This produces a cyclic borate complex containing tetracoordinate boron. The complex behaves as a stronger monoprotic acid than boric acid itself.



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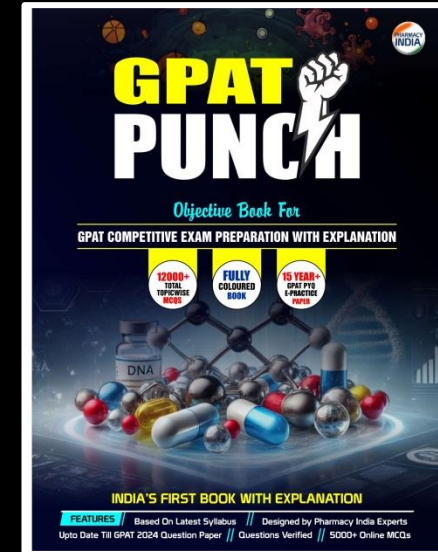
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06.

In the identification test for chlorambucil, addition of potassium mercuric iodide solution produces:

[GPAT-2007]

- (a) Yellow coloured precipitate
- (b) Yellow coloured solution
- (c) Buff coloured precipitate
- (d) Red coloured precipitate



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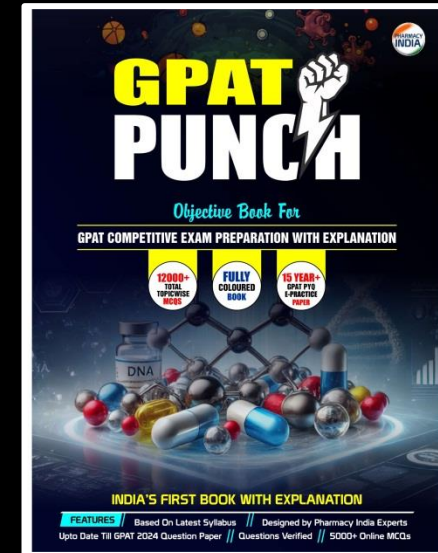
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[GPAT-2007]

- (a) Yellow coloured precipitate
- (b) Yellow coloured solution
- (c) Buff coloured precipitate
- (d) Red coloured precipitate



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Explanation:

Chlorambucil contains a basic nitrogen-containing group that can react with potassium mercuric iodide reagent. Potassium mercuric iodide is commonly known as Mayer's reagent. The reaction produces a characteristic buff or cream-coloured precipitate. Formation of the precipitate is used as an identification response.



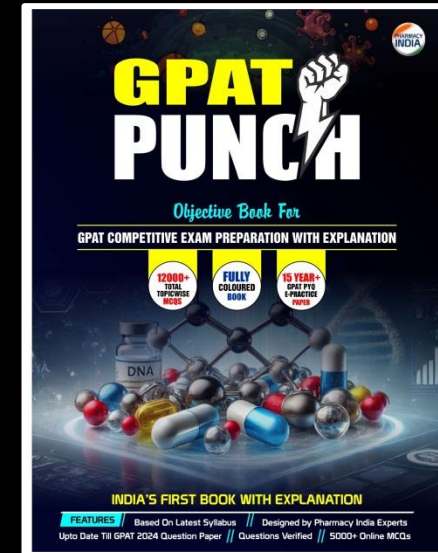
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07. Chlorambucil is assayed by titrating its dilute acetone solution with: [GPAT-2007]

- (a) 0.1 M sodium hydroxide
- (b) 0.1 M hydrochloric acid
- (c) 0.2 M perchloric acid
- (d) 0.1 M silver nitrate



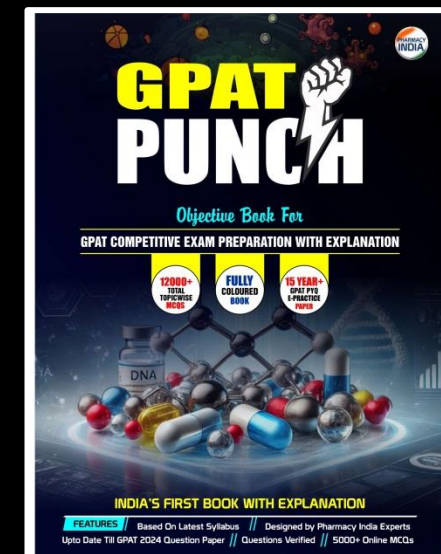
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- (c) 0.2 M perchloric acid
- (d) 0.1 M silver nitrate



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Explanation:

Chlorambucil contains a carboxylic acid functional group capable of neutralization with alkali. The drug is dissolved in a suitable acetone-containing medium for the assay. A standardized sodium hydroxide solution is used as the titrant. The amount of alkali consumed corresponds to the acidic functionality of chlorambucil.



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08.

Match the indicators with their characteristic transition ranges:

[GATE-1988]

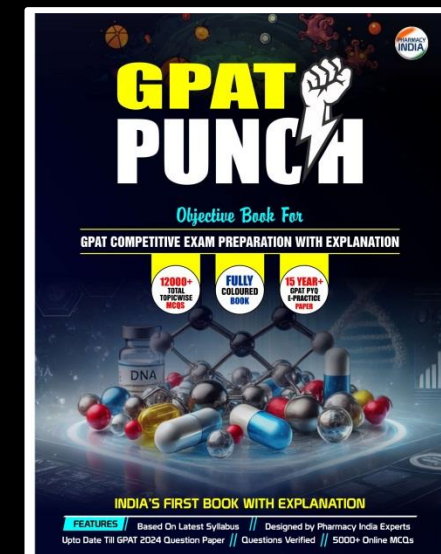
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|---------------------|---|-------------|
| 1. Methyl red | — | P. 1.2–2.8 |
| 2. Bromothymol blue | — | Q. 4.2–6.3 |
| 3. Phenolphthalein | — | R. 8.2–10.0 |
| 4. Thymol blue | — | S. 6.0–7.6 |

(a) 1-Q, 2-S, 3-R, 4-P

(b) 1-P, 2-Q, 3-S, 4-R

(c) 1-S, 2-R, 3-P, 4-Q

(d) 1-R, 2-P, 3-Q, 4-S



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08.

Match the indicators with their characteristic transition ranges:

[GATE-1988]

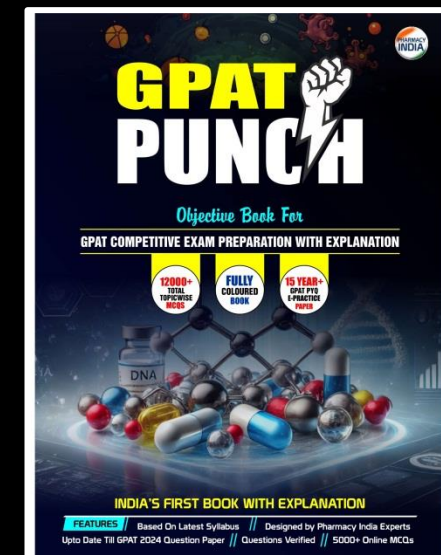
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(a) 1-Q, 2-S, 3-R, 4-P

(b) 1-P, 2-Q, 3-S, 4-R

(c) 1-S, 2-R, 3-P, 4-Q

(d) 1-R, 2-P, 3-Q, 4-S



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Explanation:

Methyl red changes colour in the mildly acidic region around pH 4.2–6.3. Bromothymol blue has a transition range around pH 6.0–7.6. Phenolphthalein changes in the alkaline range around pH 8.2–10.0. The first transition range of thymol blue lies around pH 1.2–2.8. Indicator selection depends on matching its transition interval with the titration pH change.



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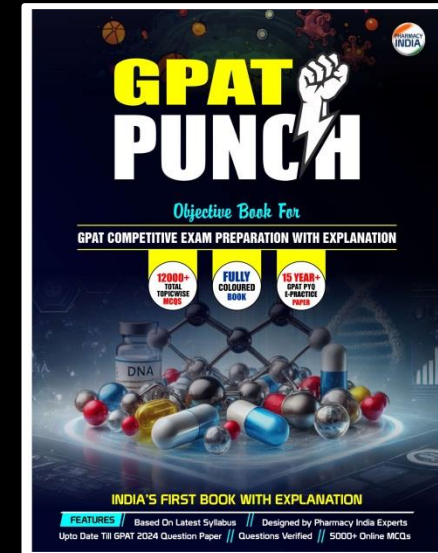


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09.

Which indicator is most suitable for titration of a weak acid with a strong base?

- (a) Bromothymol blue
- (b) Methyl orange
- (c) Methyl red
- (d) Phenolphthalein



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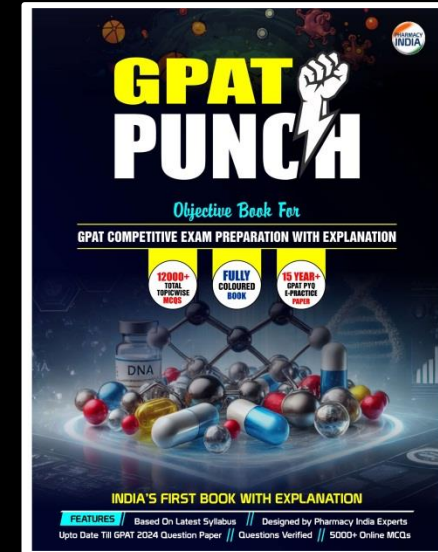


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- (c) Methyl red
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Explanation:

A weak acid–strong base titration has an equivalence point in the alkaline region. Phenolphthalein changes colour over an alkaline pH range. Its transition therefore occurs within the steep part of the titration curve. Methyl orange changes at an excessively acidic pH for this titration.



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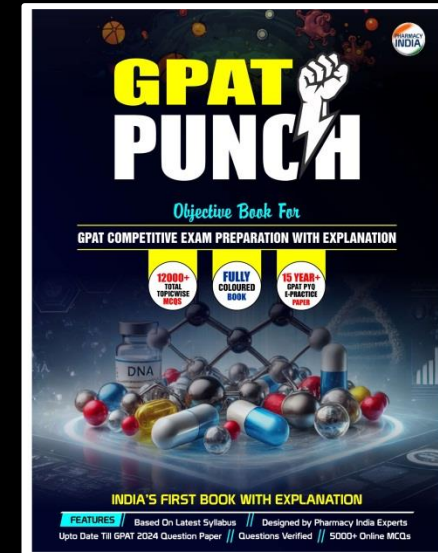


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10.

The ideal indicator for titration of a strong acid with a weak base should have a pH transition range approximately between:

- (a) 5–8
- (b) 4–6
- (c) 8–10
- (d) 7–8



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10.

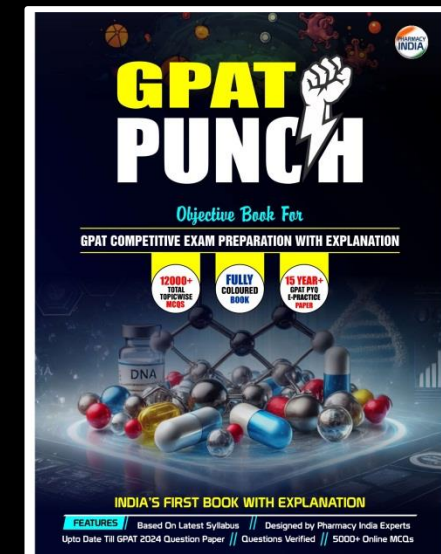
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(d) 7–8



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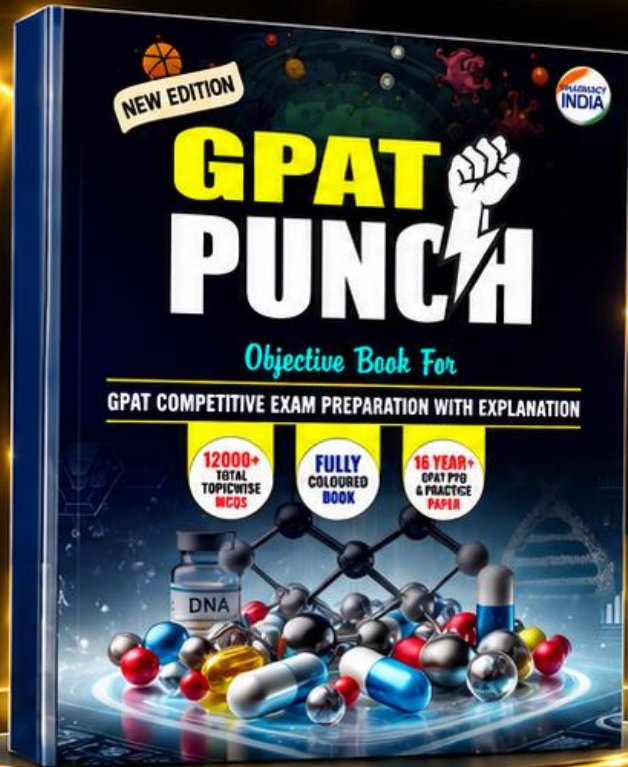
Explanation:

The equivalence point of a strong acid–weak base titration lies below pH 7. This is because the conjugate acid of the weak base undergoes hydrolysis. An indicator changing colour in the acidic region is therefore required. A transition interval around pH 4–6 is appropriate for such titrations. Indicators such as methyl red are useful in this region.

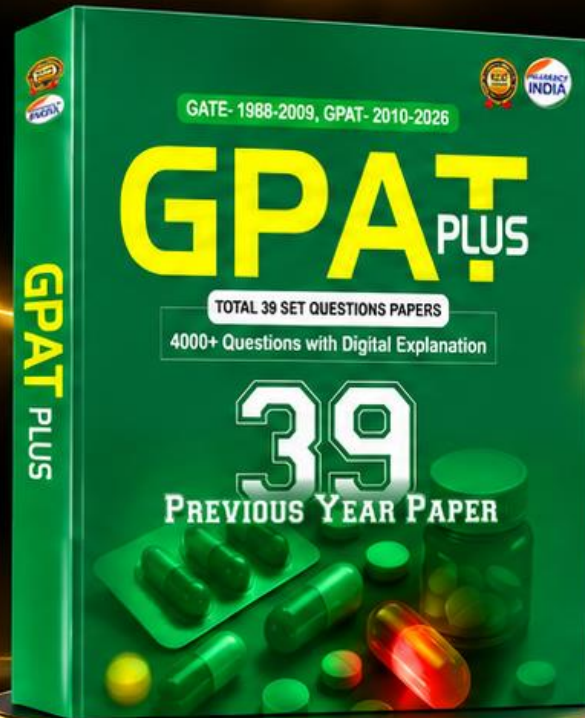


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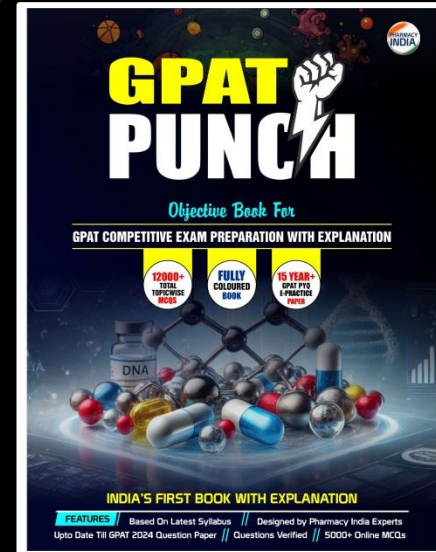


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11.

If 10 mL of 0.5 M $\text{Ca}(\text{OH})_2$ is required to titrate 50 mL of HCl, what is the molarity of HCl?

- (a) 5 M
- (b) 0.1 M
- (c) 10 M
- (d) 0.2 M



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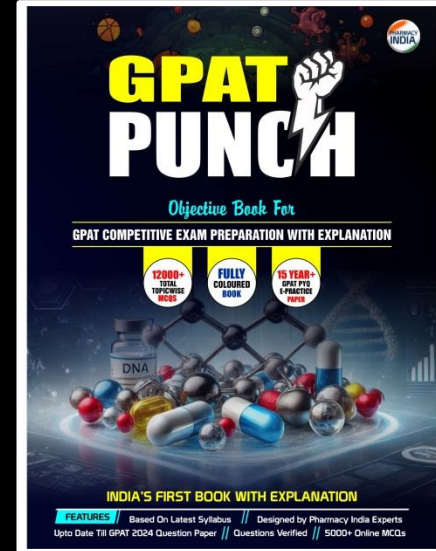


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Explanation:

The reaction is $\text{Ca(OH)}_2 + 2\text{HCl} \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O}$. Thus, one mole of Ca(OH)_2 neutralizes two moles of HCl . The moles of Ca(OH)_2 used are $0.5 \times 0.010 = 0.005$ mol. Therefore, HCl consumed is 0.010 mol in 0.050 L. The molarity of HCl is consequently $0.010/0.050 = 0.2$ M.



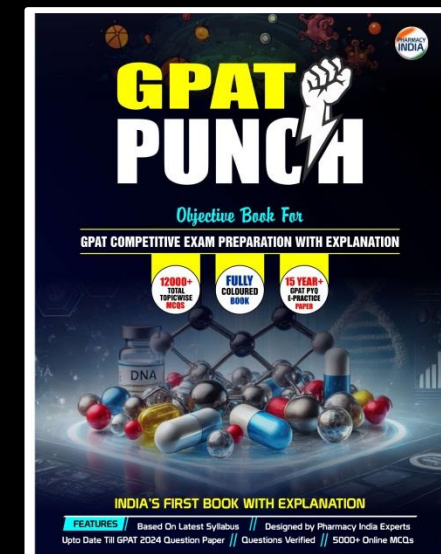
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12.

Which of the following is a buffer solution?



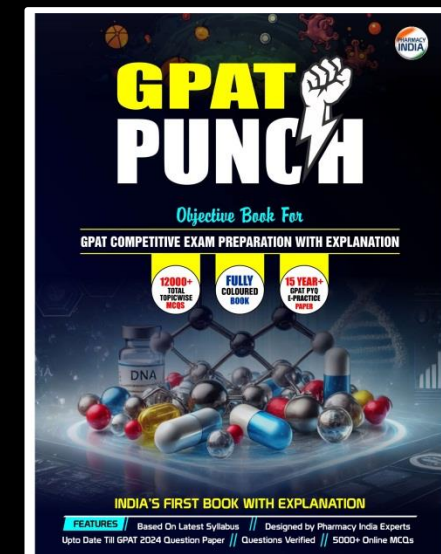
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12.

Which of the following is a buffer solution?



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Explanation:

An acidic buffer generally contains a weak acid and a salt of that acid with a strong base. Acetic acid is a weak acid. Sodium acetate provides its conjugate base, the acetate ion. Together they resist changes in pH when small quantities of acid or base are added. Therefore, CH_3COOH and CH_3COONa form a typical acidic buffer.



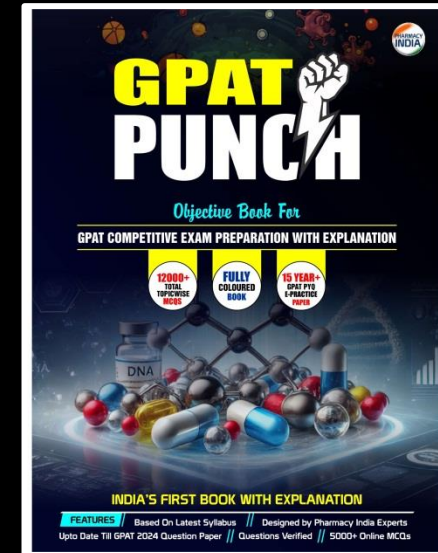
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13. If 30 mL of an acid is neutralized by 15 mL of 0.2 N alkali, what is the normality of the acid?

- (a) 0.4 N
- (b) 0.1 N
- (c) 0.3 N
- (d) 0.15 N



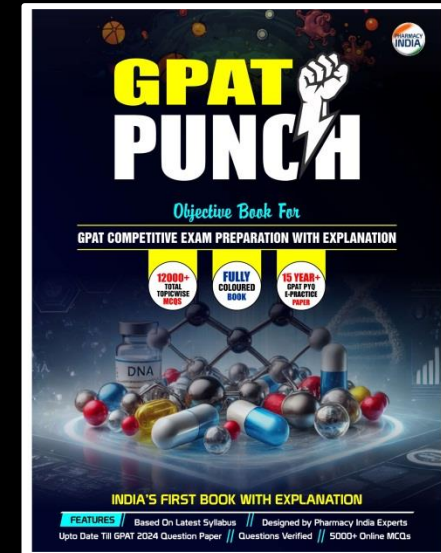
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- (b) 0.1 N
- (c) 0.3 N
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Explanation:

At the equivalence point, acid equivalents are equal to base equivalents. Therefore, $N_1V_1 = N_2V_2$ can be applied. The acid normality is calculated as $(0.2 \times 15)/30$. This gives a value of 0.1 N.



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14.

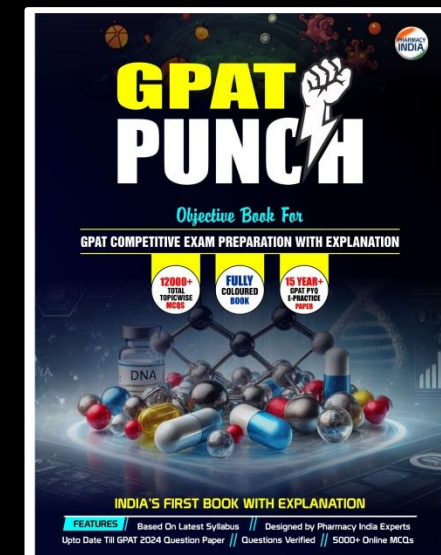
What is the molarity of H_2SO_4 if 100 mL of the solution is neutralized by 50 mL of 0.5 M $\text{Ba}(\text{OH})_2$?

(a) 0.25 M

(b) 50 M

(c) 0.5 M

(d) 100 M



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14.

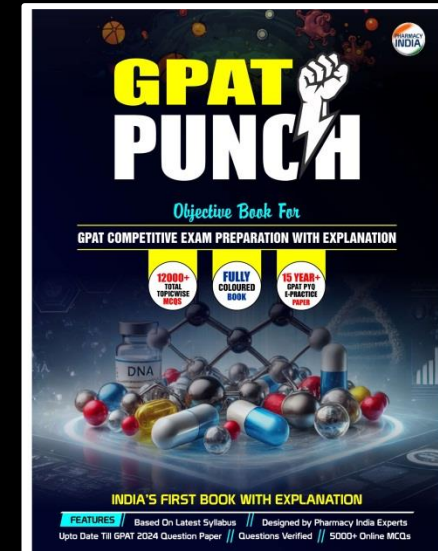
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(a) 0.25 M

(b) 50 M

(c) 0.5 M

(d) 100 M



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Explanation:

H_2SO_4 reacts with $\text{Ba}(\text{OH})_2$ in a 1:1 molar ratio. The moles of $\text{Ba}(\text{OH})_2$ used are $0.5 \times 0.050 = 0.025$ mol. Therefore, the 100 mL H_2SO_4 sample contains 0.025 mol of H_2SO_4 . Molarity is obtained by dividing 0.025 mol by 0.100 L.



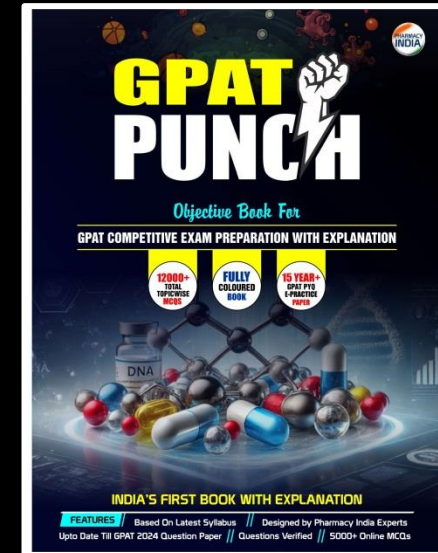
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15. What is the equivalent weight of H_2SO_4 with molar mass 98 g/mol in an acid–base reaction?

- (a) 196 g/equiv
- (b) 100 g/equiv
- (c) 49 g/equiv
- (d) 24.5 g/equiv



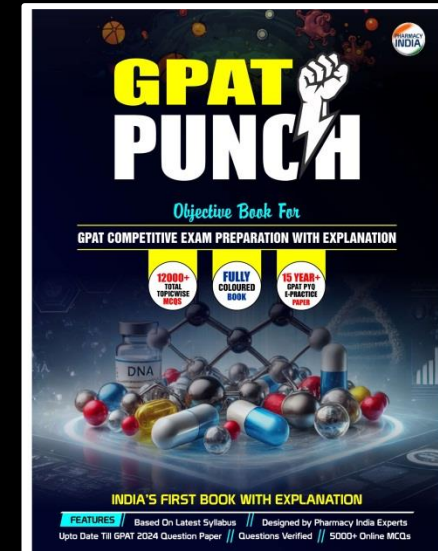
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- (b) 100 g/equiv
- (c) 49 g/equiv
- (d) 24.5 g/equiv



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Explanation:

Equivalent weight is calculated by dividing molar mass by the n-factor. Sulphuric acid contains two replaceable acidic hydrogen ions in complete neutralization. Its n-factor in an acid–base reaction is therefore 2. Dividing 98 by 2 gives 49 g/equiv.



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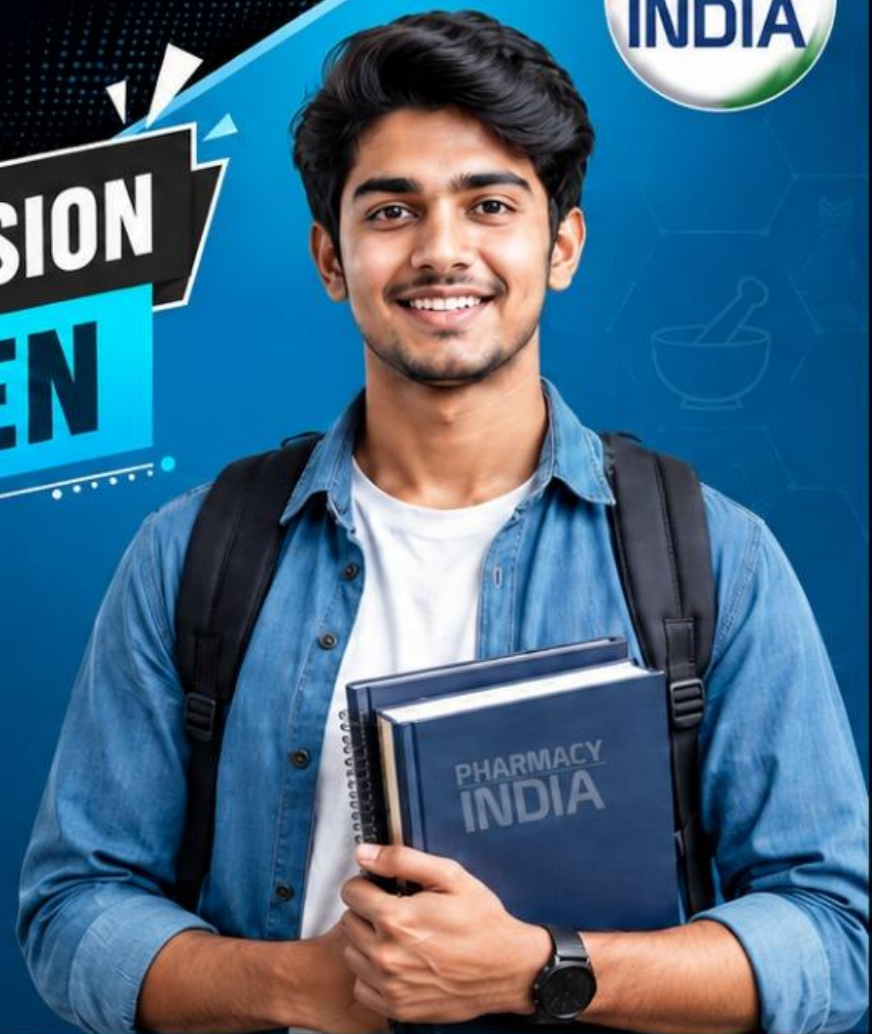
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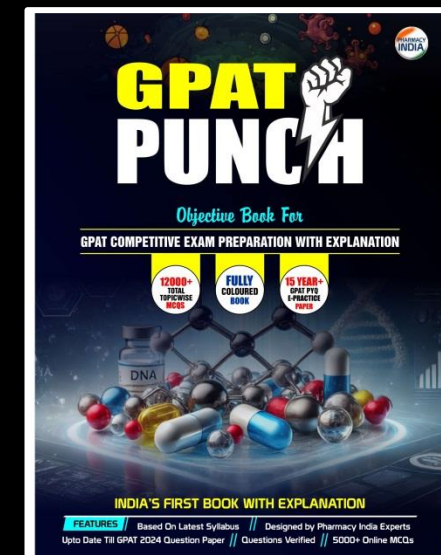
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16. Acid–base catalysis involves:

- (a) Transfer of electrons between reactants
- (b) Donation or acceptance of protons by the catalyst
- (c) Use of metal ions as catalysts
- (d) Formation of a covalent bond with the substrate only



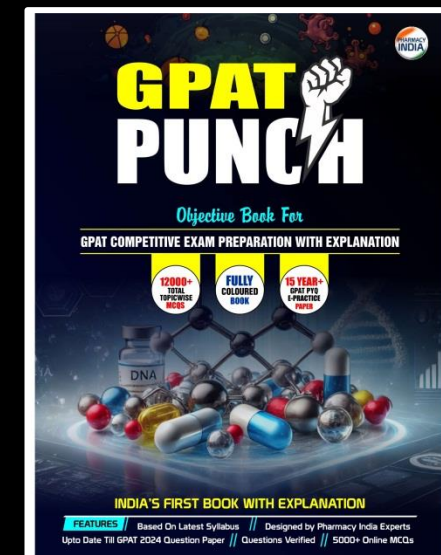
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16. Acid–base catalysis involves:

- (a) Transfer of electrons between reactants
- (b) Donation or acceptance of protons by the catalyst**
- (c) Use of metal ions as catalysts
- (d) Formation of a covalent bond with the substrate only



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Explanation:

Acid–base catalysis involves participation of an acidic or basic species in proton transfer. An acid catalyst donates a proton during the reaction mechanism. A base catalyst accepts a proton from the reacting species. This proton transfer can lower the activation energy of the reaction.



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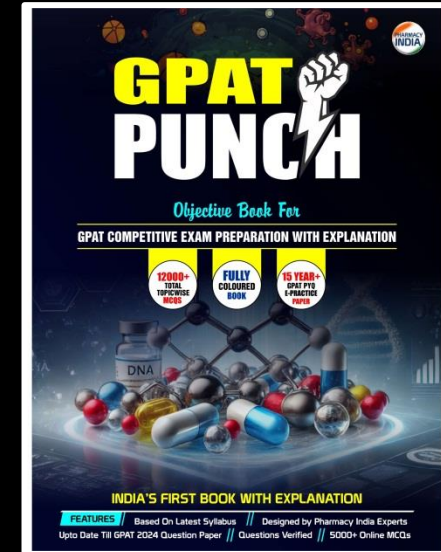


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17.

Boric acid is officially assayed primarily by:

- (a) Titrimetry
- (b) Gravimetry
- (c) Voltammetry
- (d) Coulometry



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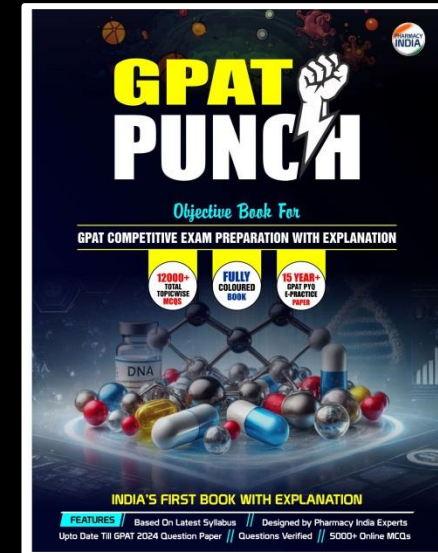


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17.

Boric acid is officially assayed primarily by:

- (a) Titrimetry
- (b) Gravimetry
- (c) Voltammetry
- (d) Coulometry



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Explanation:

Boric acid can be determined quantitatively by an acid–base titrimetric procedure. Its weak acidic character is enhanced by adding a polyhydric alcohol such as glycerol. The resulting complex can be titrated with standardized sodium hydroxide. Phenolphthalein is commonly used to detect the endpoint. Therefore, the official assay is based on titrimetry.



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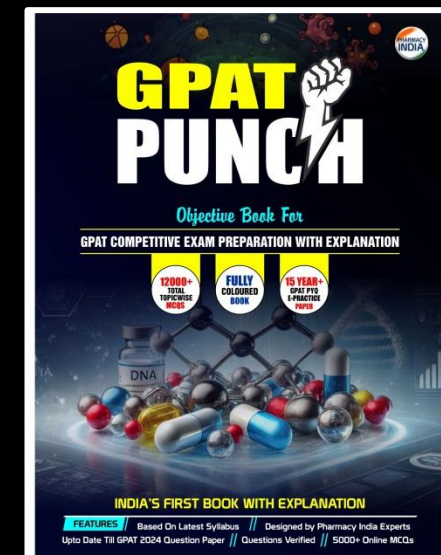


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18.

Which indicator that turns pink in alkaline solution can be used in a strong acid–strong base titration?

- (a) Methyl orange
- (b) Phenolphthalein
- (c) Bromothymol blue
- (d) Thymol blue



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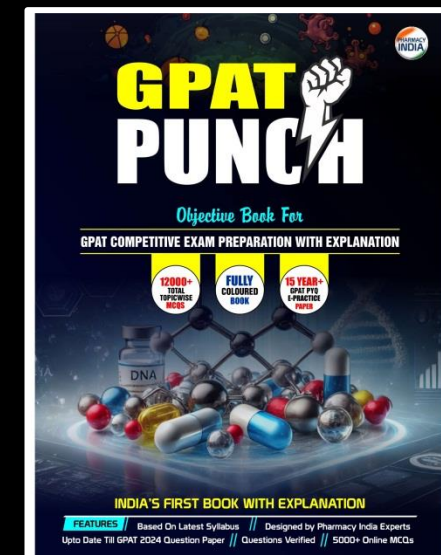


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- (a) Methyl orange
- (b) Phenolphthalein
- (c) Bromothymol blue
- (d) Thymol blue



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Explanation:

Phenolphthalein is colourless in acidic solution and becomes pink in alkaline solution. Strong acid–strong base titrations exhibit a very steep pH change near the equivalence point. The phenolphthalein transition range falls within this sharp pH change. Consequently, it can give a clear endpoint in such a titration. Its appearance of a faint persistent pink colour indicates slight excess alkali.



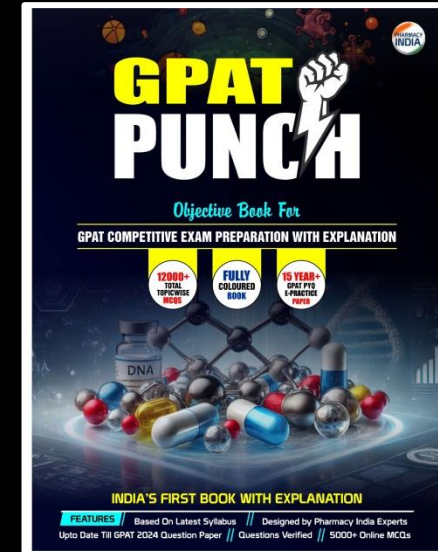
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19. What is the colour of phenolphthalein at pH 11.7?

- (a) Pink
- (b) Blue
- (c) Yellow
- (d) Colourless



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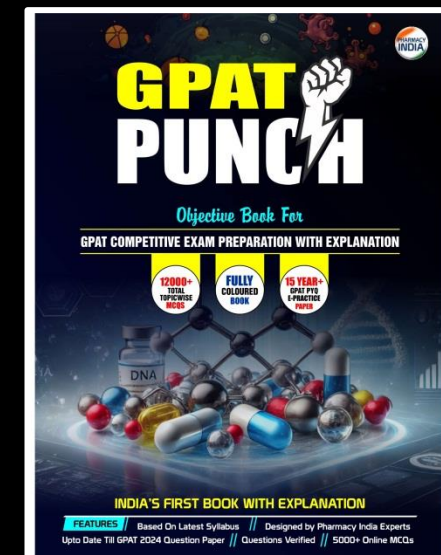


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19.

What is the colour of phenolphthalein at pH 11.7?

- (a) Pink
- (b) Blue
- (c) Yellow
- (d) Colourless



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Explanation:

Phenolphthalein changes from colourless to pink as the solution becomes alkaline. Its normal transition occurs approximately between pH 8.2 and 10.0. A solution of pH 11.7 is strongly alkaline relative to this transition range. The indicator is therefore predominantly in its coloured form.



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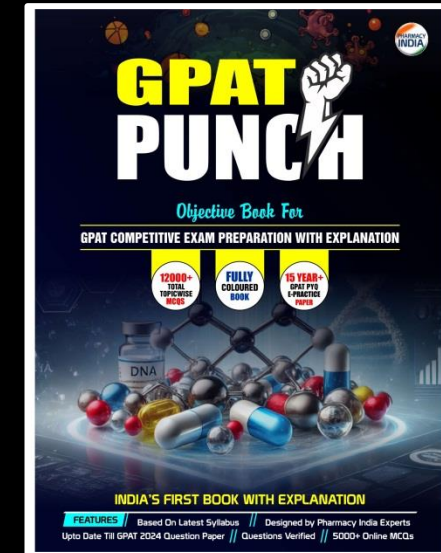


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20.

Which indicator has a pH transition range of approximately 6.8–8.4?

- (a) Bromocresol green
- (b) Methyl orange
- (c) Phenol red
- (d) Methyl red



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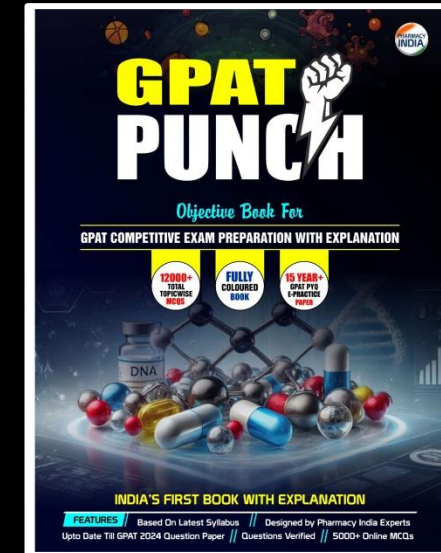


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- (a) Bromocresol green
- (b) Methyl orange
- (c) Phenol red
- (d) Methyl red



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Explanation:

Phenol red is an acid–base indicator with a transition range near neutrality. Its colour transition occurs approximately from pH 6.8 to 8.4. It changes from yellow on the acidic side toward red in alkaline conditions. This range makes it useful for detecting pH changes close to neutral conditions.



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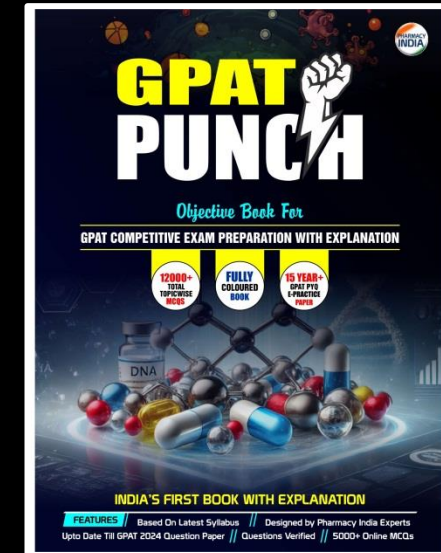


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21.

Which of the following is an example of an azo indicator?

- (a) Phenol red
- (b) Phenolphthalein
- (c) Methyl red
- (d) Ferroin



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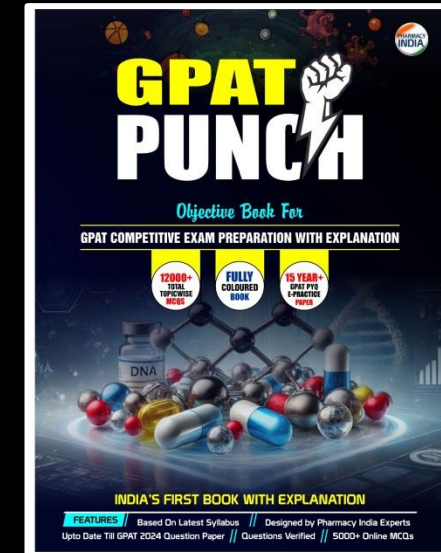


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- (a) Phenol red
- (b) Phenolphthalein
- (c) Methyl red
- (d) Ferroin



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Explanation:

Methyl red is a synthetic acid–base indicator containing an azo linkage. The azo group is represented by the –N=N– functional group. Changes in protonation alter its electronic structure and consequently its colour. Phenolphthalein belongs to a different chemical class of indicators.



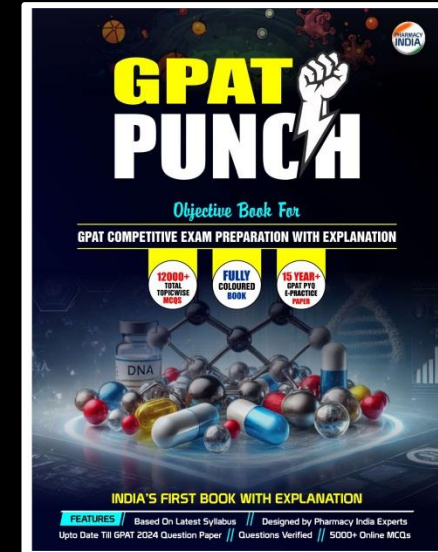
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22. In the assay of boric acid, glycerol is added mainly to:

- (a) Dissolve boric acid
- (b) Increase basicity
- (c) Increase apparent acidity
- (d) Decrease acidity



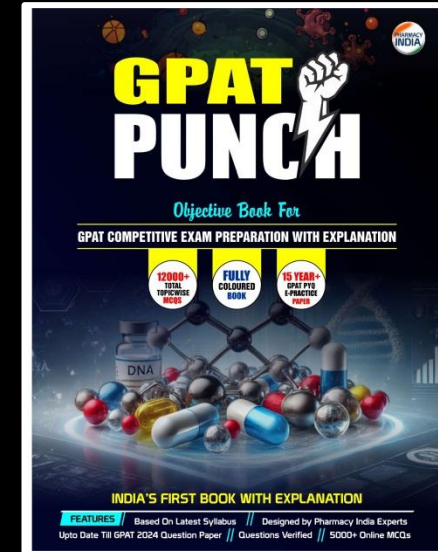
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- (a) Dissolve boric acid
- (b) Increase basicity
- (c) Increase apparent acidity**
- (d) Decrease acidity



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Explanation:

Boric acid itself is too weak to give a satisfactory direct phenolphthalein endpoint. Glycerol forms a complex with boric acid through its hydroxyl groups. Formation of this complex enhances the acidic behaviour of the system. The resulting acid can then be neutralized more sharply with sodium hydroxide.



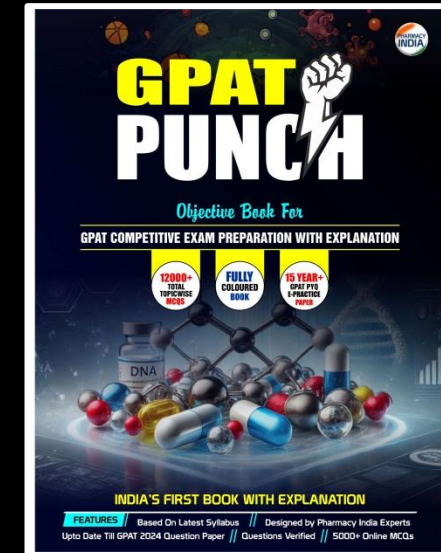
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23. Which indicator is commonly used during the titrimetric assay of boric acid in the presence of glycerol?

- (a) Phenolphthalein
- (b) Solochrome
- (c) Methyl orange
- (d) Alizarin red



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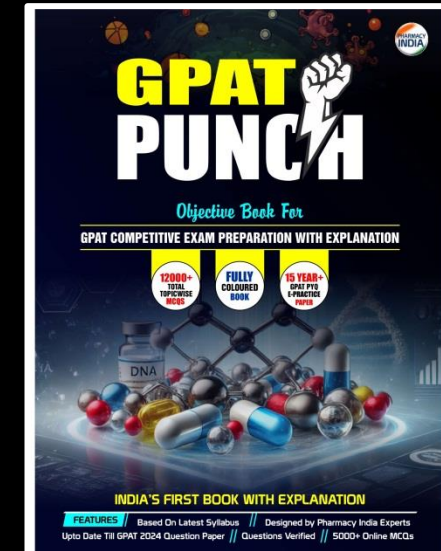
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(a) Phenolphthalein

(b) Solochrome

(c) Methyl orange

(d) Alizarin red



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Explanation:

Addition of glycerol converts boric acid into a more strongly acidic complex. This complex can be titrated with standardized sodium hydroxide solution. The endpoint occurs in a region suitable for phenolphthalein. Phenolphthalein changes from colourless to a faint pink at the endpoint.



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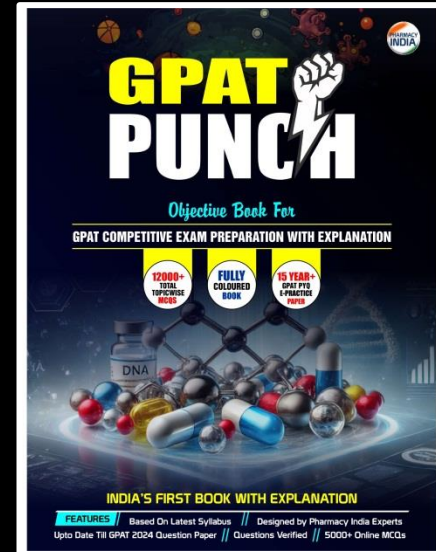


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24.

Which of the following is an example of a pM indicator?

- (a) Methyl orange
- (b) Phenolphthalein
- (c) Phenol red
- (d) Murexide



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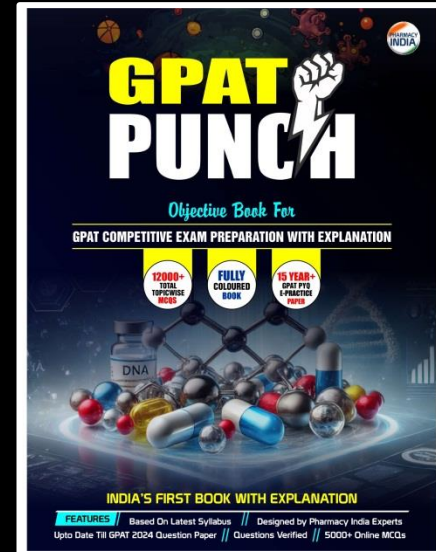


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- (a) Methyl orange
- (b) Phenolphthalein
- (c) Phenol red
- (d) Murexide



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Explanation:

A pM indicator responds to changes in the concentration of free metal ions. Such indicators are mainly used in complexometric titrations. Murexide forms differently coloured complexes with certain metal ions. Its colour changes as the concentration of uncomplexed metal ion changes near the endpoint.



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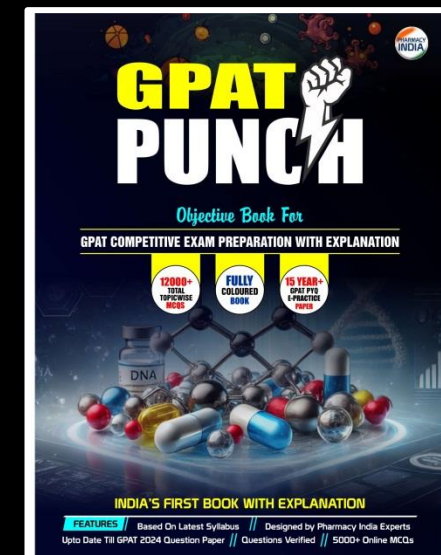


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25.

Which indicator is suitable for complete titration of sodium carbonate against a strong acid?

- (a) Methyl red
- (b) Methyl orange
- (c) Phenolphthalein
- (d) Gelatin solution



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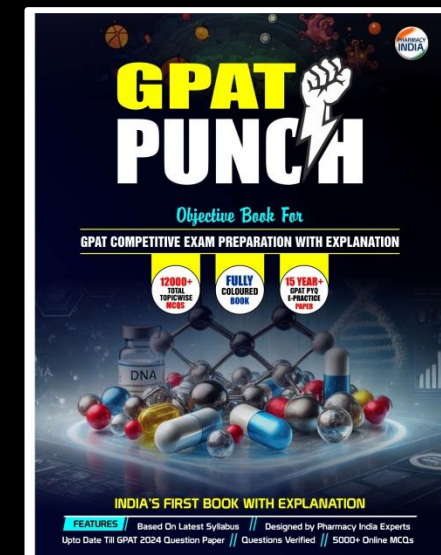


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- (a) Methyl red
- (b) Methyl orange
- (c) Phenolphthalein
- (d) Gelatin solution



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Explanation:

Sodium carbonate is neutralized by strong acid in two stages. The first stage converts carbonate into bicarbonate. Further addition of acid converts bicarbonate into carbonic acid, which forms carbon dioxide and water. The final equivalence point lies in the acidic region.



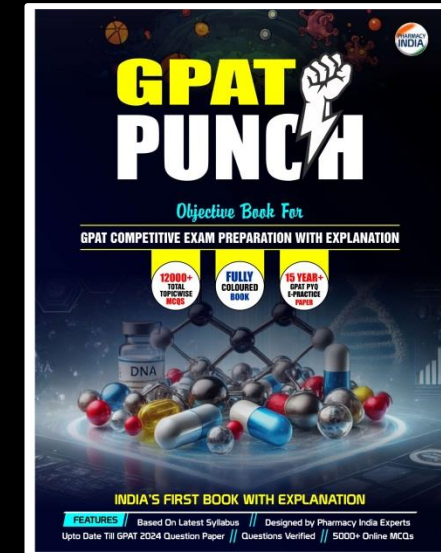
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26. Sodium methoxide is standardized using which substance?

- (a) Oxalic acid
- (b) Perchloric acid
- (c) Acetic acid
- (d) Benzoic acid



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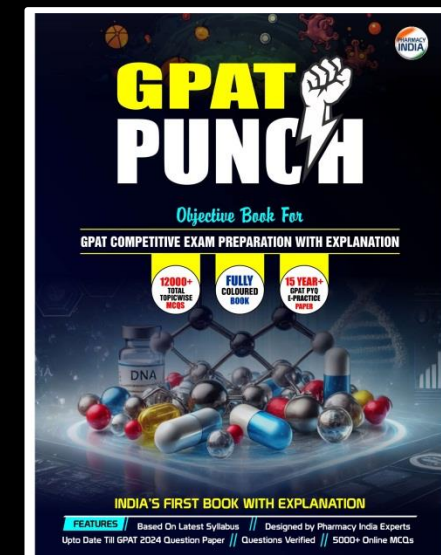


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Sodium methoxide is standardized using which substance?

- (a) Oxalic acid
- (b) Perchloric acid
- (c) Acetic acid
- (d) Benzoic acid**



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Explanation:

Sodium methoxide is a strong basic titrant commonly used in nonaqueous acid–base titration. Its exact strength must be determined before analytical use. Benzoic acid is a suitable acidic standard for standardizing sodium methoxide. A known amount of benzoic acid is titrated with the sodium methoxide solution. The titre obtained is then used to calculate the exact concentration of the titrant.



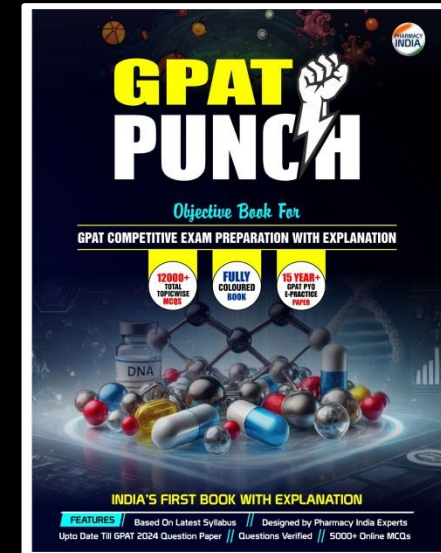
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27. What colour does phenolphthalein show in 0.01 N NaOH solution?

- (a) Pink
- (b) Orange
- (c) Colourless
- (d) Red



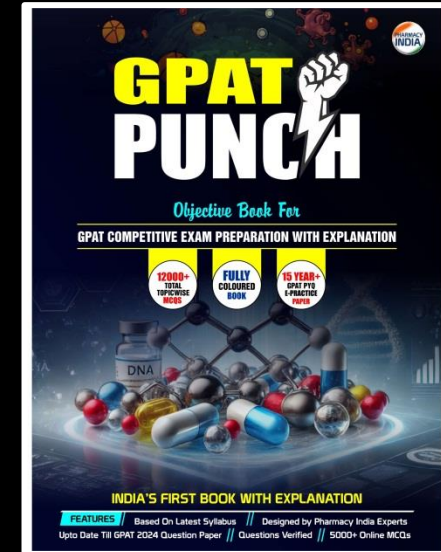
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- (a) Pink
- (b) Orange
- (c) Colourless
- (d) Red



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Explanation:

Sodium hydroxide is a strong base and produces a highly alkaline solution. Phenolphthalein is colourless in acidic and near-neutral solutions. Above its transition range, the deprotonated coloured form predominates. A 0.01 N NaOH solution is sufficiently alkaline to produce this form.



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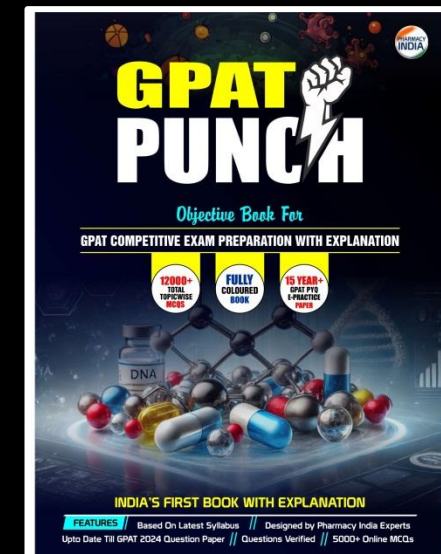


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28.

The pH transition range of methyl orange is approximately:

- (a) 8.3–10.0
- (b) 1.2–2.9
- (c) 2.8–4.9
- (d) 6.8–8.4



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28.

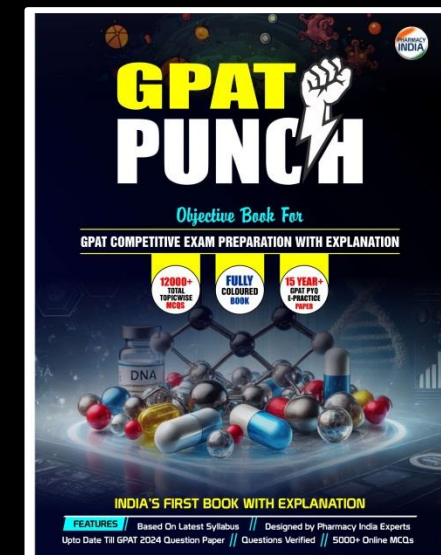
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(a) 8.3–10.0

(b) 1.2–2.9

(c) 2.8–4.9

(d) 6.8–8.4



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Explanation:

Methyl orange is an indicator that changes colour in the acidic pH region. Its acidic form is red, while its alkaline form is yellow. The visible colour transition takes place over a relatively low pH interval. This property makes methyl orange suitable for titrations with acidic equivalence points. Among the given ranges, 2.8–4.9 represents its indicated transition interval.



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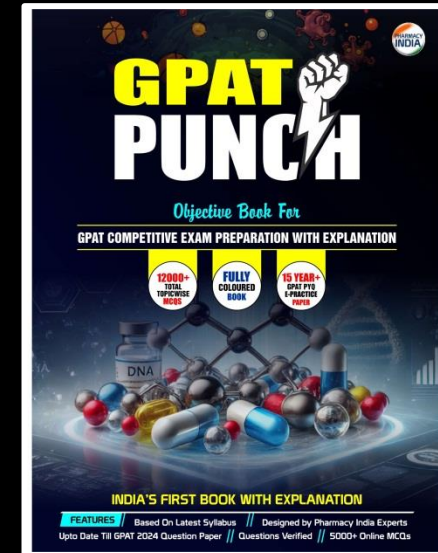


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29.

Which buffer mixture is associated with an alkaline pH range of approximately 8.0–10.0?

- (a) HCl and KCl
- (b) HCl and potassium hydrogen phthalate
- (c) NaOH and potassium hydrogen phthalate
- (d) H_3BO_3 , NaOH and KCl



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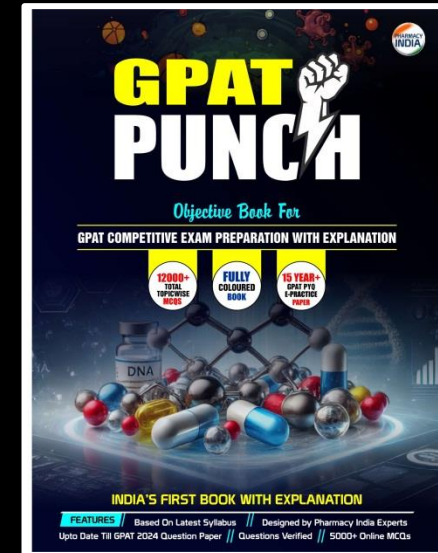


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- (b) HCl and potassium hydrogen phthalate
- (c) NaOH and potassium hydrogen phthalate
- (d) H_3BO_3 , NaOH and KCl



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Explanation:

Boric acid combined with sodium hydroxide forms a borate buffer system. Potassium chloride is included to maintain appropriate ionic conditions in the standard mixture. This system operates in the alkaline pH region. Its useful range extends approximately from pH 8 to 10.



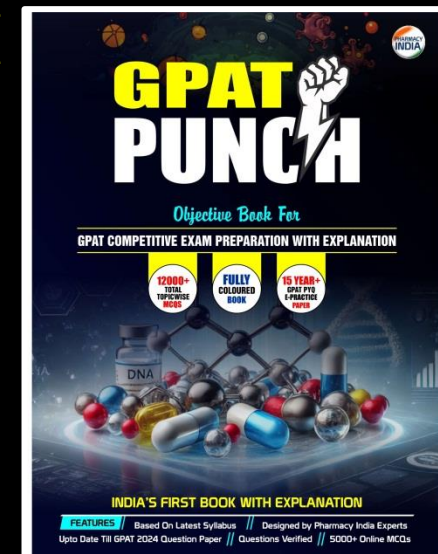
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30.

Which mixture is associated with the strongly acidic pH range of approximately 1.2–2.2?

- (a) HCl and KCl
- (b) H_3BO_3 and NaOH
- (c) NaOH and potassium hydrogen phthalate
- (d) CH_3COOH and CH_3COONa



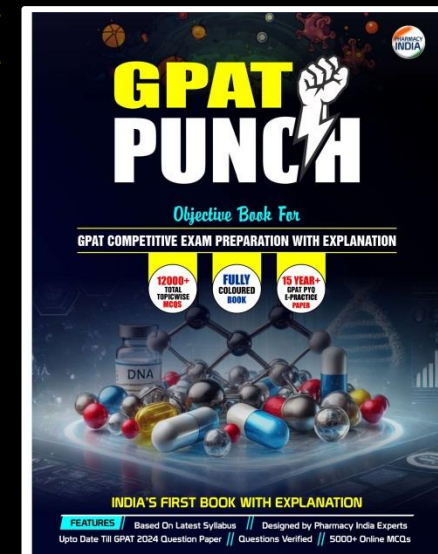
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- (a) HCl and KCl
- (b) H_3BO_3 and NaOH
- (c) NaOH and potassium hydrogen phthalate
- (d) CH_3COOH and CH_3COONa



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Explanation:

HCl provides the hydrogen ions necessary for a strongly acidic standard solution. KCl contributes ionic strength without acting as a weak-acid buffer component. The combination is used for preparing solutions in a low pH range. The indicated working interval is approximately pH 1.2–2.2.



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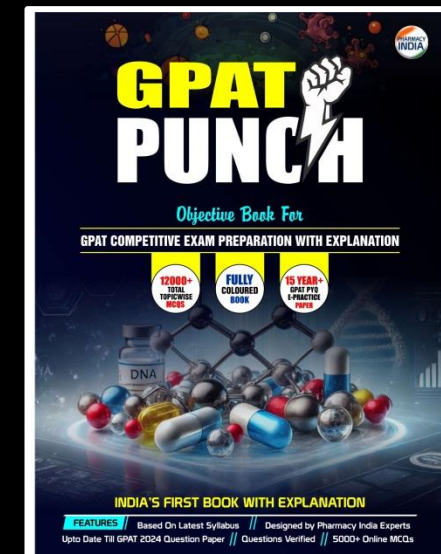


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31.

HCl and potassium hydrogen phthalate are used for a pH range of approximately:

- (a) 8.0–10.0
- (b) 0.2–4.0
- (c) 6.0–7.6
- (d) 4.2–5.8



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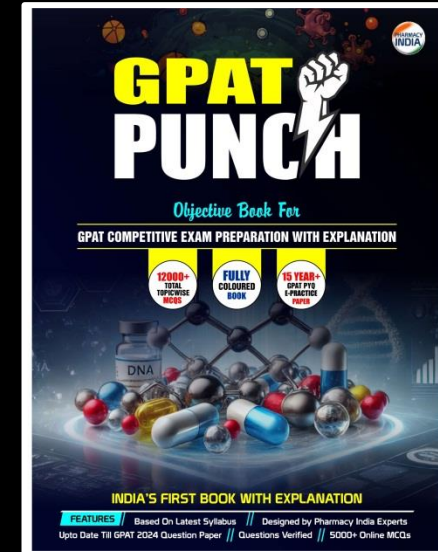
31. HCl and potassium hydrogen phthalate are used for a pH range of approximately:

(a) 8.0–10.0

(b) 0.2–4.0

(c) 6.0–7.6

(d) 4.2–5.8



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Explanation:

Potassium hydrogen phthalate is frequently used in standard pH and buffer preparations. In combination with hydrochloric acid, it provides solutions in the acidic region. Variation in the proportions allows preparation over a relatively broad low-pH interval. The stated system covers approximately pH 0.2–4.0.



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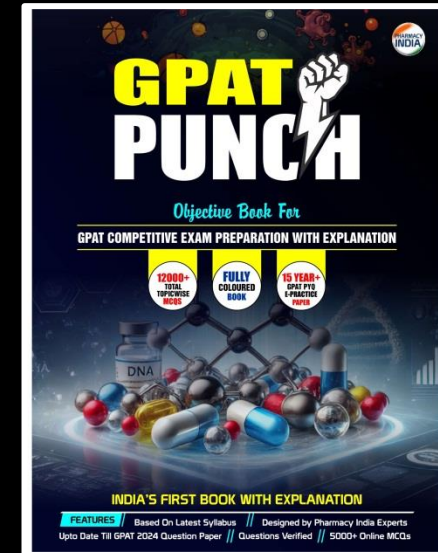


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32.

NaOH and potassium hydrogen phthalate are associated with which approximate pH range?

- (a) 1.2–2.2
- (b) 8.0–10.0
- (c) 4.2–5.8
- (d) 10.0–12.0



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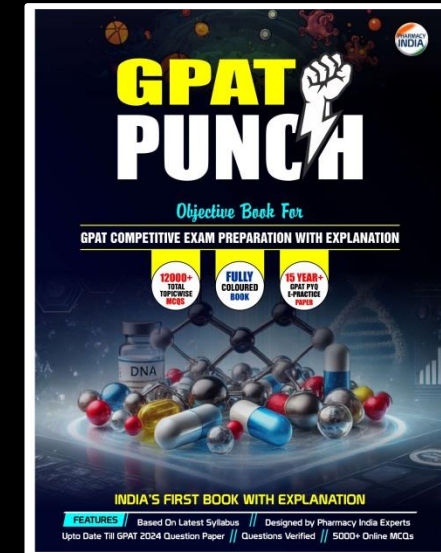


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32.

NaOH and potassium hydrogen phthalate are associated with which approximate pH range?

- (a) 1.2–2.2
- (b) 8.0–10.0
- (c) 4.2–5.8**
- (d) 10.0–12.0



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Explanation:

Potassium hydrogen phthalate can react partially with sodium hydroxide to generate an appropriate acid–base pair. The resulting system provides buffering in a moderately acidic region. Adjustment of the NaOH proportion changes the pH within this interval. The relevant range is approximately pH 4.2–5.8.



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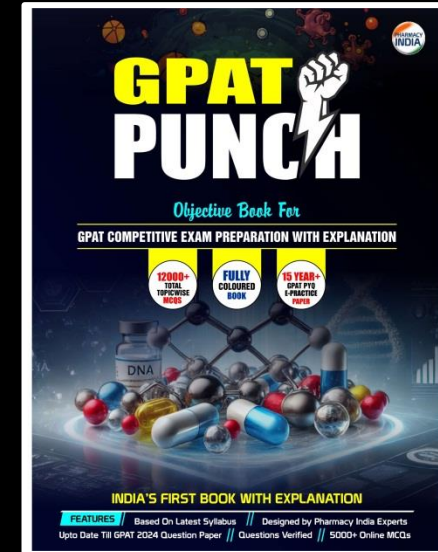


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33.

The first transition range of thymol blue is approximately:

- (a) 1.2–2.8
- (b) 6.0–7.6
- (c) 8.2–10.0
- (d) 4.2–6.3



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33.

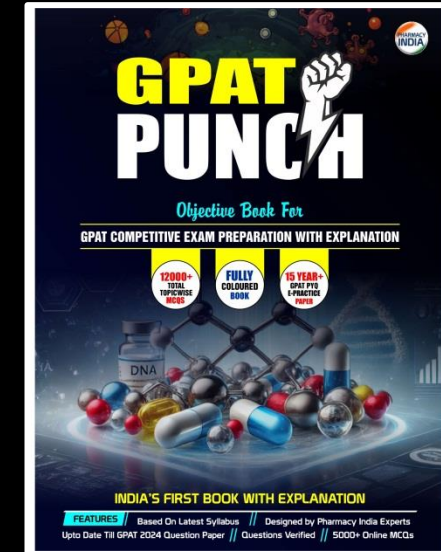
The first transition range of thymol blue is approximately:

(a) 1.2–2.8

(b) 6.0–7.6

(c) 8.2–10.0

(d) 4.2–6.3



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Explanation:

Thymol blue is unusual because it exhibits two separate indicator transitions. Its first transition occurs in a strongly acidic region. This first colour change takes place approximately between pH 1.2 and 2.8. A second transition occurs in the alkaline region at a much higher pH.



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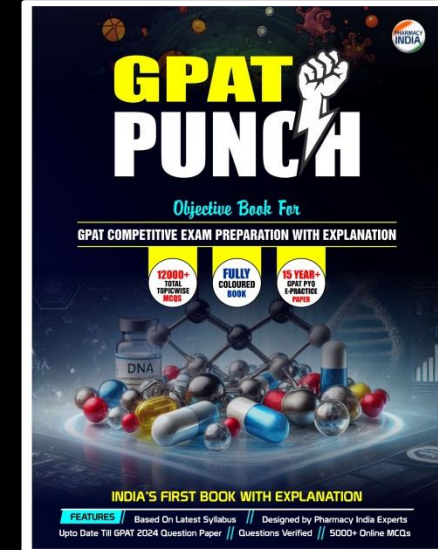


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34.

The transition range of bromothymol blue is approximately:

- (a) 1.2–2.8
- (b) 6.0–7.6
- (c) 8.2–10.0
- (d) 2.8–4.9



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34.

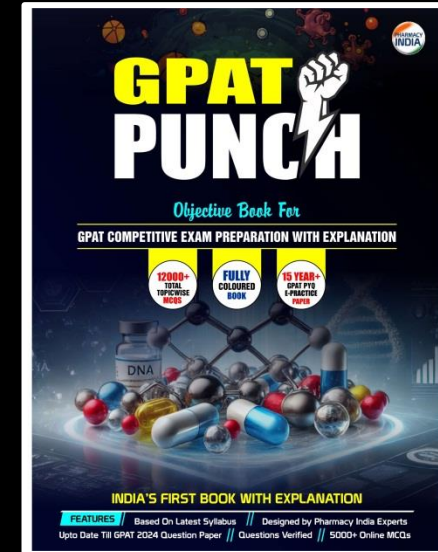
The transition range of bromothymol blue is approximately:

(a) 1.2–2.8

(b) 6.0–7.6

(c) 8.2–10.0

(d) 2.8–4.9



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Explanation:

Bromothymol blue changes colour close to the neutral region. Its transition begins in slightly acidic conditions and finishes in slightly alkaline conditions. The usual interval is approximately pH 6.0–7.6. This makes it especially useful for titrations having an endpoint close to pH 7.



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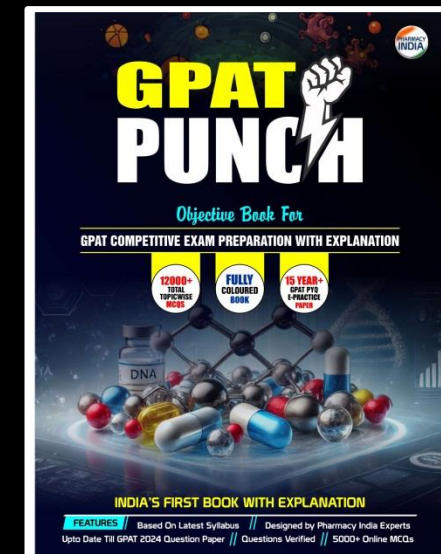


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35.

Phenolphthalein has a transition range approximately between:

- (a) 1.2–2.8
- (b) 4.2–6.3
- (c) 6.0–7.6
- (d) 8.2–10.0



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35.

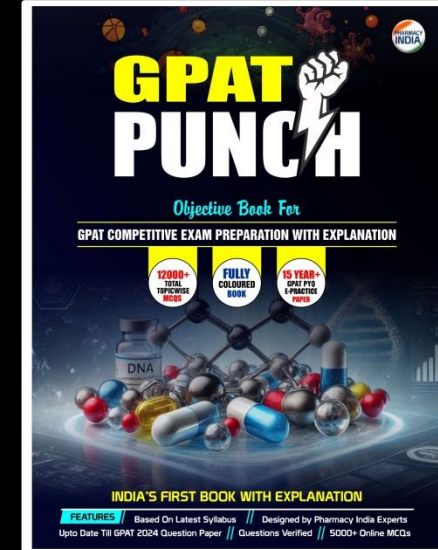
Phenolphthalein has a transition range approximately between:

(a) 1.2–2.8

(b) 4.2–6.3

(c) 6.0–7.6

(d) 8.2–10.0



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Explanation:

Phenolphthalein changes colour in the alkaline region. Below its transition range, it is essentially colourless. As the pH rises through its transition interval, a pink colour develops. The commonly accepted range is approximately pH 8.2–10.0. This makes it particularly useful for weak acid–strong base titrations.



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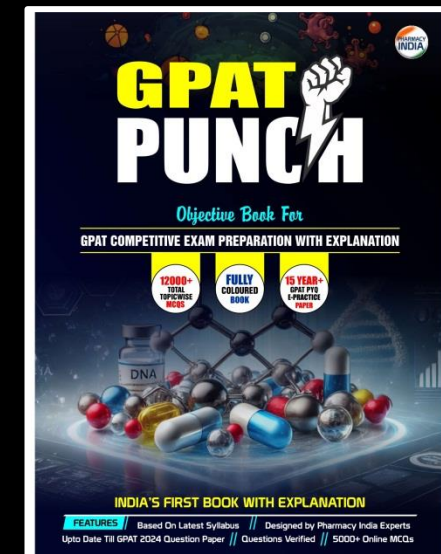


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36.

The transition range of methyl red is approximately:

- (a) 4.2–6.3
- (b) 8.2–10.0
- (c) 1.2–2.8
- (d) 6.0–7.6



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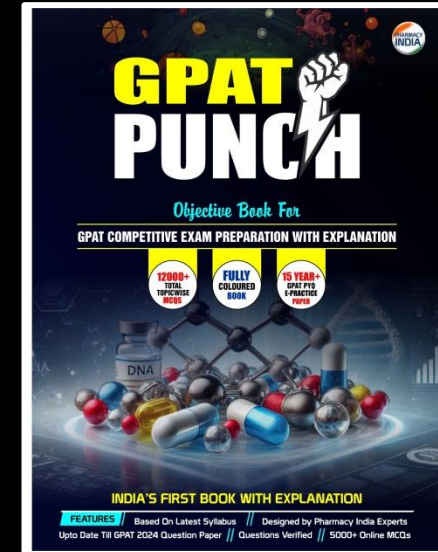
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(b) 8.2–10.0

(c) 1.2–2.8

(d) 6.0–7.6



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Explanation:

Methyl red is an azo acid–base indicator. It changes from red under more acidic conditions toward yellow as pH increases. The colour transition occurs in the mildly acidic region. Its commonly accepted transition interval is approximately pH 4.2–6.3. Therefore, methyl red is useful when the endpoint falls in this pH region.



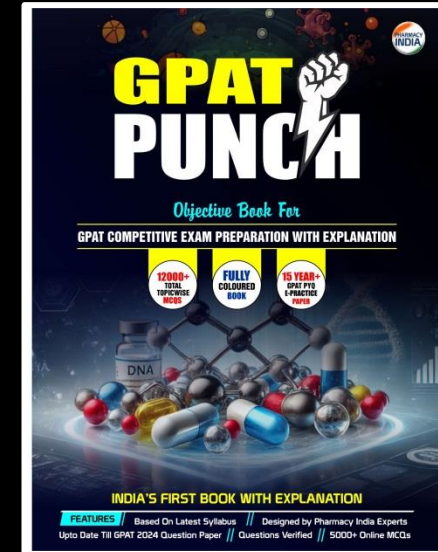
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37. What is the colour of methyl orange in an alkaline medium?

- (a) Red
- (b) Yellow
- (c) Pink
- (d) Blue



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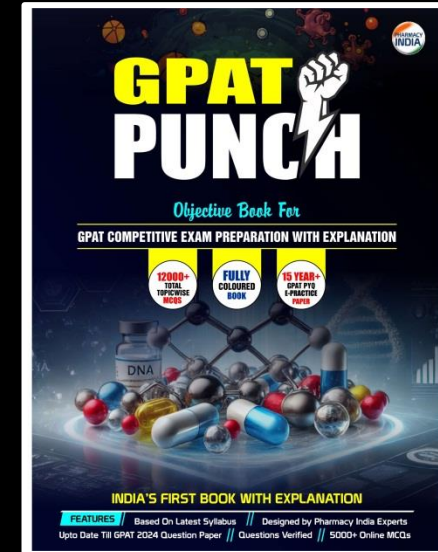
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(a) Red

(b) Yellow

(c) Pink

(d) Blue



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Explanation:

Methyl orange exists in different coloured forms depending on protonation. Its protonated form predominates in acidic solution and appears red. As pH increases, the deprotonated form becomes predominant. This form has a yellow colour.



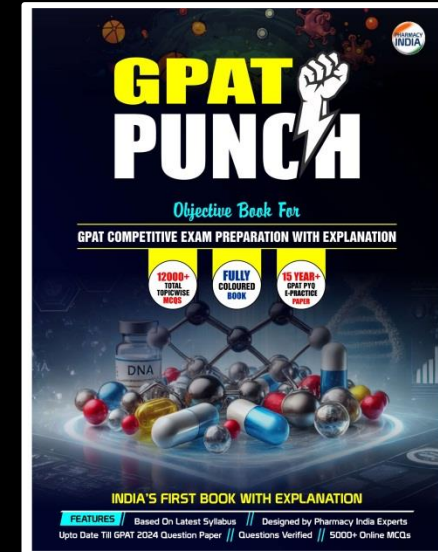
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38. What is the colour of phenolphthalein in an acidic solution?

- (a) Pink
- (b) Orange
- (c) Colourless
- (d) Yellow



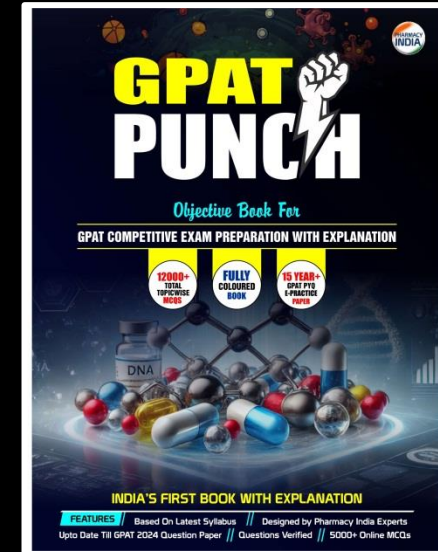
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- (b) Orange
- (c) Colourless
- (d) Yellow



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Explanation:

Phenolphthalein is an acid-base indicator whose coloured form develops in alkaline solution. Under acidic conditions, its molecular structure does not produce the characteristic visible pink colour. It therefore appears colourless. The pink form begins to appear when the pH enters its alkaline transition range.



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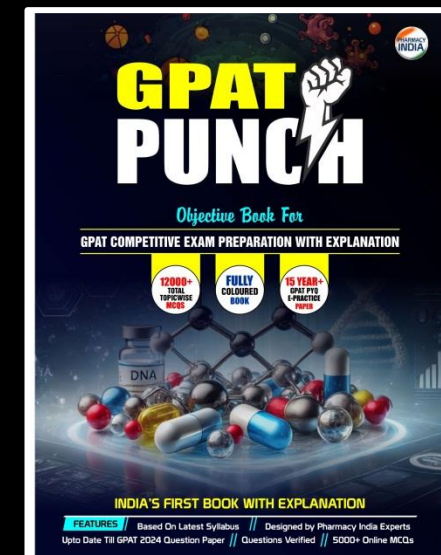


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39.

What is the characteristic colour of phenolphthalein in a sufficiently alkaline solution?

- (a) Pink
- (b) Green
- (c) Yellow
- (d) Red



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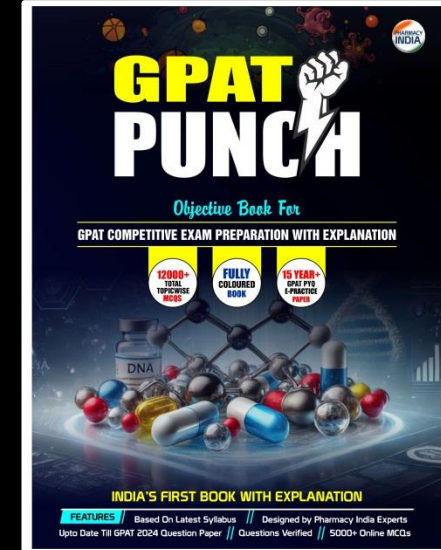


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39.

What is the characteristic colour of phenolphthalein in a sufficiently alkaline solution?

- (a) Pink
- (b) Green
- (c) Yellow
- (d) Red



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Explanation:

Phenolphthalein undergoes structural ionization as the pH becomes alkaline. The ionized form absorbs visible light and develops a pink colour. This change occurs mainly over the pH range of about 8.2–10.0. A persistent faint pink colour is commonly used to recognize an endpoint.



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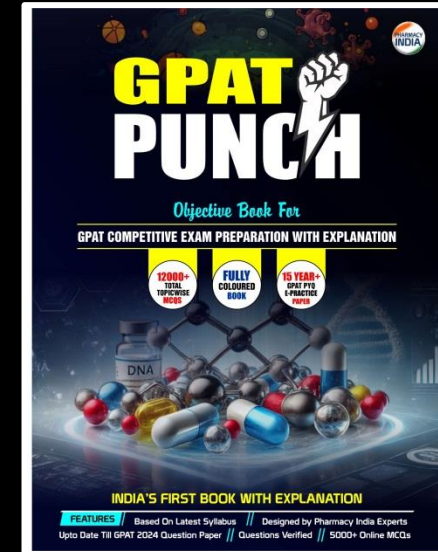


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40.

The approximate pK_a value of boric acid referred to in its acid–base titration is:

- (a) 2.1
- (b) 4.76
- (c) 7.0
- (d) 9.19



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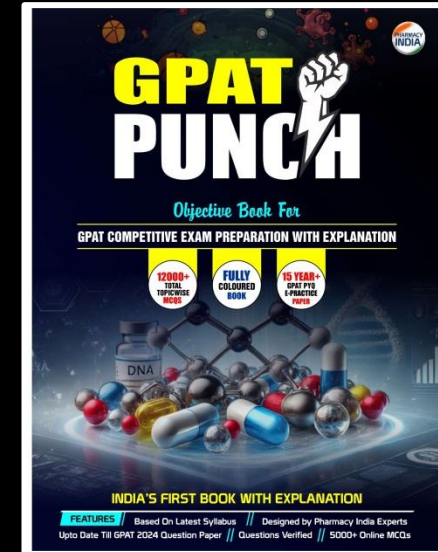


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Explanation:

Boric acid behaves as a very weak acid in aqueous solution. Its weak acidic character is reflected by a relatively high pK_a value. The pK_a is approximately 9.19 under ordinary aqueous conditions. This weak acidity makes direct titration with a conventional indicator difficult. Addition of glycerol is therefore used to obtain a sharper titrimetric response.



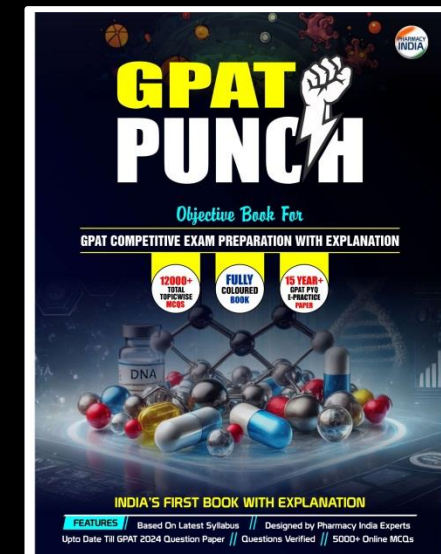
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41.

Why is boric acid not directly titrated satisfactorily with NaOH using phenolphthalein?

- (a) It is an extremely strong acid
- (b) It is too weak to produce a sharp endpoint
- (c) It precipitates NaOH
- (d) It immediately decomposes phenolphthalein



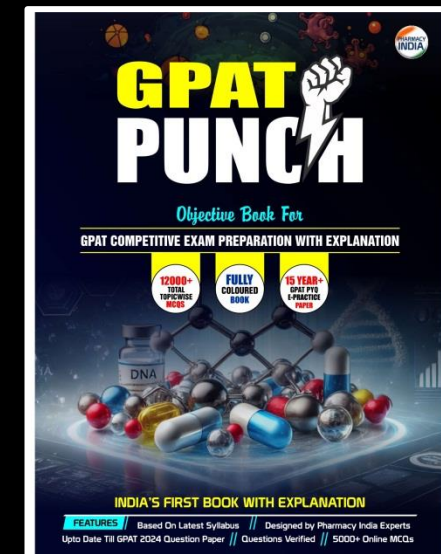
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- (d) It immediately decomposes phenolphthalein



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Explanation:

Boric acid possesses only weak acidic behaviour in aqueous solution. Consequently, the change in pH near its direct neutralization endpoint is insufficiently sharp. Phenolphthalein therefore does not give a satisfactory endpoint with boric acid alone. Glycerol is added to form a more strongly acidic borate complex. This modification permits accurate titration with sodium hydroxide.



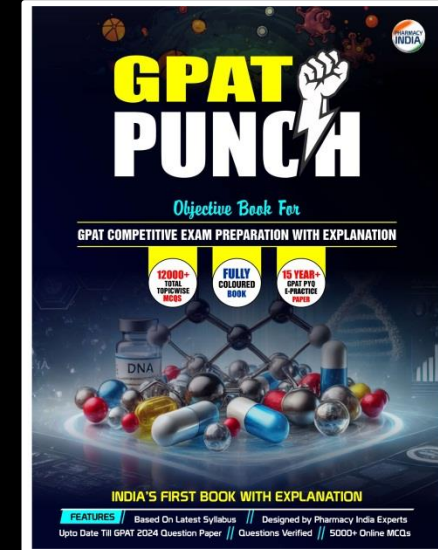
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42.

What is the main effect of complex formation between glycerol and boric acid?

- (a) The system becomes less acidic
- (b) Boric acid is converted into a strong base
- (c) A stronger titratable acidic complex is produced
- (d) Sodium hydroxide is precipitated



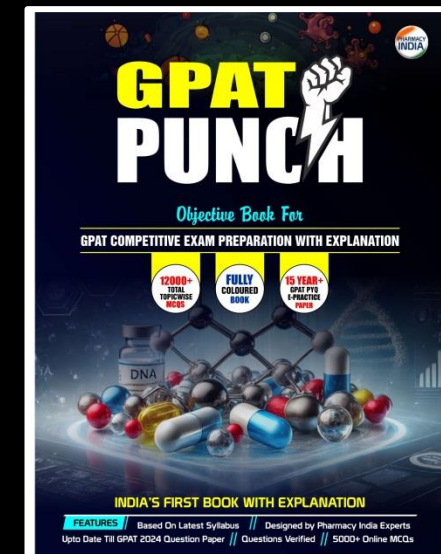
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- (d) Sodium hydroxide is precipitated



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Explanation:

Glycerol contains adjacent hydroxyl groups capable of coordinating with boron. Interaction with boric acid forms a cyclic borate complex. This complex releases hydrogen ions more readily than boric acid alone. Consequently, its apparent acidity is increased and the neutralization curve becomes sharper. The system can then be accurately titrated using sodium hydroxide.



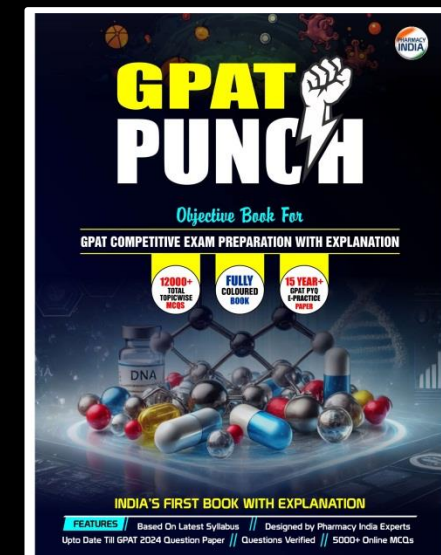
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43.

According to the Brønsted–Lowry concept, a base is a substance that:

- (a) Donates a proton
- (b) Accepts a proton
- (c) Accepts an electron pair only
- (d) Donates an electron pair only



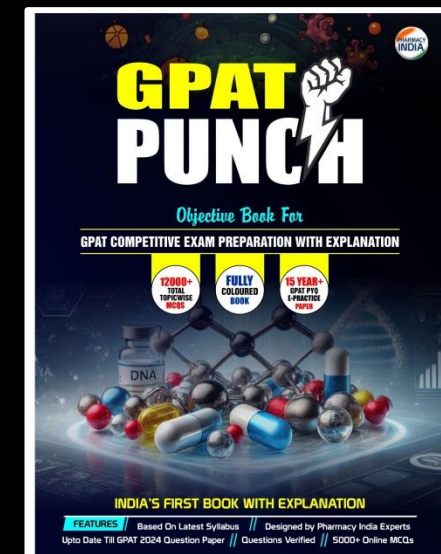
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Explanation:

The Brønsted–Lowry concept defines acids and bases in terms of proton transfer. An acid donates an H^+ ion to another species. A base accepts the H^+ ion donated by the acid. After accepting a proton, the base forms its conjugate acid. Therefore, proton acceptance is the defining behaviour of a Brønsted–Lowry base.



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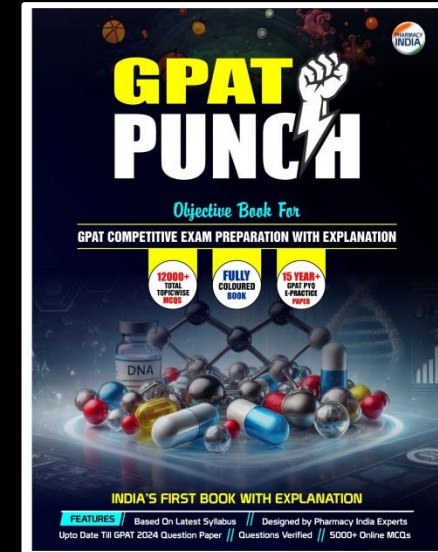


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44.

In a strong acid–strong base titration, the equivalence point generally occurs near:

- (a) pH 2
- (b) pH 5
- (c) pH 7
- (d) pH 10



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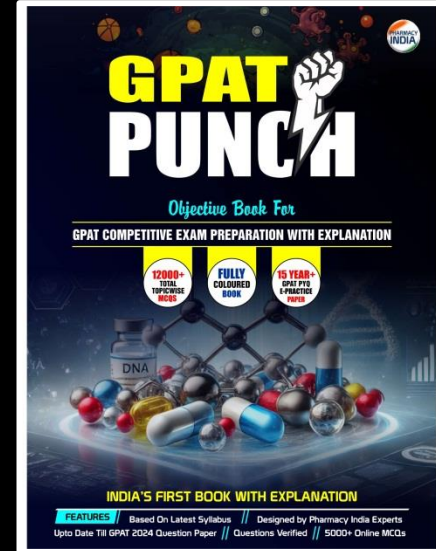


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- (a) pH 2
- (b) pH 5
- (c) pH 7
- (d) pH 10



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Explanation:

A strong acid and a strong base are essentially completely ionized in water. At equivalence, equal stoichiometric amounts of H^+ and OH^- have reacted. The resulting salt generally does not undergo significant hydrolysis. The solution is therefore approximately neutral under standard conditions.



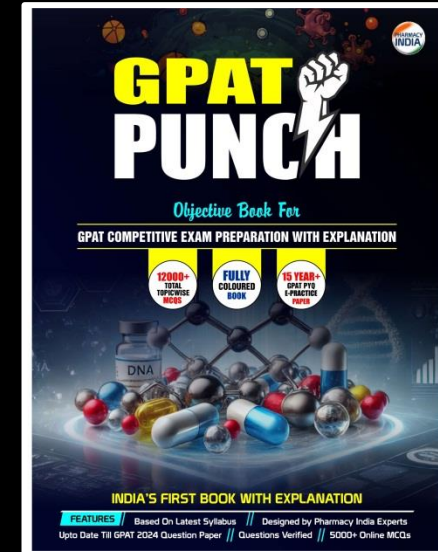
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45.

The equivalence point in a titration of a weak acid with a strong base is generally:

- (a) Below pH 7
- (b) Exactly pH 7 in every case
- (c) Always pH 1
- (d) Above pH 7



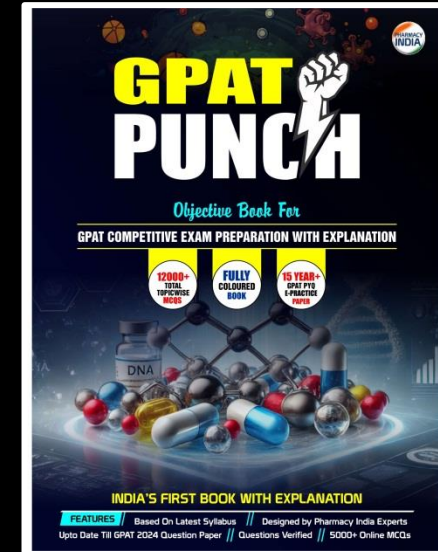
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Explanation:

At equivalence, the weak acid has been converted mainly into its conjugate base. The conjugate base reacts partially with water by hydrolysis. This reaction generates hydroxide ions in the solution. Consequently, the equivalence-point solution is alkaline.



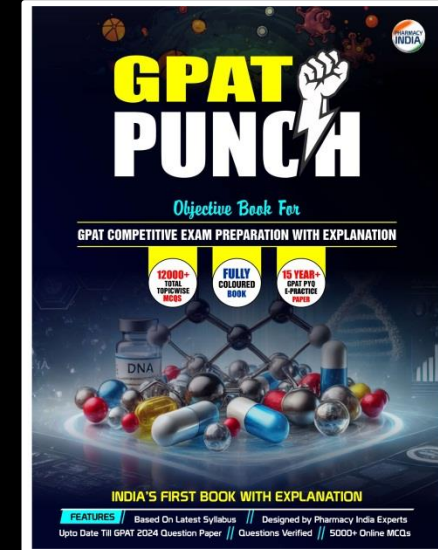
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46.

The equivalence point in a titration of a strong acid with a weak base is generally:

- (a) Below pH 7
- (b) Above pH 7
- (c) Exactly pH 14
- (d) Always pH 7



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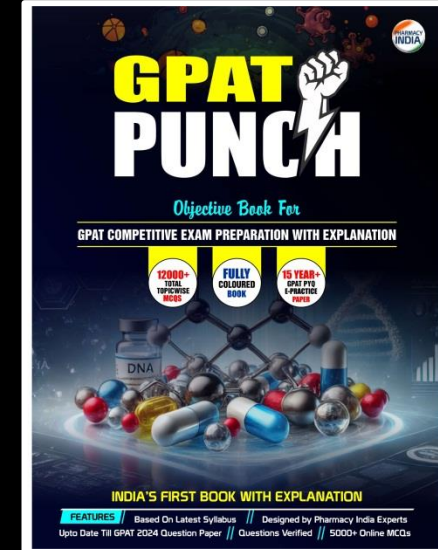


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The equivalence point in a titration of a strong acid with a weak base is generally:

- (a) Below pH 7
- (b) Above pH 7
- (c) Exactly pH 14
- (d) Always pH 7



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Explanation:

A weak base reacts with a strong acid to form its conjugate acid at equivalence. The conjugate acid can undergo hydrolysis in water. This process generates hydrogen ions and makes the solution acidic. The equivalence point therefore lies below neutrality.



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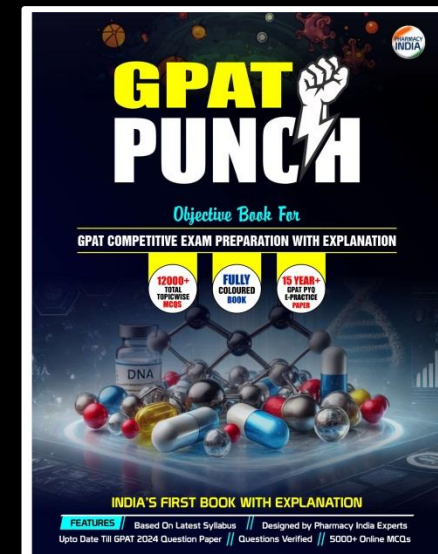


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47.

The most important factor in selecting an acid-base indicator is that its transition range should:

- (a) Match the colour of the titrant
- (b) Lie within the steep pH change near the equivalence point
- (c) Always be below pH 3
- (d) Always be above pH 10



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47.

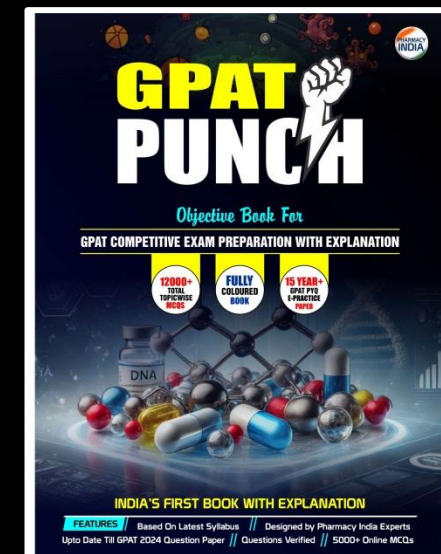
The most important factor in selecting an acid–base indicator is that its transition range should:

(a) Match the colour of the titrant

(b) Lie within the steep pH change near the equivalence point

(c) Always be below pH 3

(d) Always be above pH 10



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Explanation:

An indicator changes colour over a specific pH interval rather than at one exact pH. For an accurate endpoint, this transition must occur within the rapid pH change of the titration curve. Otherwise, the colour change may occur appreciably before or after equivalence. Different acid–base combinations therefore require different indicators. Thus, the equivalence-point pH region is the main basis for indicator selection.



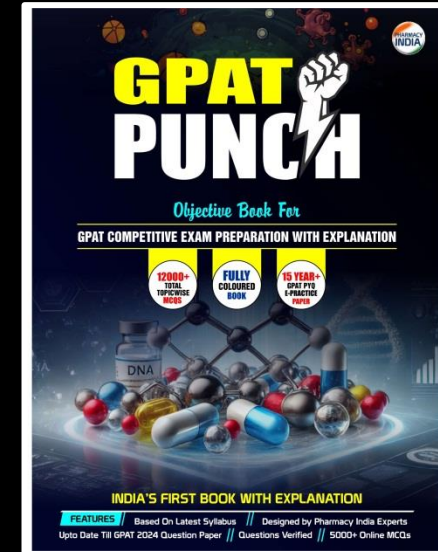
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48.

Which statement best describes the function of a buffer solution?

- (a) It resists significant changes in pH after addition of small amounts of acid or base
- (b) It causes a very large pH change on adding acid
- (c) It always maintains pH exactly at 7
- (d) It contains only a strong acid and strong base



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48.

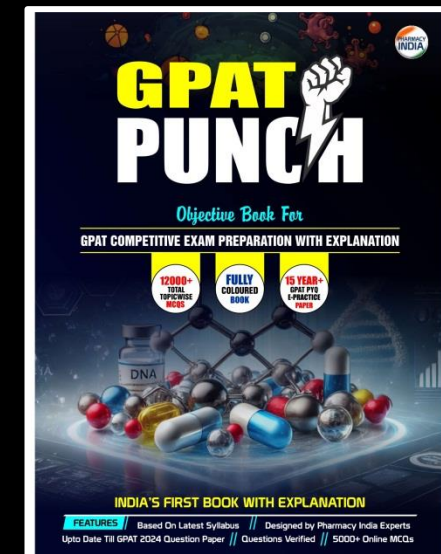
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(c) It always maintains pH exactly at 7

(d) It contains only a strong acid and strong base



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Explanation:

A buffer contains components capable of consuming small added quantities of H^+ or OH^- . This minimizes the resulting change in hydrogen-ion concentration. Acidic buffers usually contain a weak acid and its conjugate base. Basic buffers contain a weak base and its conjugate acid.



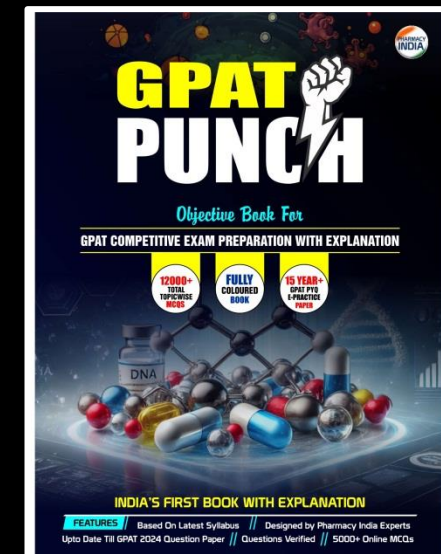
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49.

In nonaqueous acid–base titration, sodium methoxide primarily acts as:

- (a) An acidic titrant
- (b) A basic titrant
- (c) A redox indicator
- (d) A precipitating agent



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49.

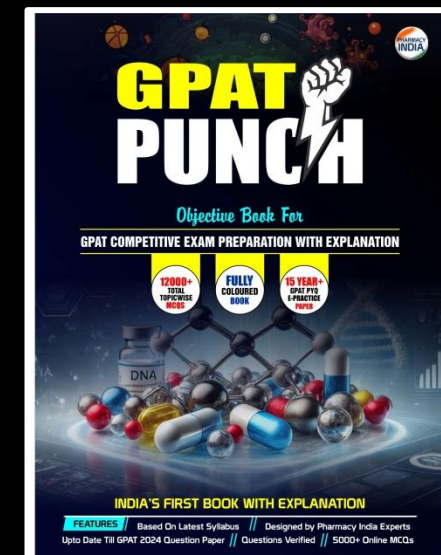
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(a) An acidic titrant

(b) A basic titrant

(c) A redox indicator

(d) A precipitating agent



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Explanation:

Sodium methoxide is a strongly basic reagent in suitable nonaqueous solvents. It is useful for titrating acidic substances that may not be satisfactorily determined in water. Before use, its exact concentration must be standardized. Benzoic acid can be employed for this standardization. Therefore, sodium methoxide functions as a basic titrant in nonaqueous analysis.



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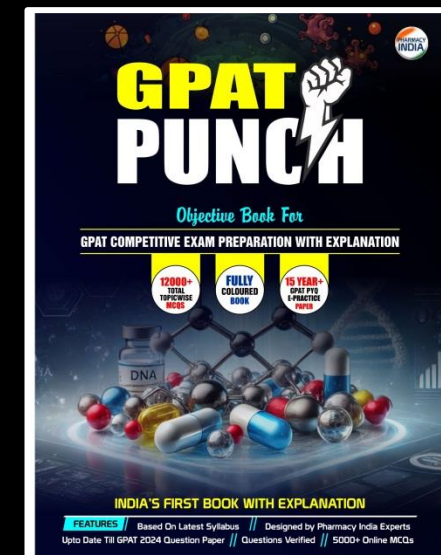


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50.

What is the n-factor of H_2SO_4 in complete acid–base neutralization?

- (a) 1
- (b) 2
- (c) 3
- (d) 4



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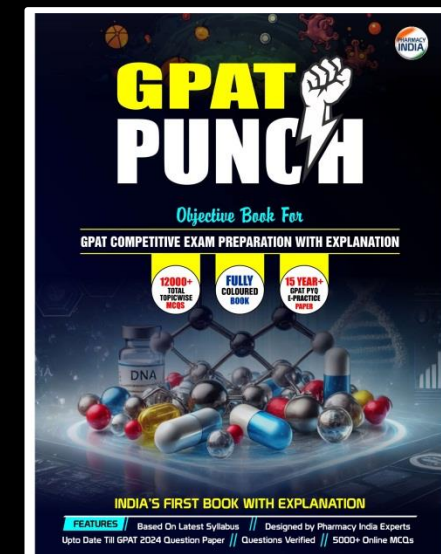


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- (a) 1
- (b) 2
- (c) 3
- (d) 4



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Explanation:

Sulphuric acid contains two ionizable acidic hydrogen ions per molecule. During complete neutralization, both hydrogen ions react with hydroxide ions. One mole of H_2SO_4 can therefore furnish two acid equivalents. Its n-factor in complete acid–base neutralization is 2. This is why its equivalent weight is $98/2 = 49 \text{ g/equiv}$.



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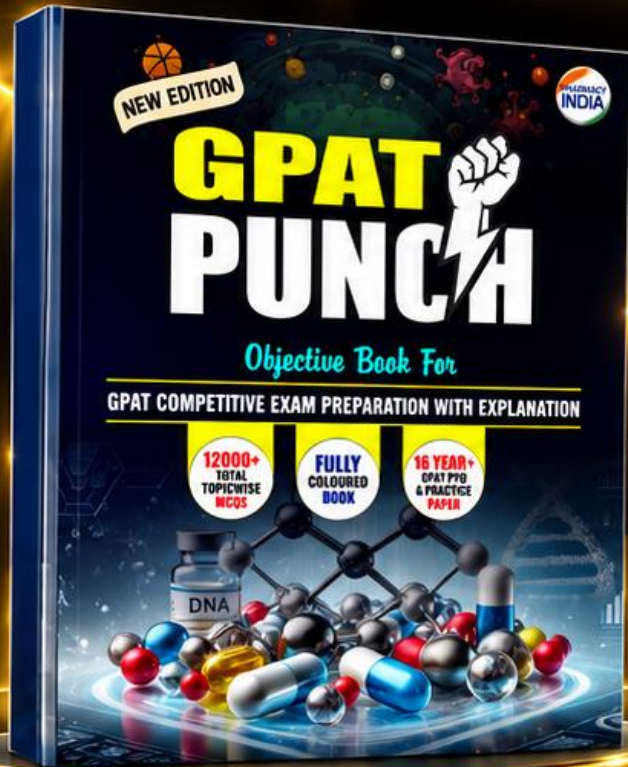


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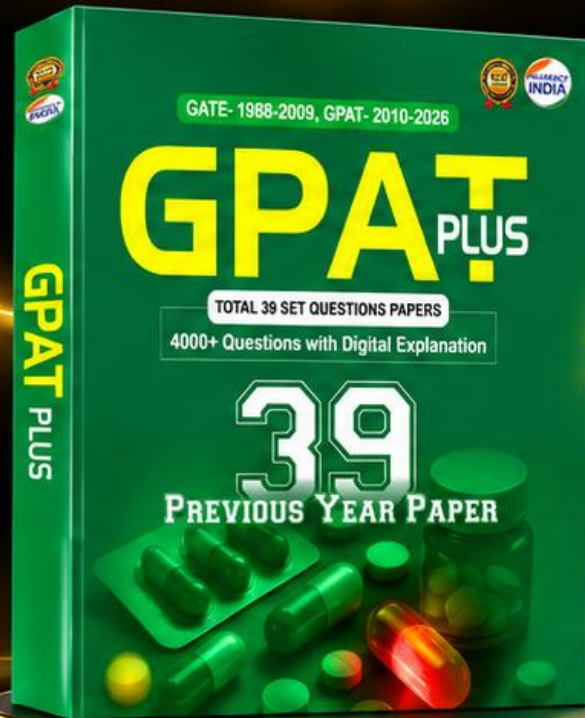


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