A-LEVEL CHEMISTRY • EXERCISE SHEET

32.2 Phenol

Name: _____ Class: _____ Date: _____ **Total: 22 marks**

KEY WORDS acidity 酸性 • phenol 苯酚 • benzene 苯 • delocalised 离域 • alcohol 醇

Objective

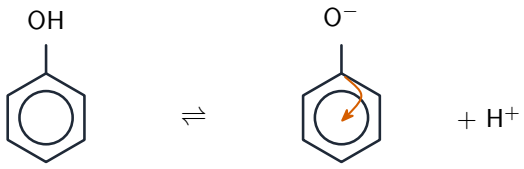
Build the skills to answer exam questions on **phenol** 苯酚 — its reactions, its **acidity** 酸性, and why its ring is more reactive than benzene.

You must be able to:

- give the reactions of phenol (with bases, sodium, bromine water, dilute HNO_3)
- explain why phenol is more acidic than water or an alcohol
- explain why phenol reacts under milder conditions than benzene

1 Worked examples

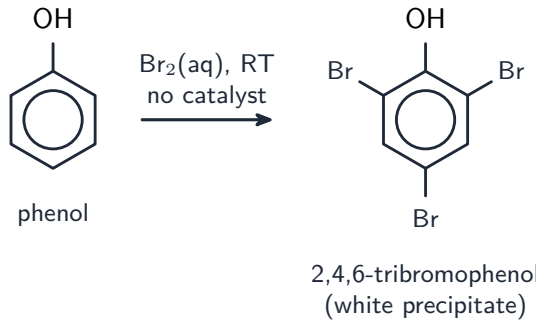
■ Acidity and ring reactivity



acidity: ethanol < water < phenol

Phenol is more acidic than water or an alcohol: the phenoxide ion's charge spreads into the ring, stabilising it

- **acidity order:** ethanol < water < **phenol** (< carboxylic acid).
- phenol's –OH loses H^+ → phenoxide; the charge is delocalised into the ring → stable ion → more acidic.



the ring is activated, so milder conditions than benzene

Phenol's ring is activated, so bromine water brominates positions 2, 4, 6 at room temperature, no catalyst — a white precipitate

- the O lone pair feeds into the ring → ring is electron-rich → reacts faster and milder than benzene.

2 Practice

2.1 Name the organic product when phenol reacts with bromine water. [1]

2.2 State what you would see when phenol reacts with bromine water. [1]

3 Exam-style questions

3.1 Phenol is more acidic than ethanol because: [1]

A B
C D

A the phenoxide ion's charge is delocalised into the ring
B phenol contains a benzene ring
C ethanol has no –OH group
D phenol is a strong acid

3.2 Phenol reacts with bromine water **faster** than benzene reacts with bromine because in phenol: [1]

A B
C D

A the ring is electron-poor
B an O lone pair feeds electron density into the ring
C the –OH removes electrons from the ring
D a catalyst is present

3.3 Phenol reacts with sodium hydroxide solution, but ethanol does not.

(a) Write the equation for phenol with NaOH(aq). [2]

(b) State what this difference shows about phenol. [1]

3.4 Explain why phenol can be brominated with bromine water at room temperature with no catalyst, while benzene needs a halogen carrier. [3]

3.5 Phenol, C_6H_5OH, is a weak acid; ethanol is not acidic in water.

(a) Write the equation for the reaction of phenol with aqueous sodium hydroxide, and name the salt formed. [2]

(b) Explain, in terms of the stability of the anion, why phenol is a stronger acid than ethanol but weaker than ethanoic acid. [4]

(c) Phenol reacts with bromine **water** at room temperature to give a white precipitate, whereas benzene needs a halogen carrier and heat. Write the equation for the phenol reaction and explain the difference in reactivity. [4]

(d) State a chemical test that distinguishes phenol from ethanol, with the result for each. [2]