Week 48

A-Level Chemistry

Homework bundle for this week

本周作业合集

exercises.lol

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A-Level Chemistry Name: _____ Score: _____

1. An alcohol reacting with an acyl chloride gives:
   - ☐ an ester (plus HCl)
   - ☐ an alkene
   - ☐ a halogenoalkane
   - ☐ an amine
2. Phenol is:
   - ☐ an –OH group joined directly to a benzene ring
   - ☐ an –OH on a long alkyl chain
   - ☐ a carboxylic acid
   - ☐ a halogenoarene
3. Compared with using a carboxylic acid, making an ester from an acyl chloride is:
   - ☐ faster and more complete
   - ☐ slower
   - ☐ reversible and incomplete
   - ☐ impossible
4. Unlike an ordinary alcohol, phenol reacts with NaOH(aq). This shows phenol is:
   - ☐ more acidic than an alcohol
   - ☐ less acidic
   - ☐ a base
   - ☐ unreactive
5. Ethanol + ethanoyl chloride gives:
   - ☐ ethyl ethanoate
   - ☐ ethene
   - ☐ ethanoic acid
   - ☐ ethanal
6. An acyl chloride reacts with an alcohol to form an _____.

7. Acyl chlorides are more reactive than carboxylic acids.

   ☐ True ☐ False

8. Phenol is a weak acid that reacts with sodium hydroxide.

   ☐ True ☐ False

9. Phenol with bromine water at room temperature (no catalyst) gives:

   ☐ 2,4,6-tribromophenol (a white precipitate)

   ☐ bromobenzene only

   ☐ no reaction

   ☐ a brown solution

10. The acidity order is:

    ☐ ethanol < water < phenol

    ☐ phenol < water < ethanol

    ☐ water < ethanol < phenol

    ☐ all equal

32. Hydroxy compounds

Answers · 答案

A-Level Chemistry

1. **an ester (plus HCl)**

   The alcohol's –OH reacts with the acyl chloride to form an ester, releasing HCl.

2. **an –OH group joined directly to a benzene ring**

   The –OH is bonded straight to the aromatic ring, changing both the –OH and the ring chemistry.

3. **faster and more complete**

   Acyl chlorides are very reactive, so esterification with them is fast and goes essentially to completion.

4. **more acidic than an alcohol**

   Phenol is acidic enough to react with NaOH, forming sodium phenoxide; alcohols are not.

5. **ethyl ethanoate**

   The ester ethyl ethanoate forms, along with HCl fumes.

6. **ester**

   Releasing hydrogen chloride gas.

7. **True**

   The chlorine is a good leaving group.

8. **True**

   The –OH on the ring is more acidic than in an alcohol.

9. **2,4,6-tribromophenol (a white precipitate)**

   The activated ring reacts readily, brominating positions 2, 4 and 6 to give a white precipitate.

10. **ethanol < water < phenol**

    Phenol is the most acidic of the three because the phenoxide charge is delocalised into the ring.

A-LEVEL CHEMISTRY • EXERCISE SHEET

32.1 Alcohols (esters from acyl chlorides)

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

KEY WORDS ester 酯 • acyl chloride 酰氯 • alcohol 醇

Objective

Build the skills to answer exam questions on the **A2 reaction of alcohols** 醇 — making an **ester** 酯 from an alcohol and an **acyl chloride** 酰氯.

You must be able to:

- give the product of an alcohol with an acyl chloride
- compare this route with esterification using a carboxylic acid
- write the equation and name the products

1 Worked examples

Ester from an acyl chloride

An acyl chloride reacts with an alcohol faster and more completely than a carboxylic acid does, giving the ester + HCl fumes

the –OH (acid) and –H (alcohol) leave as water; the C–O–C ester link forms

(concentrated H_2SO_4 catalyst; reversible)

Esters from acyl chlorides and alcohols

- **alcohol + acyl chloride → ester + HCl**, at room temperature.
- e.g. ethanol + ethanoyl chloride → ethyl ethanoate + HCl.
- this is **faster and more complete** than using a carboxylic acid (which is reversible and needs an acid catalyst + heat).

2 Practice

2.1 Name the ester formed from ethanol and ethanoyl chloride. [1]

2.2 Name the other product (the fumes) given off. [1]

3 Exam-style questions

3.1 Compared with using ethanoic acid, making an ester from ethanoyl chloride is: [1]

- **A** slower and reversible
- **B** faster and more complete
- **C** only possible with a catalyst
- **D** impossible at room temperature

3.2 Which product is given off as fumes when an alcohol reacts with an acyl chloride? [1]

- **A** H_2
- **B** CO_2
- **C** HCl
- **D** H_2O

3.3 Propan-1-ol reacts with propanoyl chloride.

(a) Write the equation for the reaction. [2]

(b) Name the ester produced. [1]

3.4 Explain why an acyl chloride is preferred over a carboxylic acid for making an ester in the lab. [2]

Solutions

2.1 ethyl ethanoate.

2.2 hydrogen chloride, HCl.

3.1 B. The reaction is fast and goes essentially to completion (not reversible).

3.2 C. HCl fumes are released.

3.3 (a) $CH_3CH_2COCl + CH_3CH_2CH_2OH \rightarrow CH_3CH_2COOCH_2CH_2CH_3 + HCl$.
(b) propyl propanoate.

3.4 the acyl chloride reaction is fast and goes to completion; whereas esterification with a carboxylic acid is slow, reversible and needs an acid catalyst and heat.

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

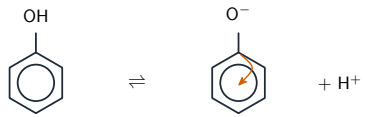
Build the skills to answer exam questions on **phenol** 苯酚 — its reactions, its **acidity** 酸性, and why its ring is more reactive than benzene.

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

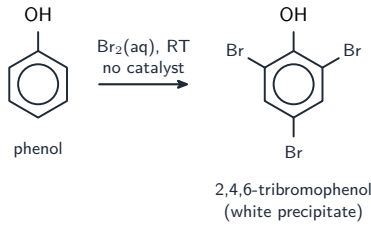
■ Acidity and ring reactivity



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** 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** 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]

Solutions

2.1 2,4,6-tribromophenol.

2.2 a white precipitate forms / the bromine water decolourises.

3.1 A. The negative charge on the phenoxide ion is delocalised into the ring, stabilising it.

3.2 B. An oxygen lone pair feeds into the ring, making it more electron-rich and reactive.

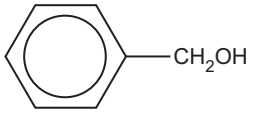
3.3 (a) $C_6H_5OH + NaOH \rightarrow C_6H_5ONa + H_2O$.
(b) phenol is acidic (more acidic than an alcohol — it reacts with a base).

3.4 a lone pair on the phenol oxygen is delocalised into the ring; this makes the ring more electron-rich, so it attracts electrophiles more strongly; benzene's ring is less electron-rich, so it needs a halogen carrier to make a strong enough electrophile.

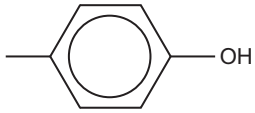
3.5 (a) $C_6H_5OH + NaOH \rightarrow C_6H_5O^-Na^+ + H_2O$; the salt is **sodium phenoxide**.
(b) In the phenoxide ion a lone pair on the oxygen is delocalised into the ring's π system, so the negative charge is spread out and the ion is stabilised — the equilibrium therefore lies further to the right than for ethanol, whose ethoxide has no such delocalisation. In ethanoate the charge is delocalised over **two electronegative oxygens** only, which stabilises it far more effectively than spreading it round a carbon ring, so ethanoic acid is the strongest of the three.
(c) $C_6H_5OH + 3Br_2 \rightarrow C_6H_2Br_3OH + 3HBr$ — white 2,4,6-tribromophenol. The oxygen's lone pair is donated into the ring, raising its electron density so it polarises an approaching bromine molecule by itself — no halogen carrier is needed.
(d) Add neutral iron(III) chloride solution: phenol gives a violet/purple colour, ethanol gives no change. (Sodium carbonate is **not** a valid test — neither gives carbon dioxide.)

7 Phenylmethanol and 4-methylphenol are isomers.

phenylmethanol



4-methylphenol



(a) Complete Table 7.1 to show the relative acidities of benzoic acid (C_6H_5COOH), phenylmethanol, 4-methylphenol and water.

Explain your answer.

Table 7.1

	name of compound
most acidic ↓	
least acidic	

explanation .....

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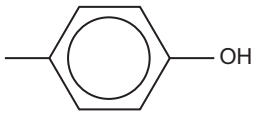
[4]

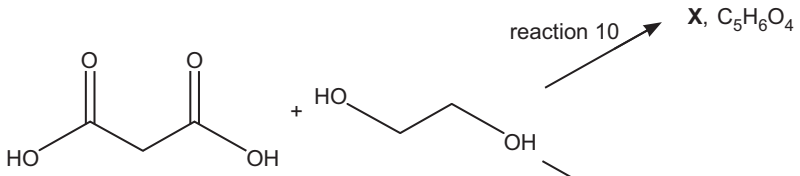
(b) 4-methylphenol reacts readily with sodium.

Complete the equation for this reaction.



[1]

(c) Under certain conditions, ethane-1,2-diol, $HOCH_2CH_2OH$, reacts with propane-1,3-dioic acid, $HOOCCH_2COOH$, to form different organic products, as shown in Fig. 7.1.



reaction 10 → **X**, $C_5H_6O_4$

reaction 11 → polymer **Y**

Fig. 7.1

(i) **X** does **not** react with Na metal.

Draw the structure of the organic product **X**, $C_5H_6O_4$, shown in Fig. 7.1.

[1]

(ii) Reactions 10 and 11 in Fig. 7.1 are different types of reaction.

Name the type of reaction for reaction 10 and for reaction 11.

reaction 10 .....

reaction 11 .....

[1]

(iii) Draw a section of polymer **Y** showing only **one** repeat unit.

The new functional group formed should be displayed.

[2]

[Total: 9]