A-LEVEL CHEMISTRY • EXERCISE SHEET

34.4 Amino acids

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS amino acids 氨基酸 • isoelectric point 等电点 • electrophoresis 电泳 • peptide bond 肽键 • zwitterions 两性离子

Objective

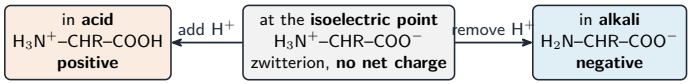
Build the skills to answer exam questions on **amino acids** 氨基酸 — **zwitterions** 两性离子, the **isoelectric point** 等电点, **peptide bonds** 肽键 and **electrophoresis** 电泳.

You must be able to:

- explain how an amino acid forms a zwitterion and how its charge changes with pH
- describe peptide-bond formation by condensation
- explain how electrophoresis separates amino acids

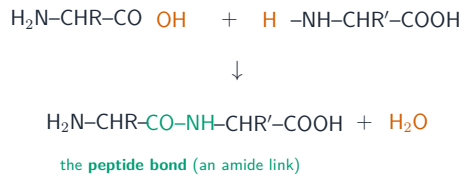
1 Worked examples

Charge with pH; peptide bonds



Charge depends on pH: positive in acid, the neutral zwitterion at the isoelectric point, negative in alkali

- in **acid** (low pH): $-COO^-$ gains H^+ → ion is **positive**.
- in **alkali** (high pH): $-NH_3^+$ loses H^+ → ion is **negative**.
- at the **isoelectric point**: mostly the neutral zwitterion, **no net charge**.



Two amino acids condense (losing water) to form a peptide (amide) bond

2 Practice

2.1 State what is meant by a **zwitterion**. [1]

2.2 Name the type of bond formed when two amino acids join. [1]

3 Exam-style questions

3.1 At a pH **below** its isoelectric point, an amino acid carries an overall: [1]

- **A** positive charge
- **B** negative charge
- **C** zero charge
- **D** double negative charge

3.2 In electrophoresis, an amino acid that is **negatively** charged moves towards the: [1]

- **A** negative electrode
- **B** positive electrode
- **C** neither electrode
- **D** both electrodes

3.3 Explain, using equations or structures, how the charge on the amino acid glycine (H_2NCH_2COOH) changes between low pH and high pH. [3]

3.4 Two amino acids are mixed and held at a pH equal to the isoelectric point of one of them. Explain what happens to each in electrophoresis. [3]

Solutions

2.1 an ion with both a positive ($-NH_3^+$) and a negative ($-COO^-$) charge but no overall charge.

2.2 a peptide bond (an amide link).

3.1 A. Below the isoelectric point, extra H^+ gives an overall positive charge.

3.2 B. A negative ion is attracted to the positive electrode.

3.3 at low pH the $-COO^-$ is protonated to $-COOH$, giving $H_3N^+CH_2COOH$, overall positive; at high pH the $-NH_3^+$ loses H^+ to give $H_2NCH_2COO^-$, overall negative; between them lies the zwitterion $H_3N^+CH_2COO^-$ at the isoelectric point.

3.4 the amino acid at its isoelectric point is a neutral zwitterion, so it does not move; the other amino acid is charged at that pH; so it migrates towards the oppositely charged electrode, separating the two.