Exercise walk-through

Amino acids ▪ 34.4

eXercise

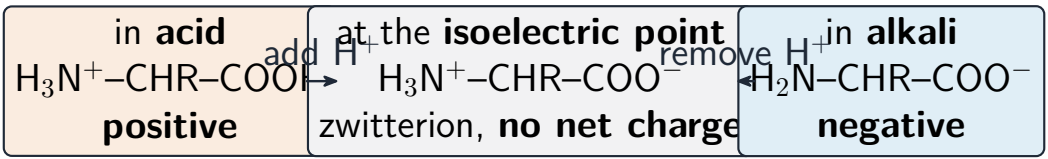
You must be able to

- 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

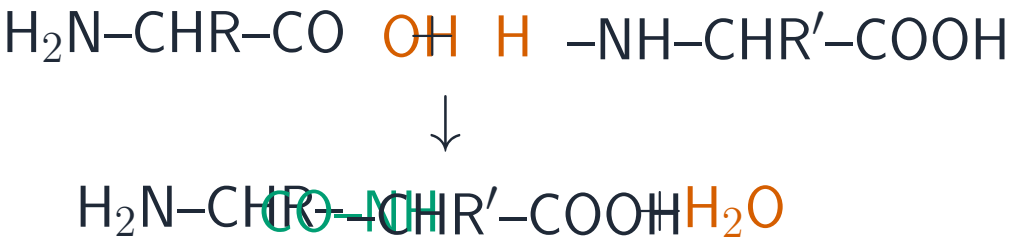
Method — Charge with pH; peptide bonds

- 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**.

Method — Charge with pH; peptide bonds



Method — Charge with pH; peptide bonds



the **peptide bond** (an amide link)

Practice 2.1 ▪ 1 mark

State what is meant by a **zwitterion**.

Solution 2.1

Worked steps

an ion with both a positive ($–NH_3^+$) and a negative ($–COO^-$) charge but no overall charge B1.

Practice 2.2 ▪ 1 mark

Name the type of bond formed when two amino acids join.

Solution 2.2

Method: Charge with pH; peptide bonds

Worked steps

a peptide bond (an amide link) B1.

Exam-style 3.1 ▪ 1 mark

At a pH **below** its isoelectric point, an amino acid carries an overall:

A positive charge

B negative charge

C zero charge

D double negative charge

Solution 3.1

Method: Charge with pH; peptide bonds

A positive charge ✓

B negative charge

C zero charge

D double negative charge

Worked steps

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

Exam-style 3.2 ▪ 1 mark

In electrophoresis, an amino acid that is **negatively** charged moves towards the:

A negative electrode

B positive electrode

C neither electrode

D both electrodes

Solution 3.2

Method: Charge with pH; peptide bonds

A negative electrode

B positive electrode ✓

C neither electrode

D both electrodes

Worked steps

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

Exam-style 3.3 ▪ 3 marks

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

Solution 3.3

Method: Charge with pH; peptide bonds

Worked steps

at low pH the $-COO^-$ is protonated to $-COOH$, giving $H_3N^+CH_2COOH$, overall positive M1; at high pH the $-NH_3^+$ loses H^+ to give $H_2NCH_2COO^-$, overall negative M1; between them lies the zwitterion $H_3N^+CH_2COO^-$ at the isoelectric point A1.

Exam-style 3.4 ▪ 3 marks

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.

Solution 3.4

Method: Charge with pH; peptide bonds

Worked steps

the amino acid at its isoelectric point is a neutral zwitterion, so it does not move M1; the other amino acid is charged at that pH M1; so it migrates towards the oppositely charged electrode, separating the two A1.