

22.1 Infrared spectroscopy

Name: _____ Class: _____ Date: _____

Total: 8 marks

KEY WORDS functional group 官能团 • infrared spectroscopy 红外光谱 • wavenumber 波数
• absorption 吸收 • relative atomic mass 相对原子质量

Objective

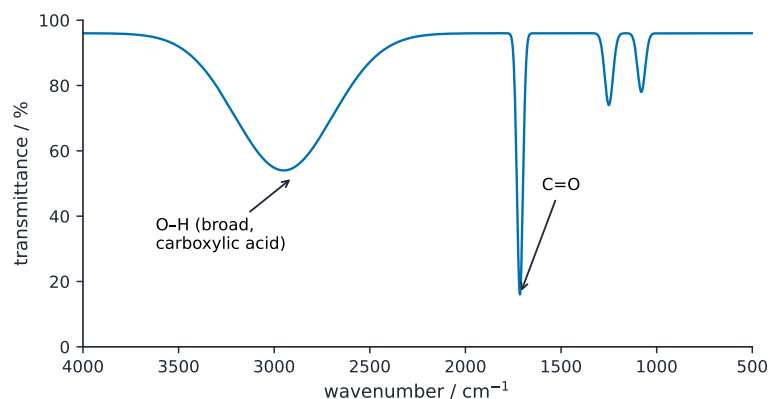
Build the skills to answer exam questions on **infrared spectroscopy** 红外光谱 — using an IR spectrum to identify **functional groups** 官能团.

You must be able to:

- analyse an IR spectrum to identify functional groups (using the given data table)
- use IR to check that a reaction has happened

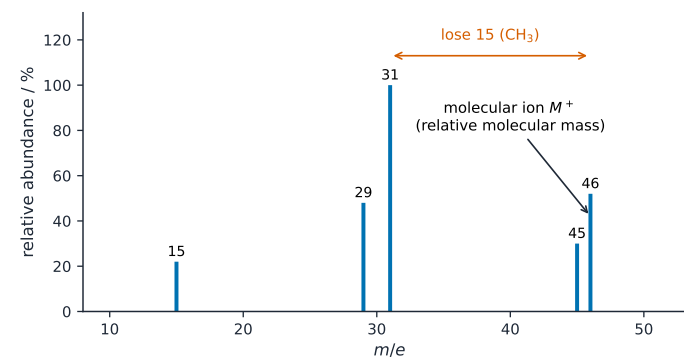
1 Worked examples

■ Reading an IR spectrum



IR: dips at characteristic wavenumbers identify functional groups (e.g. C=O, O-H)

Each bond absorbs at its own wavenumber, giving a dip. You are given the data table — just match the dips to bonds



M^+ peak $\approx M_r$ • gaps between peaks = mass of fragments lost

IR with mass spectrometry in structure determination

- broad dip $\sim 3200\text{--}3650\text{ cm}^{-1} \rightarrow \text{O-H}$ of an alcohol.
- dip $\sim 1700\text{ cm}^{-1} \rightarrow \text{C=O}$ (aldehyde, ketone, acid, ester).
- broad dip $\sim 2500\text{--}3000\text{ cm}^{-1}$ **plus** a C=O dip $\rightarrow$ a **carboxylic acid**.

Checking a reaction: if propene $\rightarrow$ propan-2-ol, the C=C dip disappears and an O-H dip appears.

2 Practice

2.1 State the bond responsible for a strong absorption at about 1700 cm^{-1} . [1]

2.2 State which functional group gives a broad absorption around $3200\text{--}3650\text{ cm}^{-1}$. [1]

3 Exam-style questions

3.1 An IR spectrum shows a broad absorption at $2500\text{--}3000\text{ cm}^{-1}$ together with a peak at 1710 cm^{-1} . The compound is most likely: [1]

- **A** an alcohol
 - **B** an alkane
 - **C** a carboxylic acid
 - **D** a halogenoalkane
-

3.2 IR spectroscopy is most useful for identifying: [1]

- **A** the relative atomic mass
 - **B** the functional groups present
 - **C** the number of carbon atoms
 - **D** the boiling point
-

3.3 Butan-2-ol is oxidised to butanone.

(a) State the change you would see in the IR spectrum (which absorption disappears and which appears). [2]

(b) Explain how IR confirms the oxidation has worked. [2]

Solutions

2.1 a C=O (carbonyl) bond.

2.2 an O–H group (in an alcohol).

3.1 C. The broad $2500\text{--}3000\text{ cm}^{-1}$ plus a C=O peak indicates a carboxylic acid.

3.2 B. IR identifies the functional groups present.

3.3 (a) the broad O–H absorption ($\sim 3200\text{--}3650\text{ cm}^{-1}$) disappears; a C=O absorption ($\sim 1700\text{ cm}^{-1}$) appears.

(b) losing the O–H and gaining a C=O shows the alcohol has been oxidised to a carbonyl (ketone).