Exercise walk-through

Infrared spectroscopy ▪ 22.1

eXercise

You must be able to

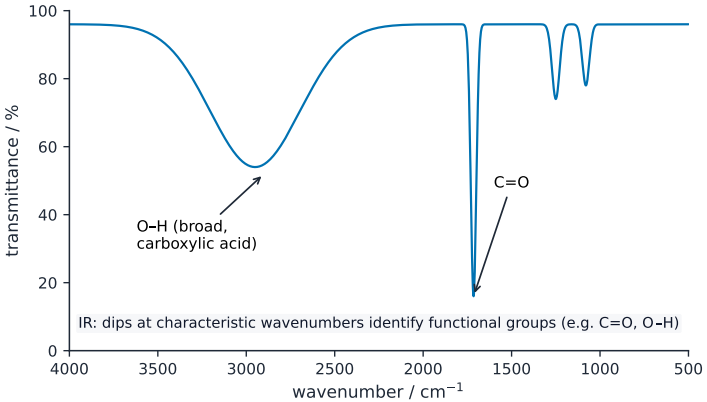
- analyse an IR spectrum to identify functional groups (using the given data table)
- use IR to check that a reaction has happened

Method — Reading an IR spectrum

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

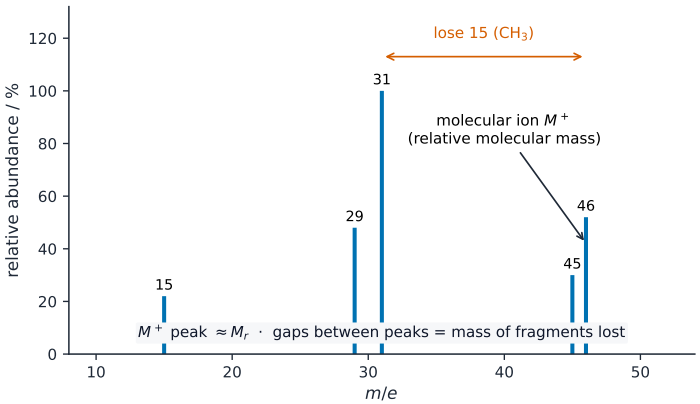
Checking a reaction: if propene → propan-2-ol, the C=C dip disappears and an O–H dip appears.

Method — Reading an IR spectrum



An IR spectrum dipping at a broad O–H band and a sharp C=O band

Method — Reading an IR spectrum



IR with mass spectrometry in structure determination

Practice 2.1 ▪ 1 mark

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

Solution 2.1

Worked steps

a C=O (carbonyl) bond B1.

Practice 2.2 ▪ 1 mark

State which functional group gives a broad absorption around 3200–3650 cm $^{-1}$.

Solution 2.2

Worked steps

an O–H group (in an alcohol) B1.

Exam-style 3.1 ▪ 1 mark

An IR spectrum shows a broad absorption at 2500–3000 cm^{-1} together with a peak at 1710 cm^{-1}. The compound is most likely:

A an alcohol

B an alkane

C a carboxylic acid

D a halogenoalkane

Solution 3.1

Method: Reading an IR spectrum

A an alcohol

B an alkane

C a carboxylic acid ✓

D a halogenoalkane

Worked steps

C. The broad 2500–3000 cm ^{1} plus a C=O peak indicates a carboxylic acid.

Exam-style 3.2 ▪ 1 mark

IR spectroscopy is most useful for identifying:

A the relative atomic mass

B the functional groups present

C the number of carbon atoms

D the boiling point

Solution 3.2

A the relative atomic mass

B the functional groups present ✓

C the number of carbon atoms

D the boiling point

Worked steps

B. IR identifies the functional groups present.

Exam-style 3.3 ▪ 2 marks

Butan-2-ol is oxidised to butanone.
(a) State the change you would see in the IR spectrum (which absorption disappears and which appears).
(b) Explain how IR confirms the oxidation has worked.

Solution 3.3

Method: Reading an IR spectrum

Worked steps

(a) the broad O–H absorption (~3200–3650 cm^{-1}) disappears **M1**; a C=O absorption (~1700 cm^{-1}) appears **A1**.

(b) losing the O–H and gaining a C=O shows the alcohol has been oxidised to a carbonyl (ketone) **M1** **A1**.