

3.11 Spectroscopy and the Electromagnetic Spectrum

Name: _____ Class: _____ Date: _____ **Total: 9 marks****KEY WORDS** electromagnetic spectrum 电磁波谱 • spectroscopy 光谱学 • solution 溶液

Objective

Build the skills to answer exam questions on **spectroscopy and the electromagnetic spectrum**.

You must be able to:

- order the **electromagnetic spectrum** 电磁波谱 by energy/wavelength
- link the type of transition to the region (microwave, IR, UV-Vis)
- explain how absorption reveals structure

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ The spectrum by energy

From low to high energy (long to short wavelength): radio < microwave < **infrared (IR)** < visible < **ultraviolet (UV)** < X-ray. Higher energy means shorter wavelength and higher frequency.

■ Matching region to transition

Each region excites a different kind of change:

- **Microwave** — molecular rotation;
- **Infrared** — bond vibration;
- **UV-Visible** — electron transitions between energy levels.

■ Absorption reveals structure

A molecule **absorbs** the wavelengths whose energy matches one of its transitions. The pattern of absorptions is a fingerprint of the bonds and electrons present.

■ Energy-wavelength relationship

Energy and wavelength are **inversely** related: $E = \frac{hc}{\lambda}$. Shorter wavelength $\Rightarrow$ more energetic photon.

2 Practice

Now apply the methods above.

2.1 Which has more energy: UV or infrared radiation? [1]

2.2 Which region of the spectrum causes bond **vibration**? [1]

2.3 As wavelength decreases, what happens to photon energy? [1]

3 Exam-style questions

3.1 Electron transitions between energy levels are typically caused by [1]

- **A** microwaves
- **B** infrared
- **C** UV-visible light
- **D** radio waves

3.2 A molecule absorbs strongly in the infrared region.

(a) What kind of molecular motion is being excited? [1]

(b) Explain what “absorption” means at the particle level. [2]

3.3 Arrange these in order of increasing energy: infrared, X-ray, visible, microwave. [2]

Solutions

2.1 UV.

2.2 Infrared.

2.3 It increases.

3.1 C — UV-visible light drives electron transitions.

3.2 (a) Bond vibration. (b) The molecule takes in a photon whose energy exactly matches an allowed transition, raising it to a higher-energy state.

3.3 microwave < infrared < visible < X-ray.