

Exercise walk-through

Electromagnetic Waves ■ 14.4

eXercise

You must be able to

- describe an **electromagnetic wave** 电磁波 as oscillating electric and magnetic fields
- state that all EM waves travel at the **speed of light** 光速 c in a vacuum
- order the regions of the **electromagnetic spectrum** 电磁波谱 by wavelength and frequency

Method — What an EM wave is

An electromagnetic wave is oscillating electric and magnetic fields, at right angles to each other and to the direction of travel. It needs **no** medium.

Method — Speed

Every EM wave travels at $c = 3.0 \times 10^8 \text{ m s}^{-1}$ in a vacuum.

Method — The spectrum (increasing frequency)

radio → microwave → infrared → **visible** → ultraviolet → X-ray → gamma.

Practice 2.1 ■ 1 mark

State the speed of all electromagnetic waves in a vacuum.

Solution 2.1

Method: Speed

Worked steps

$$3.0 \times 10^8 \text{ m s}^{-1} \quad \text{B1}.$$

Practice 2.2 ■ 1 mark

State what oscillates in an electromagnetic wave.

Solution 2.2

Method: What an EM wave is

Worked steps

electric and magnetic fields **B1**.

Practice 2.3 ■ 2 marks

Order these by increasing frequency: X-rays, radio waves, visible light.

Solution 2.3

Method: The spectrum (increasing frequency)

Worked steps

radio waves, then visible light, then X-rays **B1** **B1** *for the ends, for all correct.*

Exam-style 3.1 ■ 1 mark

All electromagnetic waves in a vacuum have the same

A frequency

B wavelength

C speed

D amplitude

Solution 3.1

A frequency

B wavelength

C speed



D amplitude

Worked steps

C.

Exam-style 3.2 ■ 1 mark

Which of these has the highest frequency?

A radio waves

B infrared

C visible light

D gamma rays

Solution 3.2

A radio waves

B infrared

C visible light

D gamma rays



Worked steps

D.

Exam-style 3.3 ■ 2 marks

A radio wave has a frequency of 1.0×10^8 Hz (take $c = 3.0 \times 10^8$ m s⁻¹).

- (a) Find its wavelength.
- (b) State whether X-rays have a longer or shorter wavelength than this.

Solution 3.3

Method: Speed

Worked steps

$$(a) \lambda = \frac{c}{f} = \frac{3.0 \times 10^8}{1.0 \times 10^8} = 3.0 \text{ m} \quad \text{M1} \quad \text{A1}. \quad (b) \text{ shorter} \quad \text{B1}.$$