

14.4 Electromagnetic Waves

Name: _____ Class: _____ Date: _____

Total: 9 marks

Objective

Build the skills to answer exam questions on **electromagnetic waves**.

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

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ 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.

■ Speed

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

■ The spectrum (increasing frequency)

radio $\rightarrow$ microwave $\rightarrow$ infrared $\rightarrow$ **visible** $\rightarrow$ ultraviolet $\rightarrow$ X-ray $\rightarrow$ gamma.

2 Practice

2.1 State the speed of all electromagnetic waves in a vacuum. [1]

2.2 State what oscillates in an electromagnetic wave. [1]

2.3 Order these by increasing frequency: X-rays, radio waves, visible light. [2]

3 Exam-style questions

3.1 All electromagnetic waves in a vacuum have the same [1]

- **A** frequency
 - **B** wavelength
 - **C** speed
 - **D** amplitude
-

3.2 Which of these has the highest frequency? [1]

- **A** radio waves
 - **B** infrared
 - **C** visible light
 - **D** gamma rays
-

3.3 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. [2]

(b) State whether X-rays have a longer or shorter wavelength than this. [1]

4 Go further

- work through the **14.4 Electromagnetic Waves** lesson on the **Learn** page;
- read the **Waves and Sound** section of the AP Physics 2 handout on the **Know** page.

Solutions

2.1 $3.0 \times 10^8 \text{ m s}^{-1}$.

2.2 electric and magnetic fields.

2.3 radio waves, then visible light, then X-rays.

3.1 C.

3.2 D.

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