

THE PHYSICS QUESTION BANK · AQA GCSE PHYSICS

Help or Hazard? – The Electromagnetic Spectrum

A one-hour lesson. Learn the electromagnetic spectrum, match each wave to its job, and decide which waves are helpful and which are hazards.

Name: _____ Class: _____ Date: _____

How to use this worksheet: work through the steps in order and write your answers in your exercise book. Copy every blue  box neatly – these are your revision notes. When you have finished a step, check your work against the **Answers** at the end and correct anything in a different colour.

 COPY INTO YOUR BOOK

By the end of this lesson I will be able to:

1. list the EM spectrum in order
2. give a use and a danger for each wave
3. explain why some waves are more dangerous
4. calculate wavelength or frequency.

Step 1: Starter (5 minutes)

In 2 minutes, write down as many types of electromagnetic wave as you can. Then try to put them in order.

 COPY INTO YOUR BOOK

The EM spectrum, from longest to shortest wavelength:

radio waves → microwaves → infrared → visible light → ultraviolet → X-rays → gamma rays

Memory trick: Raging Martians Invaded Venus Using X-ray Guns.

Step 2: Read and write (8 minutes)

Copy these three questions into your book. Then read the text and answer them in full sentences.

1. Are electromagnetic waves transverse or longitudinal?
2. What is the same about all EM waves in a vacuum?
3. Which EM waves can our eyes detect?

 READ

What are electromagnetic waves?

Electromagnetic (EM) waves are **transverse** waves: they vibrate at right angles to the direction the wave travels. They transfer energy from the source to an absorber. Unlike sound, they don't need particles, so they can cross the vacuum of space – which is how light and heat from the Sun reach us.

All EM waves travel at **the same speed** through a vacuum or air: 300 000 000 m/s. They form

a continuous spectrum, grouped by wavelength and frequency. Our eyes can only detect a very small part of it: **visible light**. The rest are invisible, but we have found uses for all of them.

COPY AND COMPLETE

All EM waves are _____ waves. They all travel at the same _____ through a vacuum: _____ m/s. Our eyes can only detect _____.

Step 3: Key facts (7 minutes)

Your task: copy this table – you'll use it for the main task.

Wave	Uses	Dangers
Radio waves	Television and radio	–
Microwaves	Satellite communications, cooking food	Can heat body tissue
Infrared	Electric heaters, cooking, infrared cameras	Burns
Visible light	Fibre optic communications	Very bright light can damage eyes
Ultraviolet	Energy-efficient lamps, sun tanning	Skin ages early; risk of skin cancer
X-rays	Medical imaging and treatment	Ionising – gene mutations and cancer
Gamma rays	Medical imaging and treatment, sterilising	Ionising – gene mutations and cancer

COPY INTO YOUR BOOK

From radio waves to gamma rays: wavelength gets SHORTER, frequency gets HIGHER, the waves carry MORE ENERGY – so they are MORE DANGEROUS.

Step 4: Main task, part 1 – Job matcher (10 minutes)

You're a science consultant. For each job, write which EM wave the company should use and one reason why.

A A café wants to toast bread under a grill. **B** A TV company wants to send signals to a satellite.
C A local radio station wants to broadcast to the whole town. **D** A hospital needs to check whether an arm is broken.

E A hospital needs to sterilise sealed packs of instruments. **F** A security company wants cameras that see people in the dark. **G** A broadband company wants to send data along glass cables. **H** A shop wants energy-efficient lamps.

 Score out of 8.

Step 5: Main task, part 2 – Help or Hazard? (8 minutes)

The hospital wants a safety poster for staff. **Your task:**

- Name the three most dangerous EM waves, most dangerous first.
- Explain WHY they are more dangerous than the others.

- Give two ways a radiographer can protect themselves.

 **COPY INTO YOUR BOOK**

X-rays and gamma rays are IONISING. They can damage the DNA in cells, causing gene mutations that can lead to cancer.

Step 6: Exam practice (12 minutes)

 **COPY INTO YOUR BOOK**

wave speed = frequency × wavelength $v = f \lambda$ (v in m/s, f in Hz, λ in m)

Q1 (2 marks) Explain why X-rays are used to make images of broken bones.

Q2 (3 marks) A radio station broadcasts at 2.0×10^8 Hz. The speed of radio waves is 3.0×10^8 m/s. Calculate the wavelength.

Q3 (4 marks) Describe the harmful effects of ultraviolet, X-rays and gamma rays, and explain why they are more harmful than radio waves.

 **Add up your marks out of 9.**

Step 7: Exit ticket (5 minutes)

Cover your book and write the EM spectrum in order from memory. Then finish:

- The EM wave I use most in my daily life is... for...
- Gamma rays are dangerous because...
- One thing I'm still not sure about is...

Answers

Only look at these once you have written your own answer!

Step 1: Starter (5 minutes)

There are seven – check your order against the box below.

Step 2: Read and write (8 minutes)

(1) Transverse. (2) They all travel at the same speed – 3×10^8 m/s. (3) Only visible light.

Gaps: transverse · speed · 3×10^8 (300 000 000) · visible light

Step 4: Main task, part 1 – Job matcher (10 minutes)

A infrared (heats the bread). B microwaves (pass through the atmosphere to satellites). C radio waves (travel long distances). D X-rays (pass through soft tissue, absorbed by bone). E gamma rays (pass through packaging, kill bacteria). F infrared (warm bodies give it out). G visible light (fibre optics). H ultraviolet (energy-efficient lamps).

Step 5: Main task, part 2 – Help or Hazard? (8 minutes)

1. Gamma, X-rays, ultraviolet. 2. Highest frequencies, so most energy; X-rays and gamma are ionising – they damage DNA, causing mutations and cancer; UV ages skin and increases skin-cancer risk. 3. Stand behind a lead screen or leave the room; wear a lead apron; keep the number of X-rays low.

Step 6: Exam practice (12 minutes)

Q1: X-rays pass through soft tissue (1) but are absorbed by bone, so bones show up on the detector (1).

Q2: $v = f \lambda$ (1); $3.0 \times 10^8 = 2.0 \times 10^8 \times \lambda$ (1); $\lambda = 1.5$ m (1).

Q3: UV ages skin and increases risk of skin cancer (1); X-rays and gamma are ionising (1) and can cause gene mutation and cancer (1); they have much higher frequency so transfer more energy (1).