Uses of the Electromagnetic Spectrum

Do Now:

1. Name three types of electromagnetic wave.
   Radio, micro, infra-red, visible light, ultra-violet, x-ray, gamma ray
2. Are electromagnetic waves transverse or longitudinal?
   Transverse
3. Define a transverse wave.
   A wave in which the oscillations are perpendicular to the direction of energy transfer.
4. Name the type of EM wave with the highest frequency.
   Gamma rays
5. Name the type of EM wave with the longest wavelength.
   Radio waves

Do Now



Uses of the Electromagnetic Spectrum

Do Now:

1. Name three types of electromagnetic wave.
2. Are electromagnetic waves transverse or longitudinal?
3. Define a transverse wave.
4. Name the type of EM wave with the highest frequency.
5. Name the type of EM wave with the longest wavelength

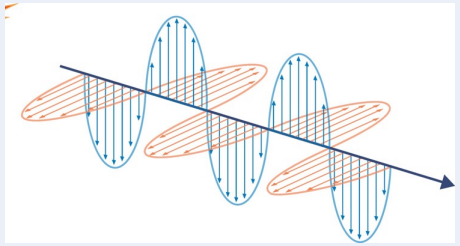
Drill:

1. Convert 30 GHz into hertz
2. A wave has a wavelength of 10 μm. How big is the wavelength in metres and in centimetres?
3. If a microwave has a frequency of 30Ghz and travels at a speed of 3×10^{8} m/s, what is its wavelength?



Do Now

Uses of the Electromagnetic Spectrum



Read Now:

Where do EM waves come from?

Electromagnetic waves are electric and magnetic disturbances. They are generated by an oscillating or vibrating charge (e.g. an electron). The oscillations of the electric and magnetic fields are perpendicular to each other and to the direction of energy transfer of the wave. Changes in atoms and the nuclei of atoms can result in electromagnetic waves being generated over a wide frequency range. Gamma rays are produced by changes in the nucleus of an unstable radioactive atom. X-rays are produced by accelerating electrons in an x-ray tube and then stopping them when they collide with a target. Radio-waves can be produced by oscillations in an electrical circuit.

1. What is an electromagnetic wave?
2. How are electromagnetic waves generated?
3. How are gamma rays produced?
4. How are X-rays produced?
5. How are radio-waves produced?

Do Now

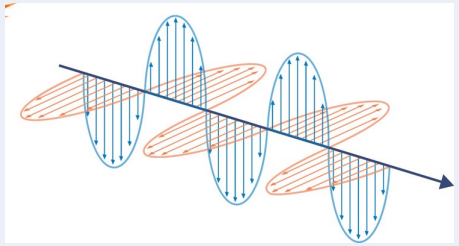
Where do EM waves come from?

Electromagnetic waves are electric and magnetic disturbances. They are generated by an oscillating or vibrating charge (e.g. an electron). The oscillations of the electric and magnetic fields are perpendicular to each other and to the direction of energy transfer of the wave. Changes in atoms and the nuclei of atoms can result in electromagnetic waves being generated over a wide frequency range. Gamma rays are produced by changes in the nucleus of an unstable radioactive atom. X-rays are produced by accelerating electrons in an x-ray tube and then stopping them when they collide with a target. Radio-waves can be produced by oscillations in an electrical circuit.

Inside

Outside

Beyond

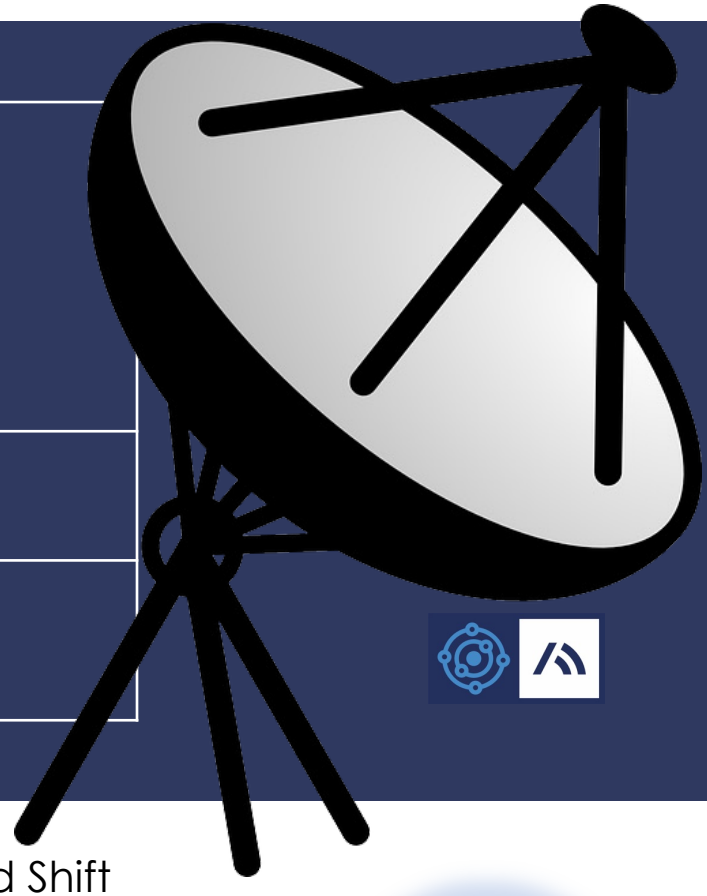


28/04/2024

Uses of the Electromagnetic Spectrum

P5.1.4

Science Mastery



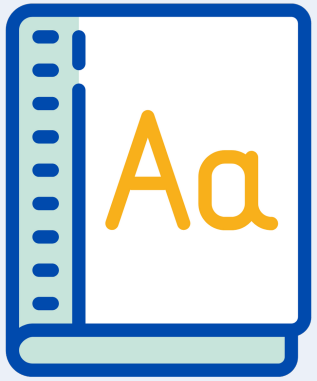
P5.1.1 PKR: Properties of waves
P5.1.2 PKR: Observing waves
P5.1.3 The Electromagnetic Spectrum
➢ **P5.1.4 Uses of the EM Spectrum**
P5.1.5 PKR: Reflection and Refraction
P5.1.6 TIF: Visible Light and Lenses
P5.1.7 TIF: Ray Diagrams
P5.1.8 TIF: Colour
P5.1.9 TIF: Big Bang Theory and Red Shift
P5.1.10 RPA: Infrared Radiation
P5.1.11 RPA: Infrared Radiation Analysis
P5.1.12 TIF: Black Bodies and Radiation
P5.1.13 TIF: Earth and Radiation



Following this lesson, students will be able to:

- Describe the uses of each group of waves in the EM spectrum
- Predict which waves will be most hazardous and describe the risks
- Describe where EM waves originate from

Key Words:



range **oscillation**

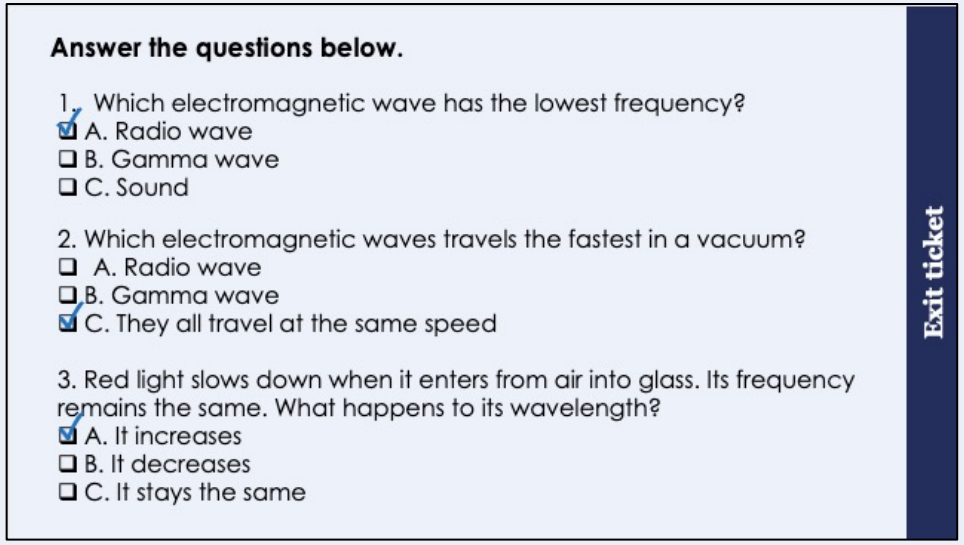
ionising

Lesson Objectives

This is the fix-it portion of the lesson

The **fix-it** is an opportunity to respond to gaps in knowledge, especially those identified by the previous lesson's exit ticket.

- The teacher should customise this slide as needed, to facilitate
  - **reteach**, **explanation, demonstration** or **modelling** of ideas and concepts that students have not yet grasped or have misunderstood.
  - **practise** answering specific questions or of key skills.
  - **redrafting** or **improving** previous work.

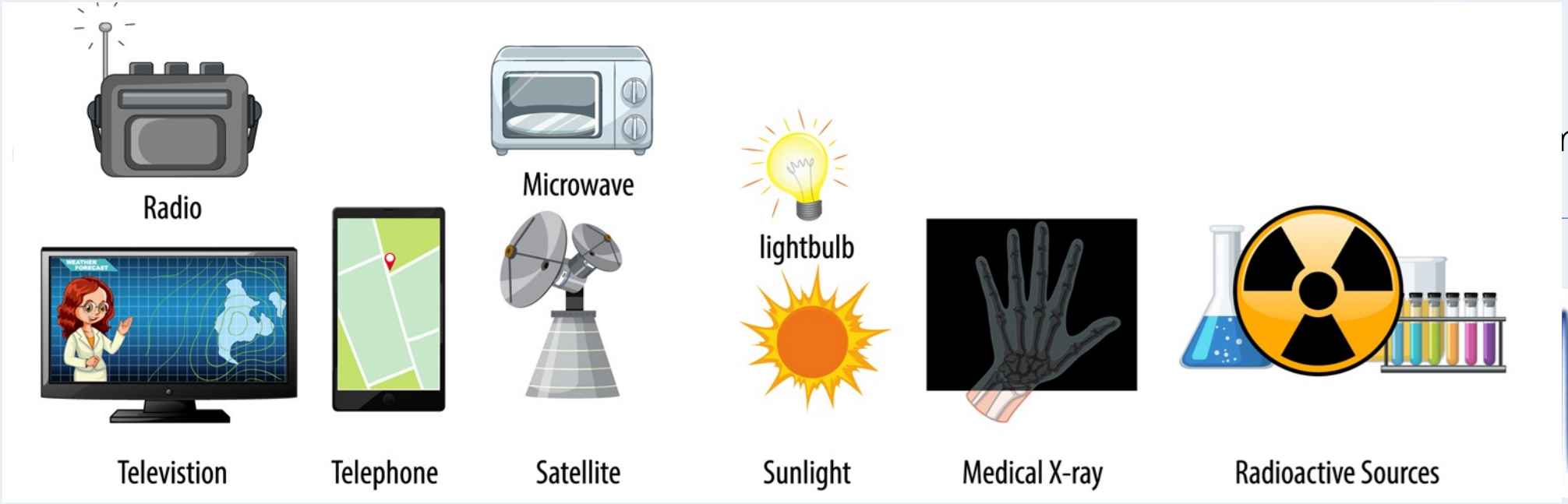


Fix-it

Uses of EM waves

EM waves are used for:

- Communication
- Medical diagnosis and treatment
- Cooking



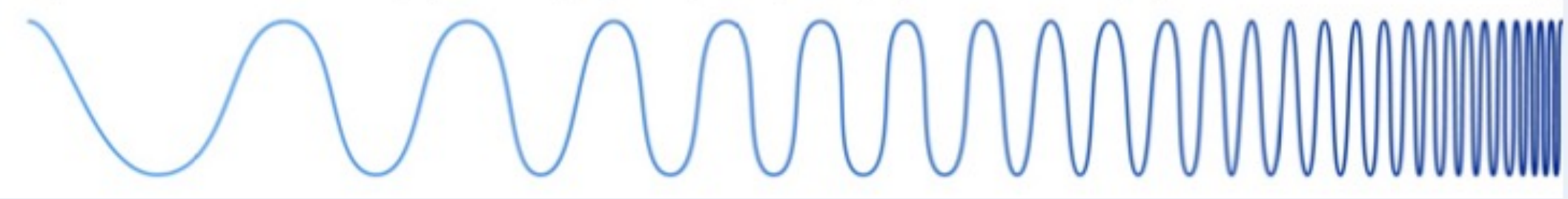
Communication using electromagnetic waves

Radio waves, microwaves, infrared and visible light are all used as **carrier waves** (waves that carries an information bearing signal).

Different **frequencies** are used for different communication purposes.

The wavelength and frequency affects:

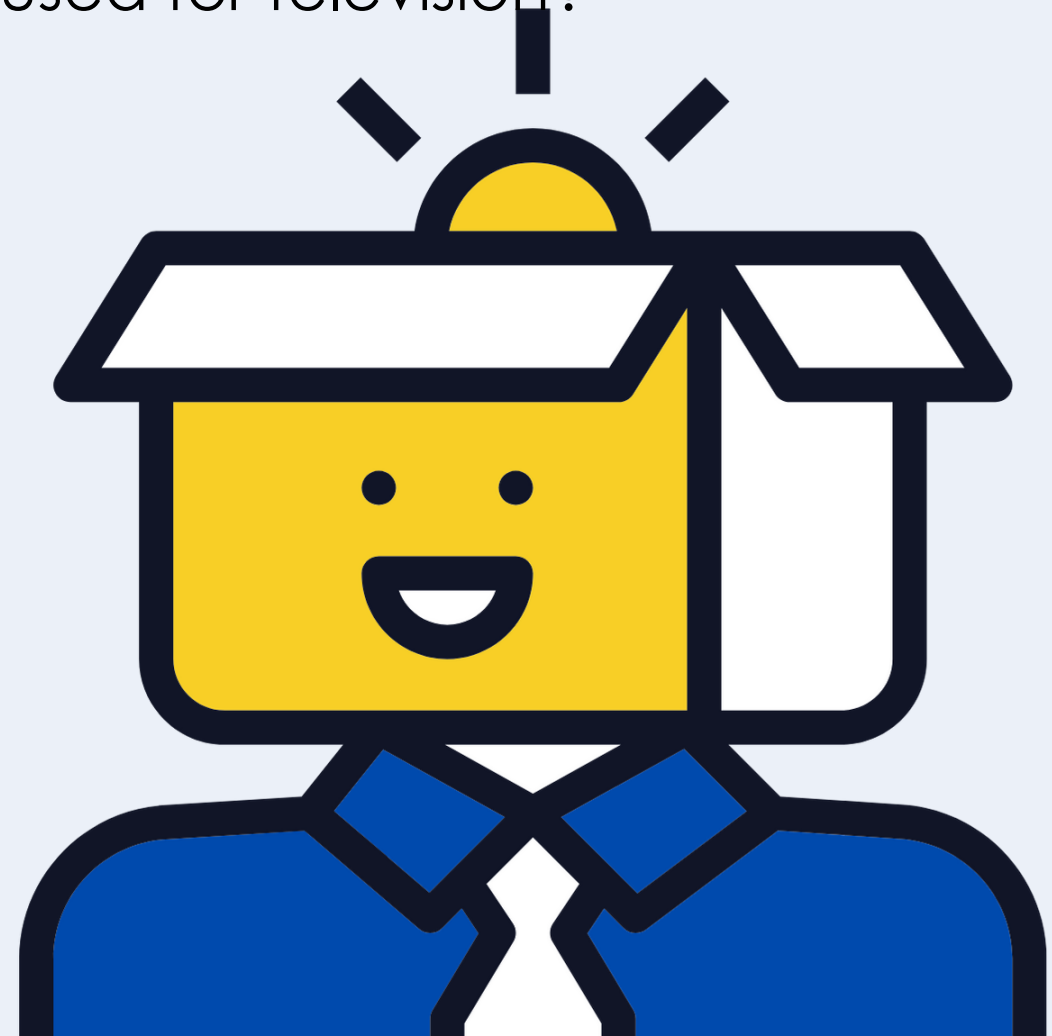
- How much **information** they can carry
- How far they can travel or their **range**
- How much they can **spread**



Communication using electromagnetic waves

1. What waves do you think might be used for local radio?
2. What waves do you think might be used for television?

- **Radio waves between 1 and 100 m are used for local radio and wavelengths greater than 100 m are used for national broadcasts as they can travel further**
- **Radio waves less than 1 m are used for TV broadcasts, as they can carry more information**
- **Ultra high frequency radio waves are used for Bluetooth and wi-fi.**



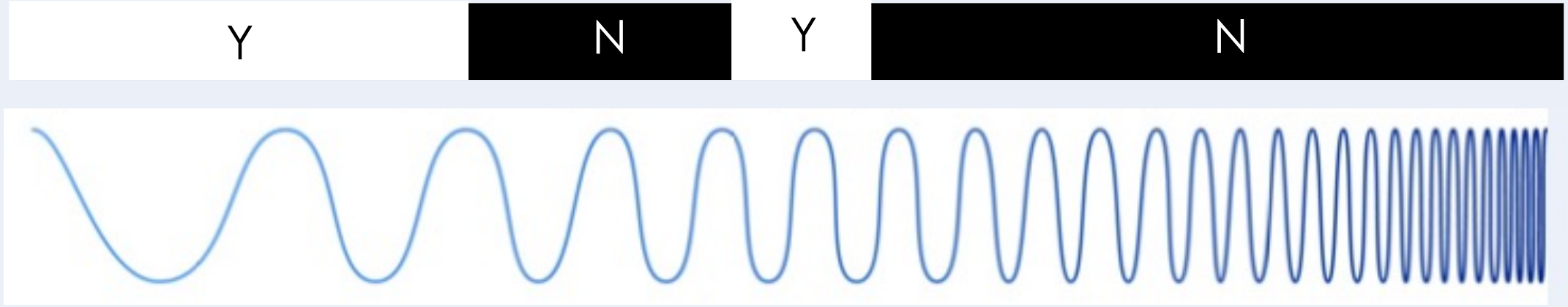
Talk Task

Communication using electromagnetic waves

The **atmosphere** blocks some wavelengths but lets others **pass through**.

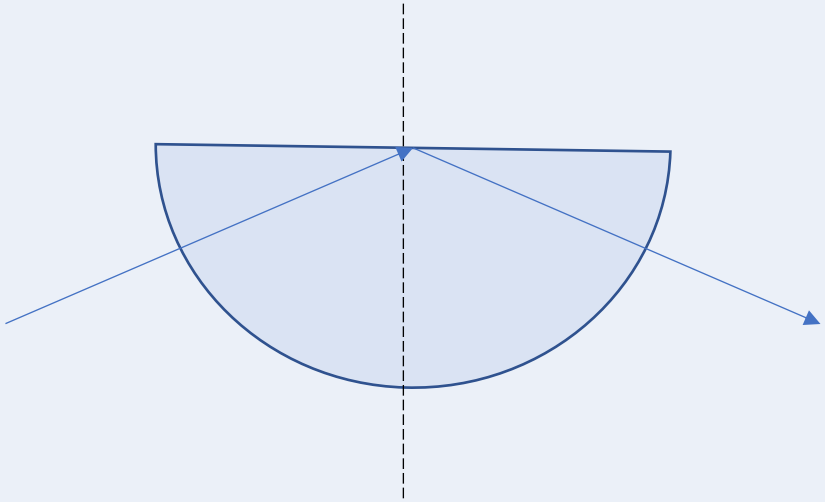
Microwaves are used to reach satellites above the earth, as they can pass through the atmosphere and can carry more information than radio-waves.

Can penetrate Earth's atmosphere?

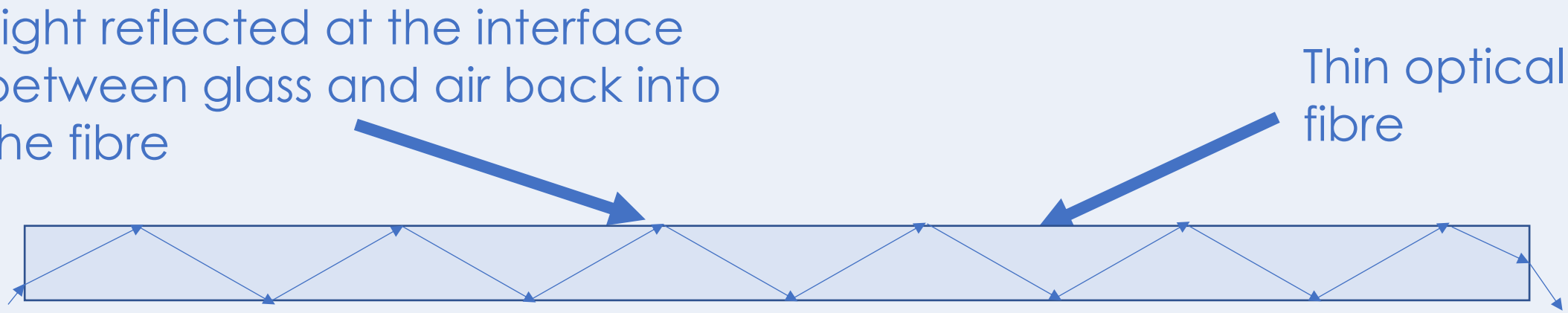


Communication using electromagnetic waves

What happens as you rotate the block so that the ray meets the straight side at different angles?



Optical (glass) fibres are used to transmit signals carried by **light** or **infra red** radiation

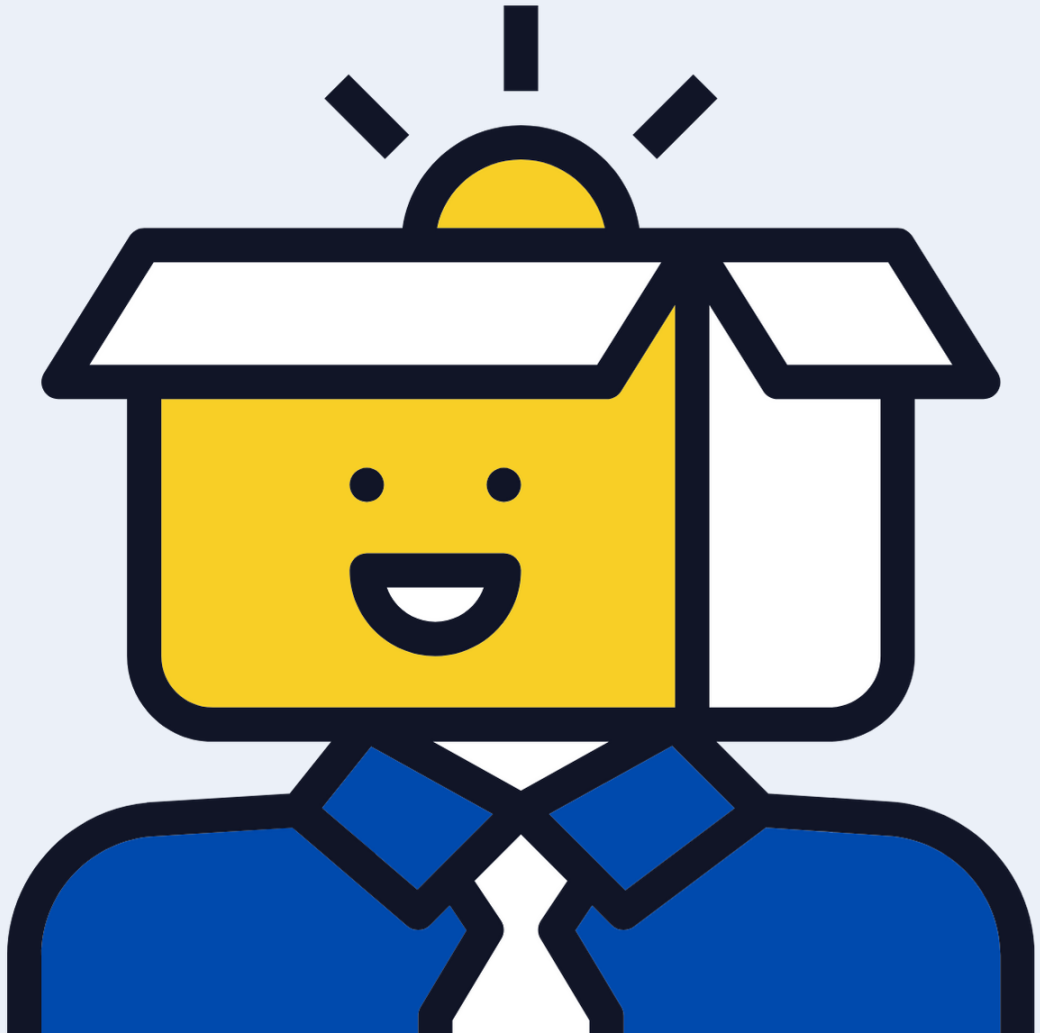


Communication using electromagnetic waves

How do you think the International Space Station communicates with Earth?

The ISS and NASA tend to use radio waves. They create the least amount of energy to create (important consideration when you're on a space craft) and can pass through the atmosphere.





Talk Task

EM waves in cooking



Where are EM waves used in the kitchen?

EM waves in medicine

X-rays are used to detect if bones have been broken.

X-rays are generated by a source (X-ray tube)



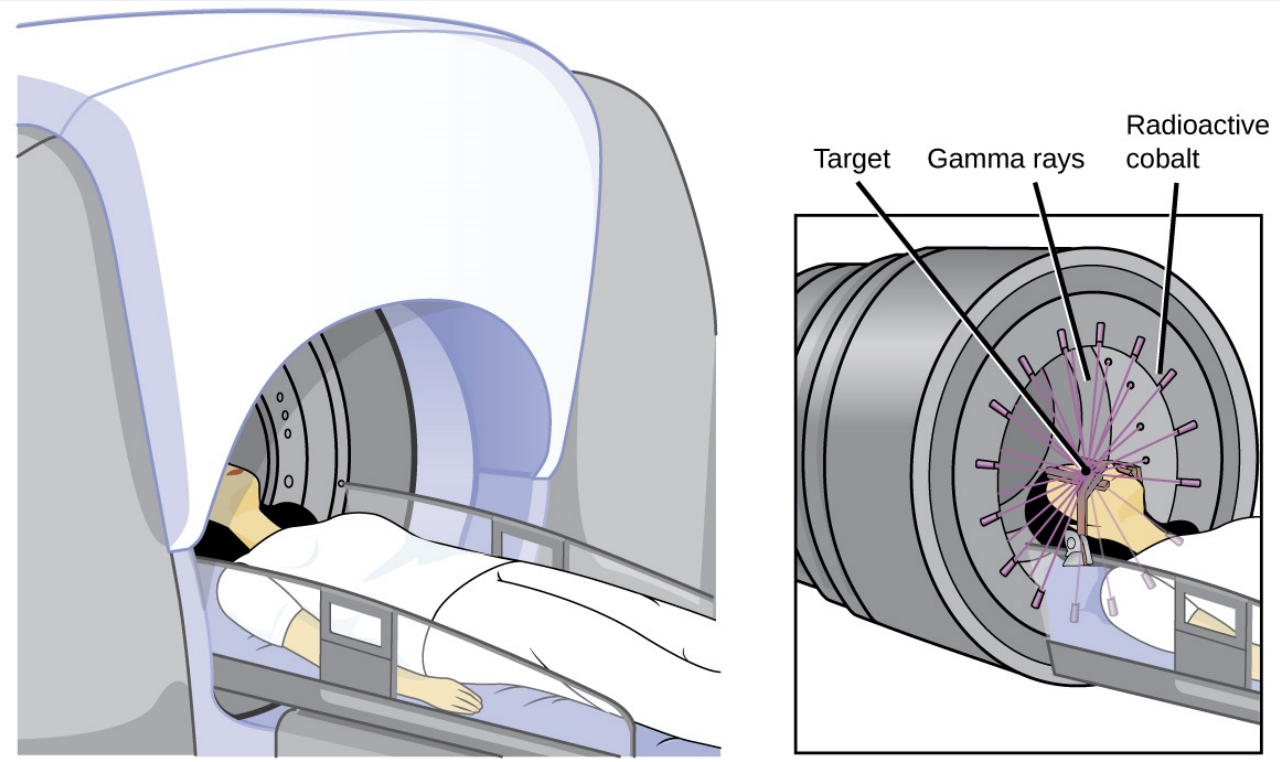
X-rays pass through soft tissue but are absorbed by bone



Parts of the film/detector which are hot by x-rays become darker than other parts

EM waves in medicine

- Gamma ray therapy is used to destroy **cancerous** tumours.
- A narrow beam is fired at the cancerous cells.
- By changing the direction at which the beam hits the tumour, it ensures that the tumour receives a full dose, while the surrounding healthy tissue receives a much lower dose.



Uses of UV light

UV light can cause some substance to glow or fluoresce. What uses can you see here?

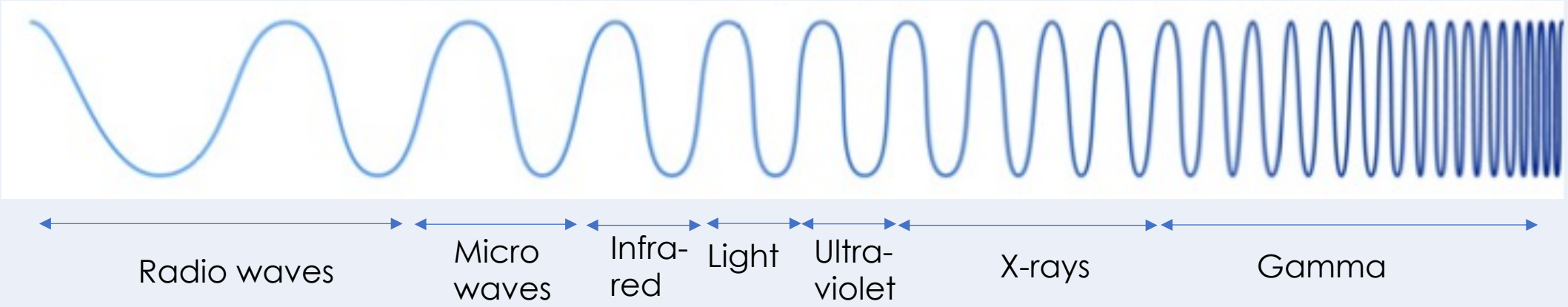






Hazards of EM waves

Which waves have the potential to be harmful?



- Higher frequency waves transfer more energy.
- UV, x-rays and gamma rays are all high energy waves.
- The higher the frequency, the higher the risk.
- They are all ionising – they have the potential to knock electrons from atoms to create ions.
- Ionising radiation can damage DNA and cause cancer.

Hazards and Risks

A **hazard** is something that could cause harm

"***UV rays*** *could cause sunburn*"

The **risk** is the likelihood of the harm that might happen to you or someone else

"*When sitting in the sun all day there is a increased risk of* ***sunburn****.*"

A radiographer takes x-rays of patients all day.
What is the <u>hazard</u> and the <u>risk</u>?

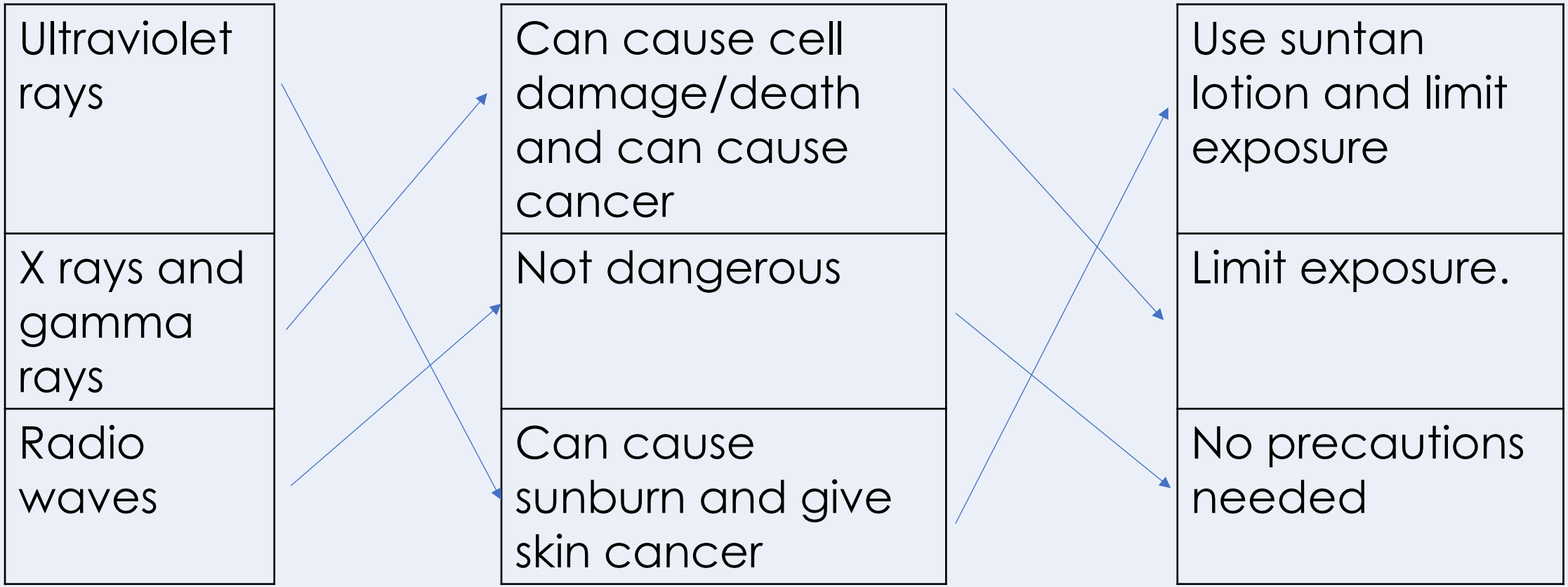
The hazard is the exposure to x-rays.

There is an increased risk of cancer.



Hazards and precautions for EM waves

Can you match the wave with the corresponding hazard and precaution?



Check for understanding

Which statements do you agree with?

Gamma rays can cause cancer

All electromagnetic radiation is dangerous

You can get radiation sickness from UV radiation

Gamma rays can cure cancer

Talk Task

Drill

1. What are microwaves used for?
2. What are gamma waves used for?
3. What are radio waves with a long wavelength used for?
4. What are radio waves with a shorter wavelength used for?
5. What are infra red waves used for?
6. What is visible light used for?
7. What is UV light used for?
8. What are x-rays used for?

Check for understanding

Drill answers

1. Microwaves are used for cooking and for communication (satellites)
2. Gamma waves are used for targeting cancerous cells. They can also be used for sterilisation of food/ medical equipment
3. Radio waves with a long wavelength is used for TV
4. Radio waves with a short wavelength are used for radio
5. Infrared waves are used for cooking and can also be used for communication
6. Visible light is used for seeing
7. UV light is used for detecting forgeries and on tanning beds
8. X rays are used to diagnose broken bones.

Check for understanding

I: Describe: *to recall facts, events or processes in an accurate way*

Example question:

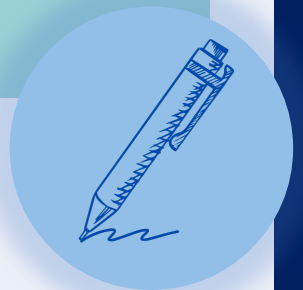
Describe how EM waves are used in communication.

Model answer:

- **Radio** waves are used in broadcasting radio and television
- **Microwaves** are used in satellite communication
- **Visible light** and **infrared** are used in communication using optical fibres

To 'describe', your answer should:

- Use **bullet points** to keep your answer clear
- Cover enough points to **fully answer** the question
- Use scientific **keywords** in your answer
- '**Say what you see**' if there is a diagram, graph or table.



Writing like a scientist

We: Describe: *to recall facts, events or processes in an accurate way*

Example question:

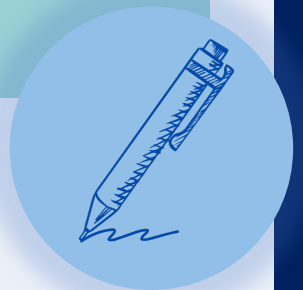
Describe how EM waves are used in cooking.

Model answer:

- **Microwaves** are used to heat water inside food
- **Infrared** is used in ovens and hobs

To 'describe', your answer should:

- Use **bullet points** to keep your answer clear
- Cover enough points to **fully answer** the question
- Use scientific **keywords** in your answer
- '**Say what you see**' if there is a diagram, graph or table.



Writing like a scientist

You: Describe: *to recall facts, events or processes in an accurate way*

Example question:

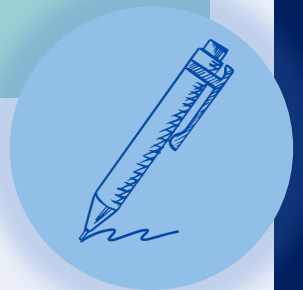
Describe how EM waves are used in medicine.

Model answer:

- **X-rays** are used in imaging to diagnose broken bones
- **Gamma rays** are used in radiotherapy to irradiate cancerous cells

To 'describe', your answer should:

- Use **bullet points** to keep your answer clear
- Cover enough points to **fully answer** the question
- Use scientific **keywords** in your answer
- '**Say what you see**' if there is a diagram, graph or table.



Writing like a scientist

Answer the questions below.

1. Which electromagnetic waves are used for communication?

- ☐ A. Radio-waves and gamma rays
- ☑ B. Radio-waves and microwaves
- ☐ C. Sound waves

2. Which waves have medical uses?

- ☐ A. UV and x-rays
- ☐ B. Microwaves and x-rays
- ☑ C. Gamma rays and x-rays

3. Which waves are used for cooking?

- ☑ A. Infra red and microwaves
- ☐ B. Infra red and gamma rays
- ☐ C. Gamma rays and microwaves

Exit ticket

Feedback

Lesson P5.1.4	
What was good about this lesson?	What can we do to improve this lesson?

Send us your feedback by clicking this link
or by emailing sciencemastery@arkonline.org
Thank you!