Uses of Electromagnetic Waves

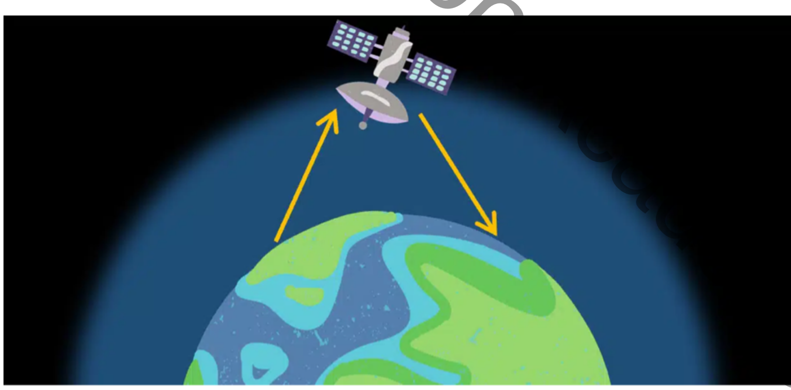
Microwaves

- **Microwaves** have wavelengths around 1 cm.
- There are two main uses of microwaves:

1. Satellite communication
2. Microwave ovens

1. Satellite Communication

- **Microwaves** are used to send signals to **satellites** which can send the signals on to distant locations.
- The satellites **orbit** the Earth, thousands of kilometers above the surface.
- Microwaves have a high enough frequency to penetrate the Earth's atmosphere and to reach satellites.
- Microwaves travel in straight lines through the atmosphere. This makes them good for transmitting (sending) signals.
- The returned signal is received by a **satellite dish**.

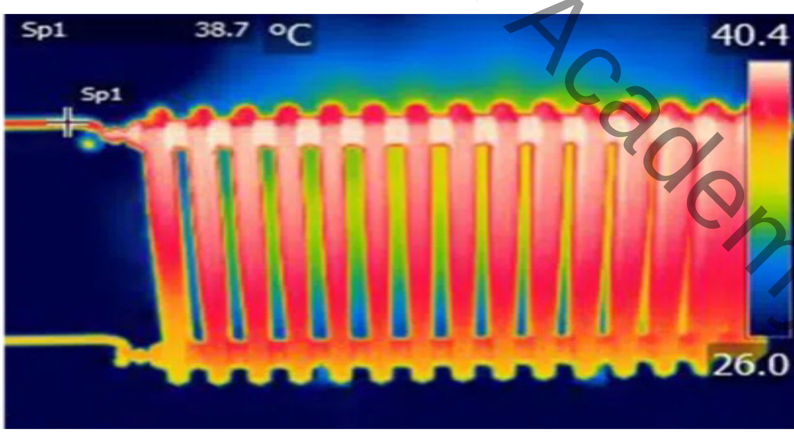


2. Microwave Ovens

- In **microwave ovens**, microwave radiation is emitted by the oven and then absorbed by **water molecules** in the food.
- This energy heats up the water molecules, which also heat up the surrounding molecules via **heat transfer**.

Infrared Radiation

- **Infrared** waves are **emitted** when objects heat up.
- Infrared waves can be used to **detect warm objects** and **measure temperature** from a distance.
- It can also be used by an infrared camera to create an image where different colours represent different temperatures as shown the below picture.

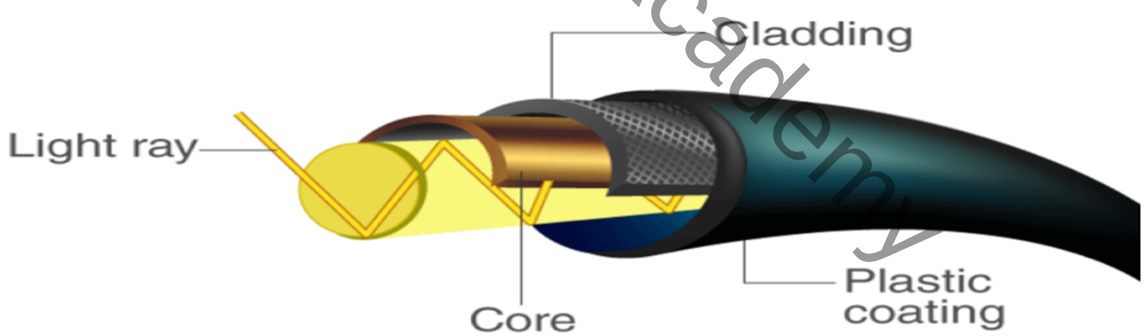


- Objects also heat up when they **absorb infrared** radiation. Food can be cooked using infrared radiation, temperature of the food increased when it absorbed IR radiation.
- Electric heaters and the heating element inside toasters both emit infrared radiation, along with a small amount of visible light, in order to heat up the air and your toast.

Visible Light

- **Visible light** is the range of wavelengths through which we see the world. However it can also be used for communications.

- **Visible light** is used in **optical fibers** made of glass to transmit information. The visible light travels along the fibre by **reflecting** off the inner surface of the fibre and is not **refracted** or **transmitted** through the fibre. This technology is now commonly used for internet connections.

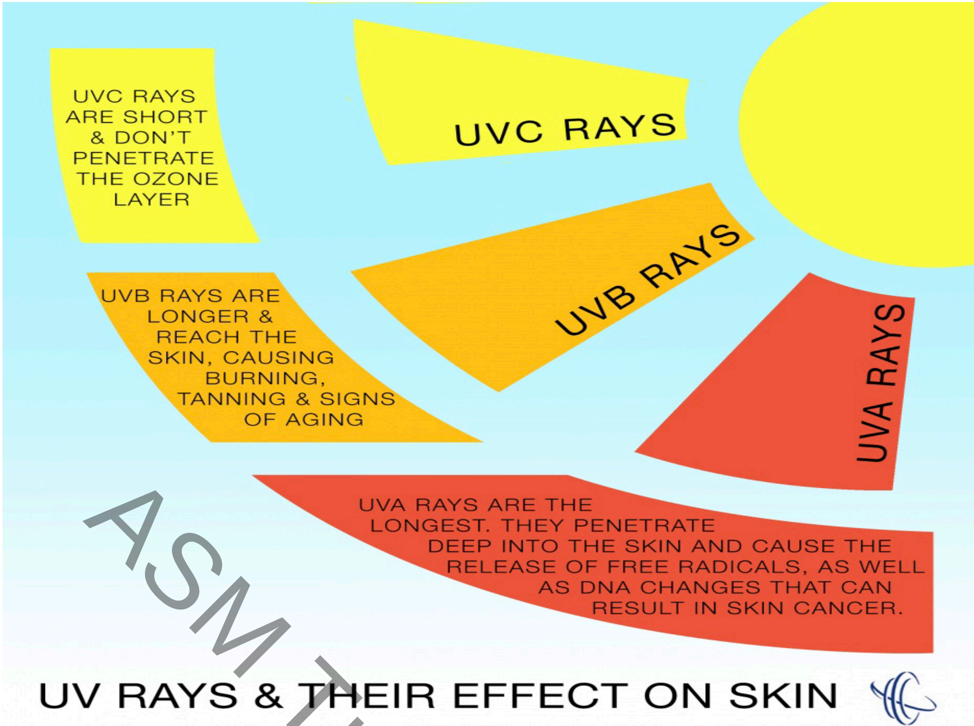


Ultraviolet Radiation

- **Ultraviolet** radiation (UV) has wavelengths of approximately 10−8 m10−8 m.
- The ultraviolet waves are useful, they can also be harmful because ultraviolet radiation can **damage cells** and **ionise** (remove electrons from) the atoms in our **DNA**. This can cause **sunburn**, **DNA mutations** and **cancer**.

- The following are uses of ultraviolet waves:

  - **Fluorescence** – this is where certain compounds, when exposed to ultraviolet waves, emit visible light. Fluorescent lights are very energy efficient.
  - **Security pens** – these are used to mark objects with writing that is only visible under ultraviolet light.
  - **Tanning** – the sun emits ultraviolet radiation and this can give you a sun tan if you spend a lot of time outside. Tanning salons also use ultraviolet lamps to give you a sun tan when it is not sunny outside. However, lots of exposure to ultraviolet radiation can be harmful.

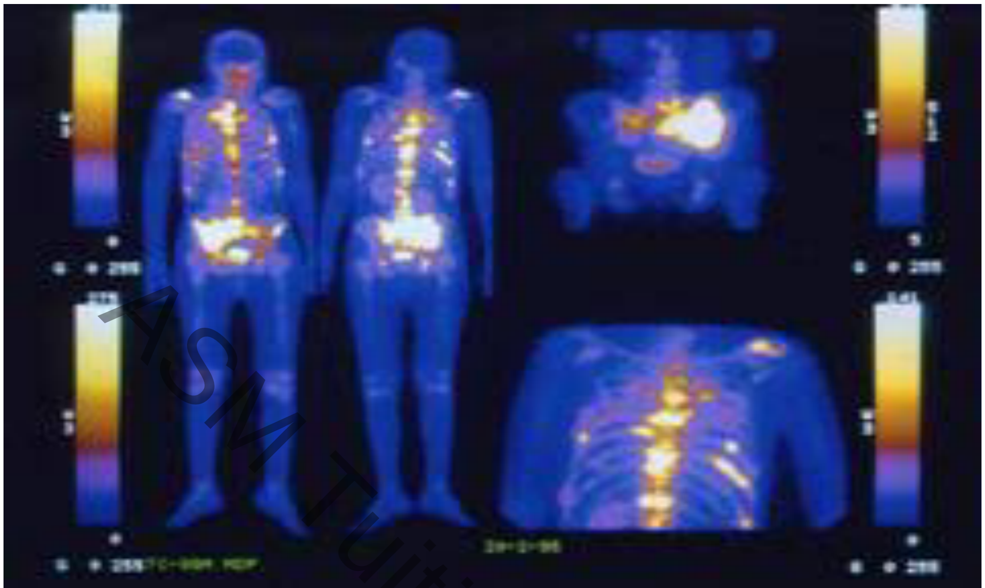


X-rays and Gamma Rays

- **X-rays** and **gamma rays** have the shortest wavelengths of all the types of **electromagnetic radiation**. They have very high energies and are therefore potentially the most harmful.
- The main uses of X-rays and gamma rays are in **medicine**:

  - **X-ray Imaging** – X-rays mostly pass through soft tissue such as muscle and fat but they are absorbed by denser materials like bones. This means if we take a picture of the body using X-rays, we can see the what the bones look like inside the body.

- **Medical Tracers** – these are radioactive medicines that are used to either treat a disease or take an image. For example, the image on the right shows a PET image. This image was taken by injecting a radioactive medical tracer into the body and then detecting the radiation emitted by the tracer.



- **Radiotherapy** – this is where X-rays and gamma rays are used to treat cancers. The high doses of radiation from the X-rays and gamma rays kills the cancer cells.