

## Light Emitting Diodes and the Electromagnetic Spectrum

Diabetes is a medical condition which causes a person's blood sugar levels to become too high. If not managed properly, diabetes can lead to many health problems.

In some diabetes patients, the retina of the eye can become starved of oxygen when they are asleep. The body tries to deal with this by producing more blood vessels to supply more blood, and therefore more oxygen. These new blood vessels are weak, and can leak fluid into the eye. This is known as diabetic retinopathy, or diabetic eye disease, and can lead to blindness.



*Sleep mask for the treatment of diabetic retinopathy, made by Polyphotonix*

*Image credit: courtesy Polyphotonix Ltd.*

Polyphotonix is a company based in County Durham who have developed a 'sleep mask' for the prevention and treatment of diabetic retinopathy. This is cheaper than other treatments, and can be used at home instead of in hospital. The mask uses organic light emitting diodes (OLEDs) to deliver a low level of light through closed eyelids while the patient sleeps. This reduces the amount of oxygen the eye needs and prevents the formation of problematic new blood vessels.

### Know

1. An OLED is a type of light emitting diode (LED). Draw the circuit symbol for an LED.
2. We can classify materials into three categories according to their electrical resistance (how easily they let electric current flow). **Name** these three categories and **state** in which category you would find OLEDs.
3. In an OLED, as with all diodes, the current flows in one direction only. Sketch a graph of current against potential difference for an OLED.
4. The Polyphotonix sleep mask produces visible light. Visible light is part of the electromagnetic spectrum. Write down the waves of the electromagnetic spectrum, in order of increasing frequency.

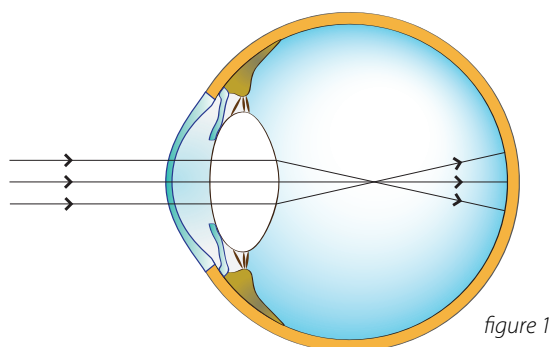
### Apply

5. All electromagnetic waves travel through empty space at a speed of  $3 \times 10^8$  m/s.
  - a. Write down the formula which relates speed, frequency and wavelength of electromagnetic waves.
  - b. Use this formula to calculate the frequency of radio waves which have a wavelength of 2.5 metres.
6. The Polyphotonix sleep mask produces a low level of visible light. Very bright visible light can cause damage to the retina of the eye. This is why you shouldn't stare at the sun. The sun also produces ultra-violet waves.

State one way in which ultraviolet waves are different from visible light waves, and explain how that property makes them harmful to humans.

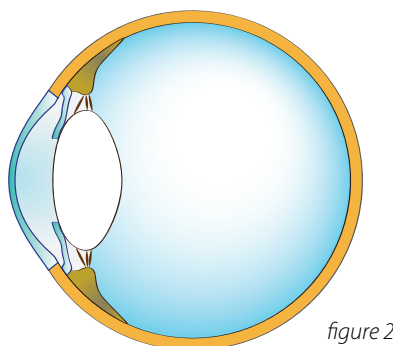
### Extend

7. The Polyphotonix sleep mask has been designed to help prevent damage to the retina of the eye. In order for us to see an object in focus, light from the object has to be focussed on the retina. Myopia (short sightedness) is a defect of the eye in which rays of light do not focus on the retina, as shown in *figure 1*:



*figure 1*

Complete *figure 2* to show how a spectacle lens can be used to correct short-sightedness:



*figure 2*



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