Electromagnetic waves

1 (a) Complete the sentences by putting a cross (☒) in the box next to your answer.

(i) All electromagnetic waves are

(1)

☒ **A** longitudinal and have the same amplitude in a vacuum

☒ **B** longitudinal and have the same speed in a vacuum

☒ **C** transverse and have the same amplitude in a vacuum

☒ **D** transverse and have the same speed in a vacuum

(ii) All electromagnetic waves have both uses and dangers.

Their potential danger increases when

(1)

☒ **A** frequency decreases and wavelength decreases

☒ **B** frequency increases and wavelength decreases

☒ **C** frequency decreases and wavelength increases

☒ **D** frequency increases and wavelength increases

(b) Some microwaves have a frequency of 1.5×10^{10} Hz.
They travel at a speed of 3.0×10^{8} m/s.

Calculate their wavelength.

(3)

wavelength = ... m

(c) Infrared is used in an electric toaster.
Infrared is also used by a television remote control.



electric toaster



television remote control

Explain why using a television remote control does not burn anyone.

(2)

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(d) Gamma rays can cause cancer.
Gamma rays can also be used to treat cancer.

Explain how gamma rays can do both.

(3)

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(Total for Question 3 = 10 marks)

2 (a) The diagram shows a section of the electromagnetic spectrum.

Five parts of this have been named.

infrared	1	2	3	green	blue	indigo	4	ultraviolet

State the names of the other four parts, 1, 2, 3 and 4, in the spaces below.

(2)

Part 1 .....

Part 2 .....

Part 3 .....

Part 4 .....

(b) Complete the sentence by putting a cross (☒) in the box next to your answer.

Infrared radiation is used for

(1)

☒ **A** cooking

☒ **B** suntanning

☒ **C** curing cancer

☒ **D** sterilising water

(c) Describe how ultraviolet radiation is used in the detection of forged bank notes.

(2)

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(d) Explain the difference in potential danger between ultraviolet radiation and infrared radiation.

(2)

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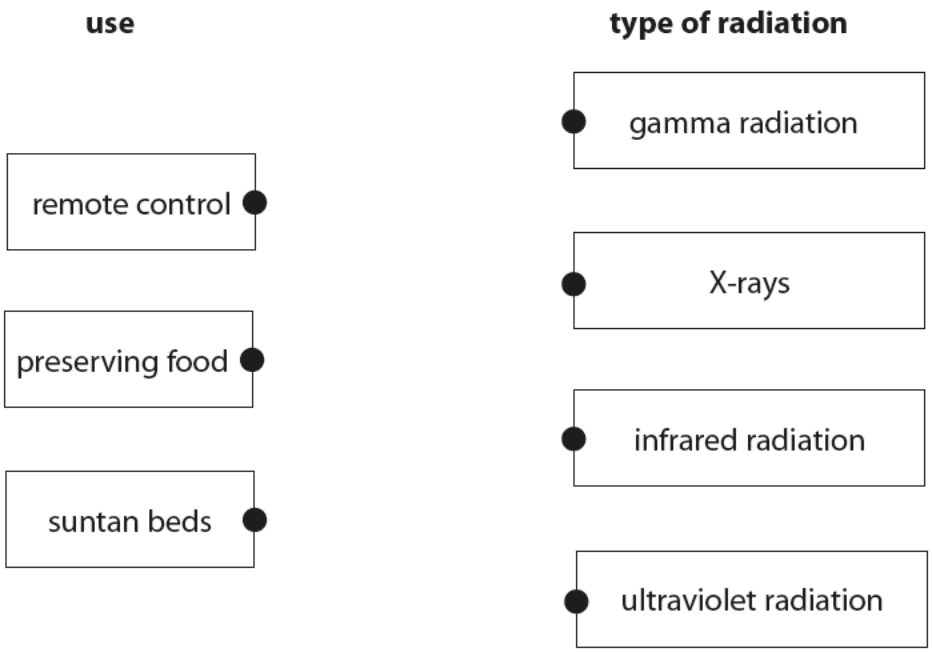
(Total for Question 1 = 7 marks)

Electromagnetic spectrum

3 (a) Different types of electromagnetic radiation have different uses.

Draw one straight line from each use to the correct type of radiation.

(3)



(b) X-rays from a star travel to a space telescope in orbit around the Earth.

Explain why visible light from the same star takes the same time to reach the telescope.

(2)

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(c) Which of these ionising radiations is from a radioactive source and is also part of the electromagnetic spectrum?

Put a cross (☒) in the box next to your answer.

(1)

- ☐ **A** alpha particles
- ☐ **B** beta particles
- ☐ **C** gamma rays
- ☐ **D** X-rays

(d) An X-ray of wavelength 2.0 nm has a frequency of 1.5×10^{17} Hz.

$1.0\ \text{nm} = 1.0 \times 10^{-9}\ \text{m}$

Calculate the speed of the wave.

(2)

speed = ... m/s

(Total for Question 1 = 8 marks)

4 (a) A student investigates how the surface of an object affects the radiation it emits.

Figure 7 shows the equipment he uses.

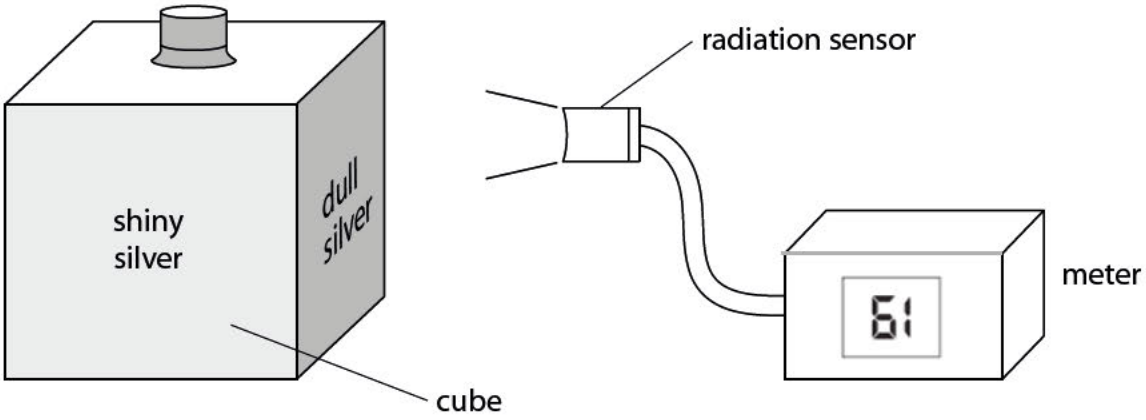


Figure 7

The cube has four different surfaces.

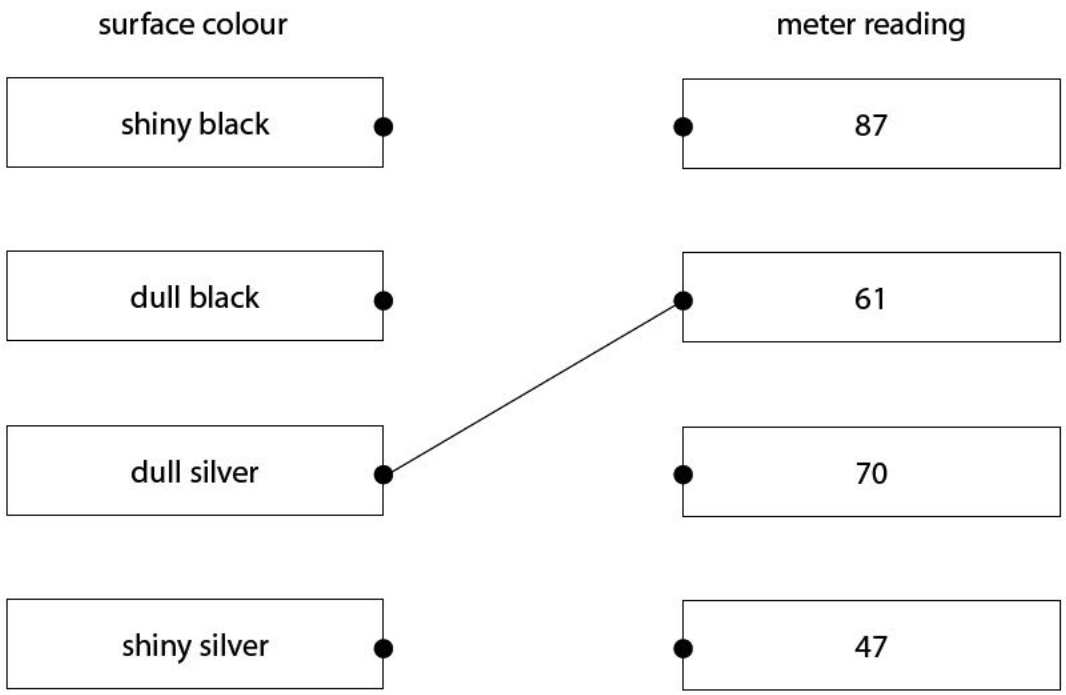
He fills the cube with boiling water so that the temperature of each surface is the same.

He uses the radiation sensor to measure the radiation emitted from each surface.

(i) His readings are shown.

Draw a line from each surface colour to its correct meter reading.
One has been done for you.

(2)



(ii) The temperature of each surface is the same.

Give a reason why the radiation sensor gives a different reading for each surface.

(1)

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(b) (i) What do all waves in the electromagnetic spectrum have in common?

(1)

☒ **A** the same frequency in a vacuum

☒ **B** the same speed in a vacuum

☒ **C** the same colour in a vacuum

☒ **D** the same amplitude in a vacuum

(ii) Blue light has a wavelength of 470 nm and a frequency of 6.30×10^{14} Hz

Calculate the velocity of blue light.

(2)

velocity = ... m/s

(c) All objects emit electromagnetic radiation.

The intensity and wavelength of the emitted radiation vary with the temperature of the object.

Figure 8 shows this variation for an object at two different temperatures.

The visible region of the electromagnetic spectrum is also shown.

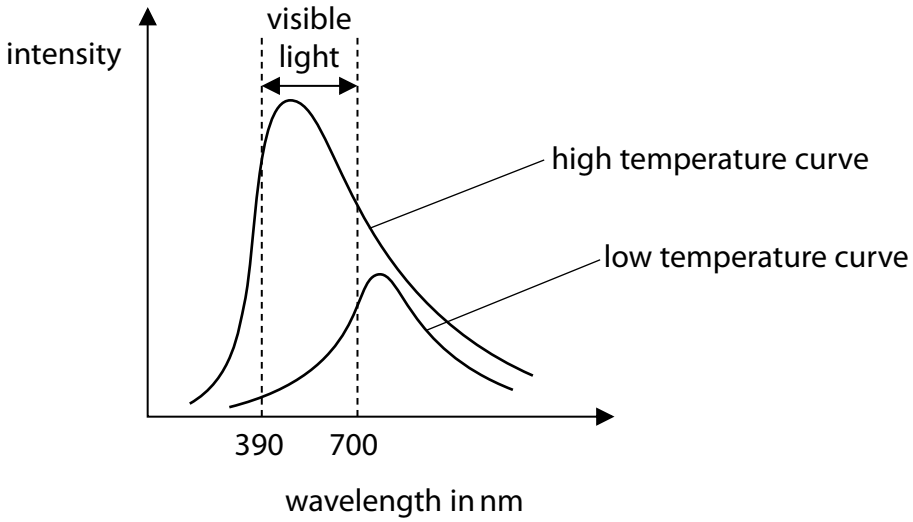


Figure 8

(i) In which part of the electromagnetic spectrum is the peak of the low temperature curve?

(1)

☒ **A** gamma

☒ **B** infrared

☒ **C** radio

☒ **D** ultra violet

(ii) Describe how intensity of the emitted radiation changes with temperature.

(2)

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(Total for Question 6 = 9 marks)

5 (a) All objects emit electromagnetic radiation.

The intensity and wavelength of the emitted radiation vary with the temperature of the object.

Figure 12 shows this variation for a filament lamp at two different temperatures.

The visible region of the electromagnetic spectrum is also shown.

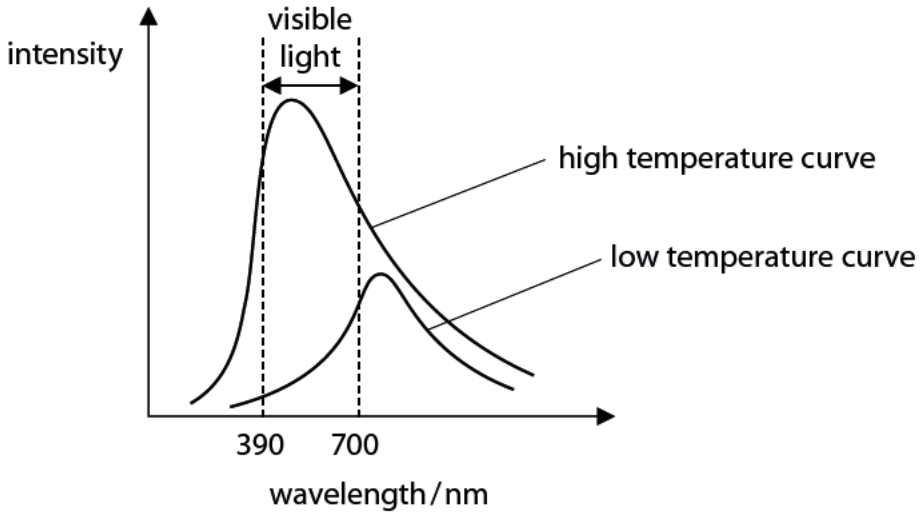


Figure 12

(i) Explain why a filament lamp appears brighter and less red as its temperature increases.

(4)

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(ii) The intensity of gamma radiation can be measured using a Geiger-Müller tube and counter.

The count rate recorded by the counter tube depends on how far away the Geiger-Müller tube is from the gamma radiation source.

The equation relating count rate to distance from the source is

$$\text{count rate} = \frac{k}{d^2}$$

where d is the distance from the source and k is a constant.

A Geiger-Müller tube is placed 0.70 m from a source of gamma radiation.
The counter displays a count rate of 85 000 count per minute.

Calculate the count rate recorded when the Geiger-Müller tube is placed 1.3 m away from the same gamma radiation source.

(3)

count rate = ... counts per minute

*(b) Sulfates and black soot are particles formed by industrial processes.

Some of these particles are found in the atmosphere over the Arctic Ocean.

The sulfates stay in the atmosphere and reflect (scatter) sunlight.

The black soot falls onto the Arctic ice.

Discuss how a reduction in these industrial processes is likely to affect the temperature of the atmosphere.

(6)

(Total for Question 8 = 13 marks)