**6** (a) A student investigates how the surface of an object affects the radiation it emits.
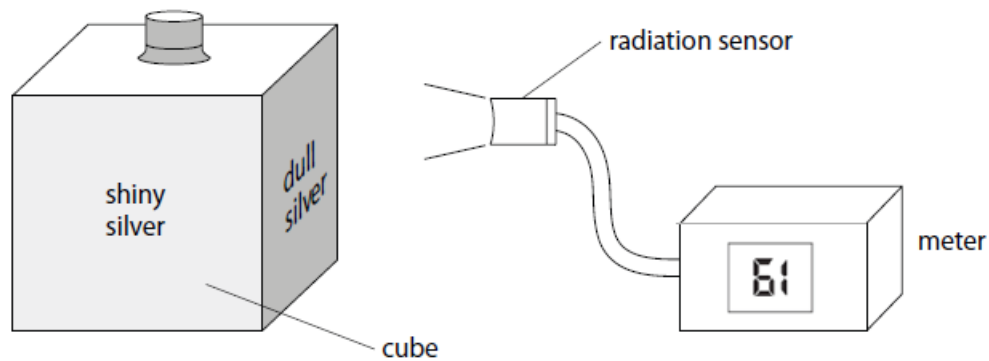
Figure 7 shows the equipment he uses.



**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)

| surface colour | meter reading |
|---|---|
| shiny black | 87 |
| dull black | 61 |
| dull silver | 70 |
| shiny silver | 47 |

(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 $6.30 \times 10^{14}$ 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.

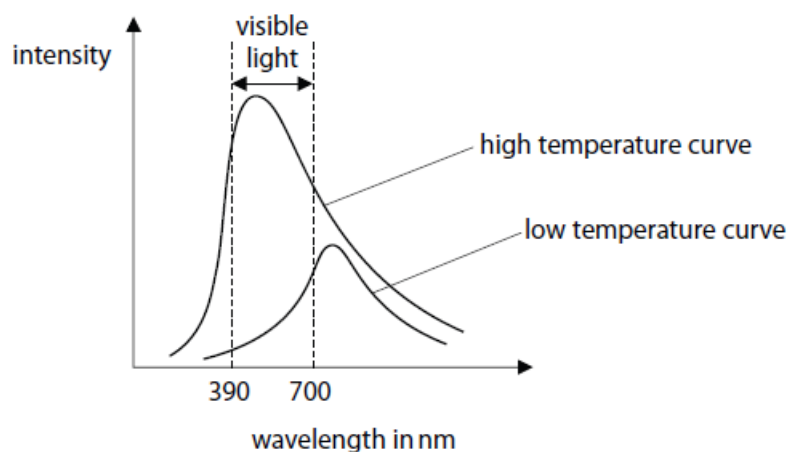The visible region of the electromagnetic spectrum is also shown.



**Figure 8**

(i) In which part of the electromagnetic spectrum is the peak of the low temperature curve?
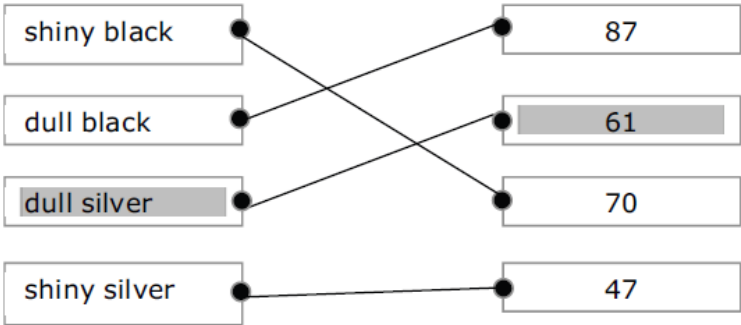
(1)

☐ **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)**

| Question number | Answer | Mark |
|---|---|---|
| 6(a)(i) | All three correct (2)<br><br>One or two correct (1)<br><br>shiny black — 70<br>dull black — 87<br>dull silver — 61<br>shiny silver — 47 | (2) |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| 6(a)(ii) | Different surfaces emit (thermal) radiation at different rates | allow reference to surfaces in question | (1) |

| Question number | Answer | Mark |
|---|---|---|
| 6(b)(i) | B | (1) |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| 6(b)(ii) | substitution and unit conversion (1)<br>$470 \times 10^{-9} \times 6.30 \times 10^{14}$<br><br>answer (1)<br>$2.96 \times 10^{8}$ (m/s) | award full marks for correct numerical answer without working<br><br>ecf unit conversion | (2) |

| Question number | Answer | Mark |
|---|---|---|
| 6(c)(i) | B | (1) |

| Question number | Answer | Mark |
|---|---|---|
| 6(c)(ii) | An answer that combines points of interpretation/evaluation to provide a logical description:<br><br>• as temperature increases, intensity increases (1)<br>• as temperature increases, maximum intensity occurs at a shorter wavelength (1) | **(2)** |