Radiation and Uses and Dangers of EM Waves

Questions

Q1.

The Asteroid Belt is part of our Solar System.

Vesta is an asteroid in the Asteroid Belt.

The distance between Vesta and the Sun is 2.4 AU.

1 AU is the distance between the Earth and the Sun.

The intensity of the Sun's radiation reaching the Earth is 1400 W/m^2.

1 W = 1 J/s

The intensity of the Sun's radiation at a distance, *d*, from the Sun is given by the equation

$$\text{intensity} = \frac{K}{(d)^2}$$

where *K* always has the same value.

(i) State the unit of *K*.

(1)

.....

(ii) Calculate the intensity of the radiation from the Sun at Vesta.

(3)

intensity = ... W/m^2

(Total for question = 4 marks)

Q2.

Figure 1 shows how the brightness of a source of light changes with wavelength.

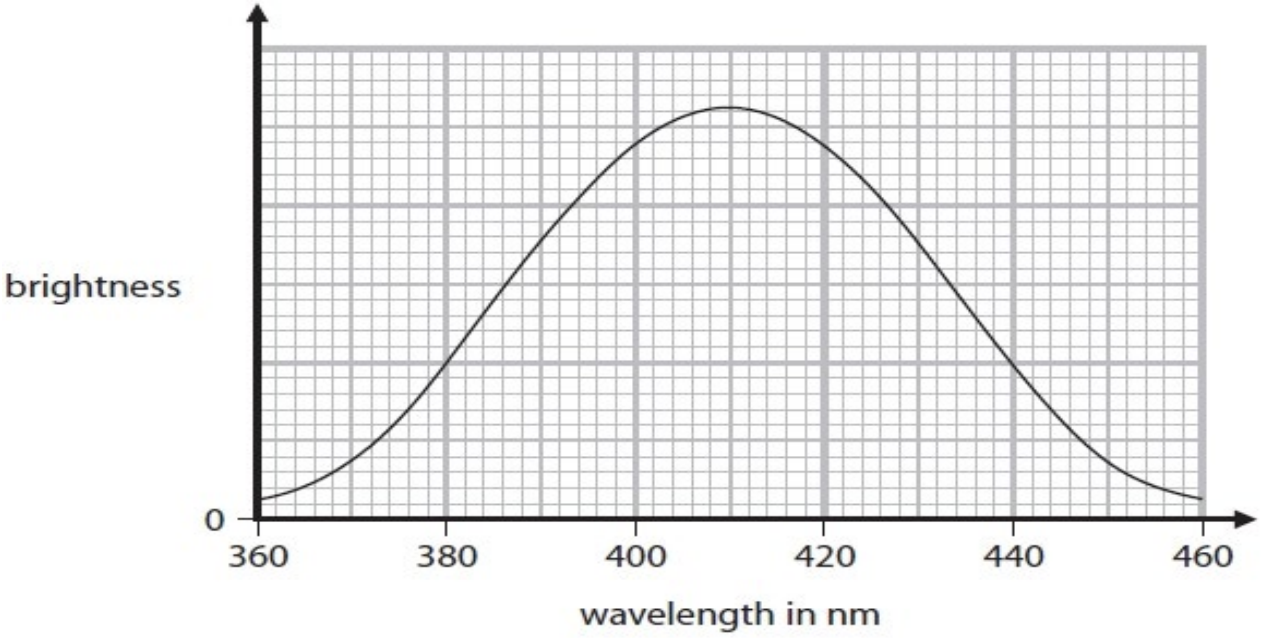

Figure 1

Describe how the brightness changes with wavelength.

(2)

.....

.....

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.....

(Total for question = 2 marks)

Q3.

(i) Figure 4 shows two light rays hitting a glass lens.

On Figure 4, draw the two light rays after they leave this lens.

(1)

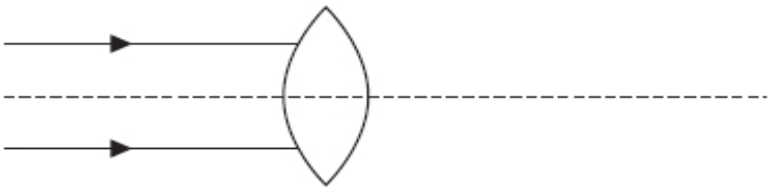

Figure 4

(ii) Figure 5 shows two light rays hitting a different glass lens.

On Figure 5, draw the two light rays after they leave this lens.

(1)

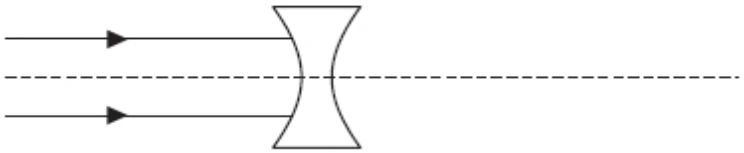

Figure 5

(iii) A lens has a focal length of 25 cm.

Calculate the power of the lens.
Use the equation

$$\text{power in dioptres} = \frac{1}{\text{focal length in metres}}$$

(2)

power of the lens = ... dioptres

(Total for question = 4 marks)

Q4.

In Figure 7, only refraction of light is shown.

Other things happen to the light as it travels from **P** to **Q**.

The intensity (brightness) of the light at **Q** is less than the intensity of the light at **P**.

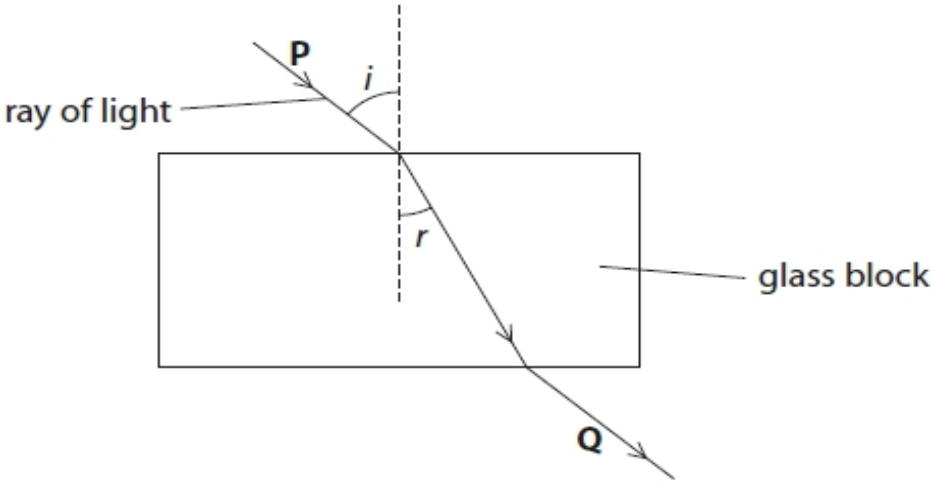

Figure 7

Explain the decrease in intensity as the light travels from **P** to **Q**.

You may add to Figure 7 to help your answer.

(3)

.....

.....

.....

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.....

.....

(Total for question = 3 marks)

Q5.

The Asteroid Belt is part of our Solar System.

Vesta is an asteroid in the Asteroid Belt.

Energy is transferred from the Sun to Vesta by radiation.

Explain why the temperature on Vesta does not continue to rise, even though it is absorbing energy from the Sun.

(3)

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.....

(Total for question = 3 marks)

Q6.

Figure 5 is a graph showing the intensity–wavelength curves for two hot objects, L and M.

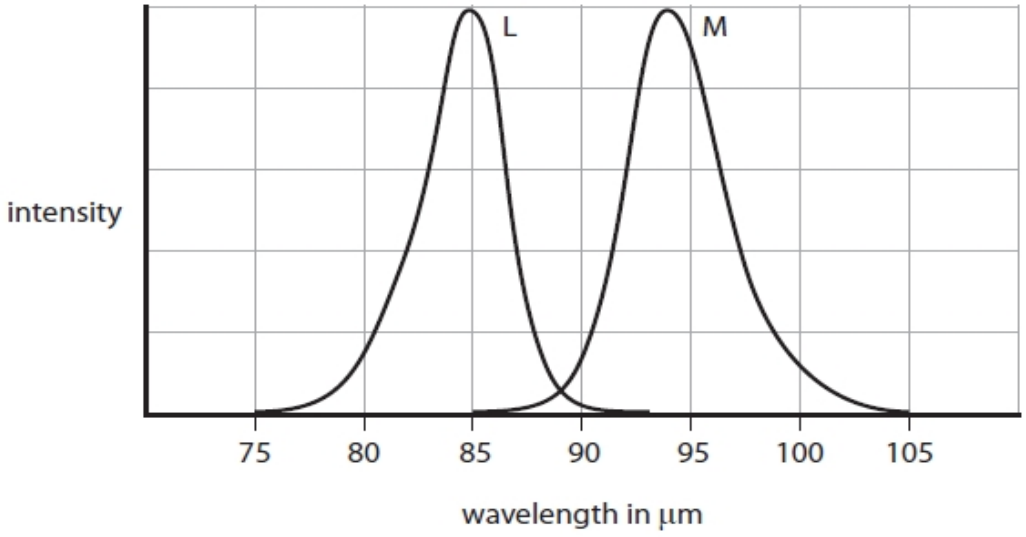


Figure 5

(i) Estimate the wavelength where the intensity is at a maximum for each of the objects.

(2)

wavelength at maximum intensity for object L = ... μm

wavelength at maximum intensity for object M = ... μm

(ii) State, with a reason, which object is the hotter object.

(1)

Object

.....

Reason.

.....

.....

(Total for question = 3 marks)

Q7.

A copper can, painted black, contains boiling water at 100 °C. The can is left to cool and a measurement of the water temperature is taken every 5 minutes. Figure 3 shows the measurements.

time in minutes	temperature in °C
0	100
5	74
10	60
15	56
20	37
25	30
30	25

Figure 3

(i) Two points, shaded in the table, have not been plotted.

Plot these two points on the graph, in Figure 4.

(2)

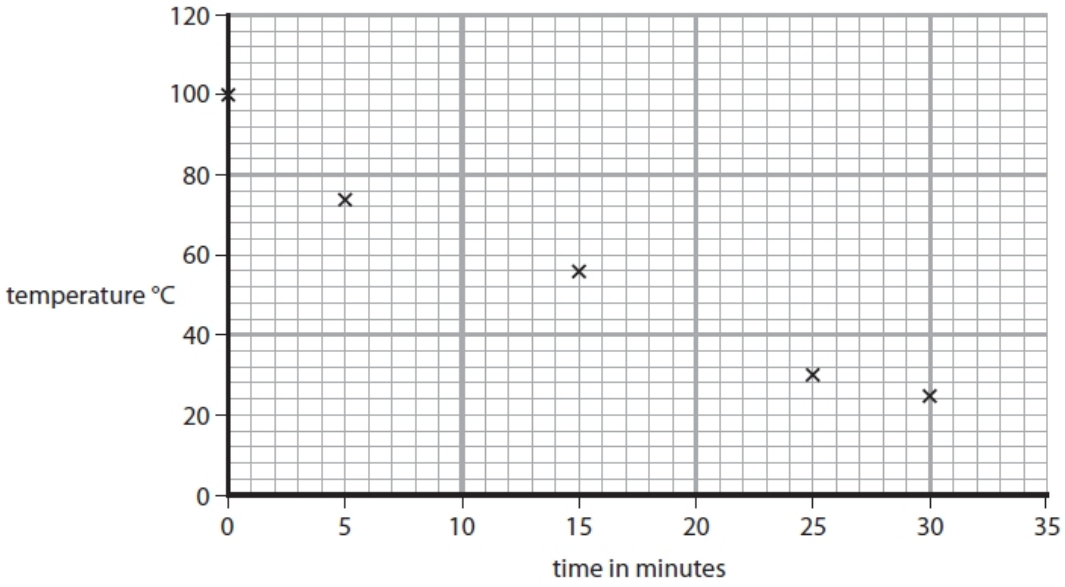


Figure 4

(ii) One of the points on the graph in Figure 4 is anomalous. Circle the anomalous point.

(1)

(iii) Draw the best fit curve on the graph in Figure 4.

(1)

(iv) An identical can contains the same amount of boiling water.

This can has a shiny silver surface.
The measurements are repeated with this can and a new curve is drawn.
State how the cooling curve would be different from the curve in the graph in Figure 4.

(1)

.....

.....

(Total for question = 5 marks)

Q8.

Figure 10 is a graph of intensity against wavelength for the electromagnetic radiation emitted by a halogen lamp.

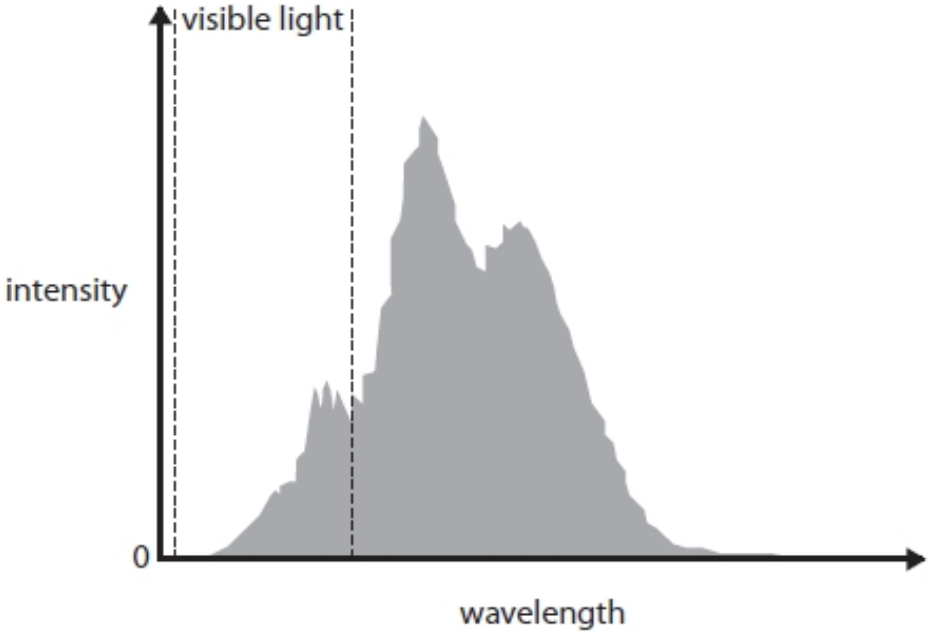


Figure 10

Describe how the intensity of the radiation varies with wavelength in Figure 10.

(2)

.....

.....

.....

.....

.....

(Total for question = 2 marks)

Q9.

(i) Use words from the box to complete the sentences below about ions.

absorbing	gaining	inner	losing	outer

(2)

Atoms may form positive ions by ..... electrons.

The electrons involved in forming positive ions are the ..... electrons.

(ii) Which of these radiations is both electromagnetic and ionising?

(1)

☒ **A** alpha

☒ **B** beta minus

☒ **C** gamma

☒ **D** neutron

(iii) Which type of radiation will travel the shortest distance in air?

(1)

☒ **A** alpha

☒ **B** beta minus

☒ **C** beta plus

☒ **D** gamma

(Total for question = 4 marks)

Q10.

A student investigates how different surfaces radiate energy as they cool.

Figure 9 shows some of the apparatus used in a part of the investigation.

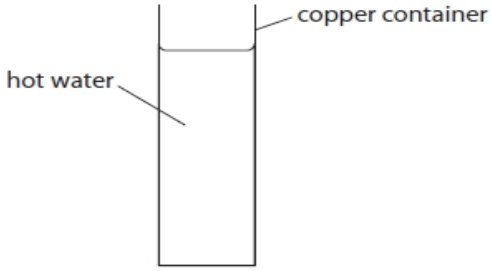


Figure 9

Describe how the student could collect data to show how the rate of cooling of the container and water change with time.

(2)

.....

.....

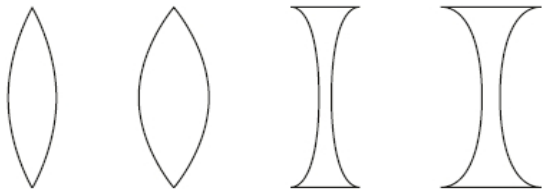
.....

(Total for question = 2 marks)

Q11.

(i) Which lens is a converging lens with the greatest power?

(1)



(ii) The equation that relates the power of a lens to the focal length of the lens is

$$\text{power (in dioptres)} = \frac{1}{\text{focal length (in metres)}}$$

The power of a lens is 5 dioptres.
Use the equation to calculate the focal length of the lens in cm.

(2)

focal length = ... cm

(Total for question = 3 marks)

Q12.

Gamma radiation can be used in food processing to irradiate food.

Explain why some food is irradiated with gamma radiation.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q13.

Explain what can happen to the body if a person has a prolonged exposure to gamma rays.

(2)

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.....

.....

.....

(Total for question = 2 marks)

Q14.

X-rays can be useful and harmful to humans.

(i) State **one** way that x-rays are useful to humans.

(1)

.....

(ii) State **one** way that x-rays are harmful to humans.

(1)

.....

(Total for question = 2 marks)

Mark Scheme - Radiation and Uses and Dangers of EM Waves

Q1.

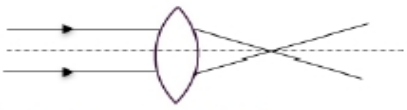
	Answer	Additional guidance	Mark
(i)	W (1)	accept watt(s) J/s do **NOT** accept Ws W/s watt(s) per second	**(1)** **AO2**

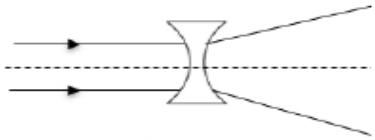
	Answer	Additional guidance	Mark
(ii)	evaluation of K (1) $K = 1^{(2)} \times 1400$ substitution (1) (intensity =) $\frac{1400}{2.4^2}$ evaluation (1) 240 (W/m^2)	 1400 accept for one mark intensity = $\frac{K}{2.4^2}$ allow numbers that round to 240 e.g. 243.05 accept answers in terms of ratios award full marks for correct answer without working.	**(3)** **AO2**

Q2.

Question number	Answer	Additional guidance	Mark
	a description to include two of the following: increases (at first) (1) reaches a peak (1) (then) decreases (1)	 is brightest at **410** (nm)	**(2)**

Q3.

Question number	Answer	Additional guidance	Mark
(i)	rays converging	 arrows not needed	**(1)**

Question number	Answer	Additional guidance	Mark
(ii)	rays diverging	 arrows not needed award 1mark if convergence and divergence are shown but with the wrong lenses	**(1)**

Question number	Answer	Additional guidance	Mark
(iii)	substitution (1) $\frac{1}{25(\times 10^{-2})}$ evaluation (1) 4(.0)	or 0.04 seen ignore powers of ten until evaluation award full marks for the correct answer without working	**(2)**

Q4.

Question number	Answer	Additional guidance	Mark
CS3	Explanation linking **three** from: (some) light is <u>reflected</u> (1) (at) the top edge (1) (some) light is <u>absorbed</u> (1) by the glass (1)	 in the air in the (glass) block credit responses in terms of attenuation/ dispersion/reflection at the second face/spreading out	**(3)** **AO2**

Q5.

	Answer	Additional guidance	Mark
	An explanation linking: Vesta (also) radiates (energy) (1) the same amount of energy that it absorbs (1) in the same time (1)	 allow emits (OWTE)for radiates 'Vesta radiates at the same average power that it absorbs' scores all three MPs 'Vesta radiates energy at the same <u>rate</u> that it absorbs' scores all three MPs	**(3)** **AO1**

Q6.

Question Number	Answer	Additional guidance	Mark
(i)	wavelength for object L = 84.(0) to 85(.0) (μm) (1) wavelength for object M = 93.(0) to 95.(0)(μm) (1)	estimates, so we are being generous with this	(2) AO 3 2a

Question Number	Answer	Additional guidance	Mark
(ii)	object L and shorter wavelength (1)		(1) AO 3 1a

Q7.

Question Number	Answer	Additional guidance	Mark
(i)	points plotted to within ± 1 small square (10, 60) (1) (20, 37) (1)		(2) AO 2 1

Question Number	Answer	Additional guidance	Mark
(ii)	point at 15,55 circled (1)		(1) AO 2 1

Question Number	Answer	Additional guidance	Mark
(iii)	best fit curve passing through most of the points seen, apart from 15,55 (1)	reject tramlining (multiple lines/curves) ignore slight shakiness in drawing	(1) AO 3 2a

Question Number	Answer	Additional guidance	Mark
(iv)	the curve will be above the first one (starting at the same point) / it will take longer to cool down / cools more slowly (1)	less steep ignore all comments about heat / the process; **the question is about the curve**	(1) AO 2 1

Q8.

Question Number:	Answer	Additional guidance	Mark
	a description to include: intensity reaches a peak value (1) additional information (1)	 other peaks irregular curve non-linear most of radiation outside visible spectrum	**(2)** AO 3 1a AO 3 1b

Q9.

Question Number	Answer	Additional guidance	Mark
(i)	Atoms may form positive ions by **losing** electrons. (1) The electrons involved are the **outer** electrons (1)	accept any clear indication that correct word is in gap	**(2)**

Question Number	Answer	Mark
(ii)	The only correct answer is **C gamma** A is not correct because alpha radiation is not electromagnetic B is not correct because beta minus radiation is not electromagnetic D is not correct because neutron radiation is not electromagnetic	(1)

Question Number	Answer	Mark
(iii)	The only correct answer is **A alpha** B is not correct because beta minus travels further in air than alpha C is not correct because beta plus travels further in air alpha D is not correct because gamma travels further in air than than alpha and beta	(1)

Q10.

Question Number	Answer	Additional guidance	Mark
	a description to include: use a thermometer (1) measure temperature at regular intervals (1)	 temp. sensor datalogger it must be clear that it is a number of readings – not just 2 eg measure temperature over time	**(2)** AO 1 2

Q11.

Question Number	Answer	Mark
(i)	 ☐ B **The only correct answer is B** **A** is not correct because it has a smaller power than B **C** is not correct because it is a diverging lens **D** is not correct because it is a diverging lens	**(1)**

Question Number	Answer	Additional guidance	Mark
(ii)	rearrangement and substitution (1) $\frac{1}{5}$ unit conversion and evaluation (1) 20 (cm)	 award full marks for the correct answer without working accept 0.2 for one mark only	(2)

Q12.

	Answer	Additional guidance	Mark
	An explanation linking **two** from: to preserve food (1) by 'killing' bacteria (1) (gamma) is (very) penetrating (and so reaches all the food). (1) sterilising (1)	 stop food going off	(2) AO2

Q13

Question number	Answer	Additional guidance	Mark
	explanation linking two from: (damage to) cell(s) (1) (because gamma rays are) ionising / high frequency/very energetic (1) (causing / curing/diagnosing) cancer / mutation / chromosomal damage / dna damage/burns (1)	 (rapid/unwanted) division of cells	(2)

Q14

Question number	Answer	Additional guidance	Mark
(i)	One from: seeing (broken) bones (1) radiotherapy (1) detecting cracks in metals (1) airport security (1) observing the internal structure of objects(1)	seeing inside the body	(1) AO1

Question number	Answer	Additional guidance	Mark
(ii)	One from: can cause cancer (1) can cause burns(1) {damage/kills/harms} cells/tissue (1) mutates DNA/cells (1)	harms organ(s) / foetus allow (highly) ionising	(1) AO1