

## The Electromagnetic Spectrum

### Questions

**Q1.**

Radio waves and gamma radiation are at opposite ends of the electromagnetic spectrum.

Compare how these two electromagnetic radiations are produced.

(6)

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**(Total for question = 6 marks)**

**Q2.**Draw **one** line from each **use of wave** to the matching **electromagnetic wave**.

One line has been drawn for you.

(3)

**use of wave**to detect forged  
banknotes

to detect broken bones

for night-vision  
camerasto sterilise medical  
equipment**electromagnetic wave**

radio waves

microwaves

infrared waves

visible light

ultraviolet waves

X-rays

gamma rays

(Total for question = 3 marks)

**Q3.**

A person warms their hands in front of a hot fire as shown in Figure 2.



(Source: © Andreas Saldavs/Shutterstock)

**Figure 2**

Use words from the box to complete the following sentences.

chemical	infrared	radio	thermal	ultraviolet
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(2)

The electromagnetic waves that the fire mostly emits are  
..... waves.

These waves transfer ..... energy to the hands.

**(Total for question = 2 marks)**

**Q4.**

Some television remote controls use infrared radiation and other remote controls use radio waves.

Explain why an infrared remote control may not switch on the television from behind an armchair but a radio wave remote control always will.

(2)

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.....

**(Total for question = 2 marks)**

**Q5.**

The following descriptions describe waves from different parts of the electromagnetic spectrum.

Complete each description by adding the name of the wave.

Use the name of each wave only once. Each description refers to a different part of the electromagnetic spectrum.

(4)

**Description 1**

used in cooking

used in short-range communication

typical wavelength 900 nm

name of wave .....

**Description 2**

used in cooking

used in communication

typical wavelength 150 mm

name of wave .....

**Description 3**

used in communication

produced by oscillations in electrical circuits

typical wavelength 150 m

name of wave .....

**Description 4**

used in medical scanning

is emitted by the nucleus of an atom

typical wavelength  $2.0 \times 10^{-3}$  nm

name of wave .....

**(Total for question = 4 marks)**

Q6.

Figure 1 shows the parts of the electromagnetic spectrum.

gamma rays	x-rays	J	visible	K	micro-waves	L
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Figure 1

(i) Which row of the table names the parts J, K and L of the electromagnetic spectrum?

(1)

	J	K	L
<input type="checkbox"/> A	infrared	radio	ultraviolet
<input type="checkbox"/> B	radio	infrared	ultraviolet
<input type="checkbox"/> C	ultraviolet	infrared	radio
<input type="checkbox"/> D	ultraviolet	radio	infrared

(ii) All electromagnetic waves can travel in a vacuum.

Which of these is the same for all electromagnetic waves travelling in a vacuum?

(1)

- A amplitude  
 B frequency  
 C speed  
 D wavelength

(Total for question = 2 marks)

**Q7.**

Some sunglasses have photochromic lenses.

Photochromic lenses are clear when the lenses are indoors but they darken in bright sunlight to reduce the effects of the sunlight.

Photochromic lenses react to ultraviolet light.

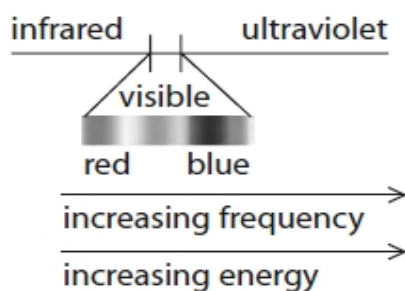
Suggest a benefit of making the lenses go dark with ultraviolet light.

(1)

.....  
 .....

**(Total for question = 1 mark)****Q8.**

Figure 8 shows a section of the electromagnetic spectrum.

**Figure 8**

(i) State **one** type of electromagnetic radiation that has a higher frequency than ultraviolet.

(1)

.....

(ii) One star is blue and another star is red.

Explain why an astronomer expects the blue star to be hotter than the red star.

(2)

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 .....  
 .....  
 .....

**(Total for question = 3 marks)**

**Q9.**

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

absorbing      gaining      inner      losing      outer

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

(2)

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)**

## Mark Scheme – The Electromagnetic Spectrum

Q1.

Question Number	Answer	Mark
	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;"><b>AO1 strand 1 (6 marks)</b></p> <ul style="list-style-type: none"> <li>• radio waves are (often) produced intentionally (by humans)</li> <li>• gamma rays are (often) produced spontaneously / randomly</li> <li>• radio waves are produced by (free) electrons</li> <li>• radio waves are produced by oscillating (free) electrons / alternating current (ac)</li> <li>• radio waves are produced in electrical circuits / aerials</li> <li>• gamma rays may result from radioactive decay</li> <li>• gamma rays produced in the nucleus</li> <li>• gamma rays produced by energy changes / rearrangement in the nucleus</li> <li>• gamma rays produced to stabilise the nucleus</li> <li>• gamma rays produced in annihilations (PET scanning etc)</li> <li>• gamma rays may be produced as a result of (nuclear) fission or fusion</li> </ul>	<b>(6)</b>



Level	Mark	Descriptor
	0	<ul style="list-style-type: none"><li>No rewardable material.</li></ul>
Level 1	1-2	<ul style="list-style-type: none"><li>Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1)</li></ul>
Level 2	3-4	<ul style="list-style-type: none"><li>Presents an explanation with some structure and coherence. (AO1)</li><li>Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1)</li><li>Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)</li></ul>
Level 3	5-6	<ul style="list-style-type: none"><li>Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1)</li><li>Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)</li></ul>

<b>Summary for guidance</b>			
<b>Level</b>	<b>Mark</b>	<b>Additional Guidance</b>	<b>General additional guidance – the decision within levels</b> e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> isolated fact(s) about one radiation	<u>Possible candidate responses</u> gamma rays are (often) produced spontaneously / randomly
Level 2	3–4	<u>Additional guidance</u> Some understanding shown i.e. a limited comparison made including some facts about the production of each radiation  OR more detailed facts given about the production of one of them	<u>Possible candidate responses</u>  radio waves produced in wires and gamma produced in nucleus  radio waves produced by AC in wires
Level 3	5–6	<u>Additional guidance</u> Understanding is detailed and fully developed.  detailed comparison made with linked facts about the production of each  (one radiation may have significantly more detail than the other but both should feature for level 3)	<u>Possible candidate responses</u>  radio waves produced by electrons oscillating in wires; gamma produced by annihilation of electrons interacting with positrons

Q2.

Question number	Answer	Additional guidance	Mark
		<p>award 1 mark for each line from the three left-hand boxes</p> <p>more than one line from a box loses the mark for that box</p>	(3)

Q3.

Question number	Answer	Additional guidance	Mark
	<p>infrared (1)</p> <p>thermal (1)</p>	<p>must be in first sentence space</p> <p>must be in second sentence space</p> <p>award 2 marks for answers in this <b>order</b></p>	(2) AO2

Q4.

Question Number	Answer	Additional guidance	Mark
	<p>an explanation linking: infrared is absorbed / blocked (by the armchair / objects) / cannot pass through</p> <p><b>OR</b></p> <p>radio waves can go through (the armchair/objects) (1)</p> <p><b>WITH</b></p> <p>(infrared and radio have) different wavelengths / frequencies OR infrared requires 'line-of-sight' (idea) OR radio waves do not require 'line-of-sight' (idea) OR diffraction (idea) (1)</p>	<p>stopped</p> <p>transmitted</p> <p>accept comparison</p>	<b>(2)</b>

Q5.

Question Number	Answer	Additional guidance	Mark
	<p>in this order</p> <p>infrared (wave) / IR (1)</p> <p>micro(wave) (1)</p> <p>radio (wave) (1)</p> <p>gamma (ray/wave)(1)</p>	<p>accept <math>\mu</math>(wave)</p> <p>accept <math>\gamma</math> not X</p>	<p><b>(4)</b></p> <p>AO 1 1</p>

Q6.

Question number	Answer	Additional guidance	Mark			
(i)	C <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">ultraviolet</td> <td style="width: 33%;">infrared</td> <td style="width: 33%;">radio</td> </tr> </table> A is incorrect infrared should be in K, radio should be in L and ultraviolet in J, B is incorrect radio should be in L and ultraviolet should be in K D is incorrect radio should be in L and infrared in K	ultraviolet	infrared	radio		(1) AO1
ultraviolet	infrared	radio				

Question number	Answer	Additional guidance	Mark
(ii)	C speed  amplitude, frequency and wavelength are not the same for all EM waves		(1) AO1

Q7.

Question Number	Answer	Additional guidance	Mark
	<p>suggestion to include <b>one</b> from</p> <p>(ultraviolet/UV) is (the most) harmful to the eyes (1)</p> <p>protects eyes from damage/harm (from UV rays) (1)</p>	<p>(UV) can damage eyes</p> <p>protects against cataracts/cancer</p> <p>accept makes it more comfortable in bright sunlight</p>	<b>(1)</b>

Q8.

Question Number	Answer	Additional guidance	Mark
<b>(i)</b>	<p>one of:</p> <p>X-ray(s) (1)</p> <p>gamma (rays) (1)</p>	<p>X</p> <p>Y</p> <p>any other waves mentioned contradicts</p>	<b>(1)</b>

Question Number	Answer	Additional guidance	Mark
<b>(ii)</b>	<p>an explanation linking <b>two</b> from:</p> <p>blue (star) emits light at higher energy (than red)</p> <p>blue has shorter wavelength/ higher frequency than red</p> <p>so blue star has higher (surface) temperature than red</p>	<p>or reverse arguments</p>	<b>(2)</b>

Q9.

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

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