3.19 The Electromagnetic Spectrum: Test Pack

AQA 8464 · Calculator allowed · about 20 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The list below shows the seven types of electromagnetic wave in order of increasing wavelength, but three of the labels are missing. State the correct type of wave for each gap.
Gamma rays, X-rays, (i) _____, Visible light, (ii) _____, Microwaves, (iii) _____

(Total for Question 1 is 3 marks)

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2 A ray of visible light travels from air into a glass block, hitting the boundary at an angle to the normal (not along the normal). Describe what happens to the light ray's speed, wavelength, frequency and direction as it crosses the boundary from air into the (optically denser) glass.

(Total for Question 2 is 4 marks)

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3 X-rays and γ rays are examples of ionising radiation. Radio waves and microwaves are not ionising.

(a) Explain why ionising radiation, such as X-rays and γ rays, can be more hazardous to the human body than non-ionising radiation, such as radio waves. **(2)**

(b) State one factor, other than the type of radiation, that affects the size of the radiation dose a person receives from a source of ionising radiation. **(1)**

(Total for Question 3 is 3 marks)

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4 A hospital X-ray machine produces X-rays with a wavelength of 5.0×10^{-11} m. Use the Physics Equations Sheet: wave speed = frequency * wavelength ($v = f * \lambda$), and the speed of electromagnetic waves in air, $v = 3.0 \times 10^{8}$ m/s, to calculate the frequency of these X-rays.

(Total for Question 4 is 3 marks)

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5 Higher tier only. Both γ rays and infrared radiation are electromagnetic waves, but γ radiation is far more hazardous to living cells than infrared radiation. Explain, in terms of frequency and ionisation, why this is the case.

(Total for Question 5 is 3 marks)

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Mark scheme · 3.19 The Electromagnetic Spectrum: Test Pack

Question 1

(i) Ultraviolet **B1**

(ii) Infrared **B1**

(iii) Radio waves **B1**

Answer: (i) Ultraviolet (ii) Infrared (iii) Radio waves

Question 2

speed decreases (the light slows down entering the denser glass), oe **B1**

wavelength decreases, oe **B1**

frequency stays the same (unchanged), oe **B1**

the ray changes direction (refracts), bending towards the normal, oe **B1**

Answer: Speed decreases, wavelength decreases, frequency is unchanged, and the ray bends towards the normal.

Question 3

(a) ionising radiation has enough energy to remove electrons from atoms or molecules (ionisation), oe **B1**

(a) this can damage or mutate the DNA in living cells, which may lead to cell damage or cancer, oe **B1**

(a) Answer: Ionising radiation can remove electrons from atoms/molecules, which can damage or mutate DNA in cells, potentially causing cancer.

(b) any one of: the distance from the source; the length/duration of exposure; the intensity/activity of the source; whether any shielding is used, oe **B1**

(b) Answer: E.g. the distance from the source (or the duration of exposure, or the activity of the source, or the shielding used).

Question 4

rearranges correctly: $f = v/\lambda$ **M1**

substitutes correctly: $f = (3.0 \times 10^{8})/(5.0 \times 10^{-11})$ **M1**

$f = 6.0 \times 10^{18}$ Hz, cao **A1**

Answer: 6.0×10^{18} Hz

Question 5

γ rays have a much higher frequency (and therefore carry much more energy) than infrared waves, oe **B1**

γ rays are ionising: they can remove electrons from atoms/molecules in living cells, which can damage or mutate DNA and potentially cause cancer, oe **B1**

infrared radiation is non-ionising and carries far less energy, so it mainly causes heating of tissue rather than ionisation/DNA damage, oe **B1**

Answer: Gamma rays have a much higher frequency and carry far more energy than infrared, making them ionising and able to damage cell DNA; infrared is non-ionising and mostly just causes heating.

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