9 (a) Explain what happens to the wavelength of light when it passes from air into glass.

(2)

*(b) Figure 13 shows a beam of red light approaching one side of a rectangular glass block.

The beam of light will pass through the block and leave through the opposite side.

AB is a wavefront.

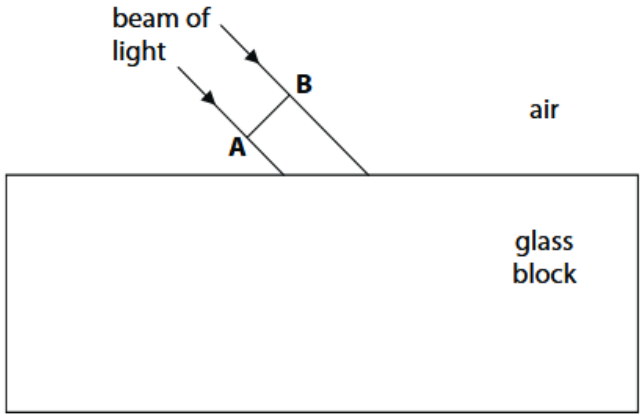

Figure 13

Discuss the path of the wavefront **AB** as it enters and leaves the glass block.

(6)

(c) The distance between the Earth and the Sun is 1.50×10^{11} m.

Light takes 500 s to travel from the Sun to the Earth.

The wavelength of red light is 670 nm.

Calculate the frequency of red light, using only the data provided.

(4)

frequency = ... Hz

(Total for Question 9 = 12 marks)

Question number	Answer	Additional guidance	Mark
9(a)	An explanation that makes reference to: identification – knowledge (1 mark) and reasoning /justification – knowledge (1 mark): • the wavelength decreases because wavelength is the ratio of wave velocity to frequency (1) • and the wave velocity reduces at the boundary but the frequency remains the same (1)	allow the same number of waves per second arrive at the boundary as leave it for no change in frequency at the boundary	**(2)**

Question number	Indicative content	Mark
9(b)	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. 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. **AO1 (6 marks)** • point A reaches the glass block before point B • A moves into the glass block and slows down • as light travels more slowly in glass than in air • B is still in air so is travelling faster than A • this causes part of the wavefront to change direction/refract • by the time B reaches the block it will have travelled further than A • therefore, the whole wavefront changes direction/refracts towards the normal • at the other face, A exits first so the process is reversed • the wavefront changes direction again so it is parallel to its original direction/refracts away from the normal	**(6)**

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Question number	Answer	Additional guidance	Mark
9(c)	Substitution into $v = \frac{s}{t}$ to find v (1) $v = \frac{1.5\times10^{11}}{500}$ Substitution into $v = f \times \lambda$ and unit conversion (1) $v = \frac{1.5\times10^{11}}{500} = f \times 670 \times 10^{-9}$ Transposition (1) Rearrangement (1) $f = \frac{\left(1.50\times10^{11}\right)}{500\times\left(670\times10^{-9}\right)}$ Answer (1) 4.5 x 10^{14} (Hz)	s is distance award full marks for correct numerical answer without working maximum 3 marks if λ in nm 4.4776 x 10^{14} (Hz)	**(4)**