(a) A student investigates what happens when light travels from air to glass.

Figure 2 shows some of the apparatus used in the investigation.

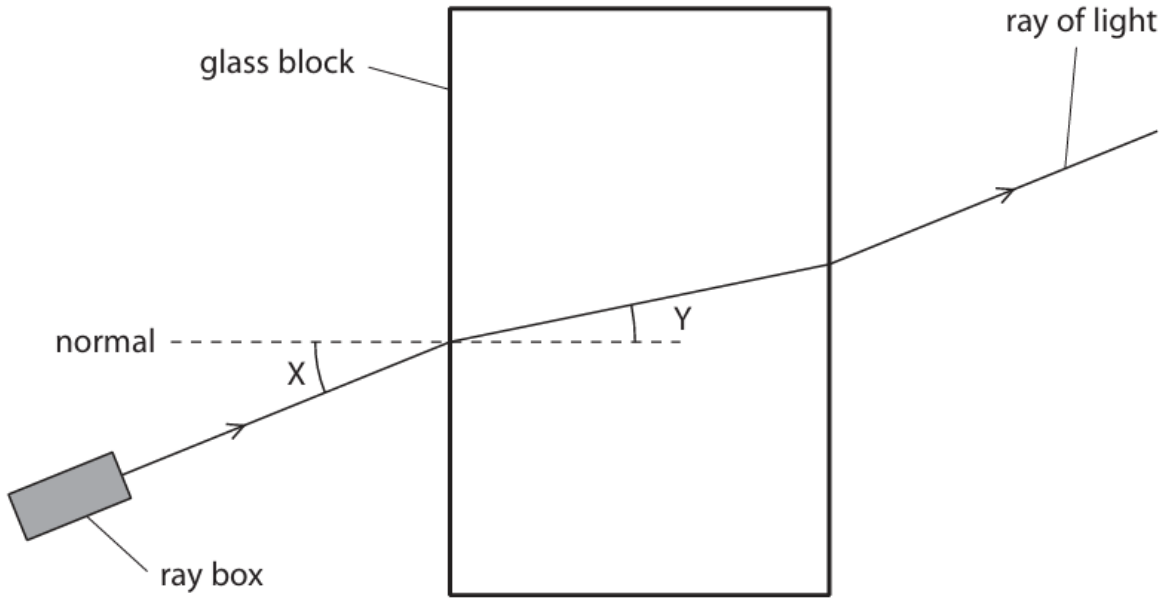

Figure 2

(i) In Figure 2, angle Y is the angle of

(1)

☒ **A** deflection

☒ **B** incidence

☒ **C** reflection

☒ **D** refraction

(ii) Figure 3 is a graph of the student's results.

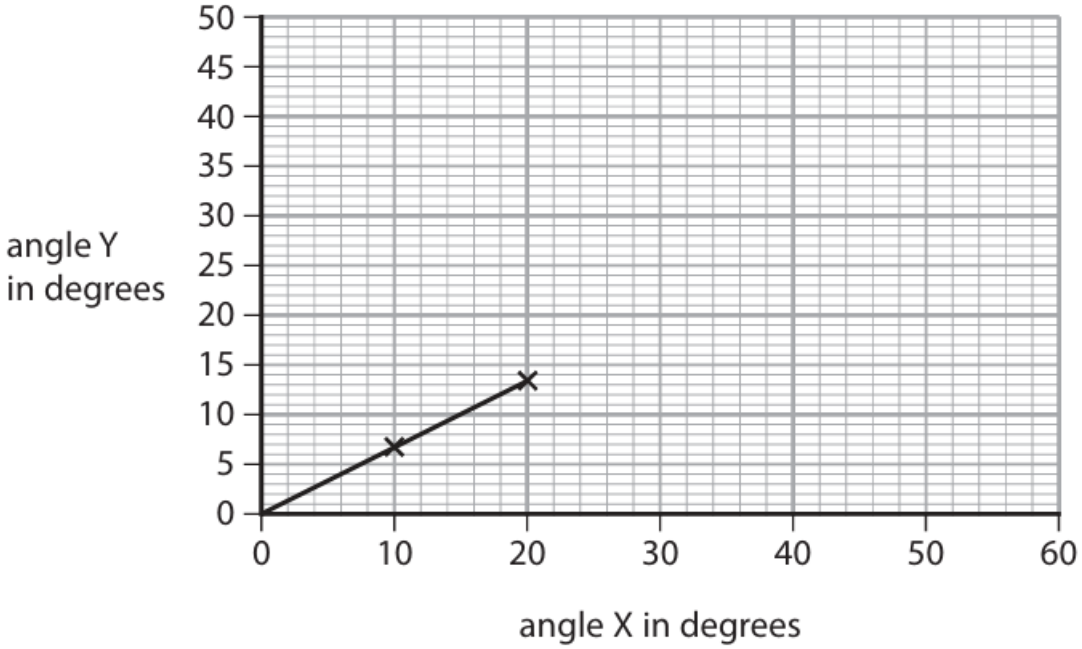

Figure 3

Use the graph to calculate a value for

$$\frac{\text{angle Y}}{\text{angle X}}$$

(2)

$$\frac{\text{angle Y}}{\text{angle X}} = \text{.....}$$

(iii) The student concludes that angle Y is directly proportional to angle X.

Explain what the student must do to test this conclusion in more detail.

(3)

(b) The speed of light is 3.0×10^{8} m/s.

The wavelength of yellow light is 5.8×10^{-7} m.

Calculate the frequency of yellow light.

State the unit.

Use the equation

$$\text{frequency} = \frac{\text{speed}}{\text{wavelength}}$$

(3)

frequency = ... unit .....

(Total for Question 2 = 9 marks)

WWW	EBI…	DIRT Task
You understand what happens when light travels from air to glass.	… you could understand what happens when light travels from air to glass.	Define refraction. Memorise the definition. Draw and label a diagram showing the refraction of light as it travels from air into glass.
You know how to calculate angle Y/angle X.	… you knew how to calculate angle Y/angle X.	Define gradient. Memorise the definition. Look at the graph and calculate the change in Y divided by the change in X (ΔY/ΔX).
You can explain what the student must do to test this conclusion in more detail.	… you could explain what the student must do to test this conclusion in more detail.	Complete the sentences: To test the conclusion, the student should: -Take multiple _____ of the angle of incidence and the corresponding angle of _____ using a ray box and protractor. -Plot a _____ of angle of refraction (y-axis) against angle of incidence (x-axis). -Check if the graph is a _____ line that passes through the _____. -If the graph is a straight _____ through the origin, it supports the idea of _____ proportionality.
You know how to calculate the frequency of yellow light.	… you knew how to calculate the frequency of yellow light.	The speed of light is 3.0×10^{8} m/s. The wavelength of blue light is 4.5×10^{-7} m. Calculate the frequency of blue light and state the unit. STEPS: -Write down the formula that links speed, frequency, and wavelength. -Rearrange the formula to make frequency the subject. -Substitute the values into the formula. -Calculate the frequency of blue light. -State the correct unit for frequency.
	Extension:	*To investigate refraction in a rectangular glass block a student uses the apparatus shown in Figure 3.* *Describe how the student should measure the angle of refraction.*

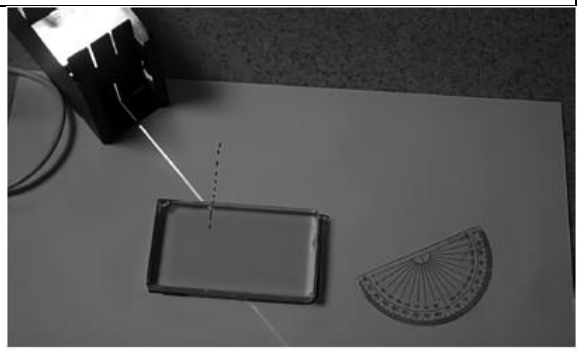

Figure 3

Question Number	Answer	Mark
2(a)(i)	**D** refraction **is the only correct answer** *A 'deflection' is an incorrect distracting description* *B 'incidence' is incorrect, that would be angle X* *C 'reflection' is incorrect, no reflection being shown in the diagram*	**(1)** AO 1 1

Question Number	Answer	Additional guidance	Mark
2(a)(ii)	any pair of coordinates selected from the line (1) in range → 0.6(0) to 0.7(0) (1)	e.g. 20 and (13 or 14) or 10 and (6 or 7) ignore any units given award full marks for a correct answer without working	**(2)** AO 2 1

Question Number	Answer	Additional guidance	Mark
2(a)(iii)	an explanation linking: repeat (1) different angles / more values of X (1) for larger angles / values of X (1)	 allow 'more measurements' / 'repeat experiment' / collect more data > 20°	**(3)** AO 3 3a

Question Number	Answer	Additional guidance	Mark
2(b)	substitution (1) $\frac{3.0 (\times 10^{8})}{5.8 (\times 10^{-7})}$ evaluation (1) 5.2×10^{14} unit (1) Hz	 answers that round to 5.2×10^{14} award 2 marks for a correct answer without working allow 1 mark for answers that round to 5.2 to any power of ten independent mark accept hz or s^{-1} or per sec(ond) or hertz accept kHz, MHz etc with correct power (10^{11} kHz, 10^{8} MHz)	**(3)** AO 2 1