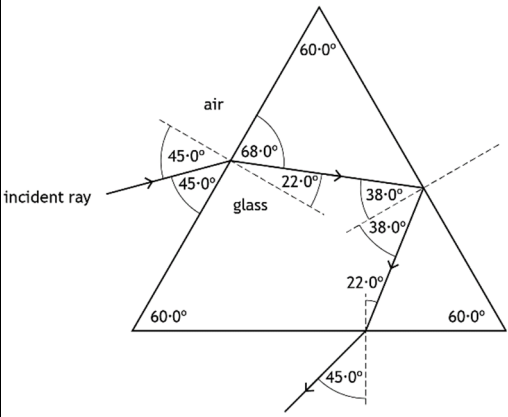


Question			Answer	Max mark	Additional guidance
9.	(b)	(iii)	 Total Internal Reflection (1) 38° (1) Refraction away from the normal on exit (1) 22° and 45° (1)	4	OR consistent with part (ii) If arithmetic error for finding one of the angles - maximum 3 marks. First two marks are independent. To access last two marks TIR must be shown. Reflection at any angle Either incidence or reflection angle labelled. Refraction at any angle Both angles required. Notes: Only penalise missing degree unit once in whole question. Decimal points not required Candidate may calculate exit angle, therefore 45.1° is acceptable
	(c)		Less deviation in spectrum position OR Less dispersion.	1	Accept: Spectrum position higher on screen Smaller spread/width of spectrum Brighter spectrum Do not accept: smaller spectrum alone

Q9(a)

Maximum Mark: 2

RESPONSE 1

$$\begin{aligned} n &= \frac{\sin \theta_1}{\sin \theta_2} \\ &= \frac{\sin 45}{\sin 22} \\ &= 1.8875 \\ &= 1.89 \end{aligned}$$

RESPONSE 2

$$\begin{aligned} n &= \frac{\sin \theta_1}{\sin \theta_2} = \frac{\sin 45}{\sin 22} \\ &= 1.887 \dots \\ &= \underline{\underline{1.89}} \end{aligned}$$

RESPONSE 3

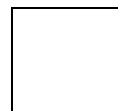
$$\begin{aligned}
 n &= \frac{\sin \theta_1}{\sin \theta_2} \\
 &= \frac{\sin 45}{\sin 22} \\
 &= 1.887 \dots \\
 &= 1.89
 \end{aligned}$$



Q9(b)(i)

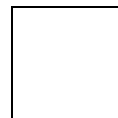
Maximum Mark: 1**RESPONSE 1**

the term critical angle is the angle in which the angle of incidence would need to be from the middle line to create an angle of refraction of 90°

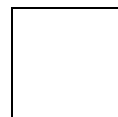
**RESPONSE 2**

The angle in which light will refract at 90° to the normal.

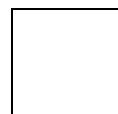
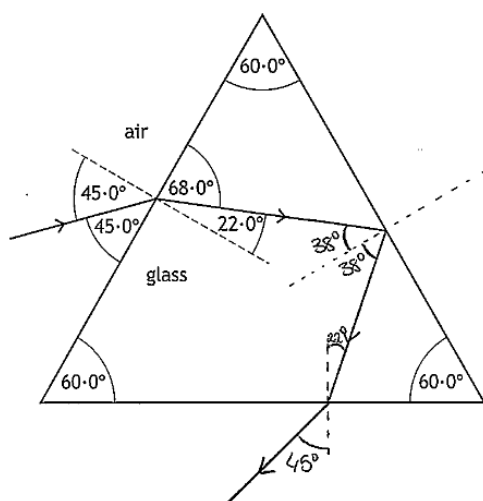
Any higher and total internal reflection will occur.

**RESPONSE 3**

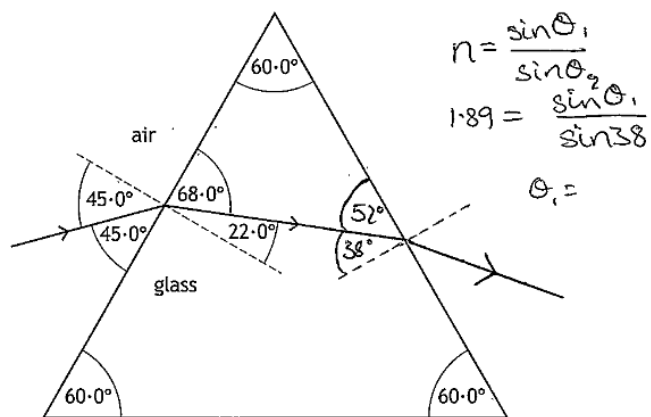
The angle at which the light is refracted at 90° .



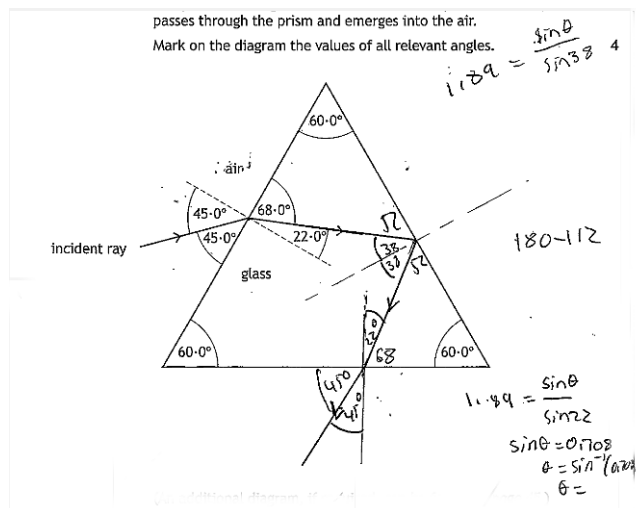
Q9(b)(iii)

Maximum Mark: 4**RESPONSE 1**

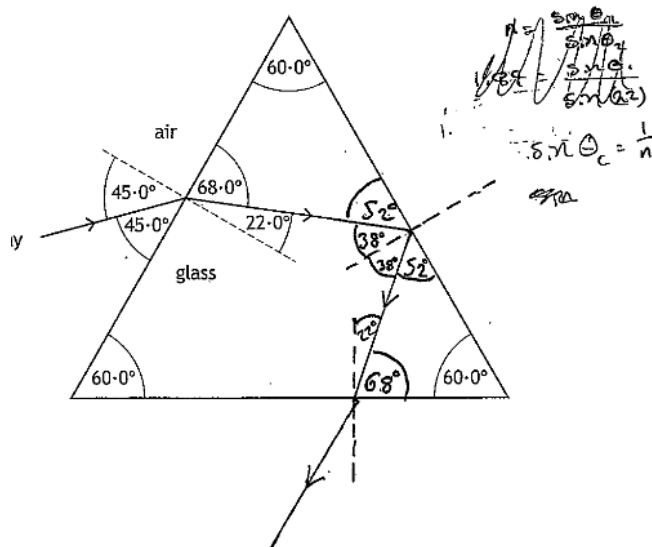
RESPONSE 2



RESPONSE 3



RESPONSE 4



Q9(c)

Maximum Mark: 1

RESPONSE 1

The spectrum produced by the second prism will be higher up on the screen and will contain less colours (or frequencies of light)

RESPONSE 2

The spectrum would be less refracted, red and violet light would be closer together.

RESPONSE 3

The different colours in the spectrum will be closer together

RESPONSE 4

produces less frequencies of light compared to the first prism

Q9(a)	2	
Response 1	1	The candidate has explicitly stated an appropriate relationship and substituted data correctly, stating the given final answer. The value stated in the penultimate line, however, is rounded incorrectly and so one mark is not awarded.
Response 2	2	The candidate has explicitly stated an appropriate relationship and substituted data correctly, stating the given final answer. The value

Question /Response	Mark	Commentary
		stated in the penultimate line is truncated as indicated by the ellipsis (...). This is not treated as incorrect rounding.
Response 3	2	The candidate has explicitly stated an appropriate relationship and substituted data correctly, stating the given final answer. Again, the value stated in the penultimate line is truncated as indicated by the ellipsis (...). This is not treated as incorrect rounding.
Q9(b)(i)	1	
Response 1	1	The candidate's statement is acceptable. The description of the angle of incidence in terms of 'the middle line' rather than the normal is not ambiguous in this case.
Response 2	0	The candidate's statement does not refer to the angle of incidence, and so is not acceptable.
Response 3	0	Again, the candidate's statement does not refer to the angle of incidence, and so is not acceptable.
Q9(b)(iii)	4	
Response 1	4	The candidate has shown total internal reflection with the correct angle of incidence (38°), refraction at the base of the triangle with the refracted ray changing direction away from the normal with the correct angles of incidence and refraction (22° and 45°).
Response 2	1	The candidate has shown the correct angle of incidence (38°), but has shown neither total internal refraction nor any refraction at the base of the triangle.
Response 3	3	The candidate has shown total internal reflection but has omitted the unit ($^\circ$) from the angle of incidence (38). They have also shown refraction at the base of the triangle with the refracted ray changing direction away from the normal with the correct angles of incidence and refraction (22° and 45°).
Response 4	3	The candidate has shown total internal reflection with the correct angle of incidence (38°), refraction at the base of the triangle with the refracted ray changing direction away from the normal with the correct angle of incidence (22°), but has omitted the angle of refraction (45°).
Q9(c)	1	
Response 1	0	The candidate's description 'higher up on the screen' is acceptable, but 'certain less colours' is incorrect. Issue 21 from the <i>Physics: general marking principles</i> (the +/- rule) applies, and the mark is not awarded.
Response 2	1	The candidate's descriptions 'less refracted' and 'red and violet light closer together' are both acceptable.
Response 3	1	The candidate's description is acceptable.
Response 4	0	The candidate's description is incorrect.