

Question number	Answer	Notes	Marks												
4 (a)	<table><thead><tr><th>Statements</th><th>Tick</th></tr></thead><tbody><tr><td>the light from the object passes through the image in a plane mirror</td><td></td></tr><tr><td>the light waves are longitudinal</td><td></td></tr><tr><td>the angle of incidence equals the angle of reflection</td><td>✓</td></tr><tr><td>the image in a plane mirror is virtual</td><td>✓</td></tr><tr><td>the incident ray is always at right angles to the reflected ray</td><td></td></tr></tbody></table> <p>1 mark for each correct tick;; if more than two ticks, -1 for each additional tick to a minimum of zero</p>		Statements	Tick	the light from the object passes through the image in a plane mirror		the light waves are longitudinal		the angle of incidence equals the angle of reflection	✓	the image in a plane mirror is virtual	✓	the incident ray is always at right angles to the reflected ray		2
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(b)	$i = 45 (^{\circ});$ $r = 26 (^{\circ});$	allow answers in range 43-47° allow answers in range 24-28°	2												

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(c) (i)	$n = \sin i / \sin r$ ;	allow in words and rearrangements	1
(ii)	<p>any 6 from:</p> <p><b>apparatus (2 marks max.)</b>  MP1. suitable named light source;  MP2. ruler / pencil / paper;  MP3. protractor;</p> <p><b>measurements needed (2 marks max.)</b>  MP4. measure angle of incidence / angle of refraction;  MP5. repeat for <b>different</b> angle(s) of incidence;  MP6. repeat for <b>same</b> angle of incidence;</p> <p><b>data analysis (2 marks max.)</b>  MP7. (use equation to) calculate <math>n</math>;  MP8. plot a graph of <math>\sin i</math> against <math>\sin r</math>;  MP9. calculate <math>n</math> from gradient / calculate average value of <math>n</math>;</p>	<p>allow any marking point if clear from labelled diagram</p> <p>e.g. ray box, light box, laser  ignore 'source of light', torch  allow optical pins</p> <p>ignore unqualified 'take repeats'</p> <p>no need to quote equation as it is requested in (c)(i)</p>	6

**Total for question 4 = 11 marks**