



NEW ZEALAND QUALIFICATIONS AUTHORITY  
MANA TOHU MĀTAURANGA O AOTEAROA

## **Level 1, 2003**

### **Physics: Demonstrate understanding of reflection and refraction of waves and light (90182)**

**National Statistics**

**Assessment Report**

**Assessment Schedule**

**Physics: Demonstrate understanding of reflection and refraction of waves and light (90182)****National Statistics**

Number of Results	Percentage achieved			
	Not Achieved	Achieved	Merit	Excellence
2,688	22.4%	41.1%	25.5%	11.0%

**Assessment Report****General Comments**

Every candidate for a National Certificate of Educational Achievement examination paper is expected to:

- read the question and do what the question asks
- allow adequate time to complete answers
- be accurate: check and/or proofread
- use appropriate technical terms
- bring the correct equipment
- write and/or draw clearly
- use pen if work is to be eligible for reconsideration.

Candidates who do not attempt all questions limit their opportunity to achieve.

Overall the waves question was answered better than the light question. More emphasis is therefore recommended on light in the future.

Candidates should be aware that poor grammar and handwriting can reduce the effectiveness of their presentation of evidence.

## Assessment Schedule

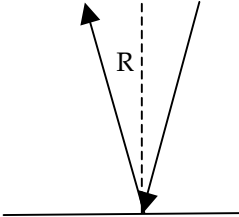
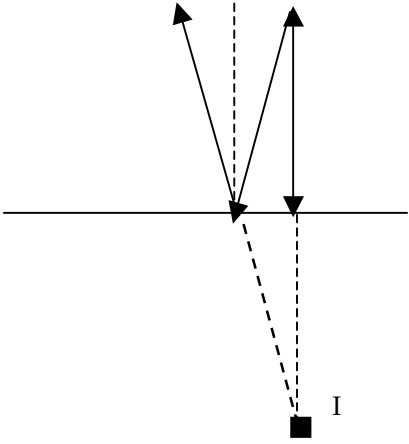
### Physics: Demonstrate understanding of reflection and refraction of waves and light (90182)

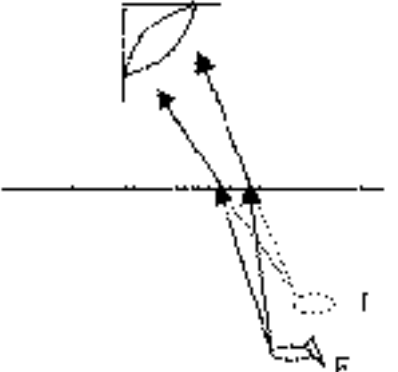
#### Evidence Statement

**Note:** Minor computational errors will not be penalised. A wrong answer will be accepted as correct provided there is sufficient evidence that the mistake is not due to a lack of understanding. Such evidence includes:

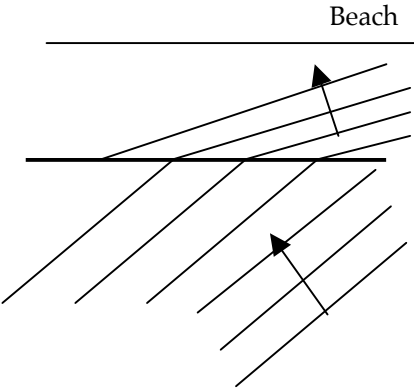
- the last written step before the answer is given has no unexpanded brackets or terms and does not require rearranging
- the power of any number that is multiplied by a power of 10 is correct.

*Italics* indicate replacement evidence.

Question	Evidence	Evidence Contributing to Achievement	Evidence Contributing to Achievement with Merit	Evidence Contributing to Achievement with Excellence	Code
One (a) (i) & (ii)		(i) Reflected ray looks to be drawn at an equal angle.  (ii) Correct angle labelled.  Both correct			A <sub>1</sub>
One (a) (iii)			Another incident ray drawn. Diagram completed correctly and image identified.  If refraction, incorrect.		M <sub>1</sub>

Question	Evidence	Evidence Contributing to Achievement	Evidence Contributing to Achievement with Merit	Evidence Contributing to Achievement with Excellence	Code
One (b) (i)		One ray drawn correctly. Refracted correctly and arrows not required.	Diagram has both rays produced from an appropriate point and diverging. Refracted correctly and arrows not required.	Diagram correctly shows light bending away from normal and two rays extended back to an appropriate image position of the fish. Arrows in the correct direction.	A <sub>1</sub> M <sub>1</sub> E <sub>1</sub>
One (b) (ii)	The image of the fish is virtual because the rays of light only appear to come from the position of the fish.	An answer that states or implies that virtual rays have been refracted or used.			A <sub>1</sub>
One (c) (i)	Total internal reflection, or internal reflection.	Correct answer.			A <sub>1</sub>
One (c) (ii)	<p>The conditions necessary are that light is travelling from a more optically dense medium to a less optically dense medium and that the light is incident at an angle greater than the critical angle.</p> <p>This is when the second fish looks towards the surface of the water above the rock. The rays from the first fish meet the water surface at an angle greater than the critical angle and the water surface thus behaves like a mirror.</p>	<i>Answer to One(c) can provide supplementary evidence if required.</i>	Light is travelling from optically denser water to less dense air at an angle of incidence that exceeds the critical angle. Optical density, critical angle and total internal reflection: 2 out of three required.	Clear explanation, which includes: optical density, critical angle and total internal reflection.	M <sub>1</sub> E <sub>1</sub>
One (d)	$n_{\text{water}} = \sin \theta_{\text{air}} / \sin \theta_{\text{water}}$ $1.33 = \sin 40 / \sin \theta_{\text{water}}$ $\theta_{\text{water}} = 29^\circ$		Answer and working correct.		M <sub>2</sub>
One (e) (i)	$\theta_1 = 90 - 43 = 47^\circ$	Answer correct.			A <sub>2</sub>

Question	Evidence	Evidence Contributing to Achievement	Evidence Contributing to Achievement with Merit	Evidence Contributing to Achievement with Excellence	Code
One (e) (ii)	43°		Answer and working correct.		M <sub>2</sub>
One (e) (iii)	A right-angled reflector can reflect the light upwards (towards the eyes of the following driver). A vertical plane reflector cannot reflect the light upwards towards the driver's eyes.		Identifies light returns to source so bike can be seen.	Explanation comparing plane and right-angled reflectors clearly identifies that light always returns to source for right-angled reflectors so that the bike can be seen, compared to a plane reflector which does not do that (unless the light is incident along normal).	M <sub>1</sub>  E <sub>1</sub>
Two (a) (i)	T = 20/6 T = 3.3 s	Working correct.			A <sub>2</sub>
Two (a) (ii)	f = 1/T f = 1/3.333333333 f = 0.30 Hz	<i>Consequential from Two (a) (i).</i>	Answer and working correct.		M <sub>2</sub>
Two (a) (iii)	λ = 10/5 λ = 1.667 m  v = fλ v = 0.30 x 1.667 v = 0.50ms <sup>-1</sup>	<i>Consequential from Two (a) (ii).</i>  A correct velocity consequential to an incorrect λ or f.		Answer correct or correct, consequential on 2 (a) (ii). λ calculated correctly	A <sub>2</sub>  E <sub>2</sub>
Two (b) (i)	The waves' speed reduces as they go into the shallower water.	Decrease speed.			A <sub>1</sub>

Question	Evidence	Evidence Contributing to Achievement	Evidence Contributing to Achievement with Merit	Evidence Contributing to Achievement with Excellence	Code
Two (b) (ii)	<p>The direction of travel of wavefronts bends towards normal, wavelength decreases.</p> 	Wavefronts change direction correctly towards the normal.	Wavefronts change direction correctly with even spacing.	<p>Wavefronts progress in the correct direction and wavelength decreases correctly.</p> <p>Wavefronts connect at deep/shallow boundary.</p>	<p>A<sub>1</sub></p> <p>M<sub>1</sub></p> <p>E<sub>1</sub></p>
Two (c)	$d_{\text{directsound}} = \frac{3}{4}W$ $d_{\text{echo}} = 1\frac{1}{4}W$ $d_{\text{echo}} - d_{\text{sound}} = \left(1\frac{1}{4} - \frac{3}{4}\right)W$ $= \frac{1}{2}W$ $d = v \times t$ $\frac{1}{2}W = 165 \text{ m}$ <p>(Note: other correct methods are possible)</p>		Correct answer but with no explanation how time is determined.	Correct answer with clear explanation of process. Time calculation process required.	<p>M<sub>2</sub></p> <p>E<sub>2</sub></p>
Two (d) (i)	$300\,000 \text{ kms}^{-1}$ $= 300\,000\,000 \text{ ms}^{-1}$	Answer correct.			A <sub>2</sub>
Two (d) (ii)	$\lambda = v/f$ $\lambda = 300\,000\,000/91 \times 10^6$ $\lambda = 3.3 \text{ m}$	<i>Consequential to Two (d) (i).</i>	Answer and working correct.		M <sub>2</sub>
Two (e)	<p>Longitudinal wave motion is parallel to the vibration causing the wave.</p> <p>Transverse wave motion however is perpendicular (right angles) to the vibration causing the wave.</p>	<i>Idea that transverse perpendicular and longitudinal parallel but understanding of vibration and wave motion unclear.</i>	Answer correct for both.		M <sub>1</sub>
TOTAL		7 × A <sub>1</sub> 3 × A <sub>2</sub>	6 × M <sub>1</sub> 4 × M <sub>2</sub>	4 × E <sub>1</sub> 2 × E <sub>2</sub>	

**Judgement Statement:**

Judgement statements (formerly referred to as sufficiency statements) help students understand how their overall results for each standard were arrived at.

Achievement	Achievement with Merit	Achievement with Excellence
6 × <b>A</b> including 2 × A2	Achievement <i>plus</i> 6 × <b>M</b> including 2 × M2	Merit <i>plus</i> 3 × <b>E</b> including 1 × E2

**Holistic Judgement**

If required, sufficiency may be obtained to a lower level of achievement by taking into account supplementary evidence from higher levels of achievement. Criterion one can only replace criterion one and criterion two can only replace criterion two.