NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 2, 2003

Physics: Demonstrate understanding of wave phenomena (90254)

National Statistics

Assessment Report

Assessment Schedule

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National Statistics

Number of Results	Percentage achieved			
	Not Achieved	Achieved	Merit	Excellence
9,046	31.7%	42.3%	20.4%	5.6%

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.

A significant number of candidates were better able to *Solve problems* than to *Give descriptions and explanations*. For instance, the standard requires candidates to *demonstrate understanding of wave phenomena* by giving *descriptions or explanations* of situations related to waves. Some candidates showed evidence of understanding but could not express their ideas effectively. In this type of question, successful candidates

- used correct physics terms eg Question 1(b) using ‘inverted’ instead of ‘around about’ and Question 3(c) ‘wavelength’ instead of ‘size of the wave’.
- wrote concise answers, one point per sentence where each point in the logical explanation was explicit. This was especially important for Merit and Excellence questions that required *reasons* and *minimal irrelevancies.*
- avoided answers which repeated the information given in the question.
- used diagrams or graphs to support their answers.

The achievement standard requires candidates to *use appropriate methods to solve problems* in order to *demonstrate understanding of wave phenomena.* Using the formula method, candidates who presented their solutions in a logical, sequential format were more successful than others. For example, one way to answer Question 1(e) was:

$m = h_i / h_o$ select formula

$0.02 = 3.2 / h_o$ select relevant information and substitute

$h_o = 3.2 / 0.02$ rearrange

$h_o = 160$ cm answer with unit

This would ensure that candidates minimise errors and provide evidence to the marker of understanding relevant concepts/principles and the process used to solve the problem. This is especially important in

Merit/Excellence questions such as Q2 part A(e) using a complex formula and involving more than one process. Candidates should be encouraged to adopt the same method for the ‘show’ type question.

Real life contexts are used wherever possible. Learning programmes should reflect this. The use of significant figures is an important physics skill.

Assessment Schedule

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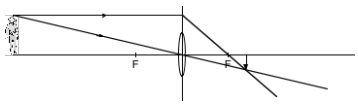
Evidence Statement

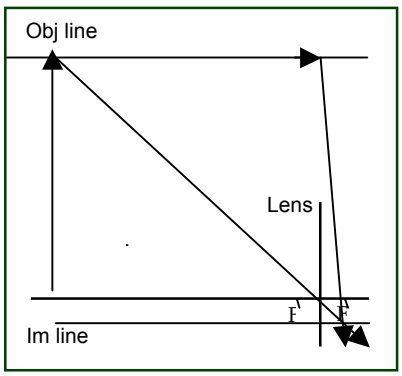
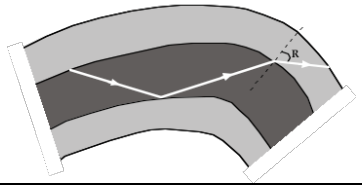
Note: Minor computational errors will not be penalised. A wrong answer will be accepted as correct provided there is sufficient evidence that the mistake is not due to a lack of understanding of the concepts in Physics.

Such evidence can include the following:
- 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
- a value has been incorrectly transcribed from the question
- consequential information used correctly from previous questions

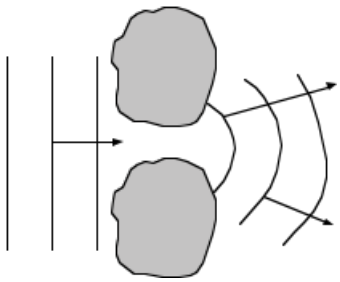
Correct units and significant figures are required only in the questions that specifically ask for them.

Italics indicate replacement evidence.

Q	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
Question One				
(a)		[1] Both real light rays drawn to locate the image with arrows. Image arrow drawn. Arrows on rays not needed. Other rays of light drawn will be accepted.		
(b)	Real, inverted, diminished	[1] Any two correct descriptions given (ignore incorrect ones).		
(c)	$1/f = 1/d_i + 1/d_o$ $1/5 = 1/5.10 + 1/D$ $1/D = 0.00392$ $D = 255$ cm $S_o S_i = f^2$ $S_o = 25/ 0.1$ $S_o = 250$ $D = 250 + 5$ $D = 255$ cm	[2] *Merit*	[2] Correct substitution into formula.	
(d)	$m = d_i / d_o$ $m = 5.10 / 255$ $m = 0.02$	[2] Correct answer.		
(e)	$M = h_i / h_o$ $h_o = 3.2/0.02$ $h_o = 160$ cm	[2] Correct answer.		

Q	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
(f)	By Calculation lens – camera film distance $d_i = x$ object – lens distance $d_o = 10x$ $1/f = 1/d_i + 1/d_o$ $1/5 = 1/x + 1/10x$ $1/5 = 11/10x$ $x = d_i = 5.5$ cm hence $d_o = 10 \times 5.5 = 55$ cm OR $S_o S_i = f^2$ $S_o = 10x – 5$ $S_i = x – 5$ $25 = (10x – 5)(x – 5)$ $25 = 10x^2 – 55x + 25$ $5 = 2x^2 – 11x + 5$ $0 = x(2x – 11)$ $x = d_i = 5.5$ cm hence $d_o = 10 \times 5.5 = 55$ cm OR $m = f/ S_o$ $0.1 = 5/ S_o$ $S_o = 50$cm $d_o = 50 + 5 = 55$ cm	2 Correct algebraic expressions for distances identified for substitution into formula. 2 Correct value for m recognized.	2 Correct algebraic expressions for distances substituted into formula to find correct lens–film distance. 2 Correct value for m recognised and used to find correct value of S_o.	2 Correct algebraic expressions for distances substituted into formula to find correct lens–film distance. Correct lens–object distance calculated. 2 Correct value for m recognised and used to find correct value of S_o. Correct lens–object distance calculated.
OR	By Scale Diagram Object distance = 55 +/– 3cm  	2 Relative heights of object and image drawn on grid.	2 Relative heights of object and image drawn on grid and a correct ray drawn to locate image.	2 Relative heights of object and image drawn on grid and correct rays drawn to locate image and object. Lens-object distance calculated.
Question Two, Part A				
(a)		1 Correct answer.		
(b)	$n_1 \sin\theta_1 = n_2 \sin\theta_2$ $n \sin 45.2° = 1.51 \times \sin 52.7°$ $n = 1.69$	2 *Merit*	2 Correct substitution into formula.	

Q	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
(c)	$n_1/n_2 = v_2/v_1$ $1.51/1.69 = v_2/1.971 \times 10^8$ $v_2 = 1.76 \times 10^8$ m s^{-1} OR $v = c/n$ $v_2 = 3.00 \times 10^8/1.69$ $v_2 = 1.78 \times 10^8$ m s^{-1}	[2] *Merit*	[2] Correct answer.	
sf	Answer written to 3 sig figs.	[1] *Merit*	[1] Correct number of sig figs.	
(d)	(d) parts (i) and (ii) marked together Critical angle is the incident angle in the glass fibre (more dense medium) that would give an angle of refraction of 90° in the cladding (less dense medium). Critical angle for this boundary is 64°. At Y incident, angle is 69° – this is greater than the critical angle, hence total internal reflection.	[1] *Merit*	[1] Clear understanding of critical angle OR clear explanation for Y by relating the incident angle to the critical angle.	[1] Clear understanding of critical angle AND clear explanation for Y by relating the incident angle to the critical angle.
(e)	$n_1\sin\theta_1 = n_2\sin\theta_2$ $1.36 \times \sin 10° = 1.58 \times \sin\theta_2$ $\theta_2 = \sin^{-1} 0.150 = 8.60°$ The angle of reflection is 90–8.60 = 81.4°.	[2] *Merit*	[2] Correct calculation of θ_2.	[2] Correct calculation of θ_2 and correct angle of reflection.
Question Two, Part B				
(a)	$v = f\lambda$ $f = 340/0.48$ = 708 = 710 Hz	[2] Correct answer.		
unit	Hz (Hertz) or s^{-1} (per second)	[1] Correct unit.		
(b)	Nodal line is formed when a crest of one sound wave and a trough of another sound wave interfere and cancel each other. Destructive interference takes place.	[1] Understanding of crest and trough meeting OR cancellation.	[1] Clear understanding of either crest/trough/two waves out of phase by 180°/two waves with path difference of half wavelength AND cancellation.	
(c)	A series of maxima and minima of loudness as Tom moves along line BC.	[1] Should state the difference in loudness along BC.		

Q	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
(d)	Distance or time difference between successive minima of loudness will increase. As f decreases and v stays the same, λ will increase. Therefore the spacing will increase.	[1] *Merit*	[1] Statement that distance or time will increase.	[1] Statement that distance or time will increase and the correct explanation.
Question Three				
(a)	Diffraction	[1] Correct word.		
(b)		[1] Diagram clearly shows waves spreading out in circular pattern after passing through the gap. Arrow(s) drawn. Wavelength the same not needed.		
(c)	Condition for diffraction to take place is that the wavelength of the water waves is equal to or greater than the gap.	[1] *Merit*	[1] Answer clearly states the link between the wavelength and the size of the gap.	
(d)	6 waves in 29.7 sec f = 6/29.7 = 20/99 = 0.202 Hz 5 crests in 16 m λ = 4 m v = fλ = 0.202 × 4 = 0.81 m s^{-1} OR v = d/t (i) dist for 4 waves = 16 m time for 4 waves = 29.7 × 4/6 = 19.8 s v = 16/19.8 = 0.81 m s^{-1} (ii) dist for 6 waves = 4 × 6 = 24m time for 6 waves = 29.7 v = 24/29.7 = 0.81 m s^{-1}	[2] Either frequency or wavelength is calculated correctly. [2] Either distance (ii) or time (i) is calculated correctly.	[2] One of frequency or wavelength are calculated correctly and used to find a value of v. [2] In either (i) or (ii) one quantity is calculated correctly and used to find a value of v. .	[2] Frequency and wavelength are both calculated correctly. Speed calculated correctly. [2] Distance and time calculated correctly. Speed calculated correctly.
Total opportunities		Criterion 1: 8 Criterion 2: 5	Criterion 1: 5 Criterion 2: 6	Criterion 1: 2 Criterion 2: 3

Judgement Statement

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

The grade awarded is the highest one that has been demonstrated in all achievement criteria up to and including that grade. The following is a guide to the standard required for each grade in the two criteria.

Criterion 1:

- Achievement – 4 different aspects of phenomena, concepts or principles are demonstrated at this level or better.
- Achievement with Merit – 7 different aspects of phenomena, concepts or principles are demonstrated of which 3 of them must be at Merit level or better.
- Achievement with Excellence – merit plus 1 of the phenomena, concepts or principles are demonstrated at Excellence level.

Criterion 2:

- Achievement – 3 different relationships, concepts or principles are used to solve problems at this level or better.
- Achievement with Merit – 6 different relationships, concepts or principles are used to solve problems of which 3 of them must be at Merit level or better.
- Achievement with Excellence – Merit plus 2 of the different relationships, concepts or principles are used to solve problems at Excellence level.