

Applied Science

Advanced GCE

Unit **G635**: Working Waves

Mark Scheme for January 2012

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All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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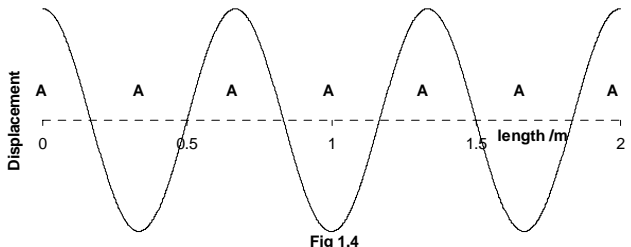
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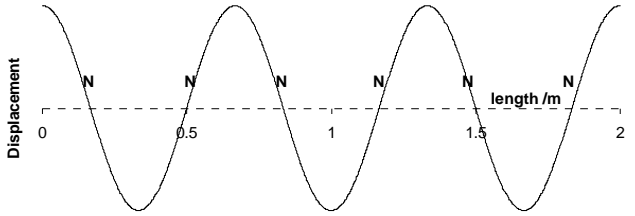
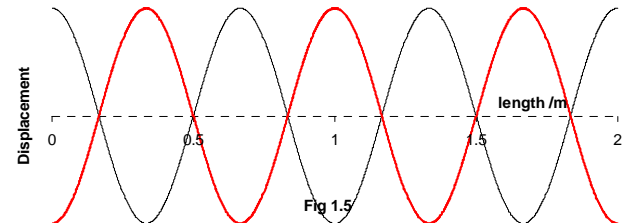
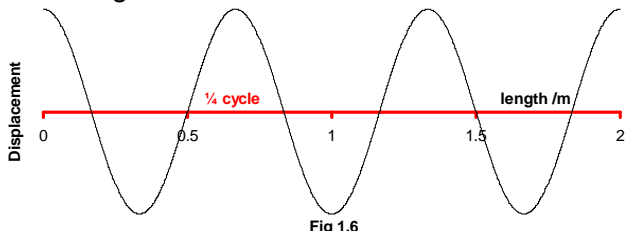
Annotations

Annotation	Meaning
	Tick
	Cross
	Benefit of doubt
	Error carried forward
	Example/Reference
	Ignore
	Not answered question
	Benefit of doubt not given
	Large dot (Key point attempted)
	Reject
	Contradiction
	Error in no. of significant figures
	Unclear
	Omission mark

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	separates marking points
NOT	answers which are not worthy of credit
REJECT	answers which are not worthy of credit
IGNORE	statements which are irrelevant
ACCEPT	answers that can be accepted
()	words which are not essential to gain credit
—	underlined words must be present in answer to score a mark
ecf	error carried forward
AW	alternative wording
ora	or reverse argument

Question		Answer			Marks	Guidance
1	(a)				4	<p>Accept 0.11 m.</p> <p>Allow ± 0.1 in measurements Accept any sig. figs. Must see two readings NOT simply the difference 1.0 m</p> <p>Accept values 2.0 to 3.0 Accept any sig. figs.</p> <p>'NA' for BOTH Periodic time and frequency required. Accept 'NA' in either column Ignore 'NA' in displacement and speed.</p>
		feature	measurements taken	value		
		displacement	(10 cm /0.1 m)	0.1(0) (m) ✓		
		speed	Distances: e.g. 0.5 and 1.5 m 1.0 and 2.0 or 0.75 and 1.75 m ✓ (Times: 0.41 and 0.81 s)	2.5 (m s ⁻¹) ✓		
		periodic time	NA	} ✓		
frequency	NA	} ✓				
	(b)	(i)			2	<p>Frequencies all correct ✓</p> <p>Wavelengths all correct ✓</p>
			<p>frequency same as graph A</p> <p>graph B ✓ } graph C ... ✓ } ..✓ graph D }</p> <p>wavelength same as graph A</p> <p>graph B ✓ } graph C ... ✓ } graph D }</p>			

Question	Answer	Marks	Guidance
(ii)	$\frac{1}{4}$ cycle / 90° / $\pi/2$ (rad) / $1 \mu\text{s}$ difference ✓ Graph A leads graph B OR graph B lags behind graph A ✓	2	Accept $\frac{3}{4}$ cycle / 270° / $3\pi/2$ (rad) / $3 \mu\text{s}$ difference Accept Graph B leads graph A / Graph A lags behind graph B Combined with $\frac{3}{4}$ cycle / 270° / $3\pi/2$ (rad) / $3 \mu\text{s}$ difference
(iii)	$4 \mu\text{s}$ / $4 \times 10^{-6} \text{ s}$ / $4 \times 10^{-3} \text{ ms}$ ✓	1	
(iv)	$f = \frac{1}{T}$ ✓ <u>Calculation</u> of reciprocal of number in (iii) ✓ $T = 250\,000 \text{ (Hz)}$ / 250 (kHz) / 0.25 (MHz) Matching unit to value ✓	3	Stated or implied 0.25 (MHz) if $T = 4 \text{ (}\mu\text{s)}$ $250\,000 \text{ (Hz)}$ if $T = 4 \times 10^{-6} \text{ (s)}$ 250 (kHz) if $T = 4 \times 10^{-3} \text{ (ms)}$ Ignore fractional answers Accept ecf for incorrect values in (iii) e.g. $T = 4 \text{ s}$ gives 0.25 (Hz) Accept ecf for incorrect values in (iii) e.g. $T = 4 \text{ s}$ gives 0.25 Hz
(c) (i)	Any two correct positions for A and no incorrect positions for A and no N where A should be ✓ i.e. 	1	Accept at any position vertically

Question	Answer	Marks	Guidance
(ii)	Any two correct positions for N AND no incorrect positions for N AND No A where N should be ✓ ✓ i.e.  Fig 1.4	1	Accept at any position vertically
(iii)	Line as shown in red ✓  Fig 1.5	1	Accept horizontal displacement up to 0.05 m (approx two dashes on axis) Ignore Amplitude variations as long as > 0
(iv)	Line along axis as shown in red ✓  Fig 1.6	1	
(v)	Any value between 0.65 and 0.68 m ✓	1	Allow 2 or more sig. figs.

Question	Answer	Marks	Guidance
(d)	<p>Open at both has antinodes at both ends. Open at one end/closed at other end has node at one end ✓✓</p> <p>OR</p> <p>Open at both has odd number of $\frac{1}{4}$ wavelengths. Open at one end/closed at other end has even number of $\frac{1}{4}$ wavelengths ✓✓</p> <p>OR Any two from:</p> <p>Different frequency/ frequencies./wavelength/s ✓</p> <p>Different pattern of nodes and antinodes ✓</p> <p>Different combination of harmonics/overtones ✓</p> <p>One has antinodes at both ends, other has node at one end ✓</p> <p>One had odd number of $\frac{1}{4}$ wavelengths, other has even number of $\frac{1}{4}$ wavelengths ✓</p> <p>Diagram of pattern of nodes/antinodes/standing wave in open pipe ✓</p> <p>Diagram of pattern of nodes/antinodes/standing wave in closed pipe ✓</p> <p>Open at both has harmonics which are all multiples of fundamental frequency. ✓</p> <p>Open at one end/closed at other end has harmonics which are only odd multiples of fundamental ✓</p>	2	
	Total	19	

Question		Answer	Marks	Guidance
2	(a)	Different temperatures / warmer / colder ✓ (Emit) different, wavelength/frequencies/ intensities, / different amounts of, infrared/radiation, ✓	2	
	(b)	Different shades of grey / false colours ✓ Different temperatures / warmer / colder ✓	2	
	(c)	(Can use it/ produces images,) at night/ in the dark ✓	1	
	(d) (i)	IR has, longer/higher, wavelength than visible OR visible has, shorter/lower, wavelength than IR ✓	1	
	(ii)	Same ✓	1	
	(e) (i)	Spatial ✓	1	
	(ii)	Thermal ✓	1	
		Total	9	

Question		Answer		Marks	Guidance
3			In the dark	4	
			In daylight		
		infrared radiation	Same ✓		
	visible light	Same/ None ✓	red longer ora ✓		
		Total		4	

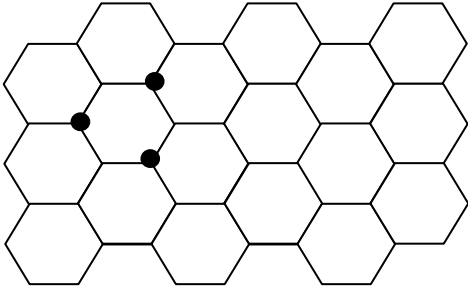
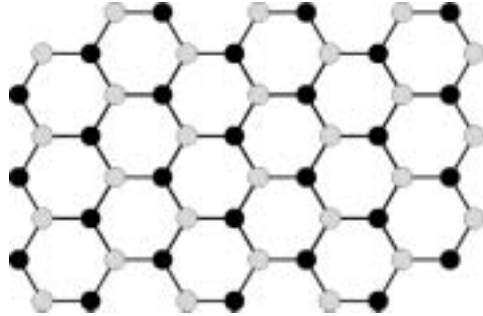
Question		Answer	Marks	Guidance
4	(a)	Photodiode ✓	1	Accept specific valid alternatives Reject eyes, photo detector
	(b)	Total internal reflection ✓	1	NOT just TIR
	(c)	Angle of incidence > critical angle ✓ At interface OR For light travelling from a more dense (medium) to(wards) a less dense medium/ in fibre/core/glass/plastic as it meets air/cladding ✓	2	Accept 42 ° instead of critical angle OR cladding has lower refractive index than core
	(d)	Any two from: Core diameter within range 50 -200 μm ✓ Core of uniform refractive index ✓ Core covered by cladding/ coating of lower refractive index ✓ (Outer) protective sheath ✓	2	Response may be by text and/or diagram
	(e) (i)	Narrower core OR Smaller diameter/thickness core ✓ Core (diameter) within range 1 -10 μm ✓	2	Ignore Smaller with no reference to diameter/ thickness

Question		Answer	Marks	Guidance
	(ii)	<p>Monomode less degradation/distortion/data loss, fewer repeater stations needed</p> <p>OR</p> <p>Step index distorted / more repeater stations needed ✓</p> <p>Monomode only one path / Step index multiple paths ✓</p> <p>Monomode, light/rays, arrives together / Step index, light/rays, arrives at different times ✓</p>	3	<p>Ignore references to cost</p> <p>Accept Light rays travel in a straight line</p>
(f)	(i)	Coherent ✓	1	
	(ii)	<p>Coherent fibres arranged in same order at both ends/ throughout</p> <p>OR</p> <p>Incoherent fibres not arranged in same order at both ends/ fibres arranged randomly ✓</p>	1	Accept coherent fibres parallel
	(iii)	Signals/data, from different users, would not be sorted correctly/ would be mixed up ✓	1	

Question	Answer	Marks	Guidance
(g)	<p>Banded marking range:</p> <p>[0 mark] response not worthy of credit.</p> <p>[1-2 marks] Candidate demonstrates a limited knowledge of one method of measuring refractive index by describing:</p> <p>For 1 mark at least one valid point. For 2 marks at least two valid points.</p> <p>The answer may not be clearly set out.</p> <p>[3-4 marks] Candidate demonstrates understanding of one method of measuring refractive index by describing and explaining:</p> <p>For 3 marks at least three valid points. For 4 marks at least four valid points.</p> <p>The answer will be set out in a manner that is easy to follow. But may contain and one or two errors or omissions in content</p> <p>[5-6 marks] Candidate demonstrates a high level of knowledge and understanding of the use of one method of measuring refractive index</p> <p>by describing: a full understanding of an appropriate method by giving clear and, and some for 5 marks at least five valid points. for 6 marks six valid points. The answer will be set out in a clear and logical manner</p>	6	<p>Any valid method may be described. Expect one of the following:</p> <ul style="list-style-type: none"> • ray box sending rays though block • pins viewed through block and rays traced • real and apparent depth • Semicircular block to find critical angle <p>Expected knowledge and learning could include the following valid points:</p> <p>Labelled diagram of how equipment is arranged ✓ e.g. for ray box method labelled Box shines light ray into (long) side of labelled block and out other side</p> <p>Correctly identify variables ✓</p> <ul style="list-style-type: none"> ▪ i and r between ray and normal. <ul style="list-style-type: none"> • real and apparent depth • critical angle <p>Appropriate measuring Instrument needed ✓ Ruler Protractor Travelling microscope/vernier callipers</p> <p>Workable method ✓</p> <p>Processing of results ✓ e.g. <ul style="list-style-type: none"> • $n = \sin i / \sin r$ • $n = 1 / \sin c$ • $n = \text{real} / \text{apparent depth}$ graph</p>

Question	Answer	Marks	Guidance
			Improved precision: ✓ e.g. <ul style="list-style-type: none">• Selecting a more precise method of measuring angles using lengths• More than one set of readings obtained• Repeated for different values of i/r• Table of results
	Total	20	

Question			Answer	Marks	Guidance
5	(a)	(i)	Analogue ✓	1	
		(ii)	Digital ✓	1	Accept Binary
	(b)	(i)	Pulse Code Modulation ✓	1	
		(ii)	Signal/ sound sampled ✓ At frequent/ regular intervals ✓	2	May be shown by diagram Accept Many points = frequent
		(iii)	Signal/voltage quantised/ converted to binary ✓	1	
		(iv)	Digital to analogue (conversion) ✓	1	Ignore D to A
			Total	7	

Question	Answer	Marks	Guidance
6 (a)	Base stations shown at centres of cells or at junctions of three cells ✓ Base stations shown at alternate junctions ✓	2	<p>Allow Base stations shown at centres of cells for 1st mark</p> <p>e.g. of alternate junctions</p>  <p>Or any three black circles or any three shaded circles:</p> 
(b)	Any adjacent cell ✓	1	
(c)	Any two from: Variation in population density ✓ Mountains/ obstructions ✓ Coverage may not have reached remote areas ✓ Coastline ✓	2	
	Total	5	

Question		Answer	Marks	Guidance	
7	(a)	<p>Any three from:</p> <p>X-rays are absorbed by bone ✓</p> <p>X-rays are not absorbed by surrounding parts/ soft tissue ✓</p> <p>X-rays are absorbed by materials with high atomic mass/number/ density ora✓</p> <p>Bones/Calcium, have high atomic mass/ number/ density ora✓</p> <p>Image (digital/film) is black where X-rays reach it / white where X-rays do not reach it ✓</p> <p>Image (digital/film) is negative ✓</p>	3	Answers may reflect the fact that digital has replaced film.	
	(b)	(i)	(Dark) grey ✓ X-rays absorbed less by fat than by <u>bone</u> ✓	2	
		(ii)	Black ✓ X-rays absorbed less by air than by fat/ soft tissue ✓	2	Reject Dark Accept air does not absorb
	(c)	Barium (meal/ions/sulfate) / iodine (compound) ✓	1		

Question		Answer	Marks	Guidance
	(d) (i)	<p>Any one from: X-rays passing through one point on the subject/patient will be spread over a larger area of the film /detector ✓</p> <p>X-rays arriving at one point on the film /detector will have passed through a larger area of the subject/patient ✓</p> <p>blurred image occurs if wide beam is diverging/ not focused ✓</p>	1	Ignore References to scattering
	(ii)	The target surface is at an angle (not 90°) to the incoming/ outgoing (X-ray) beam. Owtte ✓	1	
	(iii)	<p>Any one from: A (cone) of lead around the beam ✓</p> <p>Two pairs of adjustable lead sheets (that can be moved in and out at right angles to the direction of the beam) ✓</p>	1	Accept Lead diaphragm / Owtte
	(e) (i)	Placing an <u>aluminium</u> sheet in the beam ✓	1	
	(ii)	Removes lower frequency/ low-energy, (X-)rays/ radiation ✓	1	Ignore Removes high/certain frequencies Accept Weak (X-)rays
	(iii)	<p>Low-frequency /low-energy X-rays would be scattered (in the body) ✓</p> <p>Scattered X-rays would arrive at the wrong point on the film /detector/ cause blurring ✓</p>	2	
	(f) (i)	X-rays ✓	1	

Question		Answer	Marks	Guidance
	(ii)	(X-ray) Source/machine rotates ✓ (Array of) detector(s) rotates (opposite source) ✓ Patient / bed moves along axis /into machine OR overall motion is helical/spiral✓	3	Accept Ecf for (Gamma) Source
	(iii)	Intensity of ray reaching film in a conventional X-ray has been affected by many layers in the body ✓ CAT scan gives information about intensity at an individual point in the patient ✓	2	Accept 3D image/slices/soft tissue
		Total	21	

Question	Answer	Marks	Guidance
8	<p>Banded marking range:</p> <p>[0 mark] response not worthy of credit.</p> <p>[1-2 marks] Candidate demonstrates a limited knowledge of internet connection methods by describing:</p> <p>For 1 mark at least one valid point. For 2 marks at least two valid points.</p> <p>The answer may not be clearly set out.</p> <p>[3 marks] Candidate demonstrates understanding of internet connection methods by describing and explaining at least three valid points.</p> <p>The answer will be set out in a manner that is easy to follow. But may contain and one or two errors or omissions in content</p> <p>[4-5 marks] Candidate demonstrates a high level of understanding of internet connection methods by giving:</p> <p>for 4 marks at least four valid points. for 5 marks at least five valid points.</p> <p>The answer will be set out in a clear and logical manner</p>	5	<p>Expected knowledge and learning could include the following valid points:</p> <p>Naming or describing Dial-up and Broadband ✓</p> <p>Naming or describing use of fibre optic cable internet connection ✓</p> <p>Correctly indicating the relative suitability of at least two methods for transmitting large amounts of data ✓</p> <p>i.e. two of:</p> <ul style="list-style-type: none"> ▪ Dial-up unsuitable / would take a (very) long time, ▪ Broadband suitable/ faster, ▪ Fibre optic best/ very fast <p>Broadband achieves higher data transfer rate/capacity, by using higher frequency (signals than voice /dial-up connection over conventional copper /telephone wires) ✓</p> <p>Fibre optics permit very large information capacity/data transfer rate/capacity (IGNORE just "very fast") ✓</p>
	Total	5	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

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