

**GCE**

**Applied Science**

Unit **G635**: Working Waves

Advanced GCE

**Mark Scheme for June 2017**

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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## Annotations

<b>Annotation</b>	<b>Meaning</b>
<b>DO NOT ALLOW</b>	Answers which are not worthy of credit
<b>IGNORE</b>	Statements which are irrelevant
<b>ALLOW</b>	Answers that can be accepted
( )	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
<b>ECF</b>	Error carried forward
<b>AW</b>	Alternative wording
<b>ORA</b>	Or reverse argument

**Subject-specific Marking Instructions****INTRODUCTION**

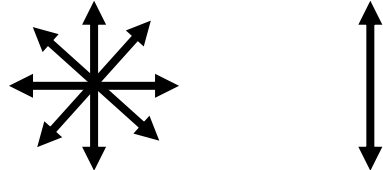
Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

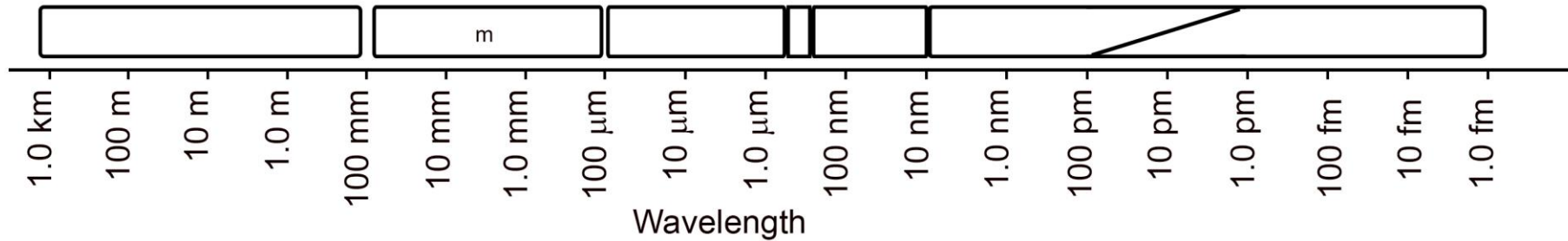
You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

Question			Answer	Marks	AO element	Guidance
1	(a)	(i)	Gamma Camera ✓	1	1	IGNORE Tracer
		(ii)	To make the heart/ soft tissue show up/Tracer/Radioactive marker/Emits gamma rays / radiation so that the gamma rays can be detected (outside the body)/ ✓	1	1	
		(iii)	Killing/treating cancer/wtte ✓	1	1	ALLOW Radiotherapy
	(b)	(i)	(Light) where (the electric/magnetic field) oscillates in only one direction/plane ✓	1	1	DO NOT ALLOW “Moves” or “travels” “goes” for “oscillates” ALLOW explanations supported by diagrams e.g. 
		(ii)	Selects (vector components of) light which is polarised/oscillating in one direction	1	2	ALLOW “angle” for “direction” ALLOW Shows parts of rock which have rotated/changed the plane of polarisation/rotation of plane of polarisation by the rock ALLOW Reduces glare/ reflections
	(c)	(i)	See diagram below ✓	1	1	
		(ii)	Penetrates water vapour/ cloud ✓	1	1	

Question	Answer	Marks	AO element	Guidance
1 (d)	$v = f\lambda$ ✓ Rearranging and substitution including conversion to m $\lambda = 1000$ m $f = \frac{v}{\lambda}$ $= \frac{3.00 \times 10^8}{1000}$ ✓ $= 3.00 \times 10^5$ Hz or $s^{-1}$ ✓	1    1  1	2	Stated or implied Stated or implied ALLOW 300 000 / $300 \times 10^3$ / $3 \times 10^5$ / $3.0 \times 10^5$ Hz or $s^{-1}$ ALLOW 300 kHz or 0.3 MHz ALLOW 3/3.0/3.00 x $10^8$ mHz for 3 marks
(e)	Speed in vacuum = $3.00 \times 10^8$ m $s^{-1}$ ✓	1	1	
<b>Total</b>		<b>11</b>		



Question			Answer	Marks	AO element	Guidance
2	(a)	(i)	Any two nodes in correctly labelled and no incorrectly placed Ns <b>and</b> Any two antinodes in correctly labelled and no incorrectly placed As ✓	1	1	<b>ALLOW</b> any position vertically if horizontal position correct correct labels on any of the figs 2.1 to 2.4 Treat "AN" as an "A" and an "N" rather than as an abbreviation for antinode
		(ii)	(Oscillator) Frequency (changes) ✓  Frequencies increase ✓  from Fig. 2.1 to 2.4 or Fig. 2.2 has twice the frequency of Fig. 2.1 or Figs. 2.3 has three times the frequency of Fig. 2.1 or Figs. 2.4 D has four times the frequency of Fig. 2.1 ✓	1  1      1	2	Stated, or implied by 'increase' Ignore reference to amplitude  ALLOW third mark for mention of harmonics/ overtones
		(iii)	Tension <b>or</b> Thickness/ density/material/mass per unit length <b>or</b> Breakage /Detached ✓	1	1	Ignore increase/decrease  <b>ALLOW</b> change in temperature if linked to either thickness or tension  Min one change only required
		(iv)	Vertically from axis to maximum /maximum -ve ✓	1	1	<b>ALLOW</b> any clear indication even if double headed arrow not used

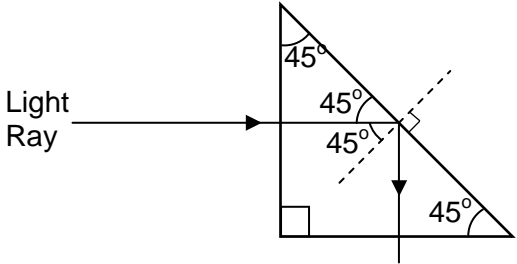
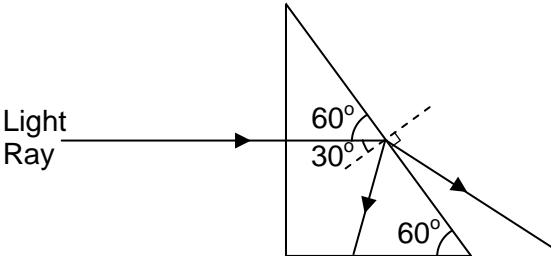
Question		Answer	Marks	AO element	Guidance
2	(b)	Graph of same height and shape displaced, ✓  Displaced by 90° to the right ✓	1  1	2	At least two cycles drawn  <b>ALLOW</b> 1st Marking point for graph of same height and shape displaced by any amount.  At least two cycles drawn  <b>ALLOW</b> drawing graph on Fig 2.6
		<b>Total</b>	<b>8</b>		



Question		Answer	Marks	AO element	Guidance
3	(a)	A perfect Black body absorbs all the electromagnetic radiation (falling on it) ✓	1	1, 2	Stated or implied
		Any <b>ONE</b> of the following: A perfect Black body is an idealised/theoretical concept/ cannot exist in practice ✓ The hole in the cube is a close approximation to a perfect Black body ✓ All the light falling on the hole will /would need to pass into the cube, very little will be reflected by the interior black surface and even less will come back to the hole ✓	1		
	(b)	(i)	a	1	<b>ALLOW</b> letter circled under diagram
		(ii)	(Blue star) Higher, line/ intensity, ORA ✓  Peak (of blue star) further to the left/ at a lower wavelength/higher frequency ORA ✓	1 1	<b>IGNORE</b> drawing on graph for either mark  <b>IGNORE</b> more to blue end of spectrum
	(c)	(i)	Infra Red /IR	1	1

Question			Answer	Marks	AO element	Guidance
3	(c)	(ii)	<p>Any <b>three</b> of the following:</p> <p>(Different parts of mountains) are at different temperatures ✓</p> <p>Reason for different temperatures:- e.g. because they are at different heights/ near/further/ rivers/other geographical features absorb/conduct heat differently ✓</p> <p>Different amounts/wavelengths/frequencies of IR are given off by objects at different temperatures ✓</p> <p>IR cameras sensitive to different wavelengths ✓</p> <p>IR cameras produce images in, false/different colours/ shades of grey /lighter darker, (depending on temperature) ✓</p>	3	2	<p><b>ALLOW</b> Heat for Temperature</p> <p><b>ALLOW</b> Heat for Temperature</p>

Question			Answer	Marks	AO element	Guidance
3 cont.	(c)	(iii)	Any <b>two</b> of the following: Can take images at night ✓ Can distinguish between, parts/objects/ similarly-coloured mountains, which are at different temperatures ✓ Can see through cloud ✓	2	2	<b>IGNORE</b> references to people
		(iv)	Spatial: The ability to distinguish between objects at slightly different places/ the smallest separation that can be distinguished/ pixels per cm/inch etc. ✓  Thermal: The ability to distinguish between objects at close temperatures/ the smallest temperature difference that can be detected. ✓	1  1	1	<b>REJECT</b> “number of pixels” without per unit length
		(v)	Spatial: Consideration of whether good spatial resolution is needed when looking at mountains ✓  Thermal: mountains may be at similar temperatures ✓	1  1	1	<b>ALLOW</b> answer interpreting “low value” of spatial resolution as poor spatial resolution  <b>ALLOW</b> alternative examples
<b>Total</b>				<b>15</b>		

Question	Answer	Marks	AO element	Guidance
4 (a) (i)	Reflected ray drawn vertically downwards <b>AND</b> No other ray drawn ✓ 	1	1	<b>ALLOW</b> if no arrow <b>ALLOW</b> $\pm 4$ degrees <b>ALLOW</b> if line does not reach/only just meets the base of the prism
	(ii) Refracted ray drawn emerging bending away from the normal on the other side of the normal from the incident ray ✓ 	1	1	<b>ALLOW</b> if no arrows 11
	(iii) <b>Either:</b> Yes and Reflected ray drawn at approximately $30^\circ$ to normal ✓ <b>or</b> (No) and Some of energy is reflected (as well as refracted) ✓	1		<b>IGNORE</b> presence or absence of emerging ray at bottom face <b>IGNORE</b> reference to energy absorbed <b>DO NOT ALLOW</b> ecf if no refracted ray drawn <b>ALLOW</b> ecf for incorrectly drawn refracted ray

Question			Answer	Marks	AO element	Guidance
4	(a)	(iv)	Light kept within optical fibres by reflection/TIR ✓  TIR ✓  TIR If $i >$ critical angle <b>Or</b> Light escapes/not TIR if critical angle $> i$ ✓	1 1 1	2	
	(b)	(i)	Critical angle will be greater/ $76^\circ / \sin^{-1}(1/1.03)$ ✓	1	2	
		(ii)	Light, entering at small angles to the axis /meeting the edge of the core of the fibre with large $i$ , will be transmitted ✓  Light entering at other than small angles passes into the cladding, is refracted out/ is lost/ escapes ✓	1 1	2	<b>ALLOW</b> either of these statements with the alternative implied by e.g. "Only" attached to either statement
	(c)		Graded index (multimode) ✓ Step index (multimode) ✓ Monomode ✓	1 1 1	2	<b>ALLOW</b> single mode
	(d)		1            3            2	1	2	
	(e)		Any <b>two</b> of the following: Negligible crosstalk ✓ Difficult to "hack" ✓ High immunity to interference ✓	2	2	Not just "More secure"
	(f)		Coherent, so that data (in different channels)/ messages/ are clearer/ not jumbled up ✓	1	1	
<b>Total</b>				<b>16</b>		

Question			Answer	Marks	AO element	Guidance
5	(a)	(i)	Amplitude Modulated/ AM ✓ Frequency Modulated/ FM ✓	1 1	1	<b>ALLOW</b> Amplitude Modulation <b>ALLOW</b> Frequency Modulation
		(ii)	Time Distance/Displacement (from source) ✓	1	1	In either order <b>REJECT</b> wavelength
		(iii)	Independent variable should be along horizontal axis/ dependent variable should be along vertical axis/ displacement depends on time/distance ✓	1	2	<b>ALLOW</b> easy of interpretation reading
	(b)	(i)	13 ✓	1	2	
		(ii)	1111 ✓	1	2	
		(iii)	Similarity: Both have (only) discrete values AND  Difference: Binary - base 2 (uses only 0 and 1), / digital - any base /Binary is a subset of digital ✓	1	1	<b>ALLOW</b> “set numbers” <b>DO NOT ALLOW</b> “numbers” alone for discrete  <b>ALLOW</b> 0-9 for “any base”
	(c)		(Higher bit rates because) higher frequencies used / many different channels ✓	1	1	Higher frequencies <b>not just</b> different frequencies <b>ALLOW</b> Higher/wider bandwidth
<b>Total</b>				<b>8</b>		

Question			Answer	Marks	AO element	Guidance
6	(a)	(i)	There are only a limited number of radio frequencies available <b>Or</b> More People/ People in different places, can make calls (using the same frequency) ✓	1	2	
		(ii)	Cannot re-use in adjacent cells/cells close together ✓ Otherwise there would be interference/cross-talk ✓	1 1	2	
	(b)		multiple access/multiplexing ✓  Shares a given frequency between many users so that people in the same place/near each other can make calls using the same frequency/ different time slots ✓	1 1	2	<b>ALLOW</b> examples e.g. FDMA.TDMA, CDMA

Question	Answer	Marks	AO element	Guidance
6 (c)	<p><b>[0 marks]</b> response not worthy of credit.</p> <p><b>[1-2 marks]</b> Candidate demonstrates a limited knowledge of base station location factors</p> <p>For 1 mark at least one valid point For 2 marks at least two valid points</p> <p><i>The answer may not be clearly set out</i></p> <p><b>[3 marks]</b> Candidate demonstrates understanding of base station location factors</p> <p>For 3 marks at least three valid points</p> <p><i>The answer will be set out in a manner that is easy to follow, but may contain one or two errors or omissions in content</i></p> <p><b>[4-5 marks]</b> Candidate demonstrates a high level of knowledge and understanding of base station location factors</p> <p>For 4 marks at least four valid points For 5 marks at least five valid points</p> <p><i>The answer will be set out clearly and logically</i></p>	5	2	<p>Valid points:</p> <p>(More masts needed) in densely-populated areas ✓</p> <p>Masts in high places (to get good signal to more places) ✓</p> <p>(More masts needed) where there are obstructions/tall buildings/hills/mountains ✓</p> <p>(More masts needed) near busy roads/motorways/ sports stadiums etc. ✓</p> <p>Signal Strength / Not too far apart/ appropriate distances suggested ✓</p> <p>Environmental factors / appearance / local opposition. <b>ALLOW</b> examples ✓</p> <p>Financial factors/ minimise total number of masts ✓</p> <p>Regulations/ Site permission ✓</p> <p>Competitor factors. E.g. Can other companies' existing masts be shared? Or need to compete on coverage ✓</p>
	<b>Total</b>	<b>10</b>		



Question			Answer	Marks	AO element	Guidance
7	(a)	(i)	Appropriate example e.g. looking for cracks in components	1	2	<b>REJECT</b> non- engineering applications
		(ii)	Parts may all be at same temperature/ Testing using IR requires variations of (surface) temperature ora <b>Or</b> X-rays can penetrate metal/ engine parts ora <b>Or</b> More X-rays will penetrate where there are gaps in the metal ✓	1	2	
		(iii)	To find where areas that are overheating/ getting hotter than others <b>Or</b> Avoids radiation hazard✓	1	2	<b>ALLOW</b> more specific examples <b>ALLOW</b> Friction /electrical faults (Implies heating) <b>ALLOW</b> heat loss
	(b)		Any <b>two</b> from:  X rays are shadow images ✓  In Fig 7.1 The shadow is sharp / Fig 7.2 The shadow is not sharp ✓  in Fig 7.2 there is a section where light reaches the screen from one side of the source but not the other/ only part of the source/ partial exposure of parts of screen to light ✓  Shadow gradually gets brighter/darker ✓	2	1	<b>IGNORE</b> references to scattering
	(c)		Low Energy/ low frequency X-rays are scattered ✓  scattered X-rays blur images ✓  Aluminium/ Filter is used to remove low Energy/ low frequency/ scattered X-rays ✓	1 1 1	1	
<b>Total</b>				<b>8</b>		

Question			Answer	Marks	AO element	Guidance	
8	(a)	(i)	X-rays <u>and</u> Gamma-rays ✓ No other ticks ✓	1 1	1		
			Type of radiation	Types of radiation that cause ionisation.			
			Gamma-rays	✓			
			Infrared				
			Microwaves				
			Mobile phone signals				
			Visible light				
			Wireless internet connections (wifi)				
		(ii)	An electron is removed ✓ (Atom) becomes positively charged ✓	1 1	1	ALLOW "Positive"/ "+" / "+1" / "+e" NB NO ecf if electron added	
		(iii)	(Cell) death/ (uncontrolled) reproduction/ mutation/ chemical reaction/creation of free radicals ✓	1	1		
	(b)		Half thickness reduces dose/amount of radiation by half ✓ (New dose = $\frac{1}{2} \times \frac{1}{2}$ ) $\frac{1}{4}$ ✓	1 1	2	Stated or implied	
	(c)	(i)	Benefits outweigh risks owtte ✓	1	1	<b>DO NOT ALLOW</b> "low risk" with no reference to benefits	

Question			Answer	Marks	AO element	Guidance
8	(c)	(ii)	<p><b>[0 marks]</b> response not worthy of credit.</p> <p><b>[1-2 marks]</b> Candidate demonstrates a limited knowledge of CAT scanners</p> <p>For 1 mark at least one valid point For 2 marks at least two valid points</p> <p><i>The answer may not be clearly set out</i></p> <p><b>[3 marks]</b> Candidate demonstrates understanding of CAT scanners</p> <p>For 3 marks at least three valid points</p> <p><i>The answer will be set out in a manner that is easy to follow, but may contain one or two errors or omissions in content</i></p> <p><b>[4-5 marks]</b> Candidate demonstrates a high level of knowledge and understanding of CAT scanners</p> <p>For 4 marks at least four valid points For 5 marks at least five valid points</p> <p><i>The answer will be set out clearly and logically</i></p>	6	1, 2	<p>Valid points:</p> <p>X-ray source and detectors on either side of the patient ✓</p> <p>Detectors arranged in a ring ✓</p> <p>X-ray source/ Detectors /Scanner rotates around the patient ✓</p> <p>X-ray beam shaped like a fan ✓</p> <p>Patient/Bed is moved in (and out of scanner), / along axis ✓</p> <p>X-ray beam follows a spiral path relative to patient ✓</p> <p>(Detectors) measure the amount of radiation being absorbed/transmitted by body. ✓</p> <p>A computer processes data ✓</p> <p>Create 3D image/ set of two-dimensional cross-sectional images/slices of body ✓</p>
<b>Total</b>				<b>14</b>		

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