GCE

Applied Science

Advanced GCE

Unit **G635:** Working Waves

Mark Scheme for June 2012

Any enquiries about publications should be addressed to:

Annotations

Annotation	Meaning
✔	Tick
✘	Cross
BOD	Benefit of doubt
ECF	Error carried forward
E.G.	Example/Reference
I	Ignore
NAQ	Not answered question
BOD	Benefit of doubt not given
●	Large dot (Key point attempted)
R	Reject
CON	Contradiction
SF	Error in no. of significant figures
?	Unclear
Λ	Omission mark
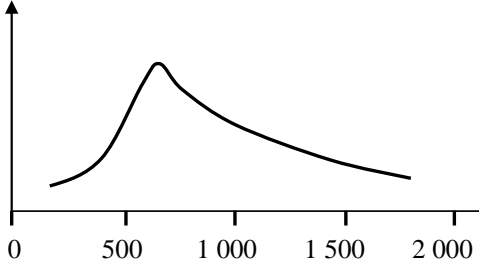
Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

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)		*Any **two** from:*	2	<u>Max</u> 1 mark if there is an incorrect statement
			Indication of **both** difference in wavelength & frequency ✓		
			Blue has higher frequency than red or vice versa ✓		**IGNORE** spectrum /rainbow without reference to wavelengths and frequency
			Red has longer wavelengths than blue or vice versa ✓		
			Different speeds/refraction in, glass/water/medium (other than air/vacuum) ✓		
			Different <u>photon</u> energy ✓		
	(b)		*Any **two** from:* Ultraviolet ✓ X-rays ✓ Gamma rays ✓	2	
	(c)		Magnetic ✓ Horizontal /(at) right angles / 90° / perpendicular (to electric field) ✓	2	**IGNORE** reference to wave direction
	(d)	(i)	*Any **one** from:*	1	
			One plane (of oscillation only) ✓		**ACCEPT** diagram to support answer
			One transverse direction (of displacement/oscillation only) ✓		**ACCEPT** indication of transverse (right angles / 90° / perpendicular)
		(ii)	*Any **one** from:* Different directions of polarisation ✓ Waves in different planes ✓ Waves are at right angles to each other ✓ Vertical and horizontal (Oscillations /fields) ✓	1	

Question			Answer	Marks	Guidance
		(iii)	To prevent interference / to distinguish between (the signals from) different transmitters ✓	1	**ACCEPT** so that signals are not mixed up
	(e)		$v = f\lambda$ ✓ Conversion of MHz to Hz ✓ $\lambda = \dfrac{2.997 \times 10^8}{474.0 \times 10^6}$ OR $\lambda = \dfrac{2.997 \times 10^8}{4.740 \times 10^8}$ ✓ 0.6323 m or equivalent with correct unit and 4 s.f. ✓	4	Stated or implied. **ACCEPT** 'triangle' **ALLOW** ecf for omitted /incorrect conversion from MHz, e.g. $\lambda = \dfrac{2.997 \times 10^8}{474.0 \times 10^3}$ Correct answer to incorrect sf can imply 1st 3 marks even if unit omitted
	(f)		Transmitter frequency is lower than that of visible light **OR** Visible light has a higher frequency (than 474.0 MHz) ✓ Cannot make/have electronic circuits/oscillators that generate at such a high frequency ✓	2	**ACCEPT** cannot make electronic circuits / oscillators this fast
			Total	15	

Question			Answer	Marks	Guidance
2	(a)	(i)	*Any **two** appropriate reasons* e.g. To check whether fire was still smouldering / Hot spots ✓ To help find the, cause/source, of the fire ✓ To find, people/bodies ✓ To avoid putting, firemen/others, in danger ✓	2	**IGNORE** just to measure temperature of objects... **IGNORE** just can see through smoke

		(ii)	Any two places differentiated in expected temperature
			   e.g. smouldering ember and cold water pipes /
			   freezer and oven ✓
			
			Different temperatures
			OR
			hotter / colder ✓
			
			Difference in appearance / false colours / shades of grey ✓
				3	**ACCEPT** if places given might reasonably be expected to be at a different temperature. Candidate may suggest difference in temperature in answer to 'why they appear different'
					
					ACCEPT suggested different temperature values or description such as room temperature and hot coal
					
					ACCEPT examples of 2 different colours
					IGNORE just a single colour / white
					ACCEPT whiter / redder etc.

Question			Answer	Marks	Guidance
(b)	(i)		Curve <u>labelled 'hot'</u> with single peak NOT at ends ✓ Single peak NOT at ends and to left of centre **of their line** ✓ Curve steeper on left than right* ✓	3	Intensity / W m^{-2} Wavelength /nm If only one curve drawn and not labelled, assume it is the red curve but lose 1st mark. **IGNORE** horizontal position If more than one curve drawn and none labelled assume the highest curve is the hot curve but lose 1st mark If hot curve not labelled but others are assume unlabelled curve is the hot curve but lose 1st mark. **IGNORE** curve touching crossing axes. ***Note** if slope varies radically on either side compare average slopes between apex and let and right extreme points

Question			Answer	Marks	Guidance
		(ii)	Curve <u>labelled 'warm'</u> drawn entirely below curve labelled 'hot' and not crossing it ✓ Peak of 'warm' curve to right of peak of 'hot' curve ✓	2	**REJECT** if no 'hot' curve drawn, no marks. If one other curve is drawn but not labelled assume the unlabelled curve is 'hot' NB 'below' not just 'lower' than so there must be <u>some</u> horizontal overlap of curves. If curves touch, warm is not below. **REJECT** if extra crossing lines **IGNORE** curve touching/ crossing axes
		(iii)	Curve **labelled 'cool'** drawn entirely below curves labelled 'warm' and 'hot' and above zero intensity ✓	1	**MUST** be at least one other curve present **ALLOW** if other curve(s) unlabelled NB 'below' not just 'lower' than so there must be <u>some</u> horizontal overlap of curves. If curves touch, cold is not below **IGNORE** curve touching crossing axes **REJECT** if extra crossing lines
	(c)		<u>Spatial</u> resolution ✓	1	
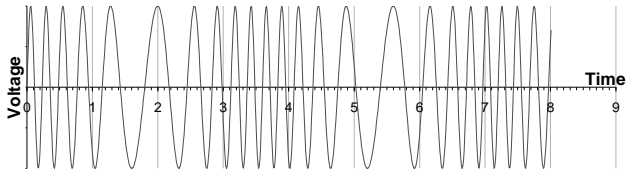
Question			Answer				Marks	Guidance
	(d)		Blue	25	Same ✓	Because same temperature /surface colour does not affect image in thermal imaging camera ✓	2	
			Red	26	Same ✓	Because temperature difference is less than thermal resolution / 2° ✓	2	**ACCEPT** temperature difference is small or wtte
			Red	28	Different /change (in colour /shade of grey/ or example) / brighter ✓	Because temperature difference more than thermal resolution /2° ✓	2	**NOT** more infrared radiation given off **IGNORE** just false colour **ACCEPT** comparison / explanation wherever in same row
						Total	18	

Question			Answer	Marks	Guidance

3	(a)		*Endoscope*
			   - An incoherent bundle of multimode fibres and a coherent bundle of multimode fibres ✓
			
			Lighting
			   - An incoherent bundle of multimode fibres ✓
			
			Long distance communications
			   - A coherent bundle of monomode fibres ✓
				3	An endoscope — An incoherent bundle of multimode fibres / A coherent bundle of multimode fibres / An incoherent bundle of multimode fibres and a coherent bundle of multimode fibres / An incoherent bundle of monomode fibres / A coherent bundle of monomode fibres
					
					Lighting a display cabinet
					
					Long distance communications

	(b)	(i)	*Any **three** from:* Coherent needed for image ✓ Otherwise it would be jumbled up ✓ Light going to subject does not need to be in any particular order ✓ Incoherent cheaper than coherent ✓ Multimode cheaper than monomode ✓ Short distance so degradation not a problem ✓	3	

Question			Answer	Marks	Guidance
		(ii)	Arrangement (of fibres/pixels) does not matter / fibres random ✓ **OR** incoherent easiest to manufacture / cheapest ✓	1	
		(iii)	To prevent, signals/phone calls, being, jumbled up/connected, to wrong people ✓ Monomode reduces signal degradation / degradation is an issue over long distances / increases separation of repeater stations ✓	2	**REJECT** answers that imply signals at random **times** rather than positions **NOT** reduces attenuation

Question			Answer	Marks	Guidance

	(c)		**[Level 0]** response not worthy of credit. *(0 marks)*
			
			[Level 1] Candidate demonstrates a limited knowledge step-index and graded-index fibres by describing:
			
			For 1 mark at least one valid point.
			For 2 marks at least two valid points.
			
			The answer may not be clearly set out e.g. use of terms such as density for RI.
			                                     (1 - 2 marks)
			
			[Level 2] Candidate demonstrates understanding of step-index and graded-index fibres describing and explaining:
			
			For 3 marks at least three valid points.
			For 4 marks at least four valid points.
			
			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
			                                     (3 - 4 marks)
			
			[Level 3] Candidate demonstrates a high level of knowledge and understanding of step-index and graded-index fires by describing:
			
			for 5 marks at least five valid points.
			for 6 marks six valid points.
			
			The answer will be clear and logical.
			                                     (5 - 6 marks)
			N.B. The number of ticks on the script will not always directly equate with the numbers of marks given.
				6	Expected knowledge and learning could include the following valid points:
					
					- **degradation** more likely for step-index (or RA)
					
					step-index
					- have a sudden change in RI at interface / between core and cladding/ RI is uniform across core
					- (multiple) paths of different lengths
					- rays arrive at different times
					
					graded-index
					- gradual (decrease) in RI from centre /core outwards
					- (multiple) paths of different lengths
					- light travels faster when further from centre/core/where RI is lower /rays travelling further travel faster*
					- rays arrive at same time **ignore** same order
					- has curved path(s)
					
					ACCEPT appropriate diagrams for any of the above
					
					* rays travelling further implies paths of different lengths

Question			Answer	Marks	Guidance
(d)			*Any **three** from:* • more data transferred (per sec) / very large information capacity ✓ • low material costs/ less likely to be stolen ✓ • small cable size ✓ • negligible crosstalk ✓ • more secure/ difficult to 'wire tap' ✓ • high immunity to interference ✓ • complete electrical isolation ✓ • large repeater spacing /less degradation/ less attenuation/ better quality signal ✓	3	**IGNORE** reference to corrosion /rust **ACCEPT** faster /more data **IGNORE** just 'cheaper'/ fitting costs **IGNORE** Reference to electric shock
(e)	(i)		*r*	1	
	(ii)		*Any **two** from:* Did not enter at right angles to surface /along radius ✓ Ray would be, refracted/change direction, as it enters the block ✓ It would be more difficult to trace the path of the ray inside the block/ measure the (critical) angle (inside block) ✓	2	or RA
	(iii)		Ray drawn on Fig. 3.4 such that angle of reflection = *t* ✓	1	(by eye, but if measured 68 ± 5°)
			Total	**22**	

Question			Answer	Marks	Guidance
4	(a)		Binary consists of 1s and 0s ✓	2	**ACCEPT** binary consists of on or off/square wave drawn
			Digital means discrete values **OR** Digital frequency display uses (figures) 0 to 9 only **OR** Binary is one, kind/subset, of digital ✓		
	(b)	(i)	Frequency Modulated/ Modulation	1	
		(ii)	Graph: Approx constant amplitude ✓ Visible variation in frequency ✓ Based on **approximate** repeating wave shape ✓	3	must draw at least three cycles) Cleary NOT a.m. must draw at least three cycles e.g. sine, saw tooth or square
		(iii)	Amplitude varies (according to the audio signal) ✓ Frequency is constant /does not vary ✓	2	**IGNORE** statements about variation of Amplitude /Frequency in FM
			Total	**8**	

Question			Answer	Marks	Guidance
5	(a)	(i)	half duplex ✓	1	
		(ii)	full duplex ✓	1	
	(b)		**[Level 0]** response not worthy of credit. **(0 marks)** **[Level 1]** Candidate demonstrates a limited knowledge of by describing: For 1 mark at least one valid point For 2 marks at least two valid points**.** The answer may not be clear. **(1 - 2 marks)** **[Level 2]** Candidate demonstrates understanding of multiplexing and cellular technologies explaining in a comprehensible way:: For 3 marks at least three valid points For 4 marks at least four valid points**.** The answer will be easy to follow but may contain one or two errors or omissions. **(3 - 4 marks)** **[Level 3]** Candidate demonstrates a high level of knowledge and understanding of multiplexing and cellular technologies by describing: for 5 marks at least five valid points for 6 marks six valid points**.** The answer will be clear and logical. **(5 - 6 marks)** *N.B. The number of ticks on the script will not always directly equate with the numbers of marks given.*	6	Expected knowledge and learning could include the following valid points: **Cells:** • reference to cellular technology /division of country into cells /diagram of cell structure (expect hexagons but allow alternative shapes) **ALLOW** base stations /masts • an indication of cell sizes (in range 1 – 40 km) • frequency/ies can be re-used • adjacent cells must have different frequencies • minimum of 7 sets of frequencies needed (may be diagram of appropriately numbered cells **Multiplexing**: • naming: multiplexing /TDMA/FDMA/ CDMA • multiplexing shares the same frequency/frequencies • more detail about one of multiplexing systems (e.g. TDMA each user gets a small share of each block of time/ CDMA /allocates encodes signals from users) • correctly relating one or more systems to analogue or digital or 1G, 2G or 3G (e.g. TDMA was used with analogue) N.B. last two bullet points relate to detail which is no longer a requirement of the specification but deserves credit if seen

Question			Answer	Marks	Guidance
	(c)		*Any **two** from:* Faster data transmission ✓ Uses higher/ higher range of frequency (for broadband) ✓ Larger range of audio frequencies can be reproduced ✓	2	**IGNORE** larger bandwidth
			Total	**10**	

Question			Answer	Marks	Guidance
6	(a)	(i)	To show up, parts of the body other than bones/tissue /blood flow ✓	1	**ACCEPT** other appropriate example **ACCEPT** they penetrate tissue with less absorption / less scattering.
		(ii)	*Any **three** from:* (Gamma ray) energy (of about 140 keV) is convenient for detection ✓ (Physical) half-life short/six hours ✓ Biological half life short/six hours ✓ Half-life is long enough to carry out an examination ✓ Half-life is short enough to keep the radiation dose the patient receives low dose ✓ Technetium can form compounds in a range of biologically-active substances ✓ It does not produce (high energy) beta particles/ only emits gamma ✓ Can be produced in the hospital when needed (using special 'generators' of molybdenum-99) ✓	3	**ACCEPT** ... leaves the body faster (than alternatives)
	(b)		photomultiplier(s) ✓ computer ✓ image ✓ lead ✓ patient ✓ sharp /in focus / clear ✓	6	

Question			Answer	Marks	Guidance
(c)	(i)		Bonds (in water) break ✓ Radicals formed ✓ Radicals attack cancer cells ✓	3	**ACCEPT** ionise (water) molecules **IGNORE** cells **ACCEPT** description of chemical stage **ACCEPT** very reactive chemicals kill cancer cells
	(ii)		Cause mutations/ uncontrolled cell growth (of healthy cells instead of killing cells)/alters DNA✓	1	**ACCEPT** divide faster
	(iii)		*Any **one** from:* Benefits outweigh risk /specific benefit e.g. kills cancer cells, delays death/ lengthens life ✓ treatment is designed to minimise dose to healthy cells ✓	1	**ACCEPT** description of method, eg rotating source to spread dose to health cells
(d)			*Any **two** from:* Wear <u>lead</u> apron /stand behind <u>lead/concrete</u> shield ✓ Increase distance from source/ leave the room ✓ Reduce time exposed to source ✓	2	**IGNORE** Geiger Counter **ACCEPT** wear film badge/ personal monitor as alternative to reduce time
			Total	17	
			Paper Total	90	