

Applied Science

Advanced GCE

Unit **G635**: Working Waves

Mark Scheme for June 2013

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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.

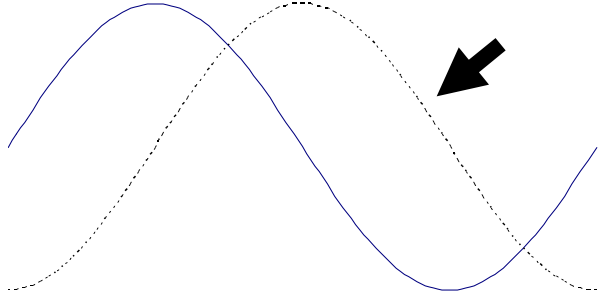
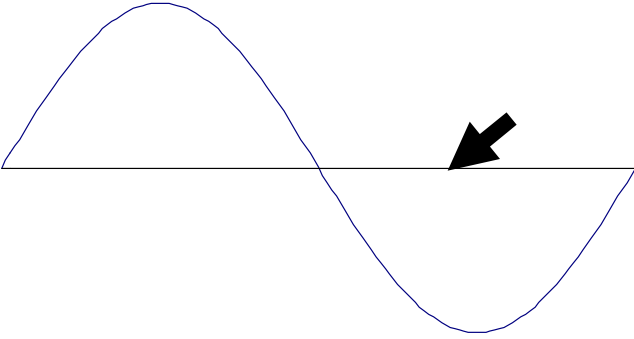
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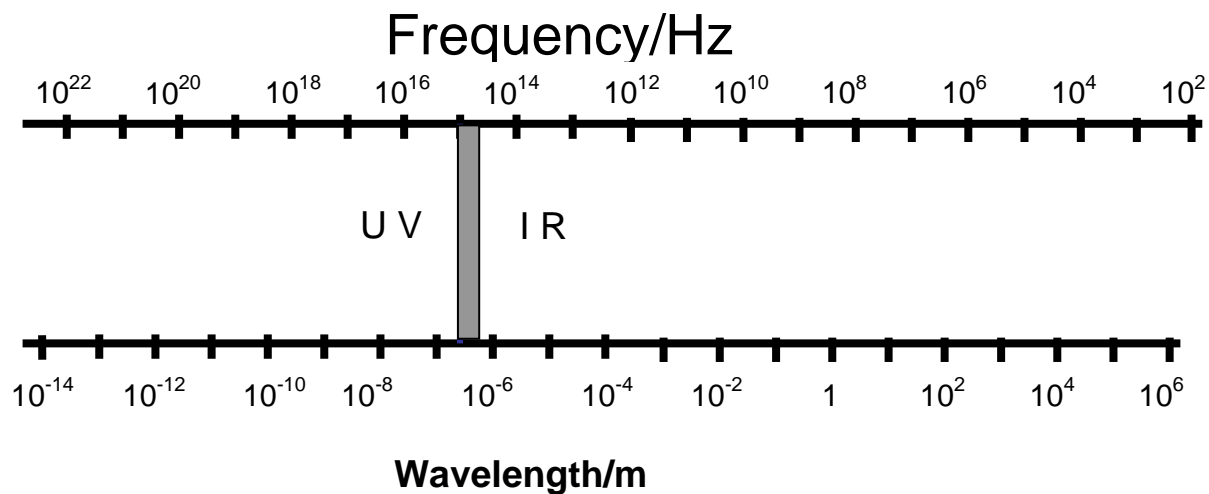
Question		Answer	Marks	Guidance
1	(a)	<p>Wavelength decreases/gets lower/shorter/less/smaller ✓</p> <p>Frequency increases/gets higher/more/bigger ✓</p> <p>Speed unchanged/stays the same ✓</p> <p>Amplitude increases/gets higher/bigger /more ✓</p>	4	<p>ACCEPT gets faster</p> <p>ACCEPT very small decrease (in water) or correct statement on impact of RI on speed</p>
	(b) (i)	Total internal reflection ✓	1	<p>ACCEPT TIR</p> <p>IGNORE reflection (without total internal)</p> <p>REJECT substitute words e.g. complete</p>
	(ii)	<p>Glass has a higher refractive index (than air) ✓</p> <p>Light travels more slowly in glass (than air) ✓</p> <p>(Light meets the surface) with an angle of incidence greater than the critical angle/emerging angle cannot be greater than 90° ✓</p>	3	<p>ACCEPT optical density for RI, but not just density</p> <p>IGNORE references to core and cladding</p> <p>May be shown by diagram</p> <p>ACCEPT $n = \sin i / \sin r$ or $n = 1 / \sin C$ or $n = c_{air} / c_{glass}$</p> <p>ACCEPT 42° for critical angle</p>
	(c) (i)	<p>Coherent bundles are arranged in the same way/same order at both ends/throughout the length</p> <p>Or</p> <p>Fibres are parallel to each other in coherent bundles ✓</p> <p>Incoherent. are arranged randomly/not arranged/not in any order/muddled ✓</p>	2	<p>May be shown by diagram</p> <p>REJECT if ordered in time rather than space is implied</p> <p>IGNORE reference to quality of glass</p> <p>May be shown by diagram</p> <p>REJECT if disordered in time rather than space is implied</p> <p>IGNORE reference to quality of glass</p>
	(ii)	<p>Appropriate application e.g. lighting/(decorative) lights/illumination ✓</p> <p>Arrangement /order is not important</p> <p>or</p> <p>Cheaper/easier to manufacture ✓</p>	2	<p>If "endoscope" answer must indicate somewhere taking light to subject</p> <p>If unclear whether application is appropriate refer to reason</p>
	(iii)	<p>Appropriate application e.g. communications/data transfer /endoscope ✓</p> <p>Information/image must be in right order/not jumbled up ✓</p>	2	<p>ACCEPT Television/computer (fibre optic cables)</p> <p>ACCEPT reason appropriate to application even if application is more appropriate for incoherent bundles</p>

Question		Answer	Marks	Guidance
	(d)	Photodiode ✓	1	ACCEPT phototransistor /LDR/CCD
	(e)	<p>[Level 0] Candidate response not worthy of credit (0 marks)</p> <p>[Level 1] Candidate will demonstrate a limited understanding by describing at least two of the valid points</p> <p>Description may not necessarily be expressed very clearly (1–2 marks)</p> <p>[Level 2] Candidate will demonstrate understanding by describing and explaining at least four of the valid points</p> <p>Description will be easy to follow (3–4 marks)</p> <p>[Level 3] Candidate will demonstrate a full understanding by describing and explaining at least six of the valid points</p> <p>Description will be expressed in logical and well-ordered manner (5–6 marks)</p>	6	<p>Expected knowledge and learning could include the following valid points by words or diagram:</p> <p>Assume answer refers to graded index unless otherwise stated</p> <ul style="list-style-type: none"> • Different paths have different lengths (words or diagram)- may refer to either step index or graded index or may not be specified • Signal does not all arrive at the same time in step index or RA <p>For graded index:</p> <ul style="list-style-type: none"> • Ray path curved in (words or diagram) • Refractive index higher near centre • Refractive index varies gradually • Light travels faster near the outside • Light travels faster along longer paths <p>Degradation:</p> <ul style="list-style-type: none"> • Is caused by different parts of the signal arriving at different times • Diagram (eg bell shaped curve) or description (eg broader pulse) of a degraded signal.
Total			21	

Question		Answer	Marks	Guidance
2	(a)	Longitudinal ✓	1	
	(b)	Transverse ✓	1	
	(c)	<i>back and forth</i> No because back and forth waves can only oscillate in one direction /longitudinal waves cannot be polarised ✓ <i>up and down</i> Yes because there is movement in only one direction at right angles to the direction of propagation/there is no horizontal (component of) oscillation ✓	2	NOT just No because they are not at right angles to the wave direction No may be implied Yes may be implied
	(d) (i)	$v = f\lambda$ ✓ $0.050 = 5.0 \times \lambda$ ✓ $\lambda = 0.010 \text{ m}$ ✓	3	Stated or implied Stated or implied ALLOW 1 or 2 significant figures REJECT 3rd mark if units incorrect or omitted Award 3 rd mark for correct value with alternative units eg 1.0 cm
	(ii)	Frequency unchanged ✓ Wavelength decreases ✓ Wavelength halved/0.005 m ✓	3	May be implied by 3 rd marking point
	(e) (i)	Maximum displacement Or Maximum height above/below normal water level Or Height of peak above/depth of trough below normal water level ✓	1	ACCEPT diagram
	(ii)	The back of the wave catches up (with the front of the wave) Or the wave is compressed ✓ Or Same energy/energy conserved, (so KE converted into PE) so amplitude goes up when velocity goes down	1	"Energy builds up" is not enough'

Question	Answer	Marks	Guidance
(f) (i)	<p>Approximate sine wave shape of the same amplitude and wavelength displaced by any amount horizontally ✓ Approximate sine wave shape of same amplitude displaced by $\frac{1}{4}$ of a cycle horizontally to right ✓</p>  <p>Dotted line marked by arrow shows candidate's line</p>	2	<p>ACCEPT any approximation to sine wave shape eg ACCEPT semicircles REJECT saw tooth</p> <p>REJECT for both marks if line drawn is less than $\frac{3}{4}$ of width of graph</p> <p>For 2nd mark 3 of 5 key points (max, min and zero amplitudes) should be within 1 cm horizontally of correct position.</p> <p>ACCEPT amplitude as same if within $\pm 20\%$</p>
(ii)	<p>Sine wave shape of smaller amplitude with same nodes as original or inverse of original ✓ Horizontal line along axis ✓</p> 	2	<p>Implies first marking point</p> <p>REJECT for both marks if line drawn is less than $\frac{3}{4}$ of width of graph</p>
Total	16		

Question			Answer	Marks	Guidance
3	(a)	(i)	To right of visible and $f > 10^{11}$ ✓	1	See diagram below REJECT if any of writing overlaps visible or to right of 10^{11} ACCEPT infrared written in full if all in within correct limits



		(ii)	To left of visible and $f < 10^{18}$ ✓	1	See diagram above REJECT if any of the writing overlaps visible or is to left of 10^{18} ACCEPT ultraviolet written in full if all in within correct limits
	(b)	(i)	Different temperatures ✓ Explanation eg disturbed earth warmer/absorbs/retains heat more readily than undisturbed earth/give off more heat/IR/radiation ✓	2	ACCEPT hotter/colder but must show comparison

Question		Answer	Marks	Guidance
	(ii)	<p>Spatial: The smallest size that can be detected (by a camera) or WTTE ✓</p> <p>Thermal the smallest temperature difference that can be detected by a camera or WTTE ✓</p>	2	<p>ACCEPT (measure of) the ability to distinguish / differentiation between two objects or WTTE</p> <p>ACCEPT answer in terms of pixels/dots per cm</p> <p>ACCEPT (measure of) the ability to distinguish / differentiation between two objects at different temperatures or WTTE</p>
	(c)	<p>Ozone (layer) absorbs ultraviolet (radiation)/UV ✓ Or Depleted ozone layer will allow more ultraviolet (radiation)/UV (to reach the earth) ✓</p> <p>One from:</p> <p>Higher dose of UV increases risk of (skin) cancer ✓</p> <p>Reference to (DNA) mutation ✓</p>	2	<p>REJECT reflects</p> <p>REJECT ionisation</p>
Total			8	

Question		Answer	Marks	Guidance
4	(a)	See diagram on next page	6	Same letter more than once does not score because contradictory
	(b)	See diagram on next page	8	More than one tick in same row does not score because contradictory
		Total	14	

<p style="text-align: center;">U</p> <p>Communication system where frequencies are reused in different parts of the country sufficiently far apart that the signals do not interfere</p>	<p style="text-align: center;"><input type="text"/></p> <p>Communication system where each frequency can be used only once</p>	<p style="text-align: center;">T</p> <p>communication system where each frequency can be used by many people by use of multiplexing</p>
<p style="text-align: center;"><input type="text"/></p> <p>Signal transmission from a satellite to a mobile phone</p>	<p style="text-align: center;">Q</p> <p>Signal transmission from a base station mast to a mobile phone</p>	<p style="text-align: center;">S</p> <p>Communication system using only one frequency so that users must take it in turns to speak</p>
<p style="text-align: center;"><input type="text"/></p> <p>A communication system which only ever operates in one direction</p>	<p style="text-align: center;">R</p> <p>Communication system using two separate frequencies so that users at both ends can talk at the same time</p>	<p style="text-align: center;"><input type="text"/></p> <p>Signal transmission from a mobile phone to a satellite</p>
<p style="text-align: center;"><input type="text"/></p>	<p style="text-align: center;">P</p> <p>Signal transmission from a mobile phone to a base station mast</p>	<p style="text-align: center;"><input type="text"/></p>

	analogue	binary	digital other than binary	None of these
The time shown on the face of a watch with rotating hands.	✓			
The frequency display "95.20" on the front of a radio			✓	
Morse code			✓	
Data sent along an optical fibre used for telecommunications		✓		
Light sent along an optical fibre in an endoscope.	✓			
The X-ray image of a broken bone stored on film	✓			
The X-ray image of a broken bone stored on a computer		✓		
Words in a book				✓
Books stored in the memory of a graphics tablet such as the kindle or i-pad		✓		

Question		Answer	Marks	Guidance
5	(a)	2 3 1 ✓	1	ACCEPT correct words in boxes ie: Next fastest Slowest Fastest
	(b)	Cannot use telephone and internet/computer at the same time ✓ Because both use the same frequency (with dial-up connections) ✓	2	REJECT if only one of telephone and internet mentioned ACCEPT answers in either order
	(c) (i)	So that it does not break ✓ If the bridge/cable bends/stretch/moves ✓	2	
	(ii)	Light would leak/escape/not undergo TIR/refract ✓ Because angle of incidence would be < than the critical angle/because angle of incidence would be too small ✓	2	ACCEPT critical angle would not be exceeded ACCEPT angle of refraction would be below 90 degrees
		Total	7	

Question			Answer	Marks	Guidance
6	(a)	(i)	(Much shorter physical half life) might not allow enough time to carry out the examination/diagnose Or (This half life) will allow enough time to carry out the examination/diagnose ✓	1	
		(ii)	(Much longer physical half life) would increase, overall radiation emitted/dose/risk to patient/others/isolation time ✓ Or (This half life) would decrease, overall radiation emitted/dose/risk to patient/others/isolation time ✓	1	ALLOW implication of risk to others even if poorly stated eg patient could pass on radiation
	(b)		18 hours = 3 half-lives ✓ Division by two at least once ✓ $1000/2 = 500$ $500/2 = 250$ $250/2 = 125$ 125 photons ✓	3	
	(c)	(i)	Excretion (of technetium-99m/radioactive material) ✓	1	ACCEPT body gets rid of some of radioactive material/radiation

Question		Answer	Marks	Guidance
	(ii)	shorter ✓	1	ACCEPT decays faster
	(iii)	Biological (half life) ✓	1	
(d)	(i)	Gamma camera ✓	1	
	(ii)	From top to bottom: (More) electron(s) ✓ Photomultiplier (tubes) ✓ (Visible) light ✓ Collimator ✓	4	IGNORE electronic signal ACCEPT description of function ACCEPT Photons ACCEPT description of function or <u>lead grid</u>
Total			13	

Question		Answer	Marks	Guidance
7	(a)	<p>One from: (potential) benefit outweighs risk ✓ If condition/illness not discovered/investigated illness/death may result that is worse than possible damage caused by X-rays ✓ X-ray doses are minimised/safer ✓ Non-invasive better than operating/infection risk ✓</p>	1	<p>eg no more X-rays than necessary Modern methods mean dose from each X-ray is less than previously</p>
	(b)	<p>[Level 0] Candidate response not worthy of credit (0 marks)</p> <p>[Level 1] Candidate demonstrates limited knowledge by describing at least one of the valid points Errors of grammar, punctuation and spelling may be intrusive (1 mark)</p> <p>[Level 2] Candidate demonstrates understanding by describing and explaining at least two of the valid points There may be occasional errors in spelling, punctuation and grammar (2 marks)</p> <p>[Level 3] Candidate demonstrates a high level of knowledge and understanding by describing and explaining four of the valid points There will be few, if any errors in spelling, punctuation and grammar (3–4 marks)</p>	4	<p>Expected knowledge and learning could include the following valid points:</p> <ul style="list-style-type: none"> • Film only absorbs a small proportion of X-ray energy • Screens made of fluorescent material • Screens made of zinc sulfide • Screens convert (X-ray) energy to light (photons) • ACCEPT convert X-rays to light • Light detected by film • Film double-sided • Screens placed on either side of film
	(c) (i)	<p>Two from: Radiation may be scattered by tissue ✓ Scattered radiation will reduce contrast /blur the image / ✓ (Grid) placed between patient and film/detector ✓ (Grid) absorbs (X)-rays ✓ (Grid) is made of (strips of) lead/alternative valid description ✓</p>	2	<p>REJECT just better/worse quality image</p> <p>IGNORE reference to strength/ energy /frequency</p>

Question		Answer	Marks	Guidance
	(c) (ii)	Two from: Wider beams produce blurred images /(Narrow beams) produce sharp(er)/clear(er) images/reference to umbra - penumbra ✓ (beam is made narrow by adjustable) lead sheets/cones around beam ✓ Use oblique target to produce X-rays ✓	2	REJECT just better/worse quality image ACCEPT improves focus of image implied
	(iii)	Two from: X-ray machines produce wide spectrum of X-rays ✓ High energy/ frequency, X-rays used for imaging or remove low energy /frequency, X-rays ✓ Appropriate material for filter eg aluminium ✓ Lowers dose ✓	2	ACCEPT weaker/stronger rays for low/high energy rays respectively
		Total	11	

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