

**GCE**

**Applied Science**

Unit **G635**: Working Waves

Advanced GCE

**Mark Scheme for June 2016**

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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.

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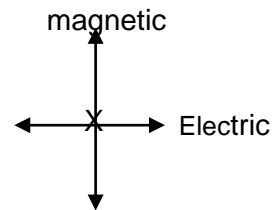
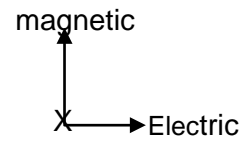
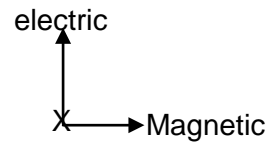
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Question			Expected Answer	Mark	Rationale/Additional Guidance
1	a	i	Any appropriate example e.g. to "see" temperature/level of water inside pipes or tanks/ leaking/breaks in circuit/ electrical faults /to see where cables are overheating ✓	1	"trespassers" is NOT appropriate. <b>ALLOW:</b> electrical problems <b>IGNORE:</b> just problems
		ii	Any appropriate example e.g. place in window to see intruders ✓	1	<b>ALLOW</b> Gas or water leaks as security issues <b>ALLOW</b> bodies/ movement (of people) <b>IGNORE</b> objects
		iii	Can see in the dark/ at night ✓	1	<b>ALLOW</b> alternative sensible answers
	b	i	(+/-) 0.1 (°C) ✓	1	
		ii	In order to distinguish between objects at close temperatures/ temperature difference/ temperature changes may be small ✓	1	
<b>Total</b>				<b>[5]</b>	

Question		Expected Answer	Mark	Rationale/Additional Guidance
2	a	Any <b>two</b> from: FM/ AM (are analogue radio transmissions) ✓ (Analogue/ radio signal) is continuous/ continuously variable ✓ M means modulated which implies analogue / not DAB ✓	<b>2</b>	
	b	Time / display /numbers shown /clock (is digital/ discrete) ✓	<b>1</b>	<b>IGNORE</b> values /binary
	c	1100 ✓	<b>1</b>	<b>ALLOW</b> leading zeros e.g. 001100
	d	Analogue signal sampled ✓ At regular/ frequent intervals / several times per cycle ✓ The (infinite number of possible) analogue signal values are rounded to a specific, predetermined set of numbers/ (process called) quantising ✓	<b>1</b> <b>1</b> <b>1</b>	May be indicated by diagram May be indicated by at least 4 samples indicated on diagram <b>IGNORE</b> just conversion to binary/ 1s and 0s
<b>Total</b>			<b>[7]</b>	

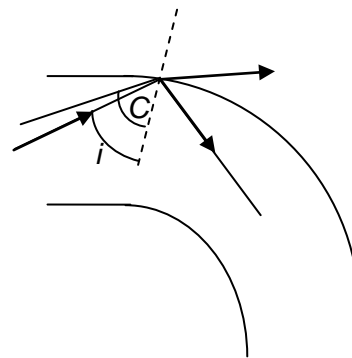
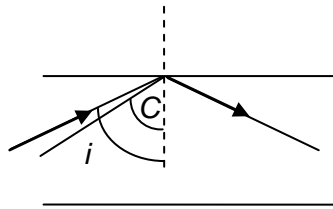
Question			Expected Answer	Mark	Rationale/Additional Guidance
3	a	i	The displacement is/ lines have moved, in the same direction as the wave/ left or right <b>Or</b> Shows compressions/ rarefactions ✓	1	<b>ALLOW</b> the displacement is / lines have moved backwards and forwards/ horizontally <b>IGNORE</b> side to side
		ii	movement sideways/ to the right/ towards the ear/ away from the fork ✓  peaks/ troughs/ compressions/ rarefactions have moved ✓	1  1	
	b	i	Two arrows drawn from cross at right angles to each other ✓	1	<b>ALLOW</b> any of examples below, in any orientation with any length of arrows
		ii	1. Radio ✓ Microwaves ✓  2. Upper limit to frequency ✓ Set by what equipment/ oscillators can generate ✓	1 1  1 1	
		iii	A: X-ray machine / plate / film / camera / CAT scanners ✓  B: UV spectroscope / UV lamp ✓	1  1	<b>ALLOW</b> Gamma applications  <b>ALLOW</b> valid alternatives e.g. sun bed/ viewing security markings
		iv	$8 \times 10^{14}$ (Hz) ✓	1	
		v	$v = f\lambda$ <b>OR</b> $c = f\lambda$ ✓ $c = 4 \times 10^{-7} \times 8 \times 10^{14}$ ✓  $= 3 \times 10^8$ (m s <sup>-1</sup> ) <b>Or</b> $= 300,000,000$ (m s <sup>-1</sup> ) ✓	1 1  1	Stated or implied Stated or implied Ecf for $f = 3 \times 10^{16}$ Hz Ecf for $f = 3 \times 10^{16}$ Hz ( $c = 1 \times 10^{10}$ (m s <sup>-1</sup> ) to 1 sf) <b>IGNORE</b> answers to more than 1 sig. fig. for 3rd mark
		vi	Wavelength/ frequency/given values/values in table is only given to 1 s.f./ given values are approximate ✓	1	<b>IGNORE</b> estimate
	c	i	<b>At least two</b> identical (non-sine) cycles any additional cycles must also be identical ✓	1	<b>ALLOW</b> minor differences which are errors in sketching <b>REJECT</b> Sine waves with varying amplitude

Question			Expected Answer	Mark	Rationale/Additional Guidance
3 cont.		ii	Any non repeating wave ✓	1	<b>REJECT</b> if only minor differences which are errors in sketching <b>ALLOW</b> one cycle or less of common repeating wave such as sine
		iii	vertical axis: displacement ✓ horizontal axis: time and units ✓	1 1	<b>REJECT</b> time period
<b>Total</b>				<b>[19]</b>	



Question		Expected Answer	Mark	Rationale/Additional Guidance
4	a	400K C 5270K B 7000K A All three correct ✓	1	
	b	A: Blue ✓ <b>One</b> from: The peak of the curve is at the, low wavelength/blue/left, end of the spectrum ✓ Low wavelength end of the visible spectrum is blue ✓ More blue light emitted than other colours ✓  B: Yellow / White ✓ <b>One</b> from: Emits all colours in the visible spectrum ✓ Peak of the curve is in the middle of the visible spectrum ✓  C: Red ✓ <b>One</b> from: The peak of the curve is at the, high wavelength/red/right, end of the spectrum ✓ High wavelength end of the visible spectrum is red ✓ More red light emitted than other colours ✓	1   1   1   1	ALLOW white/ violet/ indigo      ALLOW orange–yellow but not just orange
	c	(Perfect black body) absorbs all the light/radiation (falling on it) ✓  the term "black" body refers to (lack of) <b>reflected</b> light or colours are produced by <b>emitted</b> light ✓	1   1	
<b>Total</b>			<b>[9]</b>	

Question			Expected Answer	Mark	Rationale/Additional Guidance
5	a	i	Any <b>two</b> from: To prevent leakage ✓ To increase the critical angle ✓ To prevent rays at a large angle to the axis passing down fibre ✓ Reducing multipath dispersion ✓	<b>2</b>	
		ii	Cladding/outer layer, has lower RI Or Core has higher RI ✓	<b>1</b>	<b>ALLOW</b> Glass has a lower RI than core <b>ALLOW</b> Glass has a higher RI than cladding <b>REJECT</b> Glass has a lower/higher RI if unclear which layer is meant by glass
		iii	So that total internal reflection (TIR) will occur ✓	<b>1</b>	<b>ALLOW</b> speed (of light) depends on RI
	b		(For TIR to take place) angle of incidence must be $> C$ ✓ Bend in fibre makes $i$ smaller ✓	<b>1</b> <b>1</b>	Example of suitable diagrams to gain each of these marks shown below.





Question		Expected Answer	Mark	Rationale/Additional Guidance
5	c	<p><b>[0 marks]</b> response not worthy of credit</p> <p><b>[1- 2 marks]</b> Candidate demonstrates a limited knowledge of multimode distortion</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><b>[3 marks]</b> Candidate demonstrates understanding of multimode distortion</p> <p>For 3 marks at least three valid points</p> <p>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</p> <p><b>[4-5 marks]</b> Candidate demonstrates a high level of knowledge and understanding of multimode distortion</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 <b>clearly and logically</b></p>	<b>4</b>	<p><i>Valid points:</i></p> <p>Rays enter the fibre / fibre can accept rays, at different angles ✓</p> <p>Some rays travel further than others ✓</p> <p>Rays arrive at different times ✓</p> <p>Rays arriving at different times spreads out the signal ✓</p> <p>Rays with longer paths arrive later ✓</p> <p>The greater the angle between the ray and the axis, the greater the path length ✓</p> <p>All travel at the same speed ✓</p> <p>Called multimode/multipath distortion/dispersion ✓</p> <p>Above points may be made by a diagram</p>
	d	<p>Any <b>two</b> from:</p> <p>All waves travel along axis in monomode/ only one path ✓ Small diameter ✓ Less distortion/degradation ✓ Signal can travel further before it needs to be regenerated ✓</p>	<b>2</b>	<p>ALLOW reverse argument.</p>

Question			Expected Answer	Mark	Rationale/Additional Guidance
5	e		<p>Any <b>two</b> from:</p> <p><b>Faster</b> data transmission ✓</p> <p>Low material costs / glass is more abundant ✓</p> <p>Small cable size ✓</p> <p>Negligible crosstalk ✓</p> <p>High immunity to/less interference ✓</p> <p>(Complete) electrical isolation /Can be used in wet environments ✓</p> <p>Wiretapping is more difficult ✓</p>	<b>2</b>	<b>ALLOW</b> cheaper
	f	i	<p>Draw the incoming and outgoing rays ✓</p> <p>Draw the path of the ray inside the block ✓</p>	<b>1</b> <b>1</b>	
		ii	<p>So that ray enters the block at right angles to the surface / along the normal/ going towards the centre or</p> <p>Otherwise the ray will be refracted/ deviate on entry ✓</p> <p>To make it easy to trace the path of the ray inside the block ✓</p>	<b>1</b> <b>1</b>	
		iii	<p><b>1</b> Laser ✓</p> <p><b>2</b> Photodiode ✓</p>	<b>1</b> <b>1</b>	<b>ALLOW</b> LED

Question			Expected Answer	Mark	Rationale/Additional Guidance
5	f	iv	Coherent : <i>Any <b>one</b> from:</i> Communication <b>or</b> transferring image(s)/ endoscope ✓	1	<b>ALLOW</b> internet / data transmission
cont	cont		Incoherent : appropriate application e.g. lighting/ light source in endoscope. ✓	1	<b>ALLOW</b> decoration
			<b>Total</b>	<b>[23]</b>	

Question		Expected Answer	Mark	Rationale/Additional Guidance
6	a	<p>Any <b>two</b> from:</p> <p>Obstructions / Mountains / High buildings ✓</p> <p>Population (density)/city / country or wtte ✓</p> <p>High demand near busy roads ✓</p> <p>Coastline / national boundaries ✓</p>	2	
	b	<p>Uplink: signal from phone to, mast/ transmitter/ base station</p> <p>Downlink: signal from, mast/ transmitter/base station, to phone ✓</p>	1	<b>REJECT</b> satellite
	c	<p>full duplex: can talk and listen/ transmit and receive at the same time ✓</p> <p>half duplex: users take it in turns to talk and listen/ transmit and receive at the same time /only one person can talk at a time</p> <p><b>or</b></p> <p>can talk or listen/ transmit or receive but not both at the same time ✓</p>	1  1	

Question		Expected Answer	Mark	Rationale/Additional Guidance
6	d	<p><b>[0 marks]</b> response not worthy of credit</p> <p><b>[1-2 marks]</b> Candidate demonstrates a limited knowledge of cellular technology</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><b>[3-4 marks]</b> Candidate demonstrates understanding of cellular technology</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><b>[5-6 marks]</b> Candidate demonstrates a high level of knowledge and understanding of the purpose and implementation of cellular technology by setting out</p> <p>For 5 marks at least <b>five</b> valid points For 6 marks at least <b>six</b> valid points <b>clearly and logically</b></p>	<b>6</b>	<p><i>Valid points:</i></p> <p>Only a limited number of frequencies are available (for mobile phone use)</p> <p>Adjacent cells must have different frequencies</p> <p>Non-Adjacent cells can have the same frequency</p> <p>BDEHIJ (Any two or more but no others) cannot have the same frequency (as F)</p> <p>ACGK (Any two or more but no others) can have the same frequency (as F)</p> <p>A&amp;C/ C&amp;G/ G&amp;K must have different frequencies from each other</p> <p>Adjacent cells sharing the same frequency would experience interference</p> <p>Transmitters use low energy so that they do not interfere</p> <p>Several frequencies may be allocated to a single cell</p> <p>The country can be covered by seven frequencies</p>
		<b>Total</b>	<b>[11]</b>	

Question		Expected Answer	Mark	Rationale/Additional Guidance	
7	a	<p>Any <b>four</b> from:</p> <p>Grid is made of lead ✓</p> <p>Grid absorbs, scattered rays/ C&amp;E Or Grid does not allow scattered rays/ C&amp;E to pass ✓</p> <p>Rays A, C and E are scattered ✓</p> <p>Scattered rays would hit the wrong part of the sensor ✓</p> <p>Scattered rays would make image less clear ✓</p> <p>B and D are not scattered and pass through to the sensor ✓</p> <p>Unscattered rays, hit the sensor /form image ✓</p>	4	ALLOW “deflected” for “scattered”	
	b	i	Converts X-ray (energy) into (visible) light ✓	1	
		ii	<p>Image-intensifying screens: light exposes film / is detected by film / causes a chemical reaction (in film) ✓</p> <p>digital X-ray cameras: light detected by photodiode(s) / photomultiplier/detector array ✓</p>	1 1	

Question		Expected Answer	Mark	Rationale/Additional Guidance
7	c	<p>Any <b>two</b> from:</p> <p>X-rays images are shadows (formed where X-rays have been absorbed) ✓</p> <p>X-rays are absorbed by bone/dense material/ material with high atomic number ✓</p> <p>X-rays are not absorbed (very much) /pass straight through tissue less dense material/ material with low atomic number ✓</p> <p>Difficult to distinguish between parts of body which have, similar/ low, absorption (of X-rays) ✓</p>	2	

Question			Expected Answer	Mark	Rationale/Additional Guidance
7	d	i	Time taken for half the active nuclei to disintegrate <b>OR</b> time taken for the activity to fall to half (its original value) ✓	1	<b>ALLOW</b> other alternatives to "activity"
		ii	Time taken for biological processes to remove half the active material ✓	1	<b>ALLOW</b> excretion
		iii	$\frac{1}{T_E} = \frac{1}{T_B} + \frac{1}{T_R}$ stated or implied ✓ $T_B = 12$ (hours) and $T_R/T_P = 6$ (hours) ✓ $\frac{1}{T_E} = \frac{1}{12} + \frac{1}{6}$ $= \frac{1+2}{12}$ $= \frac{3}{12}$ $T_E = 4$ (hours) ✓	1  1	<b>ALLOW</b> alternative nomenclature e.g. $T_P$ for physical half life.  Or implied by correct substitution. (If substituting into an <b>incorrect</b> formula <b>MUST</b> be clear that values are for $T_B$ and $T_R/T_P$ )
	e		<i>Any two from:</i> Screening of non-cancerous areas ✓ Use Gamma/ beams from more than one direction \rotate source ✓ Narrow Beam ✓ Use alpha source which is absorbed close to site of cancer ✓  Administer dose in several sessions/ administer dose over a period of weeks/ months ✓  So that healthy cells can recover ✓	2	
			<b>Total</b>	<b>[16]</b>	



**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](mailto:general.qualifications@ocr.org.uk)

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Telephone: 01223 552552  
Facsimile: 01223 552553

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