

**GCE**

**Applied Science**

Unit **G635**: Working Waves

Advanced GCE

**Mark Scheme for June 2014**

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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.

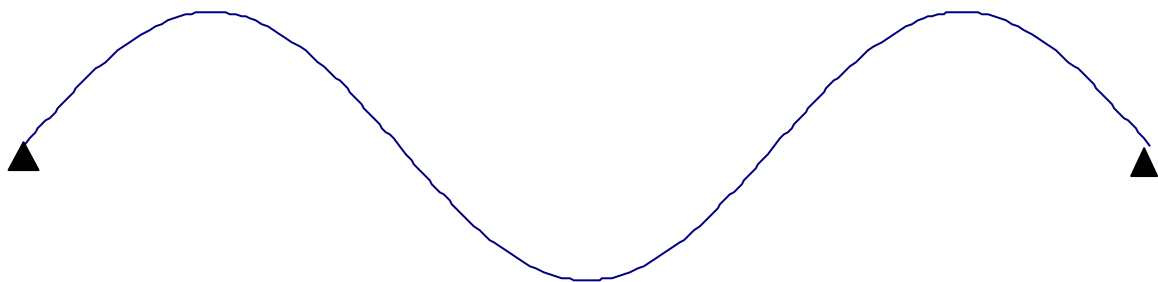
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Question		Expected Answer	Mark	Rationale/Additional Guidance	
1	a	Infra-red /IR Infra-red /IR ✓	1		
	b	i	Ice cream ✓	1	<b>IGNORE</b> colour
		ii	Sponge /pudding✓	1	<b>IGNORE</b> colour
		iii	Ice cream ✓	1	<b>IGNORE</b> colour
		iv	Plate ✓	1	<b>IGNORE</b> colour
	c	False colours /shades of grey ✓ Comparison of appearance between sponge, ice cream <b>and</b> plate ✓	1 1	<b>IGNORE</b> references to temperature	
	d	uniform colour /shade of grey /all look the same ✓	1		
		Total	<b>[8]</b>		

Question		Expected Answer	Mark	Rationale/Additional Guidance	
2	a	0.5(0) ✓	1		
	b	X marked on both graphs on SAME part of wave ✓  Both distances along bar with correct units (assume cm if not stated) ✓  Speed = distance/time ✓  <u>2000</u> ✓	1  1  1  1	<b>REJECT</b> if more than one X one graph  <b>ALLOW</b> for any two distances differing by $20 \pm 2$ cm even if X not marked <b>ALLOW</b> difference $20 \pm 2$ if measurements not recorded <b>ALLOW</b> Ecf for incorrectly placed Xs  Stated or implied <b>ALLOW</b> if displacement used instead of distance <b>ALLOW</b> if single distance measurement used.  <b>ALLOW</b> last three marks if answer only recorded	
	c	Not a repeating wave /wave has no pattern ✓	1	<b>ALLOW</b> not a full wave	
	d	i	2.4 ✓	1	
		ii	$v = f\lambda$ ✓ $v = 125 \times 2.4$ $v = 300$ ✓	1  1	Stated or implied  <b>ALLOW</b> Ecf from (i) e.g. $v = 150$ if $\lambda = 1.2$
		iii	$f = 1/T$ or $T = 1/f$ or $T = 1/125$ (s) ✓  $T = 0.008(00) / 8 \times 10^{-3}$ (s) ✓  0.002(00) ✓	1  1  1	Stated or implied <b>ALLOW</b> alternative notation e.g. $t$ for period throughout  <b>ALLOW</b> 2(.00) <u>ms</u> ('m' must be written in)
		iv	0.5 /half ✓ 2 /twice ✓	1 1	

	v	2 peaks and 1 trough or vice versa or both ✓ Line meets ▲ at ends ✓	1 1	See diagram below
<b>Total</b>			<b>[16]</b>	



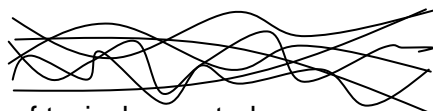
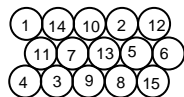
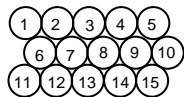
Question		Expected Answer	Mark	Rationale/Additional Guidance
3	a	Actual temperatures related to, colours/shades of grey/image /calibrates ✓	1	<b>ALLOW</b> warmer/colder for "temperatures"
3	b	<p><b>[0 marks]</b> response not worthy of credit.</p> <p><b>[1-2 marks]</b> Candidate demonstrates a limited knowledge of spatial and thermal resolution</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 applications of thermal imaging 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 by <b>relating</b> knowledge of spatial and thermal resolution to applications</p> <p>describing with full understanding 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>Valid points:</p> <p><b>Spatial resolution:</b></p> <ul style="list-style-type: none"> <li>How well it can distinguish between objects at different places/ separation of points which can be distinguished</li> </ul> <p><b>Or</b></p> <p>Definition/detail pixels/unit length of image ✓</p> <ul style="list-style-type: none"> <li>Relevant example of application illustrating spatial resolution: e.g. Looking for leaks from underground pipes ✓</li> <li>Why good spatial resolution is advantage in example given e.g. Water leaking from pipe may be close to it so need to recognise where pipe appears to be just slightly wider ✓</li> </ul> <p><b>Thermal resolution:</b></p> <ul style="list-style-type: none"> <li>How well it can distinguish between objects at different temperatures/ difference of temperature which can be distinguished ✓</li> <li>Relevant example of application illustrating Thermal resolution e.g. Identifying houses which are at different temperatures ✓</li> <li>Why good thermal resolution is advantage in example given e.g. Some properties may be better insulated than others ✓</li> </ul>
		<b>Total</b>	<b>[7]</b>	

Question		Expected Answer	Mark	Rationale/Additional Guidance
4	a	Ray A correctly drawn reflected so that $i = r$ by eye ✓	1	If more than one reflection look at first Expect $r = 74^\circ \pm 10^\circ$
		Ray B: straight horizontal line ✓	1	
	b	(Outer) (protective) sheath/ jacket/ coating/ buffer ✓	1	
		(Central) core ✓	1	
		ii Single square wave with rounded corners and sloping sides. May have lost flat top completely ✓	1	
		iii Different paths lengths ✓  Signals (leaving the start at the same time) will arrive at different times ✓	1	
			1	
	c	Refractive index/optical density, changes gradually ✓	1	Max. 1 mark for "density" instead of "optical density"
		Refractive index/optical density, changes radially ✓	1	
		Refractive index/optical density, lower towards the outside/ higher towards the centre ✓	1	
		ii Continuous curved paths ✓	1	At least two curved paths
		iii Ray bends/changes direction gradually, as refractive index changes gradually/ deviation due to refraction occurs gradually ✓	1	
		iv Step index: speed constant / same for all rays ✓ (Graded-index); speed varies ✓ Graded-index); rays travel faster further from axis /wtte ✓	1	
			1	
			1	
		v (For graded index): All rays arrive at (nearly at) the same time ✓	1	<b>ALLOW</b> RA for step index if clearly stated that answer refers to step index

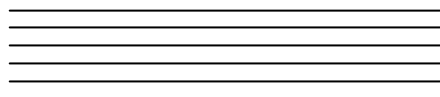
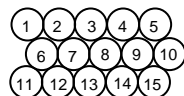
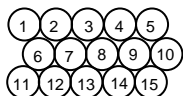
			Because rays which have to go further travel faster ✓	1	<b>IGNORE</b> “outer” instead of “further”
	d	i	Different arrangement of fibres at each end. Examples shown below ✓	1	Diagrams which look more like rays travelling down a fibre than a bundle of fibres should not be given credit (unless labels or text shows that the candidate intends each line to represent a fibre )
		ii	Signals would be mixed up /go to the wrong person ✓	1	
		iii	Fibres arranged same way throughout/ at both ends <b>Or</b> Fibres parallel ✓	1	Note above d(i) also applies here
		iv	Incoherent: takes light to subject ✓ Coherent: carries image from subject/to camera ✓	1 1	<b>ALLOW</b> lighting
			<b>Total</b>	<b>[22]</b>	



4 d i Examples of typical expected answers:



4 d iii Examples of typical expected answers:



Question		Expected Answer	Mark	Rationale/Additional Guidance
5	a	See below	4	

Example	analogue	binary	digital other than binary	None of these
<b>The time shown on the face of a watch with rotating hands.</b>	✓			
The M62 motorway				✓
An amplitude modulated radio signal	✓			
A DAB radio signal		✓		
This year 2014			✓	

Question			Expected Answer	Mark	Rationale/Additional Guidance
5	b	i	<p><b>Banded marking range:</b></p> <p><b>[0 mark]</b> response not worthy of credit.</p> <p><b>[1-2 marks]</b> Candidate demonstrates a limited knowledge of Internet systems giving:</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 Internet systems giving:</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 by relating knowledge of Internet systems giving:</p> <p>for 5 marks at least five valid points. for 6 marks six valid points.</p> <p>The answer will be set out in a clear and logical manner</p>	6	<p>Valid points:</p> <p>Higher frequency allows faster bit rate/data transmission speed, ORA ✓</p> <p>Higher frequency results in greater bandwidth ✓</p> <p>Lower wavelength allows faster bit rate /data transmission speed ORA ✓</p> <p>Higher frequency implies lower wavelength or vice versa related to at least one of systems /correct calculation of <math>f</math> or <math>\lambda</math> ✓</p> <p>Dialup/ 8 Mbp/s system use conventional /copper telephone wires ✓</p> <p>Dialup uses audio frequency ✓ 40 Mbps system uses wavelength of infra red / light produced by laser /LED ✓ 3G uses radio frequency ✓</p> <p>40 Mbps system uses optical fibres ✓ 40 Mbps less susceptible to interference ✓</p> <p>3G uses multiple access technologies (multiplexing) /many users at same time ✓</p> <p>Comment about range of 3G ✓</p> <p>Dialup can't use telephone at same time /8 Mbps system can use telephone at same time ✓</p>

Question			Expected Answer	Mark	Rationale/Additional Guidance
	b	ii	<p><b>Any two</b> from:</p> <p>Can't get broadband (in a particular location)/ Can access phone line anywhere ✓</p> <p>Already have all the equipment/ modem/reluctance to change/ user familiar with it ✓</p> <p>Broadband connection just went down ✓</p> <p>In the middle of changing providers ✓</p> <p>Don't need fast data transfer ✓</p>	2	<b>REJECT</b> cheaper/ no subscription
5	b	iii	<p>Higher bit/ data rate ✓</p> <p>1s and 0s closer together/ Higher frequency ✓</p>	1 1	More data in a given time
	c		<p>(Signal) intensity inversely proportional to distance<sup>2</sup> (from source) ✓</p> <p>Because (energy) is spread over a larger area/ Area of surface of sphere <math>\propto</math> radius<sup>2</sup> ✓</p>	1 1	<b>ALLOW</b> example e.g. as distance doubles intensity reduced to quarter
			<b>Total</b>	<b>[16]</b>	

Question			Expected Answer	Mark	Rationale/Additional Guidance
6	a	i	the thickness (of material required) to reduce (an incident beam of) radiation to half (its original intensity) ✓	1	
		ii	(10,000/2 = 5,000 5000/2 = 2500)  Two half thicknesses ✓  (2 x 0.068) 0.136 ✓	1  1	<b>ALLOW</b> appropriate log calculation
	b	i	Sharp shadow ✓ <b>Any two</b> from: Light falls evenly between A and C and below E/ bright at, A/B/any part of A to C ✓ No light, between C and E/at D ✓ Shadow ends at C and E ✓	1 2	<b>IGNORE</b> comments on variation of brightness between A and C
		ii	Unsharp shadow/ blurred edge ✓ <b>Any three</b> from: Light falls evenly between M and N ✓  Illumination gradually gets less from N to O ✓  (Because) from N to O light only reaches the wall from part of tube ✓  Dark shadow between O and P ✓	1 3	<b>IGNORE</b> comments on variation of brightness between M and N
	c	i	Treatment: (attempting to) cure /reduce symptoms ✓  Diagnosis is identification/investigation of problem ✓	1  1	<b>ALLOW</b> example e.g. radiotherapy to kill cancer cells  <b>ALLOW</b> example e.g. detect tumours

Question			Expected Answer	Mark	Rationale/Additional Guidance
6	c	ii	<p><b>Any two</b> from:</p> <p>Blood can take the tracer round the body ✓</p> <p>Reaches parts of the body that would not show up on X-Ray images ✓</p> <p>Reaches (e.g.) soft tissue/ blockage/ within bones/ veins/ arteries/ heart/ brain ✓</p> <p>Emits (gamma) radiation from within the body ✓</p> <p>Radiation detected to form images ✓</p>	2	<p><b>ALLOW</b> identifies</p> <p><b>ALLOW</b> identifies</p>
		iii	<p><b>Any three</b> from:</p> <p>Half-life (of six hours) is long enough to carry out an examination ✓</p> <p>Half-life (of six hours) is short enough to reduce harm to patient/ keep the radiation dose low ✓</p> <p>Readily detectable ✓</p> <p>It can form compounds in a range of biologically-active substances / possible to concentrate it in the tissue or organ the doctor wants to examine ✓</p> <p>Relatively safe/ does not produce high energy beta particles ✓</p> <p>Readily available/ It can be produced in the hospital (when needed/ using special “generators”) ✓</p>	3	
		iv	Gamma Camera ✓	1	

		v	<b>Any three</b> from: To remove scattered g-rays ✓ To improve image ✓ Made from lead (disk) ✓ Placed between the patient and the, detector/scintillator ✓ Many holes through it ✓ Holes (normally) parallel (to each other) /special collimators, have diverging/converging holes ✓	<b>3</b>	
			<b>Total</b>	<b>[21]</b>	

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