

GCE

Applied Science

Unit **G635**: Working Waves

Advanced GCE

Mark Scheme for June 2015

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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



Blank Page – this annotation **must** be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.

Subject-specific Marking Instructions

We do not annotate Religious Studies scripts.

Awarding Spelling, Punctuation and Grammar to scripts with a coversheet

1. If a script has a **scribe cover sheet** it is vital to check which boxes are ticked and award as per the instructions and grid below:
 - a. Assess the work for SPaG in accordance with the normal marking criteria. The initial assessment must be made as if the candidate had not used a scribe (or word processor) and was eligible for all the SPaG marks.
 - b. Check the cover sheet to see what has been dictated (or what facilities were disabled on the word processor) and therefore what proportion of marks is available to the candidate.
 - c. Convert the SPaG mark to reflect the correct proportion using the conversion table given below.

SPaG mark awarded	Mark if candidate eligible for one third (eg grammar only)	Mark if candidate eligible for two thirds (eg grammar and punctuation only)
0	0	0
1	0	1
2	1	1
3	1	2
4	1	3
5	2	3
6	2	4
7	2	5

8	3	5
9	3	6

2 If a script has a **word processor cover sheet** attached to it the candidate **can** still access SPaG marks (see point 1 above) unless the cover sheet states that the checking functionality is enabled, in which case no SPaG marks are available.

1 If a script has a **word processor cover sheet** **AND** a **scribe cover sheet** attached to it, see point 1 above.

2 If the script has a **transcript, Oral Language Modifier, Sign Language Interpreter or a Practical Assistant cover sheet**, award SPaG as normal.

Question		Expected Answer	Mark	Rationale/Additional Guidance	
1	a	The number of vibrations/cycles /waves/movements backwards and forwards (of the air), per second/unit time ✓	1	Allow rate of oscillation Allow other time units e.g. per minute Ignore How frequent the wave is Ignore references to pitch, period	
	b	$v = f\lambda$ ✓ 343.2 ÷ 341.3 ✓ (= 1.00556695) = 1.006 to 4 sig figs ✓	3	Stated or implied. v, f or λ may be subject of equation Accept w for λ Reject other letters UNLESS 2 nd or 3 rd mark achieved Rearrangement and substitution May be implied by the answer even if not/incorrectly rounded to correct sf Correct answer to 4 s f = 3 marks	
	c	Moving horizontally /longitudinally ✓ movement to and fro ✓ Returns to its initial/equilibrium position (after one complete cycle) ✓	3	answer must indicate movement in the correct direction e.g. along dotted line/left/right/away from tuning fork/ along the direction of the wave Reject reference to vertical motion for 1 st MP Accept forwards & backwards /oscillates/vibrates. Accept correct ref to marking points given diagrammatically for any marks	
	d	i	One higher (Pitch) than the other ✓ 512 higher <u>Pitch</u> than 256/ higher frequency has higher <u>Pitch</u> ✓	2	ora

Question			Expected Answer		Mark	Rationale/Additional Guidance	
1	d	ii	Fork with a frequency of 512 Hz has gone through:	Phase relationship		Allow 360° or 720° Allow one/two phase/wavelength Allow half a phase/wavelength Ignore just “half” Reject one cycle Allow quarter of a phase/wavelength Ignore just “quarter”	
			Two complete cycles	In phase/ zero/none/one cycle ✓			1
			One complete cycle	180 ° /half a cycle/ π radians/completely out of phase/ in antiphase ✓			1
			Half a cycle	512 leads 256 ✓ by 90 ° /quarter of a cycle/ $\pi/2$ radians ✓			2
Total					[13]		

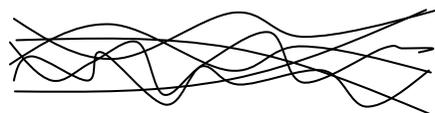
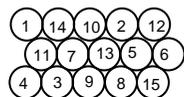
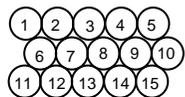
Question		Expected Answer	Mark	Rationale/Additional Guidance	
2	a	Statement	Letter corresponding to the region		<p>Reject if More than one letter given</p> <p>Ignore F and/or G but Reject if any other extra letter given</p> <p>Ignore F and/or G but Reject if any other extra letters given</p> <p>Ignore F and/or G but Reject if any other extra letters given</p> <p>Allow "All"</p> <p>Accept D in addition to G otherwise Reject if more than one letter given</p>
		Produced by sudden deceleration of electrons	B		
		Can be seen with the human eye	D	1	
		Thermal radiation produced by objects at room temperature	E	1	
		Thermal radiation produced by objects at a temperature of 800 K	D E	1 1	
		Thermal radiation produced by objects at a temperature of 40 000 K	C D <u>and</u> E	1 1	
		... velocity of $3.0 \times 10^8 \text{ m s}^{-1}$	ABCDEFGG	1	
		Produced by A.C. current in metal rods	G	1	
Total			[8]		

Question			Expected Answer	Mark	Rationale/Additional Guidance
3	a	i	Different /false colours/shades of grey/ brightness	1	Allow examples e.g. red= hot, blue = cold
		ii	Same	1	
	b	i	Spatial resolution ✓	1	
		ii	Thermal resolution ✓	1	
	c		2.0 m ✓ Appropriate explanation ✓	2	Allow half the distance e.g. any of: 640/4 = 320/2 Allow even if distance incorrect 480/4 = 240/2 Allow even if distance incorrect Angle (subtended) by the object will be the same at this distance Gives the same number of pixels per cm Resolution is halved so distance must be halved Assumes cameras have the same (focal length) lenses
	d		Engineering application may need to look at objects with (very) small temperature differences between them ✓ Rescue team need to tell the difference between people and surroundings/ concrete/ etc ✓ Estimate of rescue team temperature difference / thermal resolution ✓	3	Allow any value(s) within the range 1 to 10 K/°C
			Total	[9]	

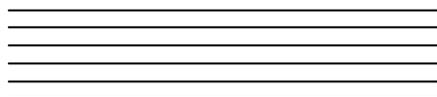
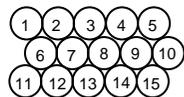
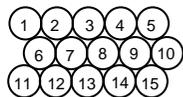
Question			Expected Answer	Mark	Rationale/Additional Guidance
4	a		Electrical isolation/ less risk of electrocution/ short circuit/fire ✓	1	
	b	i	coherent bundles: (fibres) arranged in the same order throughout/at both ends or (fibres) parallel ✓ incoherent bundles: (fibres) arranged in random order ✓	1 1	Allow suitable diagram (e.g. see below) Allow suitable diagram (e.g. see below)
		ii	Incoherent. Cheaper/easier to manufacture/ order does not matter/ not carrying data	1	
	c		Not a correct model. Glass has a higher refractive index (than water) /ora ✓ Step index: ratio of refractive indices is the other way round/outer layer /cladding has lower refractive index than centre/core ✓	1 1	Allow Step index: refractive indices are much closer

4 b i Examples of typical expected answers:

Coherent bundles:

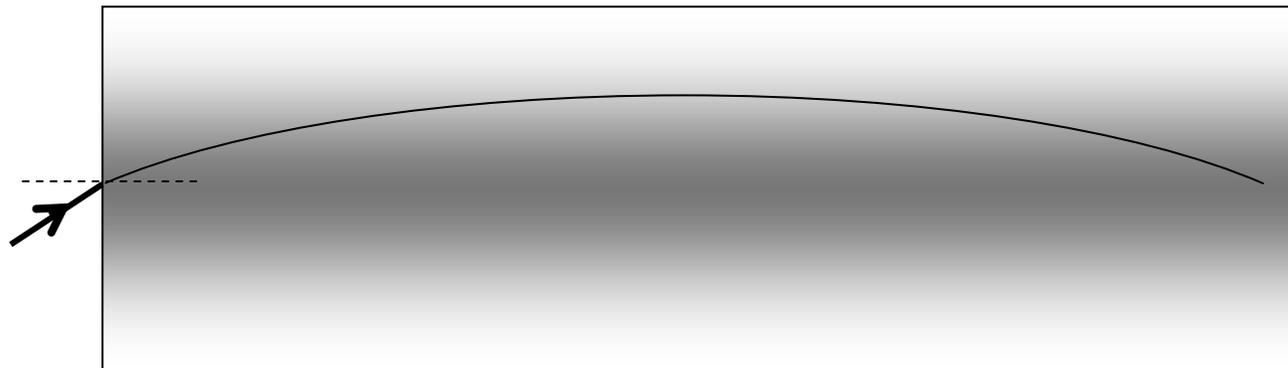


Incoherent bundles:

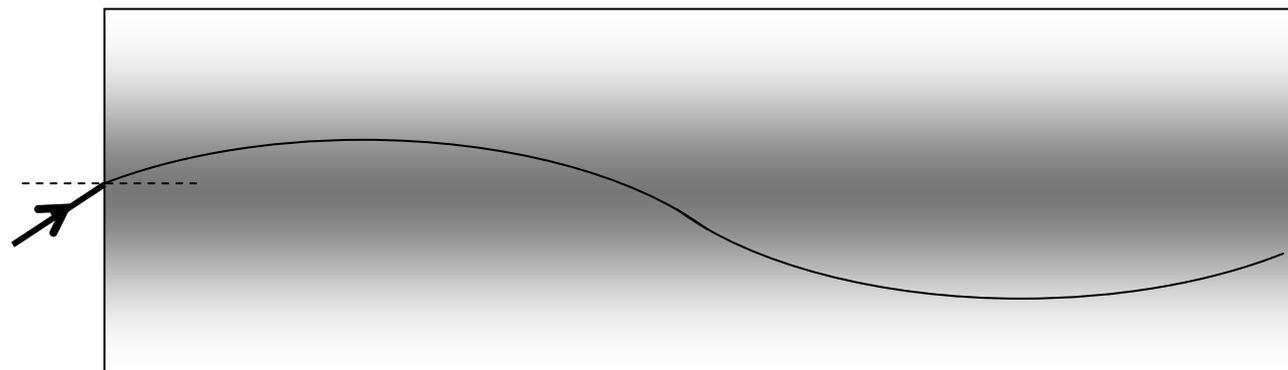


Question			Expected Answer	Mark	Rationale/Additional Guidance
4	d	i	Ray is travelling from an (optically) less dense /lower refractive index medium towards/ into /meeting an (optically) more dense /higher refractive index medium ✓	1	Response must refer to medium
		ii	Angle of incidence is less than the critical angle / $35^\circ < 41^\circ$ ✓	1	
	e	i	Water is (optically) less dense/ has lower refractive index, than glass /ora ✓	1	
		ii	Angle of incidence is greater than the critical angle / $55^\circ > 41^\circ$ ✓	1	
	f	i	Refractive index ✓ Any 2 from: dark shading represents a higher refractive index/ slower speed of light ✓ Gradual variation ✓ Radial variation ✓	1 2	Allow speed of light (in the glass) Or vice versa. Allow density Allow "core" to imply centre/axis
		ii	Ray deviates towards normal on entering fibre ✓ Curved path ✓ Curve bends initially towards axis ✓	1 1 1	See examples below If multiple paths drawn mark ray starting furthest to left

4 f ii e.g.



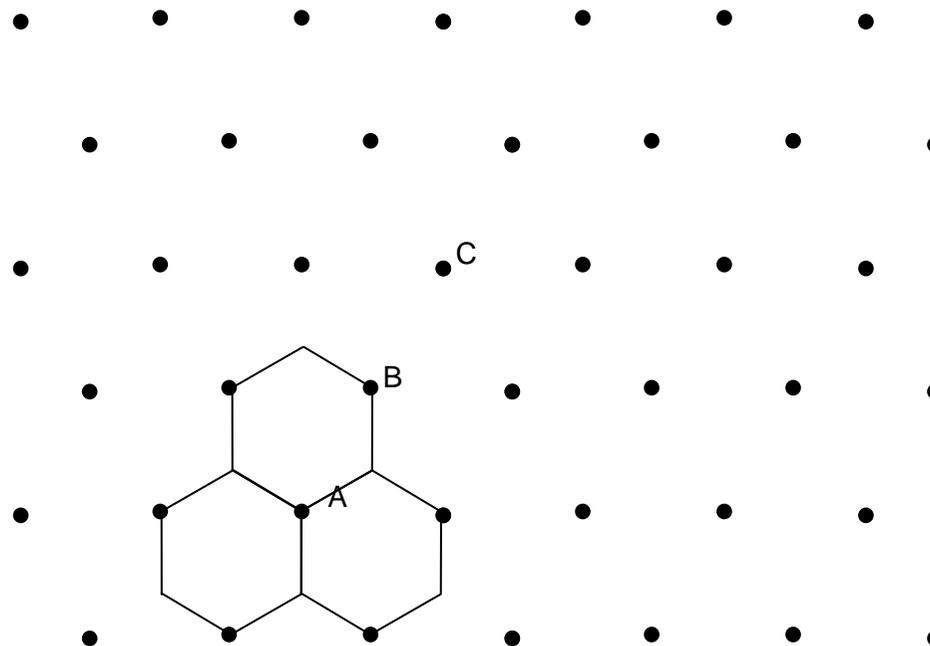
or



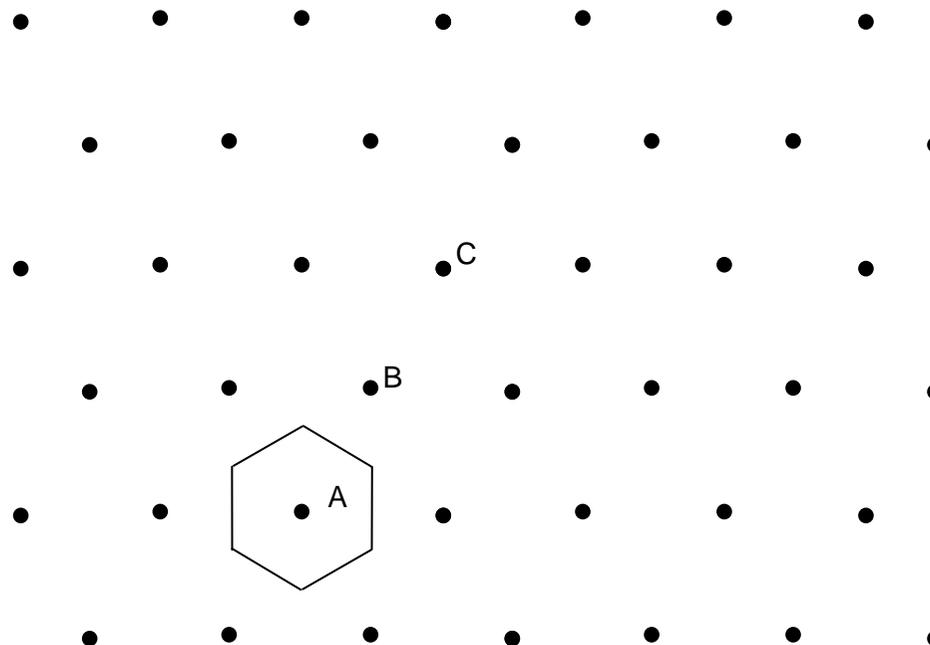
Question			Expected Answer	Mark	Rationale/Additional Guidance
4	f	iii	<p>Banded marking range:</p> <p>[0 mark] response not worthy of credit.</p> <p>[1-2 marks] Candidate demonstrates limited knowledge of graded-index optical fibres by describing.</p> <p>For 1 mark at least one valid points For 2 marks at least two valid points</p> <p>The answer may not be clearly set out.</p> <p>[3-4 marks] Candidate demonstrates understanding of graded-index optical fibres by describing and explaining:</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.</p> <p>[5 marks] Candidate demonstrates a high level of knowledge and understanding of graded-index optical fibres by describing:</p> <p>For 5 marks at least five valid points</p> <p>The answer will be set out in a clear and logical manner.</p>	5	<p>Expected knowledge and learning could include the following valid points</p> <p>(Graded index): Better quality/ less distortion/allow diagram to show ✓ Fewer repeater stations needed ✓</p> <p>Allow reverse argument.</p> <p>Graded index rays travel faster further away from axis/ faster corresponds to longer path lengths ✓ Graded index rays arrive (more nearly) together/ at the same time. ✓</p> <p>Step-index rays travel paths of different lengths ✓ Step-index rays do not all arrive together/ arrive at different times ✓</p> <p>Ignore any references to disadvantages of graded index.</p>
			Total	[21]	

Question			Expected Answer	Mark	Rationale/Additional Guidance
5	a	i	City/town (centre)/ area of dense population/Urban/ (central) London/other large city ✓	1	
		ii	Two from: Obstructions ✓ Permission to use sites ✓ Suitable high spots ✓ Variations in population density ✓	2	Allow availability of sites for either Permission to use sites or Suitable high spots Reject "Highly populated area" (must suggest variation)
		iii	Hexagonal cell encompassing 'A' ✓	1	Allow additional hexagons
			Three hexagonal cells shown as in first diagram below /one hexagonal cell shown with 'A' at centre ✓	1	Reject if more than one hexagon except as in first diagram See diagrams below
		iv	A&B/ B&C/ Adjacent base stations use different frequencies ✓	1	
			A&C/ nonadjacent base stations (may) use the same frequencies ✓	1	
	b		(Multiple access technology) enables many users to use the same/one frequency at the same place/time ✓ By dividing/ coding/multiplexing the signal ✓	1 1	Allow TDMA/ FDMA/CDMA
			Total	[9]	

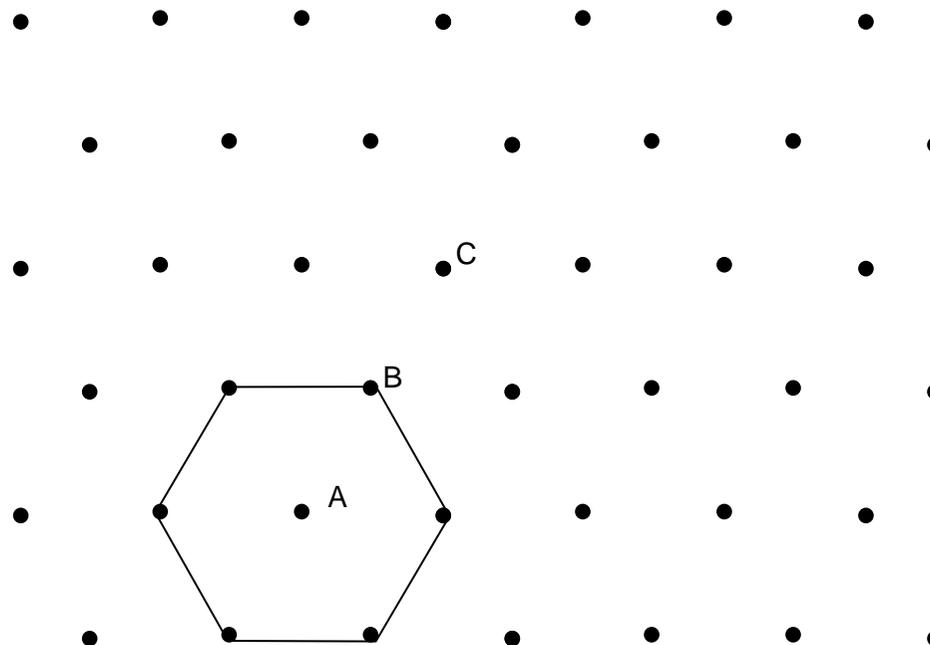
5 a iii 2 Marks



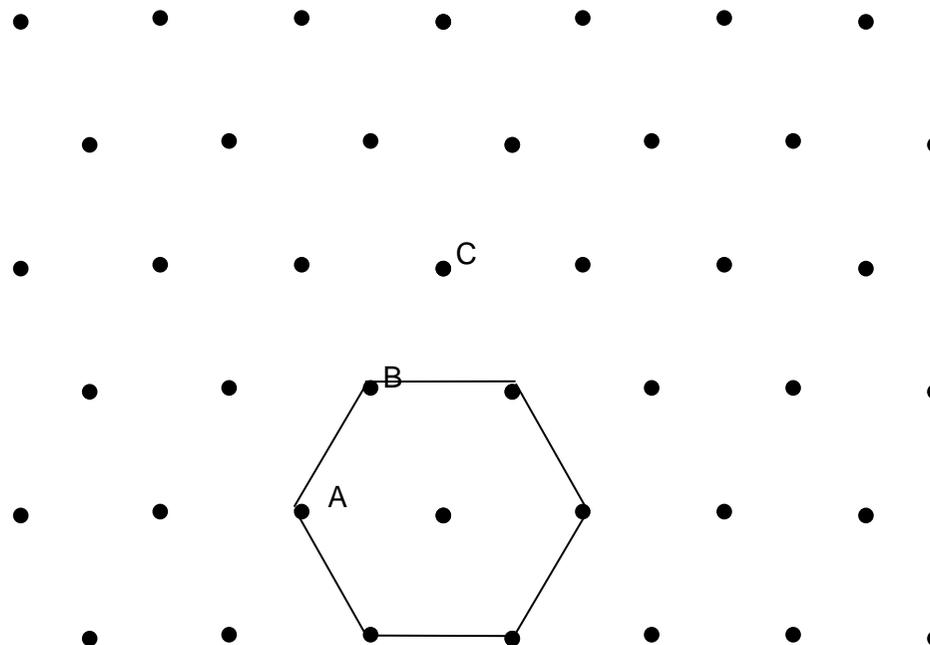
5 a iii OR: 2 marks



5 a iii Allow for 2 marks:

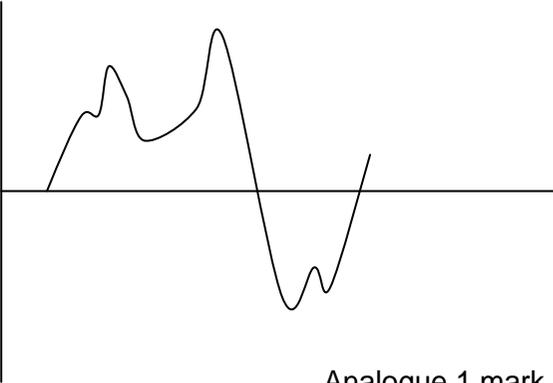


5 a iii Allow for 1 mark:

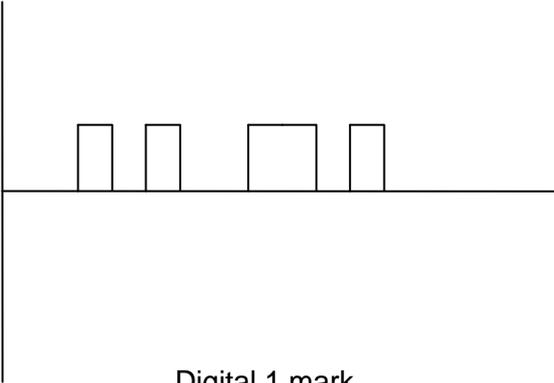


Question			Expected Answer	Mark	Rationale/Additional Guidance
6	a	i	Frequency Modulation ✓	1	Allow Frequency Modulated
		ii	Analogue: continuously variable ✓ Digital: whole numbers ✓ Digital: discrete values ✓	1 1 1	Allow infinite number of possible values Allow correctly labelled diagrams e.g. see below Allow binary or on/off Also scores 2nd MP Allow correctly labelled diagrams e.g. see below
		iii	AM / Amplitude Modulation ✓ in AM the amplitude of the signal varies (according to the audio signal) but frequency stays the same ✓ in FM the frequency of the signal varies (according to the audio signal) but amplitude stays the same ✓	1 1 1	Allow Amplitude Modulated Allow correctly titled diagrams allow missing/incorrect axis labels e.g. see below Allow correctly titled diagrams allow missing/incorrect axis labels e.g. see below Allow FM signals provide better quality than AM for 1 of 2nd & 3rd marks
	b		One of the following Higher transmission rate ✓ Limited available bandwidth ✓	1	Allow uncompressed has too much data
	c		Any two of the following Frequency/Wavelength ✓ Transmission bandwidth available ✓ Number of quantizing levels used/ bit depth ✓ Quality required ✓ (Amount /type of) compression to be used ✓	2	
Total				[10]	

6a ii example of acceptable diagrams

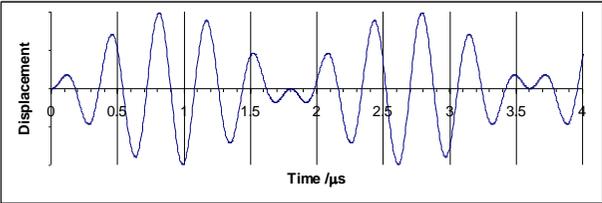


Analogue 1 mark

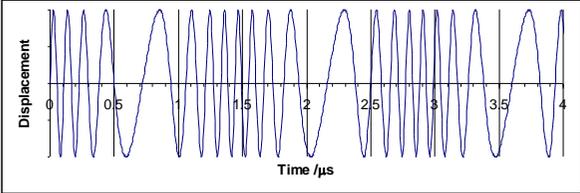


Digital 1 mark

6 a iii examples of acceptable diagrams
AM (Amplitude need not necessarily go down to zero)



FM



Question			Expected Answer	Mark	Rationale/Additional Guidance
7	a	i	B ✓	1	Allow C
		ii	ABC ✓	1	
		iii	ABCE ✓	1	
	b		any two from: X(-rays/radiation) γ (-rays/radiation) α β uV ✓	1	
	c		Radiation (with enough energy) to ionise an atom/ Radiation that can remove an electron from an atom ✓	1	Radiation that can ionise an atom
	d		any two from: causes chemical reaction/created free radicals/example ✓ can cause change/ mutation (of cells) ✓ cells cannot reproduce/ uncontrolled cell reproduction ✓ kills cells ✓ Penetrates skin ✓	2	Ignore ionisation removes electrons from atoms (already credited in (c)) Ignore divide rapidly
	e		any two from: cancer or specific examples inc, tumour/ leukaemia ✓ genetic damage ✓ infertility ✓ changes in the blood ✓ nausea/vomiting /tiredness ✓ loss of appetite ✓ loss of hair ✓ damage to the vital organs ✓ damage to central nervous system ✓	2	Ignore mutations Allow e.g. gut

Question			Expected Answer	Mark	Rationale/Additional Guidance
7	f (cont)	i	any one from: X-rays ✓ CAT scans ✓ (X-rays in conjunction with) barium meal ✓ Tracer techniques/Gamma camera ✓	1	
		ii	Radiotherapy/ Killing cancer/tumours/High dose of X/ γ rays ✓	1	Reject Chemotherapy
		iii	Benefits may outweigh hazards/ patient might die if disease not found/ treated/Cure	1	
	g	i	any one from increase sensitivity of detector ✓ more sensitive X-ray emulsions ✓ image intensifying screens ✓ selective lead screening ✓ Filter/screen to remove unwanted frequencies ✓	1	Accept use a narrower beam
		ii	any one from rotating beam ✓ Selective lead shielding to reduce the dose to parts of the body not undergoing radiotherapy treatment ✓ Limit frequency of treatments ✓ Filter/screen to remove unwanted frequencies ✓	1	Accept use a narrower beam
		iii	any one from reducing the size of source used ✓ increasing distance from the source (inverse-square rule) ✓ reducing time of exposure ✓ inserting materials such as lead or concrete between the source and the person ✓ Monitoring device ✓	1	

Question		Expected Answer	Mark	Rationale/Additional Guidance
7	h	<p>Banded marking range:</p> <p>[0 mark] response not worthy of credit.</p> <p>[1 mark] Candidate demonstrates limited knowledge of the principles of the CT scanner by describing at least one valid point.</p> <p>The answer may not be clearly set out.</p> <p>[2-3 marks] Candidate demonstrates understanding of the principles of the CT scanner by describing:</p> <p>For 2 marks at least two valid points For 3 marks at least three valid points</p> <p>The answer will be set out in a manner that is easy to follow.</p> <p>[4-5 marks] Candidate demonstrates a high level of knowledge and understanding of the principles of the CT scanner by describing:</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 in a clear and logical manner,</p>	5	<p>Expected knowledge and learning could include the following valid points:</p> <p>Absorption of X rays depends on density/bones absorb more etc. ✓</p> <p>Allow advice given to patients ✓</p> <p>Patients must be still so that image is not blurred ✓</p> <p>Patient moves through the machine ✓</p> <p>X-ray beam is shaped like a fan ✓</p> <p>Rotation (of Source / X-ray tube/Machine)* ✓</p> <p>The combined effect is a spiral ✓</p> <p>On opposite side of the patient is ring of many fixed detectors ✓</p> <p>Measuring the intensity at each position ✓</p> <p>Computer processes the image ✓</p> <p>Produces images of the body, slice by slice/3D ✓</p> <p>*(Allow (early versions) source / X-ray tube and a detector /film cassette moved in straight lines in opposite directions on either side of the patient)</p>
		Total	[20]	

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

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OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

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