

Question Number	Answer	Acceptable answers	Mark
1(a)(i)	<input checked="" type="checkbox"/> B $2.5 \div 4$		(1)

Question Number	Answer	Acceptable answers	Mark
1(a)(ii)	either $P = 2.5 \times 0.2$ or $2.5 = P / 0.2$ (1) 0.5 (W) (1)	give full marks for correct answer, no working	(2)

Question Number	Answer	Acceptable answers	Mark
1(b)(i)	3.0 ± 0.5 (cm)		(1)

Question Number	Answer	Acceptable answers	Mark
1(b)(ii)	an explanation linking <ul style="list-style-type: none"> • 2 MHz (1) and any one from: <ul style="list-style-type: none"> • has a higher intensity inside tissue (1) • less energy absorbed (1) • less attenuation (1) • penetrates furthest /deepest (1) 	this frequency alone RA loses intensity more gradually highest penetration accept "2MHz and 4MHz" with correct reason for 1 mark	(2)

Question Number			mark
QWC	*)	<p>A comparison of endoscopes with any one of the following devices:</p> <p>Diagnostic devices</p> <ul style="list-style-type: none"> • CAT scanners • Fluoroscopes • Thermal imagers / IR thermometers • Pulse oximeters • PET scanners • X-ray machines • Gamma cameras <p>Link to electromagnetic radiation</p> <ul style="list-style-type: none"> • Endoscopes use TIR of light in optical fibres • CAT scanners X- rays and computer to generate 3D images • Fluoroscopes use X- rays and a video camera • Thermal imagers use infrared emitted by a body • IR / red LEDs used to measure oxygen levels • PET scanners detect radiation emitted by electron-positron annihilation • Gamma cameras detect gamma rays from radioactive sources <p>Other factors for comparison</p> <ul style="list-style-type: none"> • Safety • Ease of use • Frequency / wave length • Intensity • Penetration • Ionising / non-ionising 	(6)
Level	0	No rewardable content	
1	1 - 2	<ul style="list-style-type: none"> • a limited comparison between an endoscope and one device e.g. endoscopes use light and CAT scanners detect broken bones • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy 	
2	3 - 4	<ul style="list-style-type: none"> • a simple comparison between an endoscope and one device, linking them to the electromagnetic radiation used for both and a detail of use for one of them e.g. endoscopes use visible light to examine internal organs and CAT scans use X-rays • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy 	
3	5 - 6	<ul style="list-style-type: none"> • a detailed comparison between an endoscope and one device, linking them to the electromagnetic radiation used for both and a detail of use for both of them e.g. endoscopes use visible light which is passed down optical fibres by TIR to examine internal organs. Fluoroscopes use X-rays and a video camera to show positioning of stents in arteries. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors 	

Question Number	Answer	Acceptable answers	Mark
2(a)	A all the time		(1)

Question Number	Answer	Mark												
2(b)	<table border="1"> <thead> <tr> <th>radiation</th> <th>type</th> <th>transfer</th> </tr> </thead> <tbody> <tr> <td>alpha</td> <td>particle</td> <td>energy</td> </tr> <tr> <td>beta</td> <td>particle (1)</td> <td>energy</td> </tr> <tr> <td>gamma</td> <td>wave (1)</td> <td>energy (1)</td> </tr> </tbody> </table> <p>2 words in 1 box scores 0 for that box</p>	radiation	type	transfer	alpha	particle	energy	beta	particle (1)	energy	gamma	wave (1)	energy (1)	(3)
radiation	type	transfer												
alpha	particle	energy												
beta	particle (1)	energy												
gamma	wave (1)	energy (1)												

Question Number	Answer	Acceptable answers	Mark
2(c)	<p>Any two from the following points</p> <ul style="list-style-type: none"> sterilising food (1) sterilising medical equipment(1) detection of cancer(1) treatment of cancer(1) 	<p>cleaning water</p> <p>PET scan gamma camera</p> <p>Radiotherapy</p> <p>Industrial uses eg Measuring thickness Tracers (Gamma) telescopes</p>	(2)

Question Number	Answer	Acceptable answers	Mark
2(d)	<p>A description including the following points</p> <ul style="list-style-type: none"> travel at the same speed (1) in a vacuum/space (1) 		(2)

Question Number	Answer	Acceptable answers	Mark
3(a)(i)	A infrared and microwaves		(1)

Question Number	Answer	Acceptable answers	Mark
3(a)(ii)	C lower frequency than ultraviolet		(1)

Question Number	Answer	Acceptable answers	Mark
3(b)(i)	<p>A description including two of the following points</p> <p>Either</p> <ul style="list-style-type: none"> UV penetrates the skin / can damage normal cells/ cause cell mutation/ionise cells (1) can cause (skin) cancer / can cause premature ageing (1) <p>OR</p> <ul style="list-style-type: none"> UV penetrates the eye / can damage/mutate cells in the eye (1) can cause cataracts / damage to the retina (macular degeneration) (1) 	<p>Ignore "harm" or "harmful" Accept "tissue" for cells</p> <p>sunburn</p> <p>can cause (snow) blindness</p>	(2)

Question Number	Answer	Acceptable answers	Mark
3(b)(ii)	<p>An explanation linking two of the following points</p> <ul style="list-style-type: none"> (ultraviolet/it) has a higher frequency (than infrared) (1) (therefore ultraviolet/it) has higher (photon) energy (1) (ultraviolet/it) penetrates further /(ultraviolet/it) causes ionisation (1) 	<p>Accept reverse argument if clearly about IR</p> <p>has a shorter wavelength</p>	(2)

Question Number	Indicative content	Mark
QWC	<p data-bbox="261 179 345 210">*3(c)</p> <p data-bbox="367 179 1133 210">A comparison including some of the following points</p> <p data-bbox="367 251 553 282">Similarities</p> <ul data-bbox="423 288 911 390" style="list-style-type: none"> <li data-bbox="423 288 911 318">• used white light from the Sun <li data-bbox="423 322 639 353">• glass prism <li data-bbox="423 357 883 390">• produced a visible spectrum <p data-bbox="367 431 911 461">(Herschel's) infrared experiment</p> <ul data-bbox="415 468 1365 676" style="list-style-type: none"> <li data-bbox="415 468 1365 533">• used a thermometer to measure the temperature of different colours of the visible spectrum <li data-bbox="415 537 1101 568">• temperature increased towards the red end <li data-bbox="415 572 1230 637">• temperature increased more past the red end of the spectrum. <li data-bbox="415 641 1317 676">• temperature rise was due to invisible rays named infrared <p data-bbox="367 717 899 748">(Ritter's) ultraviolet experiment</p> <ul data-bbox="415 754 1365 1034" style="list-style-type: none"> <li data-bbox="415 754 1365 819">• used silver chloride on paper this slowly turns black in visible light. <li data-bbox="415 823 1317 889">• silver chloride turned black faster as the paper was put at the violet end of the spectrum <li data-bbox="415 893 1349 958">• beyond the violet the silver chloride turned black even more rapidly <li data-bbox="415 962 1247 1034">• due to the presence of invisible rays (originally called chemical rays) now called ultraviolet 	(6)

Level	0	no rewardable material
1	1 -2	<ul style="list-style-type: none"> a limited description of either experiment including two or more basic points (written or shown on a labelled diagram) e.g. prism is made of glass; the colours of the spectrum are ROYGBIV OR (Herschel's) experiment discovered IR; he measured the temperature of the spectrum OR (Ritter) put sensitive (silver chloride) paper at different places in the spectrum; (Ritter's) experiment discovered UV the answer communicates ideas using simple language and uses limited scientific terminology spelling, punctuation and grammar are used with limited accuracy
2	3 -4	<ul style="list-style-type: none"> a simple description of either experiment including a statement linking two ideas and a point of similarity or difference with the other experiment e.g. (Herschel) moved a thermometer beyond the red end of the spectrum and the temperature increased and both (Herschel's and Ritter's) experiments use a prism to produce the spectrum (NB this last point could be shown in a labelled diagram) OR The sensitive paper that (Ritter) used turns black in visible light and it turns black quicker when moved beyond the violet end of the spectrum and (Ritter's) experiment shows ultraviolet rays but (Herschel's) experiment shows infrared rays (NB this last point could also be shown in a labelled diagram) the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately spelling, punctuation and grammar are used with some accuracy
3	5 -6	<ul style="list-style-type: none"> A detailed description including statements about each experiment that link ideas to show a point of similarity AND a point of difference e.g. (Herschel) measured the temperature of the colours and discovered a higher temperature beyond the red end and (Ritter) used sensitive (silver chloride) paper that turned black very quickly when moved beyond the violet end of the spectrum and both experiments use a prism to separate the colours of the spectrum and (Herschel's) experiment uses a thermometer instead of sensitive paper (already stated) the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately spelling, punctuation and grammar are used with few errors

Question Number	Answer	Acceptable answers	Mark														
4(a)(i)	<ul style="list-style-type: none"> infrared (1) radio waves (1) 2 marks if both correct i.e. <table border="1" data-bbox="303 545 1211 660"> <tr> <td>gamma rays</td> <td>X-rays</td> <td>ultraviolet</td> <td>visible light</td> <td>infrared /IR</td> <td>microwaves</td> <td>radio (waves)</td> </tr> </table> <ul style="list-style-type: none"> 1 mark for one correct 1 mark if answers interchanged i.e. <table border="1" data-bbox="303 915 1226 1030"> <tr> <td>gamma rays</td> <td>X-rays</td> <td>ultraviolet</td> <td>visible light</td> <td>radio (waves)</td> <td>microwaves</td> <td>infrared /IR</td> </tr> </table>	gamma rays	X-rays	ultraviolet	visible light	infrared /IR	microwaves	radio (waves)	gamma rays	X-rays	ultraviolet	visible light	radio (waves)	microwaves	infrared /IR		(2)
gamma rays	X-rays	ultraviolet	visible light	infrared /IR	microwaves	radio (waves)											
gamma rays	X-rays	ultraviolet	visible light	radio (waves)	microwaves	infrared /IR											

Question Number	Answer	Acceptable answers	Mark
4(a)(ii)	gamma (rays)	or symbol for gamma e.g. γ	(1)

Question Number	Answer	Acceptable answers	Mark
4(b)(i)	<p>A description linking one of the following pairs</p> <ul style="list-style-type: none"> • on items (1) • assist in identification (if stolen) (1) • on document/currency (1) • help to identify forgery (1) • write (on paper) (1) • secret message (1) • stamp / on (back of) hand (1) • as pass out for an event (1) 	<ul style="list-style-type: none"> • named item • to identify (owner) • banknotes eq (1) • (to identify) genuine notes/forges (1) • write (message /note)(1) • (that) other people cannot see(1) • (print on) t-shirt (1) • shows up in club (1) <p>Allow to detect UV (radiation) for 1mark Ignore uv light uses not on ink, e.g. forensic use on blood/ use in the dark (as it glows)/ etc.</p>	(2)

Question Number	Answer	Acceptable answers	Mark
4(b)(ii)	causes damage to (unprotected) eyes/skin/DNA/ cells (1)	blindness /(skin) cancer/(sun)burn (to skin)/mutations	(1)

Question Number	Answer		Mark
4(c)	<p>A description linking one of the following pairs</p> <ul style="list-style-type: none"> • (at the) airport /customs / docks / security checks (1) • for dangerous/illegal items (1) • checking welds (1) • to examine under the surface (1) • checking paintings eq (1) • to look for detail under the top paint layer (1) • X-ray telescopes/astronomy • to study/look at objects in space • check packaging e.g. cans/packets • (to see if) filled to correct level • sterilising (1) • food/hospital equipment (1) 	<p>statement of recognised application</p> <p>detail of how it works/ how it is used</p> <ul style="list-style-type: none"> • to scan {luggage / people/ vehicles} (1) • (check) for things that are not meant to be there e.g. liquids, knives, guns, explosives, drugs etc (1) <p>checking pipes/engines/aircraft/structures etc</p> <p>for cracks</p> <p>IGNORE idea of X-ray vision</p> <p>e.g. stars/ galaxies/ space/black holes/neutron stars/planets</p> <p>for 'foreign' objects</p> <p>killing bacteria</p> <p>NOT to scan (the body) for broken bones</p>	(2)