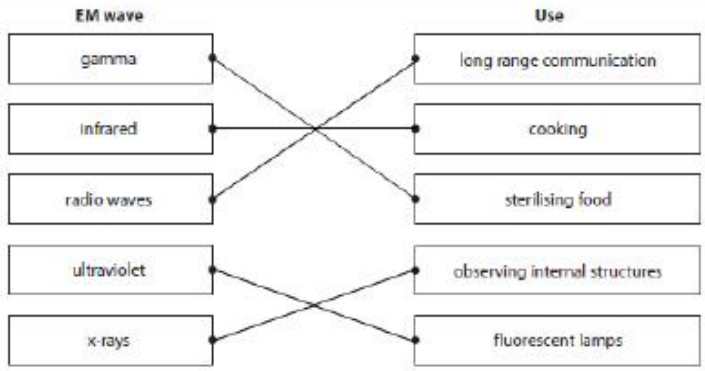
Mark Scheme

2017 Onwards

Q1.

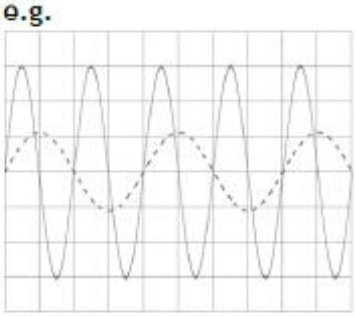
Question number	Answer	Notes	Marks
(a)	 all four correct;;;	gamma use is given so only judge other four EM waves for marks three or two correct scores 2 marks one correct scores 1 mark	3
(b)	C (internal heating of tissue); A is incorrect because this is a hazard of visible and ultraviolet radiation B is incorrect because this is a hazard of x-ray and gamma radiation D is incorrect because this is a hazard if infrared radiation		1
(c)	radio (waves);		1
	Total for Question = 5 marks		

Q2.

Question number	Answer	Notes	Marks
(a)	violet;	reject purple, ultraviolet, UV	1
(b)	idea that UV causes mutations/damage (in cells); (leading to) (skin) cancer/blindness;	allow kills cells/tissue, sunburn, burns skin	2
(c) (i)	speed = frequency × wavelength;	allow standard symbols and rearrangements e.g. $f = v/\lambda$ allow c, v for speed	1
(ii)	substitution OR rearrangement; evaluation; e.g. $300000000 = f \times 15$ OR $f = v/\lambda$ (f =) 20000000 (Hz)	-1 for POT error accept 20 MHz, 20 million (Hz), 20×10^6 (Hz), $2(.0) \times 10^7$ (Hz)	2

Q3.

Question number	Answer	Notes	Marks
(a)	any two from: MP1. light waves are transverse and sound waves are longitudinal; MP2. light travels faster than sound; MP3. light can travel through vacuum but sound waves can't;	ignore references to frequency and wavelength condone 'different speeds'	2
(b) (i)	B (microwaves); A is incorrect because gamma rays have a shorter wavelength than infrared C is incorrect because ultraviolet rays have a shorter wavelength than infrared D is incorrect because visible light waves have a shorter wavelength than infrared		1
(ii)	B (heating lamps); A is incorrect because ultraviolet rays are used in fluorescent lamps C is incorrect because there is too much interference from the Earth for infrared to be used for satellite transmissions D is incorrect because gamma rays are used to sterilise medical equipment		1
(iii)	D (skin burns); A is incorrect because infrared is not absorbed by the retina B is incorrect because infrared is non-ionising C is incorrect because infrared cannot penetrate into the body to cause internal heating		1

(c)	trace drawn with higher amplitude throughout; trace drawn with higher frequency throughout; e.g. 	allow variable amplitude allow variable amplitude	2

Q4.

(b)	(i)	C - ultraviolet; A is not correct as microwaves cause internal heating B is not correct as radio waves do not give skin burns D is not correct as visible light cannot harm skin cells.		1
	(ii)	A - sunbathing; B, C and D are not correct as all reduce the absorption of UV by skin.		1
			Total for Question : 7 marks	

Pre 2017

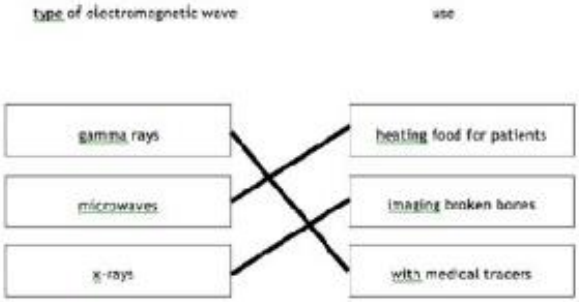
Q1.

Question number	Answer	Notes	Marks
a	**C** – radio; this has the longest wavelength A—this has the shortest wavelength B—this has a shorter wavelength than radio D—this has a shorter wavelength than radio		1
b	any two from: MP1. (same) speed; MP2. (all) transverse (waves); MP3. (can all) travel through vacuum; MP4. (all) transfer energy;	allow 3×10^{8} m/s	2

	Answer	Notes	Marks
c	for **three** named parts of the spectrum 1 use and 1 harmful effect max. **gamma use;** • radiotherapy • sterilising medical equipment / food • (radioactive) tracers **gamma harmful effect;** • causes cancer / cell mutation **x-ray use;** • observing internal structure of the body/eq **x-ray harmful effect;** • causes cancer / cell mutation	 allow treating cancer damage is not sufficient kills cells damage is not sufficient	6

	ultraviolet use; • fluorescent lamps • treating skin disorders • killing bacteria **ultraviolet harmful effect;** • damage to skin (cells) • blindness **visible use;** • optical fibres • photography **visible harmful effect;** • eye damage (at high intensity) **infrared use;** • short range communication e.g. remote controls • heaters • night vision equipment **infrared harmful effect;** • burns skin/tissue **microwave use;** • cooking • satellite communications **microwave harmful effect;** • internal heating of body tissue **radio use;** • communications;	allow tanning, security allow sunburn, skin cancer allow cataracts ignore sunburn ignore 'damage' allow internal burns	
		Total for question = 9 marks	

Q2.

Question number	Answer	Notes	Marks
(a) (i)	C – speed in free space;		1
(ii)	All lines correct = 2 marks Any correct line = 1 mark  		2
(iii)	(direction of vibration) perpendicular to (direction in which the wave travels);	allow at right angles to or 90° to	1

Q3.

(c)		any two of MP1 can travel through vacuum OR needs no medium; MP2 speed (in a vacuum) OR speed = 3 X10^8 (m/s); MP3 obeys laws of reflection / refraction; MP4 obeys wave equation OR speed = frequency × wavelength; MP5 carries energy/ information; MP6 they are transverse	"speed in a vacuum" where seen, scores 2 marks (MP1 and MP2) Accept reflect, refract, diffract	2
(d)	i	D - X-rays		1
	ii	A – absorbed by the bone		1
	iii	X-rays OR gamma rays idea of causing damage to cancer cells e.g. cells killed/mutated/ionised/destroys;	allow symbol γ do not allow UV Independent mark	2

Q4.

c (i)	any one of: fluorescence; production of vitamin D; calcifying fillings/eq; killing bacteria; treating skin conditions/(skin) cancer;	ignore **unqualified** ultraviolet lamps, security markers etc. allow tanning bed, fluorescent tubes, **detecting** security markings/false bank notes allow setting fillings	1
(ii)	any **one** similarity from: MP1. both EM waves / part of EM spectrum; MP2. both travel at the same speed / speed of light (in free space); MP3. both transverse waves; MP4. both can travel through a vacuum; any **one** difference from: MP5. visible light has **lower** frequency / ORA; MP6. visible light has **higher** wavelength / ORA;	 allow $3x10^8$ m/s ignore references to energy and penetrating power, ultraviolet can't be seen by humans	2

Q5.

Question number	Answer	Notes	Marks
	any six from: MP1. excessive exposure is caused by high intensity or high amplitude or long period of exposure; MP2. radio waves (probably) don't cause harm to human bodies; MP3. microwaves can cause (internal) heating of body (cells); MP4. IR can cause surface burns to skin; MP5. visible can cause vision impairment;	ignore references to devices references to advantages unqualified 'damage' as it is in the stem of the question allow tissue for cells throughout not 'sunburn' allow blindness, damage to fovea/retina	6

	MP6. UV can cause skin cancer; MP7. x-rays can {mutate/kill} cells inside the body; MP8. gamma can {mutate/kill} cells inside the body;	allow sunburn ionise cells / DNA damages eyes/cornea, blindness causes cataracts cause skin aging allow ionise cells / DNA causes radiation poisoning causes cancer allow ionise cells / DNA causes radiation poisoning causes cancer if no specific parts of the EM spectrum are referred to, a max. of 1 mark can be awarded for any/all of the acceptable forms of damage	
		Total for Question = 6 marks	

Q6.

Question number	Answer	Notes	Marks
(a)	any two from MP1. (same) speed(in a vacuum); MP2. transverse waves; MP3. travel through vacuum/do not require a medium; MP4. em wave/spectrum; MP5. carry information ; MP6. transfer energy;	ignore refraction reflection diffraction interference heat produced by Sun effects on body do not accept unqualified energy	(2)
(b)	infrared: skin burns; ultraviolet: damage to surface cells; OR blindness;	ignore for IR skin cancer/ cell mutation /sunburn accept causes (skin) cancer for UV sunburn for UV damage to eye for UV	(2)
(c)	red;		(1)

Q7.

Question number	Answer	Notes	Marks
(a) (i)	Any one of- MP1 Speed / velocity (in a vacuum); MP2 Transverse (wave); MP3 Electromagnetic (wave); MP4 A general wave property;	 e.g. reflection, refraction, diffraction, transfer energy	1
(ii)	Any two of- Frequency; Wavelength; Energy;	Any wavelength or frequency relationship if stated must be correct	2

Q8.

Question number	Answer	Notes	Marks
(a)	(Current / Electron/particle movement) in a single direction;		1
(b) (i)	ANY SUITABLE, e.g. Travel quickly / at the speed of light; Can code information; Can travel long distances / through buildings / walls / objects; Not harmful/dangerous; can diffract / reflect;		1
(ii)	(microwaves) use - communication / cooking ; harmful effect - heating ; (ultraviolet) use - fluorescent lamps / kill bacteria / harden fillings ; harmful effect - <u>skin</u> cancer / eye damage / sunburn;	ALLOW correct alternatives	4

Q9.

Question number	Answer	Notes	Marks
(a)	B - light;		1

Q10.

Question number	Answer	Notes	Marks
(a)	two correct comparative statements about temperature:- MP1 Bear('s fur) and snow about the same temperature; MP2 Bear's head/nose/eyes warmer (than fur); MP3 Bear's eyes are warmer than eyes/nose OR bear's eyes are the warmest; MP4 Sky/air is cooler than bear/snow OR sky/air is the coldest;	allow reverse arguments bear's nose is cooler than its eyes bear/snow warmer than air	2
(c) (i)	Any two of- MP1. Snow reflects UV OR does not absorb UV; MP2. Sky absorbs UV OR does not reflect UV; MP3. Bear('s fur) absorbs UV OR does not reflect UV; MP4. Bear's eyes reflect UV OR do not absorb UV;	ignore other verbs such as emits radiates	2
(ii)	Any one of- Sky absorbs UV; Sky not emitting UV; Sun not included in image;	allow air or atmosphere for sky ignore 'blocks out' Accept sky doesn't reflect or only reflects UV diffusely	1
(iii)	Any two of - MP1. UV/light travels in air, not in glass or hair (material); MP2. UV is absorbed by hair; MP3. TIR does not happen; MP4. explanation of why TIR can't happen ;	light/UV always travels in the less dense medium ORA for optical fibre Allow reflection in hair is external, not internal there is no critical angle	2

Q11.

Question number	Answer	Notes	Marks
(a) (i)	C (ultra violet);		1
(ii)	A (longitudinal);		1
(iii)	C (internal structure of objects);		1
(b) (i)	any sensible use further detail e.g. sterilising medical equipment; gamma kills bacteria; OR treating cancer/mutates cancer **cells**; radiotherapy/**focused** gamma rays; OR detecting cancer; PET scanner/(radioactive) tracers/gamma camera;	ignore CT scan, CAT scan, MRI scan allow kills cancer/cells allow scintillation counter	2
(ii)	any 2 of: MP1. any one sensible comment about risk for either; e.g. increased risk of cancer/mutation of cells damage to neighbouring/good/healthy cells MP2. a further detail of the risk; e.g. radiation is ionising gamma has high/highest energy MP3. statement about the relative risk/exposure of doctor or patient; e.g. patient is only exposed for a short period of time doctor has continual (low level) exposure		2
(iii)	any one sensible method; e.g. (use for a) limited time idea of working at a distance/in another room	ignore protective clothing, lead shielding, lead apron etc.	1

Q12.

(b)

circle the mistake in this sentence	the correct word(s) is
They all travel at 3×10^2 m/s in a vacuum.	10^8 GIVEN
Sound waves are electromagnetic.	any of radio, micro(wave), infrared (IR), visible, ultraviolet (UV), X-ray or gamma
Infra-red waves are the most harmful to people.	gamma
Gamma waves are used for heating up food.	micro(waves)/ Infrared (IR)
Radio waves have the highest frequency.	Gamma (γ)
Gamma waves have a very long wavelength.	radio (waves)

each line for 1 mark;;;;;

5

Q13.

Question number	Answer	Notes	Marks
(a)	<table><tr><th>longest wavelength</th><th>⟶</th><th>shortest wavelength</th></tr><tr><td>infrared</td><td>visible (light)</td><td>ultraviolet</td></tr></table>	All three must be correct for the mark Allow IR for infrared Allow visible (without light) Allow UV for ultraviolet	1
(b)	Any two of: Radio (waves); Microwave(s); x-rays; Gamma (rays);	Allow T-rays γ - rays or γ	2
(c) (i)	Any two of 1. killing bacteria e.g. in water purification OR in hand driers in toilets OR sterilisation of equipment; 2. medical uses e.g. setting dental fillings OR detection of bacteria OR treatment of (named) skin diseases; 3. security markings e.g. for checking banknotes; 4. fluorescent lamp e.g. tanning machines, black-light, detecting blood /other body fluids; 5. data reading e.g. blu-ray devices	Must be specific, ignore vague answers such as 'used in a hospital', 'for CSI' Allow other sensible suggestions for each MP	2
(ii)	Any two of 1. cell damage e.g. (skin) cancer, cell mutation; 2. Sunburn/skin aging; 3. eye damage e.g. cataracts, blindness;	Must be specific, do not allow vague answers such as 'causes burns' 'danger to skin' 'burns skin'	2
		Total	**7**

Q14.

Question number	Answer	Notes	Marks
(a) (i)	C (the same speed in free space)		1

Q15.

Question number	Answer	Notes	Marks
(a) (i)	any two from:- MP1. travels at speed of 3×10^8 m/s; MP2. travels in a vacuum; MP3. transverse wave; MP4. transfer energy / information; MP5. can be reflected/refracted/diffracted;	travel at the same speed /speed of light	2
(ii)	B gamma rays;		1

Q16.

(b)	ANY THREE – microwaves are electromagnetic waves; penetrate (a few cm) into the food; cause water molecules to vibrate more / heat water; conduction through the rest of the potato	no marks for whether or not the statement is true needs ref to water, not just particles / molecules needs conduction ref, not just spreads out	Max 3

Q17.

(d)	(i)	electromagnetic (spectrum)	Accept transverse (waves)	1
	(ii)	Any **two** from X-rays have shorter wavelength; ORA X-rays have higher frequency; ORA X-rays have higher energy; ORA X-rays have greater penetration range; ORA X-rays have greater effects on living tissue; ORA	Idea of comparison must be there REJECT 'visible light can be seen' / eq	2

Q18.

Question number	Answer	Notes	Marks
(a)	A – visible (light) B – X-rays	REJECT: rainbow REJECT: 'light' alone ACCEPT: X / X - radiation	1 1
(b)	C		1
(c)	B		1
(d)	B		1
(e)	For first chosen region of the spectrum corresponding hazard; corresponding risk reduction; For second chosen region of the spectrum corresponding hazard; corresponding risk reduction; **NB No mark for naming the type of radiation**	e.g. microwaves - heating of tissue / perceived risk of cancer close oven door / hands-free cell phone / monitor exposure e.g. infra red – risk of skin burning / cell damage avoid hot places / reflective clothing / avoid exposure (to sun) e.g. visible light eye damage sun glasses / avoid exposure (to sun) e.g. ultraviolet – risk of {skin / eye} damage / blindness IGNORE: sunburn skin cream / sunglasses / avoid exposure (to sun) e.g. x-rays – risk of cancer / cell damage (lead) shielding / monitor exposure e.g. film badge / avoid exposure e.g. gamma - risk of cancer / cell damage (lead) shielding / monitor exposure e.g. film badge / avoid exposure	4

Total 9 Marks

Q19.

Question number	Answer	Notes	Marks
(a)	A - microwave(s) B - X–rays	REJECT 'micro' REJECT 'X' ACCEPT capital or lower case X, with or without hyphen	2
(b) (i)	C		1
(ii)	D		1

Total 4 Marks

Q20.

Question number	Answer	Notes	Marks
a i	Any two from – Radio; Microwaves; Infrared; Visible;		2
ii	Microwaves; Infrared;		2
b	D Increasing wavelength		1
c i	(wave) speed = frequency x wavelength	Accept equivalent Accept recognised symbols	1
ii	Substitution into correct equation; Evaluation; Unit; Eg. (wave) speed = 200 000 x 1500 300 000 000 m/s	mark unit and calc independently Power Of Ten error = -1 e.g. not converting kHz to Hz Accept • bald answer • answer in SF • alternative speed units with corresponding evaluation e.g. 300 000 km/s 1.08×10^{12} km/hour	3

Q21.

Question number		Answer	Notes	Marks
a		ultraviolet;	UV	1
b		gamma;	accept γ	1
c		frequency decreases; because c= f.λ OR speed is constant;	accept eqn in words all travel at same speed	2
d		infrared;	IR	1
e	i	any three from:- MP1. time taken (is noted); MP2. for the beam /microwaves to get to plane and return; MP3. distance calculated from speed = distance/time; MP4. distance is halved;	 for signal to get to plane and back accept 'bounce back' any form of the eqn allow time halved	3
	ii	any suitable and sensible suggestion; e.g. • planes move very fast • planes travel a long distance in a short time • planes can arrive from any direction • updates distance/position of plane frequently		1

Total for question = 9 marks

Q22.

Question number			Answer	Notes	Marks
	(a)	(i)	B radio waves		1
		(ii)	C Microwaves and radio waves travel at the same speed in a vacuum.		1
		(iii)	any one sensible property; e.g. travels (very) fast travel at speed of light can be coded can travel in vacuum	Allow can penetrate the ionosphere, can carry more information (than radio) higher frequency /shorter wavelength	1

Q23.

Question number	Answer	Notes	Marks
(a)	cooking – micro(waves) OR infrared (waves); treating cancer – ultraviolet OR x-rays OR gamma (rays); identifying broken bones - x-rays;	if more than one example given for each use then reject mark if any incorrect	3
(b)	C - the same speed;		1