Question number	Answer	Notes	Marks
1 (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
(b) (i)	Any two of - MP1. (hollow) hair / fibres contains an insulator; MP2. air is an insulator/poor conductor (of thermal energy); MP3. air is kept / trapped near the body (by fur); MP4. convection currents cannot form between hairs; MP5. white fur is a poor emitter of thermal energy / I R;	hair is an insulator only small convection currents can form	2
(ii)	Any three of - MP1. Black (skin) is a good emitter/radiator of thermal energy; MP2. White (fur) is a good reflector of thermal energy; MP3. Black (skin) is a good absorber of thermal energy; MP4. the reflected thermal energy is absorbed by the black (skin);	Allow white fur is a poor emitter.	3
(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

Total 12 marks

Question number	Answer	Notes	Marks
2 (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. 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

Total 8 marks

Question number	Answer	Notes	Marks
3 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

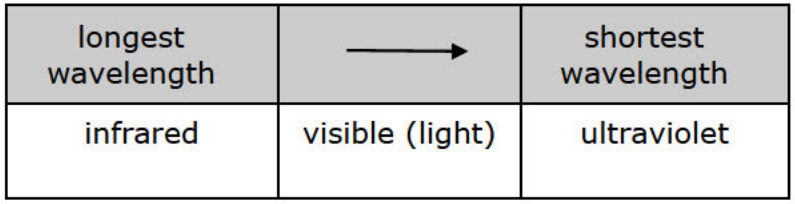
(Total for Question 3 = 9 marks)

Question number	Answer	Notes	Marks
4 a i	96 000 000; matching unit e.g. Hz;	allow 96 x10^6 Allow for 2 marks 96 MHz 96 000 kHz	1 1
ii	Idea that plaque vibrates also;	Allow shakes plaque free breaks plaque up Ignore ideas of physical contact, e.g.: hits plaque knocks plaque off	1
iii	One of to clean out the **debris** / eq; to cool the tip / eq ; to reduce damage to the tooth/eq;	allow wash away ignore unqualified 'to clean'	1

b	i	B reflected ;		1
	ii	wave speed = frequency x wavelength;	Allow rearrangements and standard abbreviations and symbols e.g. frequency = speed /wavelength $v = f \times \lambda$ etc	1
	iii	rearranged equation ; substitution; evaluation; e.g. $f = v/\lambda$ $(f =) \frac{1540}{0.00044}$ 3.5 (MHz)	rearrange and sub in either order allow a power of ten (POT) error for 2 marks allow matching unit e.g. 3500 kHz	3

(c)	Any TWO from MP1 US is longitudinal wave OR MP1 UV is transverse wave; MP2 US needs a medium; MP3 UV an electromagnetic wave; MP4 UV has (much) higher frequency than US/ RA; MP5 US has a lower speed than UV; MP6 UV has same speed as light;	Care- avoid giving two marks for MP1 allow equivalent statement about λ speed of ~300 m/s (in air) speed of $3x10^8$ m/s Ignore statements about harmful effects	2

(Total for Question 4 = 11 marks)

Question number	Answer	Notes	Marks
5 (a)		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

Question number	Answer	Notes	Marks
5 (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**

Question number	Answer	Notes	Marks
6 (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

Question number	Answer	Notes	Marks
7(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)

Total for Question 7 = 5 marks