Question Number	Answer	Acceptable answers	Mark
1(a)	**B** cm		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(b)	**D** yellow		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(c)	A description including any two of human eye can only {react to /see} visible (light) (1) bee eye can {react to/see} {ultraviolet/infrared/different frequencies/different wavelengths} (1) {Maxima/peaks} more evenly spaced for bee (1)	 bee can 'see' outside (human) visible range smaller frequency range than bee **ignore** 'see more colours' human peaks are concentrated in lower frequencies	**(2)**

Question Number	Answer	Acceptable answers	Mark
1(d)	**C** sound		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(e)	conversion of time 4x60 (1) substitution (1) 1608 / (4x60) **ecf if conversion shown** evaluation (1) 6.7 (m/s)	award full marks for correct answer with no working [1608 / 4 for 1 mark for these two] **allow** 402 for 2 marks **accept** for 2 marks: 5.36 (t=300 s 60→120→180→240→300, i.e. 4 steps of 60) 4.02 (t=400 s based on the misconception of 100 s to 1 minute) **allow** maximum of 1 mark for any other power of 10 error if no working	**(3)**

Question Number	Answer	Acceptable answers	Mark
1(f)	A suggestion which includes any two of: 1. harmful effect e.g. damage to {skin (cells) / cancer / mutation / eyes} (1) 2. bee can 'see' objects reflecting UV radiation (1) 3. allows bees to find (more) food (1) 4. discussion of different (intensities /) {brightnesses / amounts} (1) 5. discussion of time of exposure compared to life span (1)	 sunburn {emitting/giving out} for reflecting **OWTTE** accept 'see pollen' for MP2 OR 3 **ignore** honey **ignore** making food relevant mention of more exposure/ absorption by humans discussion such as humans have long term exposure which can be cumulative	**(2)**

Total for Question 4 = 10 marks

Question Number	Answer	Acceptable answers	Mark
2(a)(i)	X-ray	X	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(ii)	(visible) light	visible (waves)	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(iii)	radio (waves)		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(iv)	gamma / X-rays / ultraviolet	X / UV	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(b)	an explanation linking: • travel with same speed (1) • in a vacuum / in space (1)	They travel at the speed of light / same numerical speed for all	**(2)**

Question Number		Indicative Content	Mark
QWC	**2 (c)**	A description including some of the following points • Harmful effects include (skin) burns, eye damage, (skin) cancer, cell damage, mutation • IR and UV are on either side of visible light (in the em spectrum) • UV has shorter wavelength than IR • UV has higher frequency than IR • higher energy (associated) with UV • IR causes (skin) burns • UV causes damage to eyes / (skin) cancer / damage to cells (not just damage to skin) / sunburn • (potential) danger increases with frequency Ignore • irrelevant information e.g. UV used to scan unborn babies	**(6)**
Level		No rewardable content	
1	**1 - 2**	• a limited description stating one fact about a harmful effect or frequency e.g. skin burns **OR** UV has high frequency (no comparison) • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple description making a correct <u>comparison</u> of harmful effects **OR** a frequency comparison e.g. IR causes skin burns and UV causes (skin) cancer **OR** the higher the frequency the more harm they cause **OR** UV has a high<u>er</u> frequency (than IR) • 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**	• a detailed description including harmful effects of both UV and IR **AND** relating at least one to <u>frequency</u> e.g. UV causes skin cancer but IR (only) causes skin burns as UV has a high(er) frequency • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

(Total for Question 5 = 12 marks)

Question Number	Answer	Acceptable answers	Mark
3(a)(i)	C travel with the same speeds in a vacuum, have different frequencies		**(1)**

Question Number	Answer	Acceptable answers	Mark
3 (a)(ii)	{damage to/ionise/mutate} {cells / DNA/tissue/ organs/ fetus} / cause {cancer/tumour}	kills cells/bacteria	**(1)**

Question Number	Answer	Acceptable answers	Mark
3 (b)(i)	Gamma, γ, ϑ, ϒ	UV, ultraviolet (rays/waves/radiation) Ignore X-rays	**(1)**

Question Number	Answer	Acceptable answers	Mark
3 (b)(ii)	one correct use (for UV/X-ray/gamma ray)	for example, (UV) – sunbeds, sterilise, detect banknotes (X-ray) - viewing internal organs / broken bones/airport security (gamma ray) – treat /cure cancer, kill {cells/bacteria} If one incorrect example is given, this mark is lost	**(1)**

Question Number	Answer	Acceptable answers	Mark
3 (c)(i)	one from: MP1 heating of (body/human/internal) {cells / organs/tissues} (1) MP2 {heating/boiling/exciting / vibrating} water (in the body) (1)	Accept heating of blood Ignore damages, burns, cancer, mutates, heating (on its own), skin	**(1)**

Question Number	Answer	Acceptable answers	Mark
3 (c)(ii)	explanation to include any **three** of: MP1 (Phones/ they) use lower frequencies / RA (1) MP2 lower frequency: lower energy / RA (1) MP3 lower {frequency/energy} less (potential) danger / RA (1) MP4 (phones /they) emit less (intense) radiation RA (1) MP5 phones are less powerful (1)	wavelength can suitably replace frequency eg use longer wavelength condone use lower MHz (comparison needed not just values quoted) Accept lower frequency (not energy) does {less /no} {damage/harm} for 2 marks ignore references to penetration ignore references to energy replacing power here For 2 marks -The resonant frequency of water molecules is the same as the oven frequency	**(3)**

(Total for Question 1 = 8 marks)

Question Number	Answer	Acceptable answers	Mark
4(a)(i)	**D** 27 (1)		**(1)**

Question Number	Answer	Acceptable answers	Mark
4(a)(ii)	an explanation linking: • no change in mass (number) (1) • (because) gamma is a wave (electromagnetic) / has no mass (itself) (1) OR • mass decreases (1) • idea of mass – energy equivalence (1) (must be clearly stated)	gamma is only energy / not a particle nucleus de-excites / rearranged for one mark do not allow 'mass number decreases'	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b) (i)	**A** gamma can penetrate further than alpha or beta (1)		**(1)**

Question Number	Answer	Acceptable answers	Mark
4(b) (ii)	description to include: • protects / stops radiation escaping (1) • affecting operator/doctor/nurse (1)	absorbs (radiation) other people / others	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b) (iii)	two from: • non invasive / no surgery required (1) • no radioactive substances left in the body (1) • no anaesthetic used • patient does not become radioactive (1) • outpatient procedure (1) • does not affect the whole body (1) • (accurate) targeting of tumour (1) • painless (at the time) for the patient • procedure (may be) quicker	no need to operate / cut open patient / reduces risk of infection no harmful side effects like chemotherapy ignore answers\that apply equally to other treatments e.g. 'kills cancer'	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b) (iv)	explanation linking two from: • idea of targeting / beams concentrate / focus on tumour (1) • avoid damage to healthy cells / tissue (1) • (reaching / getting to) all parts of the tumour (1)	more rays hit tumour / beams overlap at tumour ignore '(more) beams penetrate more' / (more) accurate	**(2)**

(Total for Question 4 = 10 marks)

Question Number	Answer	Acceptable answers	Mark
5(a)(i)	☒ **B** seven		**(1)**

Question Number	Answer	Acceptable answers	Mark
5(a)(ii)	☒ **C** red, orange, yellow		**(1)**

Question Number	Answer	Acceptable answers	Mark
5(b)	ultraviolet → detecting forged bank notes gamma rays → cooking microwaves → detecting cancer three correct (2) one or two correct (1)		**(2)**

Question Number	Answer	Acceptable answers	Mark
5(c)(i)	a suggestion from any **two** of the following: (areas of the hand) show • Patches / (shaded) areas / brightness / colour(s) (1) • Indication of temperature / heat (1)	blood flow / veins / arteries / named part of hand thermal / hot / cold / warm / cool / hotter / colder / warmer / cooler any colour identified as hot or cold / any part of the hand identified as hot or cold (2) **Ignore** germs / bacteria / nerves	**(2)**

Question Number	Answer	Acceptable answers	Mark
5(c)(ii)	an explanation linking **two** of the following: X-rays {mutate / damage / harm / ionise} cells or DNA (1) the {energy / frequency / wavelength / penetration} is different (1) Correctly identified difference (1)	 {kills/destroys} cells / causes cancer / tumours / ionising Penetrates the skin / body x-rays have {more energy / high(er) frequency / {short(er) / low(er)} wavelength / great(er) penetration} (2) RA for infrared **Ignore** power	**(2)**