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

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

Question Number	Answer	Acceptable answers	Mark
1(b)	substitution: (1) $3.0 \times 10^8 = 1.5 \times 10^{10} \times \lambda$ transposition: (1) $\lambda = c/f$ or $(\lambda =) \frac{3.0 \times 10^8}{1.5 \times 10^{10}}$ evaluation: (1) 0.02 (m)	Give full marks for correct answer, no working **Allow** substitution and transposition in either order if clear **Ignore** powers of 10 until evaluation e.g. 3/1.5 2 marks λ = f/c (0) then 1.5/3 1 mark bald 1.5/3 0 mark 2×10^{-2} (m) ignore formula triangle	**(3)**

Question Number	Answer	Acceptable answers	Mark
1(c)	An explanation linking **two** of the following points • wavelength / frequency (1) • are different (1) **OR** • toaster on for longer (1) • (so) much more energy (1)	wavelength for toaster different from wavelength for remote. Scores 2 power / intensity of toaster greater than for remote for 2 marks	**(2)**

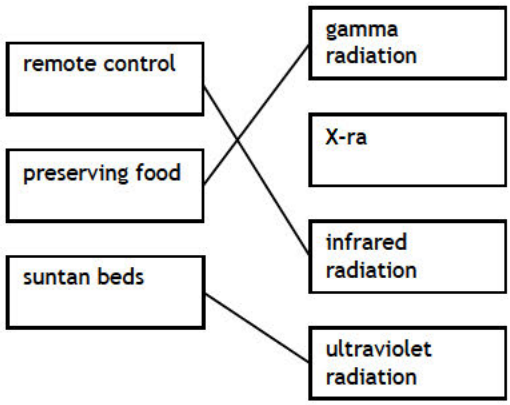
Question Number	Answer	Acceptable answers	Mark
1(d)	An explanation linking **three** of the following points • gammas change cell growth / eq (1) • (so can) cause uncontrolled growth (1) • (but also can) be focussed to (kill cancer cells)(1) • without damaging other cells	kill / damage cells mutate/damage DNA concentrated / aimed at tumour / penetrate	**(3)**

Question Number	Answer	Acceptable answers	Mark
2(a)	1 red 2 orange 3 yellow 4 violet 1 mark for red **or** violet in correct place 1 mark for two of the three others in correct order		**(2)**

Question Number	Answer	Acceptable answers	Mark
2(b)	A		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(c)	• Idea of shining UV light on note (1) • genuine notes (makes them) glow **ORA** (1)	Scan / (put) under fluoresce/emit light/show symbol/Queen's head/markings	**(2)**

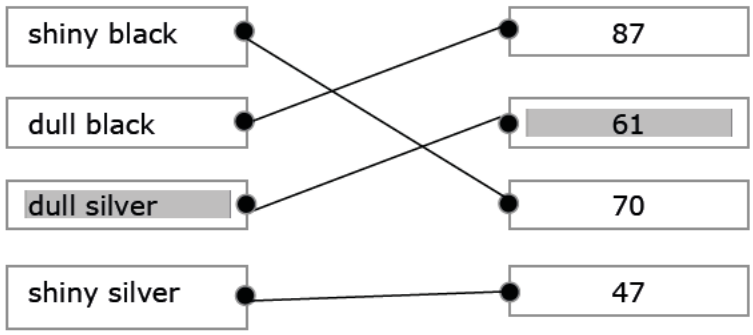
Question Number	Answer	Acceptable answers	Mark
2(d)	An explanation including two of the following points: • (potential) danger increases with frequency (1) • UV has a higher frequency than IR (1) • UV is more dangerous **ORA**(1) • IR causes burns (1) • UV causes (skin)cancer(1)	danger is greater at higher frequency damages/ mutates cells IGNORE eye damage/sunburn	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(a)	use type of radiation  3 correct = 3 marks 2 correct = 2 mark 1 correct = 1 mark	Two lines from a use negates that use	**(3)**

Question Number	Answer	Acceptable answers	Mark
3(b)	An explanation including : • (all e-m waves) have same speed (1) • in {space/vacuum} (1)	(from equation) same speed and same distance = same time 3×10^8 m/s / speed of light	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(c)	C		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(d)	substitution ie (v =) $1.5 \times 10^{17} \times 2 \times 10^{-9}$ (1) evaluation ie (v =) 3×10^8 m/s (1)	[Remember that equations, including $v = f\lambda$ are given on page 2. Please do not credit] Give full marks for correct answer, no working 3 x any other power of 10 =1 mark	**(2)**

Question number	Ans	Mark
4(a)(i)	All three correct (2) One or two correct (1)  	(2)

Question number	Answer	Additional guidance	Mark
4(a)(ii)	Different surfaces emit (thermal) radiation at different rates	allow reference to surfaces in question	(1)

Question number	Answer	Mark
4(b)(i)	B	(1)

Question number	Answer	Additional guidance	Mark
4(b)(ii)	substitution and unit conversion (1) $470 \times 10^{-9} \times 6.30 \times 10^{14}$ answer (1) 2.96×10^{8} (m/s)	award full marks for correct numerical answer without working ecf unit conversion	(2)

Question number	Answer	Mark
4(c)(i)	B	(1)

Question number	Answer	Mark
4(c)(ii)	An answer that combines points of interpretation/evaluation to provide a logical description: • as temperature increases, intensity increases (1) • as temperature increases, maximum intensity occurs at a shorter wavelength (1)	**(2)**

Question number	Answer	Mark
5(a)(i)	An explanation that combines identification via a judgement (2 marks) to reach a conclusion via justification/reasoning (2 marks): • intensity of radiation increases with temperature (1) • the distribution of the emitted wavelengths of radiation is affected by temperature (1) • at low temperatures the intensity of radiation emitted is low and the (range of) emitted wavelengths (of radiation) are high so the lamp appears dull red (1) • at higher temperatures the intensity of the radiation is greater and the (range of) emitted wavelengths (of radiation) are low so the lamp appear to be brighter and less red (1)	**(4)**

Question number	Answer	Additional guidance	Mark
5(a)(ii)	Substitution and rearrangement to find k (1) $k = 85000 \times 0.70^2$ Substitution to find new count rate (1) count rate = $\frac{85000 \times 0.70^2}{1.3^2}$ Answer (1) 25000 (counts per minute)	41650 24645 (counts per minute)	(3)

Question number	Indicative content	Mark
*5(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO2 (6 marks)** • the soot could make the ice black • black ice will absorb more IR radiation than white ice • black ice might cause an increase in the temperature of the Earth because absorption of IR radiation (can) cause an increase in temperature • reduction in soot might reduce warming because the ice will not be as black/will be more white • shiny sulfates (are good at) reflecting/scattering IR radiation which means less heat absorbed • sulfates scatter the IR and this reduces the amount of IR radiation falling on the Earth • sulfates might cause a decrease in the temperature of the Earth • reduction in sulfates might increase warming	(6)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• The discussion attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2) • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3–4	• The discussion is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2) • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5–6	• The discussion is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2) • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)