Mark Scheme

Q1.

Question Number	Answer	Mark
(i)	**D** refraction **The only correct answer is D** *A 'deflection' is an incorrect distracting description* *B 'incidence' is incorrect, that would be angle X* *C 'reflection' is incorrect, no reflection being shown in the diagram*	**(1)** AO 1 1

Question Number	Answer	Additional guidance	Mark
(ii)	any pair of coordinates selected from the line (1) in range → 0.6(0) to 0.7(0) (1)	e.g. 20 and (13 or 14) or 10 and (6 or 7) ignore any units given award full marks for a correct answer without working	**(2)** AO 2 1

Question Number	Answer	Additional guidance	Mark
(iii)	an explanation linking: repeat (1) different angles / more values of X (1) for larger angles / values of X (1)	 allow 'more measurements' / 'repeat experiment' / collect more data > 20°	**(3)** AO 3 3a

Q2.

Question Number	Answer	Mark
(i)	**A ray box** ***B*** *is not correct because a ruler does not produce a beam of white light* ***C*** *is not correct because a measuring cylinder does not produce a beam of white light* ***D*** *is not correct because an ammeter does not produce a beam of white light*	**(1)** **AO1**

Question Number	Answer	Mark
(ii)	**C green** ***A*** *is not correct because red appears at the start of the spectrum* ***B*** *is not correct because orange appears in the middle of the spectrum* ***D*** *is not correct because violet appears at the end of the spectrum*	**(1)** **AO1**

Q3.

Question number	Answer	Additional guidance	Mark
	infrared (1) thermal (1)	must be in first sentence space must be in second sentence space award 2 marks for answers in this **order**	**(2)** **AO2**

Q4.

	Answer	Additional guidance	Mark
(i)	x-ray(s)	allow X x no mark if more than one wave given e.g. x-rays and gamma rays scores 0	**(1)** **AO1**

	Answer	Additional guidance	Mark
(ii)	infrared	allow any recognisable spelling IR ir no mark if more than one wave given e.g. infrared and gamma rays scores 0	**(1)** **AO1**

	Answer	Additional guidance	Mark
(iii)	infrared	allow any recognisable spelling IR ir no mark if more than one wave given e.g. infrared and gamma rays scores 0	**(1)** **AO1**

	Answer	Additional guidance	Mark
(iv)	gamma (rays)	allow any recognisable spelling γ no mark if more than one wave given e.g. gamma rays and UV scores 0	**(1)** **AO1**

Q5.

Question number	Answer	Additional guidance	Mark
	a description to include two of the following: increases (at first) (1) reaches a peak (1) (then) decreases (1)	 is brightest at **410** (nm)	**(2)**

Q6.

	Answer	Acceptable answers	Mark
(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)**
(ii)	an explanation linking **two** of the	kills/destroys cells / causes cancer /	**(2)**

	following: X-rays mutate / damage / harm / ionise cells or DNA (1) the energy / frequency / wavelength / penetration is different (1) Correctly identified difference (1)	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	

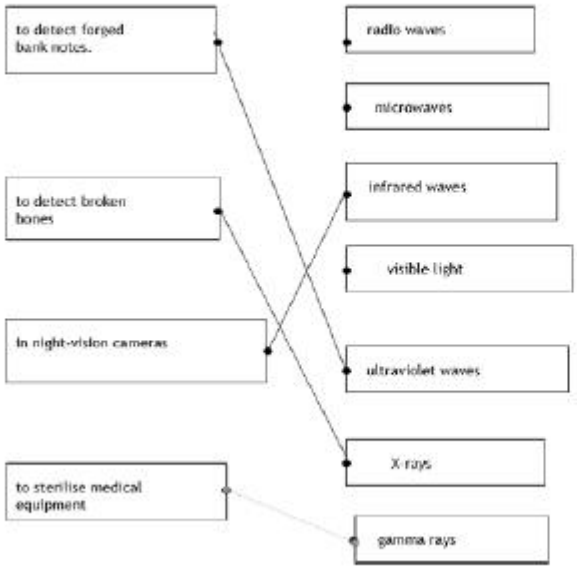
Q7.

		Indicative Content	**Mark**
QWC	*	A discussion including some of the following points Possible dangerous e-m radiations Microwaves Infrared Ultraviolet (UV) X-rays gamma rays Correctly linked to Internal heating of body cells (microwaves) Skin burns (infrared) Damages skin cells/sunburn (UV) Damages eyes (UV) Can cause skin cancer (UV) Can cause cataracts (UV) Damage to cells inside the body(X-rays) Mutate/ kill cells in the body (gamma) Damages DNA (X-rays and gamma rays) Link to frequency As the frequency increases/wavelength decreases (microwave ->	**(6)**

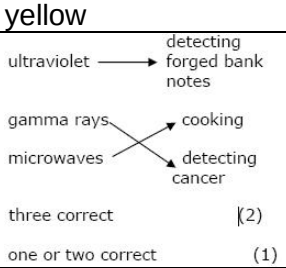
		gamma) the waves become more penetrating and do more damage/danger as they have more energy.	
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description e.g. gives at least 2 correct radiations and links both to correct damage OR at least 2 correct radiations named with link to correct damage from one and idea that frequency is linked to damage OR just has link between higher frequency and more damage/dangerous e.g. infrared burns your skin and X-rays can damage cells. OR X-rays have a higher frequency than microwaves and can cause cancer OR Higher frequencies cause more damage to cells. • 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 e.g. gives most of the correct radiations and links to correct damage, at least one with detail of the damage that is caused OR links two to detail of the damage, AND has a link between frequency and energy/danger e.g. Microwaves are absorbed by water in body cells. UV can cause skin cancer and damages your eyes. Xrays and gamma rays can damage cells inside your body OR Gamma and X-rays can penetrate deep into the body. Gamma does most damage as it has the highest frequency. • 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 e.g. gives most of the correct radiations with links to detail of the damage AND explains the link between frequency and energy/danger. e.g Microwaves heat up the water in cells. UV can cause cataracts. Gamma rays are the most penetrating and can mutate cells inside the body because they have the highest frequency. • The answer communicates ideas clearly and coherently uses a range of scientific	

		terminology accurately • spelling, punctuation and grammar are used with few errors

Q8.

Question number	Answer	Additional guidance	Mark
		award 1 mark for each line from the three left-hand boxes more than one line from a box loses the mark for that box	(3)

Q9.

	Answer	Acceptable answers	Mark
(a)(i)	☒ **B** seven		**(1)**
(a)(ii)	☒ **C** red, orange, yellow		**(1)**
(b)	 three correct (2) one or two correct (1)		**(2)**
(c)(i)	a suggestion from any **two** of the following: (areas of the hand) show • Patches / (shaded) areas / brightness / colour(s) (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	**(2)**

	• Indication of temperature / heat (1)	part of the hand identified as hot or cold (2) **Ignore** germs / bacteria / nerves	
(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)**

Q10.

	Answer	**Acceptable answers**	**Mark**
(a)(i)	Gamma/ γ (wave(s)/ ray(s)/radiation)	X-rays/ radiation	**(1)**
(a)(ii)	Any two from It fluoresces (1) UV (radiation) transfers/gives energy to ink/ink absorbs energy from UV (radiation) (1) (energy from UV is)(re-)radiated/(re)-emitted by ink at lower frequency/as (visible) light (1)	fluorescent Ink/it absorbs UV (light/radiation) Ignore UV is reflected as visible light Ignore luminous emits visible light	**(2)**
(b)	transposition λ = v/f (1) substitution λ = $3 \times 10^8/7 \times 10^9$ (1) evaluation 0.043 (m) (1) Ignore any unit given by candidate	Subst. and transform. either order 1 mark only can be scored for correct substitution after incorrect transposition. $3 \times 10^8/7 \times 10^9$ gains 2 marks Accept any number of sig.figs. that rounds to 0.04 0.04 , 0.0428 (m) (1) Give full marks for correct answer with no working. 0.04 × any other power of	**(3)**

		10 = 2 marks	

		Indicative Content	Mark
QWC	***c**	A discussion including some of the following points Possible dangerous e-m radiations Microwaves Infrared Ultraviolet (UV) X-rays gamma rays Correctly linked to Internal heating of body cells (microwaves) Skin burns (infrared) Damages skin cells/sunburn (UV) Damages eyes (UV) Can cause skin cancer (UV) Can cause cataracts (UV) Damage to cells inside the body(X-rays) Mutate/ kill cells in the body (gamma) Damages DNA (X-rays and gamma rays) Link to frequency As the frequency increases/wavelength decreases (microwave -> gamma) the waves become more penetrating and do more damage/danger as they have more energy.	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description e.g. gives at least 2 correct radiations and links both to correct damage OR at least 2 correct radiations named with link to correct damage from one and idea that frequency is linked to damage OR just has link between higher frequency and more damage/dangerous e.g. infrared	

		burns your skin and X-rays can damage cells. OR X-rays have a higher frequency than microwaves and can cause cancer OR Higher frequencies cause more damage to cells. • 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 e.g. gives most of the correct radiations and links to correct damage, at least one with detail of the damage that is caused OR links two to detail of the damage, AND has a link between frequency and energy/danger e.g. Microwaves are absorbed by water in body cells. UV can cause skin cancer and damages your eyes. Xrays and gamma rays can damage cells inside your body OR Gamma and X-rays can penetrate deep into the body. Gamma does most damage as it has the highest frequency. • 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 e.g. gives most of the correct radiations with links to detail of the damage AND explains the link between frequency and energy/danger. e.g Microwaves heat up the water in cells. UV can cause cataracts. Gamma rays are the most penetrating and can mutate cells inside the body because they have the highest frequency. • The answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q11.

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

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

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

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

Question Number	Answer	Acceptable answers	Mark
(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	* **(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	**0**	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	

Q12.

	Answer	**Acceptable answers**	**Mark**
	C		**(1)**

Q13.

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

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

Question Number	Answer	Acceptable answers	Mark
(b)(i)	Gamma, γ, 8, Y	UV, ultraviolet (rays/waves/radiation) Ignore X-rays	**(1)**

Question Number	Answer	Acceptable answers	Mark
(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
(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
(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)**

Q14.

Question Number	Answer	Additional guidance	Mark
	an explanation linking: infrared is absorbed / blocked (by the armchair/objects) / cannot pass through it **OR** radio waves can go through (the armchair/objects) (1) **WITH** (infrared and radio have) different wavelengths / frequencies OR infrared requires 'line-of-sight' (idea) OR radio waves do not require 'line-of-sight' (idea) OR diffraction (idea) (1)	allow stopped transmitted accept comparison	**(2)**

Q15.

Question number	Answer	Additional guidance	Mark
	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • the heating effect for the oven and the phone depends on their power (1) • and since the power of an oven is much greater than the power of a phone, the oven produces a greater heating effect (1)	allow not the same wavelength/microwaves cover a range in wavelengths	**(2)**

Q16.

Question Number	Answer	Mark
	C red **The only correct answer is C red** **A** is not correct because blue has a shorter wavelength than red **B** is not correct because green has a shorter wavelength than red **D** is not correct because yellow has a shorter wavelength than red	**(1)**

Q17.

Question number	Answer	Mark
	☒ A blue Green, orange and yellow all have a lower frequency than blue	(1)

Q18.

Question number	Answer	Additional guidance	Mark
(i)	C ultraviolet | infrared | radio A is incorrect infrared should be in K, radio should be in L and ultraviolet in J, B is incorrect radio should be in L and ultraviolet should be in K D is incorrect radio should be in L and infrared in K		(1) AO1

Question number	Answer	Additional guidance	Mark
(ii)	C speed amplitude, frequency and wavelength are not the same for all EM waves		(1) AO1

Q19.

	Answer	Acceptable answers	Mark
(i)	☒ **B** highest frequency		(1)
(ii)	☒ **D** positively charged		(1)

(iii)	an explanation linking: • (when) the filament is heated/very hot (1)with **one** of: • electrons escape (have enough energy) (1) • electrons escape from the surface (1)	cathode / metal (for filament) released accept boil off IGNORE produces / emits	**(2)**
(iv)	a suggestion that electrons do not reach target	otherwise electrons collide with (air) particles electrons are absorbed electrons ionise air stops electrons reaching target	**(1)**

Q20.

Question Number	Answer	Acceptable answers	Mark
(a)	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
(b)	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)**

Q21.

	Answer	**Acceptable answers**	**Mark**
	D energy and information (1)		**(1)**

Q22.

Question number	**Answer**	**Mark**
	(Carried by) electromagnetic wave	**(1)**

Q23.

Question number	Answer	Additional guidance	Mark
(i)	**One** from: seeing (broken) bones (1) radiotherapy (1) detecting cracks in metals (1) airport security (1) observing the internal structure of objects(1)	seeing inside the body	**(1)** **AO1**

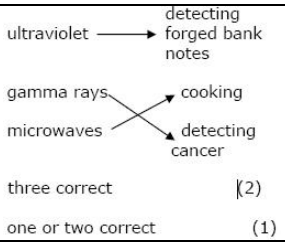
Question number	Answer	Additional guidance	Mark
(ii)	**One** from: can cause cancer (1) can cause burns(1) {damage/kills/harms} cells/tissue (1) mutates DNA/cells (1)	harms organ(s) / foetus allow (highly) ionising	**(1)** **AO1**

Q24.

	Answer	Acceptable answers	Mark
	A		**(1)**

Q25.

	Answer	Acceptable answers	Mark

	 three correct (2) one or two correct (1)		**(2)**

Q26.

	Answer	**Acceptable answers**	**Mark**
(i)	Gamma/ γ (wave(s)/ ray(s)/radiation)	X-rays/ radiation	**(1)**
(ii)	Any two from It fluoresces (1) UV (radiation) transfers/gives energy to ink/ink absorbs energy from UV (radiation) (1) (energy from UV is)(re-)radiated/(re)-emitted by ink at lower frequency/as (visible) light (1)	fluorescent Ink/it absorbs UV (light/radiation) Ignore UV is reflected as visible light Ignore luminous emits visible light	**(2)**

Q27.

	Answer	**Acceptable answers**	**Mark**
	alpha particles (In the left section) gamma rays (centre section) infrared radiation (right section) (2)	Any one in correct position for one mark, all three in correct position for two marks	**(2)**

Q28.

	Answer	**Acceptable answers**	**Mark**
(i)	C damage to the eyes (1)		**(3)**
(ii)	D all three signals arrive at the same time (1)		**(1)**
iii	Description linking **one** of the following pairs:	invisible ink/smart water glows under UV	**(2)**

	• security marking (1) • ink absorbs UV and re-radiates (visible) light (1) • fluorescent lamps (1) • coating absorbs UV and reradiates (visible) light (1) • genuine bank notes (1) • watermark absorbs UV and reradiates (visible) light (1) • disinfecting water (1) • UV kills bacteria (1) • sun beds (1) • UV absorbed by (melanin in) skin (1) Any suitable use gains 1 mark Any suitable use + detail gains 2 marks	(outside of) lamp glows when hit by UV forgeries/fake bank notes/passports/fingerprints/ body fluids etc markings glow under UV tanning beds tans the skin /the body e.g. disco lighting (1) makes clothing glow (1)	

Q29.

Question Number	Answer	Additional guidance	Mark
(i)	Atoms may form positive ions by **losing** electrons. (1) The electrons involved in forming positive ions are the **outer** electrons (1)	accept any clear indication that correct word is in gap	(2)

Question Number	Answer	Mark
(ii)	The only correct answer is **C gamma** A is not correct because alpha radiation is not electromagnetic B is not correct because beta minus radiation is not electromagnetic D is not correct because neutron radiation is not electromagnetic	(1)

Question Number	Answer	Mark
(iii)	The only correct answer is **A alpha** B is not correct because beta minus travels further in air than alpha C is not correct because beta plus travels further in air than alpha D is not correct because gamma travels further in air than alpha and beta	(1)

Q30.

	Answer	Acceptable answers	Mark
	A description to include The purpose of using gamma radiation (1) Some relevant detail about how it achieves the purpose (1)	Purposes may include sterilising food /medical equipment detection / treatment of cancer imaging /detect flaws in materials	**(2)**

Q31.

	Answer	Acceptable answers	Mark
(b)(i)	A description including the following: • magnifies • the image • <u>refracts</u> the light	brings nearer / zooms in / looks closer / makes bigger / enlarges intermediate / real image	**(2)**
(b)(ii)	☒ B energy		**(1)**

Q32.

	Answer	Acceptable answers	Mark
(i)	☒ **B** seven		**(1)**
(ii)	☒ **C** red, orange, yellow		**(1)**

Q33.

Question Number	Answer	Mark
(i)	red **or** orange	**(1)** AO 1 1

Question Number	Answer	Additional guidance	Mark
(ii)	green **or** blue **or** indigo **or** violet		**(1)** AO 1 1

Q34.

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	• using distance^2 (1) $(0.9^2) = 0.81$ • substitution(1) (intensity) = $\frac{200}{(0.9^2)}$ • evaluation (1) 250 (W/m^2)	 Allow ecf from mp1 200/0.81 has achieved first two marks correct answer with no working scores full marks 246.9 numbers which would correctly round up to 250 (e.g. accept 246) 222 scores two marks (using 200/0.9)	**(3)**

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

Question Number	Answer	Acceptable answers	Mark
(c)	damage to cell/DNA (1)	causes cancer / stops cell division / causes tumours / causes radiation burns for cell accept tissue / named tissue / organ / for damage accept kills / destroys / mutates / denatures / ionises but not just ionising by itself 'radiation poisoning' by itself insufficient	**(1)**

Question Number		Indicative Content	Mark
QWC	*** (d)**	An description including some of the following points • C is heated • C is the cathode / filament • A is the anode • A is the (metal) target • electrons produced at C • by thermionic emission (boil off filament) • p. d. (voltage) between A and C • electrons move towards A • through a vacuum B • electrons accelerated by voltage (between A & C) • electrons collide with A	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a description limited to isolated facts e.g. B is a vacuum • 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 linking some facts e.g. electrons / negative particles come from the cathode OR electrons collide with the anode OR electrons accelerate in the tube • 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 e.g. **electrons** come from the cathode and hit the anode N.B. must mention electrons to get level 3 • 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 = 12 marks)

Q35.

	Answer	**Acceptable answers**	**Mark**
(a)(i)	**B** highest frequency		**(1)**
(a)(ii)	**D** positively charged		**(1)**
(a)(iii)	an explanation linking: • (when) the filament is heated/very hot (1)with **one** of: • electrons escape	cathode / metal (for filament) released accept boil off IGNORE produces / emits	**(2)**

	(have enough energy) (1) • electrons escape from the surface (1)		
(a)(iv)	a suggestion that electrons do not reach target	otherwise electrons collide with (air) particles electrons are absorbed electrons ionise air stops electrons reaching target	**(1)**
(b)	transposition $2 \times e \times V / m = v^2$ (1) substitution $v^2 = 2 \times 1.6 \times 10^{-19} \times 40\,000 / 9.1 \times 10^{-31}$ (1) evaluation of v 1.2×10^8 (m/s) (1)	Either order ignore powers of ten until evaluation give full marks for correct answer, no working accept 1.19×10^8	**(3)**