2009 Physics

Standard Grade − Credit

Finalised Marking Instructions

Part One: General Marking Principles for Physics Standard Grade – Credit

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the specific Marking Instructions for each question.

(a) Marks for each candidate response must always be assigned in line with these general marking principles and the specific Marking Instructions for the relevant question. If a specific candidate response does not seem to be covered by either the principles or detailed Marking Instructions, and you are uncertain how to assess it, you must seek guidance from your Team Leader/Principal Assessor. You can do this by posting a question on the Marking Team forum or by e-mailing/phoning the emarker Helpline. Alternatively, you can refer the issue directly to your Team Leader by checking the 'Referral' box on the marking screen.

(b) Marking should always be positive, ie marks should be awarded for what is correct and not deducted for errors or omissions.

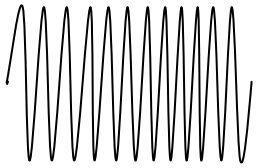
Physics – Marking Issues

The current in a resistor is 1·5 amperes when the potential difference across it is 7·5 volts. Calculate the resistance of the resistor.

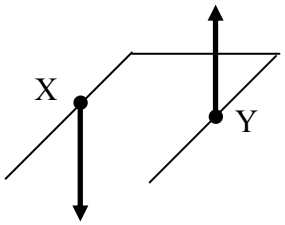
	Answers	**Mark + Comment**	**Issue**
1.	$V=IR$ $7{\cdot}5=1{\cdot}5R$ $R=5{\cdot}0\ \Omega$	(½) (½) (1)	Ideal answer
2.	$5{\cdot}0\ \Omega$	(2) Correct answer	GMI 1
3.	5·0	(1½) Unit missing	GMI 2 (a)
4.	$4{\cdot}0\ \Omega$	(0) No evidence/wrong answer	GMI 1
5.	_____ Ω	(0) No final answer	GMI 1
6.	$R=\frac{V}{I}=\frac{7{\cdot}5}{1{\cdot}5}=4{\cdot}0\,\Omega$	(1½) Arithmetic error	GMI 7
7.	$R=\frac{V}{I}=4{\cdot}0\,\Omega$	(½) Formula only	GMI 4 and 1
8.	$R=\frac{V}{I}=$ _____Ω	(½) Formula only	GMI 4 and 1
9.	$R=\frac{V}{I}=\frac{7{\cdot}5}{1{\cdot}5}=$ _____Ω	(1) Formula + subs/No final answer	GMI 4 and 1
10.	$R=\frac{V}{I}=\frac{7{\cdot}5}{1{\cdot}5}=4{\cdot}0$	(1) Formula + substitution	GMI 2 (a) and 7
11.	$R=\frac{V}{I}=\frac{1{\cdot}5}{7{\cdot}5}=5{\cdot}0\,\Omega$	(½) Formula but wrong substitution	GMI 5
12.	$R=\frac{V}{I}=\frac{75}{1{\cdot}5}=5{\cdot}0\,\Omega$	(½) Formula but wrong substitution	GMI 5
13.	$R=\frac{I}{V}=\frac{7{\cdot}5}{1{\cdot}5}=5{\cdot}0\,\Omega$	(0) Wrong formula	GMI 5
14.	$V=IR\quad 7{\cdot}5=1{\cdot}5\times R\quad R=0{\cdot}2\ \Omega$	(1½) Arithmetic error	GMI 7
15.	$V=IR$ $R=\frac{I}{V}=\frac{1{\cdot}5}{7{\cdot}5}=0{\cdot}2\,\Omega$	(½) Formula only	GMI 20

Part Two: Marking Instructions for each Question

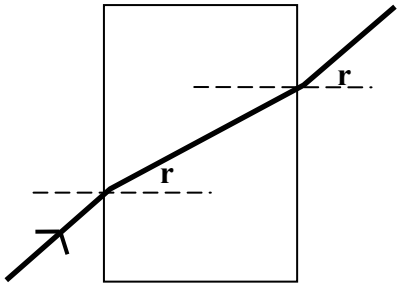
Question			Expected Answer/s	Max Mark	Additional Guidance
1	**a**	**i**	3×10^8 m /s	**1**	Must have correct unit (1) or (0) Accept 300 000 000 m/s Accept 300 million m/s NOT '(same as) speed of light' alone
1	**a**	**ii**	$\lambda = \frac{v}{f}$ (½) $= \frac{3\times10^8}{5\times10^9}$ (½) $=$ 0·06 m (1)	**2**	If GHz incorrectly or not converted treat as unit error (only penalise once)
1	**b**		$v = 2 \times 10^8$ (m/s) (1) data mark $t = \frac{d}{v}$ (½) $= \frac{40000}{2\times10^8}$ (½) $= 2 \times 10^{-4}$ s (0·0002 s) (1)	**3**	Must use correct value for *v* If any other value for *v* is used then it must be from the *Speed of light in materials* table in the Data sheet – but lose the data mark – can get 2 for correct use of relationship. If any other value for v is used (ie not from the table) then (½) mark max for correct equation selection. If candidates use 3·0 x 10^8 for v then sig fig issue, accept answers in the following range for 2 marks: 1 x 10^{-4}, 1·3 x 10^{-4}, 1·33 x 10^{-4}
1	**c**		Carry more information **OR** less/no (electrical) interference **OR** cheaper **OR** larger bandwidth/capacity **OR** less amplifiers needed etc **OR** less repeaters required **OR** less signal loss **OR** lighter **OR** more secure (or similar)	**1**	NOT : 'faster' alone Accept faster ONLY if qualified by rate of data transfer NOT : 'less recharging' 'more efficient' '**no** signal loss'
2	**a**		Sound (waves) with frequency above 20 000 Hz or 20 kHz **OR** sound (waves) above/beyond the range of human hearing	**1**	Must clearly indicate frequency/range. **NOT** ambiguous answers which could be interpreted as being loudness eg 'sounds you can't hear' **NOT** 'high frequency sounds' alone

Question			Expected Answer/s	Max Mark	Additional Guidance
2	**b**		1500 m/s	**1**	Must have correct unit (1) or (0)
2	**c**		d = v × t (½) = 1500 × 0·36 (½) = 540 (m) (1) Must have unit if this is final answer So depth = $\frac{540}{2}$ = 270 m (1)	**3**	If correct speed (1500) is used in (c) but 2(b) is incorrect, can still get full marks. If no division by two then (2) marks max. **Note**: 1 mark is allocated for division by two: the division of **time** or **distance** by two can occur at any point, eg by starting with half the time value (0·18 s) or halving the calculated distance
3	**a**		Light (waves/signals) travels faster than sound (waves) **OR** converse statement	**1**	**NOT**: 'sound is slower' **OR** ' light is faster' **-must** have a comparison
3	**b**			**2**	(1) for approx. same frequency as modulated signal (accept between 10 and 26 waves) (1) for **approx.** constant amplitude even if amplitude is very small Allow for some y-shift.
3	**c**		P_{out} = $P_{gain} \times P_{in}$ (½) $25000 \times 30 \times 10^{-3}$ (½) = 750 W (1)	**2**	If there is no (or an incorrect) conversion of 30 mW then treat as unit error (deduct (½) mark)

Question			Expected Answer/s	Max Mark	Additional Guidance
4	**a**	**i**	(Current) increases **OR** gets bigger **OR** rises	**1**	(1) mark for a correct statement (0) marks for '(current) changes' only
4	**a**	**ii**	A (position) S B This position gives maximum current **OR** this position gives least/minimum resistance **(must be 'least' or equivalent, not 'less')** **OR** This position gives greatest/maximum voltage ACROSS fan	**1** **1**	(1) for correct position (1) for correct justification Accept a correct statement referring to minimum resistance **OR** to maximum current - even if answer to 4 (ii) (A) is wrong **NOT** answers relating to power or energy **NOT** voltage to/through fan
4	**b**	**i**	The commutator ensures/keeps current (is) in the correct direction **OR** Reverses/changes the direction of current every half turn **OR** Keeps the coil rotating (in the same direction)	**1**	Accept an answer which indicates function of commutator to allow current to always be in same direction through field **NOT** 'smoother rotations' (does not answer question)
4	**b**	**ii**	Carbon brushes do not wear (away) the commutator OR Carbon brushes do not damage the commutator **OR** withstand heat better **OR** to allow low friction contact	**1**	(1) for correct statement Accept an answer which indicates one valid reason for carbon brushes Answer could relate to brushes wearing to the shape of the commutator **NOT** 'better conductor' **NOT** 'easier to change' **NOT** 'cheaper' **NOT** 'non-magnetic' **NOT** 'don't rust'

Question			Expected Answer/s	Max Mark	Additional Guidance
4	**c**	**i**		**1**	(½) for each correct direction Arrows should be reasonably vertical.
4	**c**	**ii**	Reverse the magnetic field direction **OR** Reverse current **OR** Change the direction of the current	**1**	(1) for a correct statement which would reverse the direction of field or current e.g. swap battery connections, swap north and south (magnets/poles), swap poles reverse polarity **NOT** 'swap/change magnets' **NOT** 'swap/change battery' +/- rule applies If candidates give answer as "reverse field **or** reverse current" then 1 mark If candidates give answer as "reverse field **and** reverse current" then 0 marks as changes would cancel.

Question			Expected Answer/s	Max Mark	Additional Guidance
5	**a**		Switch is connected to the neutral/ blue wire **OR** heating elements would always be live, even if switch is off **OR** there is no fuse in the fire/the resistor should be a fuse **OR** Blue (neutral) and brown (live) wires should be swapped **OR** Blue (neutral) and brown (live) wires are wrong way round	**1**	(1) mark for any correct statement **NOT** '(blue and brown) wires are in the wrong place' **NOT** any mention of earth/green and yellow wire
5	**b**	**i**	Total power rating = 350 + 150+ 300 (½) = 800 (W) (½) $Power_{standby}$ = 9% of 800 = $800 \times \frac{9}{100}$ (½) = 72 (W) (½)	**2**	**If the power for the electric fire is included at any stage then 0 marks.** (1) mark for getting total power = (800 W) (½) mark for correct substitution in percentage calculation Unit not required in final answer, but deduct (½) if wrong unit given **OR** take percentage of individual powers then add: 31·5 + 13·5 + 27·0 = 72 (W)
5	**b**	**ii**	E = P × t (½) = 0·072 × 14 × 24 (½) = 24 (kWh) (1) Accept 1 – 4 sig figs (sig fig: 20, 24, 24·2, 24·19)	**2**	**Must** use answer from Q5 (b) (i) (½) mark deduction for wrong (or no) conversion of W into kW or days into hours. **Note**: only (½) mark max deduction for unit error. Award (1) mark for correct numerical final answer, unit not required, but deduct (½) if unit is not kWh or written out in full (eg NOT kWhrs).
6	**a**		Hold lens between distant (½) object and paper (or similar) (½) Use lens to focus/get sharp/clear image (½) Measure distance from lens to paper (½)	**2**	(½) mark for each statement some sense that object is distant eg a window(frame), trees across the playground, etc also accept description of parallel rays from object
6	**b**		Refraction is when speed/wavelength changes (1) when the light travels into the material or lens/from one medium to another (1)	**2**	(1) mark for each correct statement (independent marks) **NOT** 'light changes direction' alone or 'light bends' alone Can still get one mark for change of medium

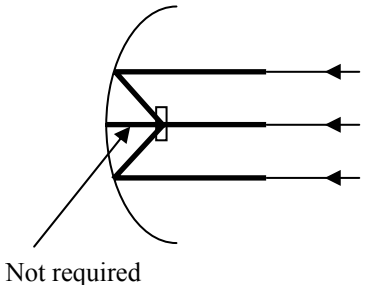
Question			Expected Answer/s	Max Mark	Additional Guidance
6	c	i		2	Independent marks for each path (1) mark for showing correct path within glass – path should show clear refraction (not along the normal) (1) mark for showing correct refraction at the second surface – refraction should be away from normal For a correctly drawn diagram the path of the emergent ray should show approx. same direction as given ray. If candidates get first refraction wrong, eg draw it below the normal, then they can still get second mark if they show a correct second refraction for **their** ray.
6	c	ii		1	Only one angle r of refraction required, but if refracted angle indicated is in air, then second normal must be shown.
7	a		<table><tr><td>*Type of radiation*</td><td>*Source*</td></tr><tr><td>Beta only</td><td>C</td></tr><tr><td>Both alpha and gamma</td><td>B</td></tr></table>	1	(½) for each correct answer +/- rule if more than one source selected in either answer
7	b		(½) for 4 half-lives (½) for halving at each stage 18000 → 9000 → 4500 → 2250 → 1125 (Activity) = 1125 Bq (1)	2	First two ½ marks are **independent** Candidates who show less than/more than four halvings can gain second ½ mark but all stages must be numerically halved .
8	a		The voltage (gradually) rises **OR** increases **OR** reaches 6V	1	(1) mark for a correct statement **NOT** 'the voltage **is** 6V ' – must be some implication of voltage increasing
8	b		Reduce value of resistor (R)/reduce resistance (1) Reduce value of the capacitor/reduce capacitance (1)	2	(1) mark for each change **NOT** 'use 'smaller' capacitor/resistor' **NOT** 'reduce size of capacitor/resistor' **NOT** 'lower the capacitor/resistor' **NOT** 'remove the resistor' **NOT** 'decrease/reduce/change the voltage' ALLOW 'increase the voltage'

Question			Expected Answer/s	Max Mark	Additional Guidance
8	**c**	**i**	$V_S = V_{LDR} + V_{53k\Omega}$ $6{\cdot}0 = 0{\cdot}7 + V_{53k\Omega}$ (½) $V_{53k\Omega} = 5{\cdot}3$ V (½)	**1**	Subscripts not required in equation Deduct (½) if wrong or missing unit
8	**c**	**ii**	$\frac{V_Q}{V_{53k\Omega}} = \frac{R_{LDR}}{R_{53k\Omega}}$ (½) $\frac{0{\cdot}7}{5{\cdot}3} = \frac{R_{LDR}}{53000}$ (½) $R_{LDR} = 7000\Omega$ (1) **OR** $V_{LDR} = V_S \times \frac{R_{LDR}}{R_{LDR} + R_{53k\Omega}}$ (½) $0{\cdot}7 = 6{\cdot}0 \times \frac{R_{LDR}}{R_{LDR} + 53000}$ (½) $0{\cdot}7 \times (R_{LDR} + 53000) = 6 \times R_{LDR}$ $0{\cdot}7 \times 53000 = 5{\cdot}3 \times R_{LDR}$ $R_{LDR} = 7000\Omega$ (1)	**2**	Accept value given in answer from 8(c)(i) **OR** I = V/R = 5·3/53000 = 0·0001 (A) then R = V/I = 0·7/0·0001 = 7000 Ω **(½) for <u>using</u> both equations** (½) for both substitutions (1) for final answer
9	**a**		LDR **OR** solar cell **OR** photodiode **OR** phototransistor **OR** CCD	**1**	**NOT** 'light sensor' **NOT** 'light gate' **NOT** 'camera' Accept correct symbols in place of names
9	**b**		*Gas* / *Sensor*: A B C D Hydrogen **0 1 0 1** Helium 1 1 1 0 Oxygen 1 0 1 0	**2**	(1) mark for each correct row – no ½ marks

Question			Expected Answer/s	Max Mark	Additional Guidance
9	**c**	**i**	**OR** (gate)	**1**	
9	**c**	**ii**	A A = 0 B = 1 C = 0 D = 1 B hydrogen	**2**	(1) for all correct (1) or (0) (only answer possible)
10	**a**		BC and DE	**1**	(½) for each correct part +/- rule if more than two parts given. Do not accept single letters e.g. B and D **NOT** 'where graph is flat/horizontal' **NOT** 'where speed is constant'
10	**b**	**i**	W = m × g (½) = 90·0 × 10 (½) = 900 N (1)	**2**	Accept g = 9·81:W = 883 N 2 – 5 sig fig {880, 883, 882·9, 882·90} Accept g = 9·8: W = 882 N 1 – 4 sig fig {900, 880, 882, 882·0}
10	**b**	**ii**	F_{res} = F_u - F_d (½) = 958·5 – 900 = 58·5 (N) (½) $a = \frac{F_{res}}{m}$ (½) $a = \frac{58 \cdot 5}{90 \cdot 0}$ (½) = 0·65 ms^{-2} (1) for W = 880 a = 0·87 ms^{-2} for W = 882 a = 0·85 ms^{-2} for W = 882·9 a = 0·84 ms^{-2} for W = 883 a = 0·839 ms^{-2}	**3**	Accept answer for weight from b(i) Can use wrong answer for F_{res} if arith error BUT: (½) mark max for formula only if no attempt is made at subtraction to get F_{res}.

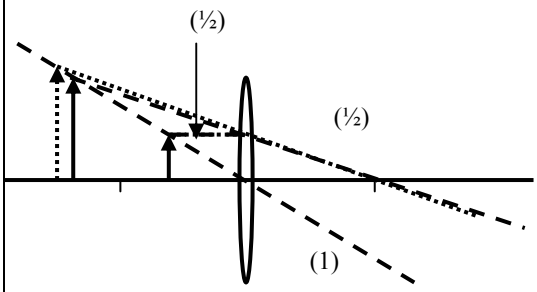
Question			Expected Answer/s	Max Mark	Additional Guidance
11	**a**		$a = \frac{v - u}{t}$ (½) $= \frac{0 \cdot 6 - 0}{1 \cdot 5}$ (½) $= 0 \cdot 4$ m/s^2 (1)	**2**	
11	**b**	**i**	E_p = m g h (½) = 0·02 × 10 ×0·8 (½) = 0·16 J (1)	**2**	Accept g = 9·81 or 9·8: 1 – 3 sig fig {0·2, 0·16, 0·157}
11	**b**	**ii**	E_p = Ek = 0·16 J (1) for cons of energy or implied E = $\frac{1}{2}$ mv^2 (½) $0 \cdot 16 = \frac{1}{2} \times 0 \cdot 02 \times v^2$ (½) v = 4 m/s (1)	**3**	Accept answer for E_p from 11 (b) (i) **OR** v = √(2gh) (1) for implied conservation of E and (½) for equation = √(2 x 10 x 0·8) (½) = 4 m/s (1) If 0·2 J in (b)(i) then v = 4 If 0·157J in (b)(i) then v = {4, 4·0, 3·96} 1 – 3 sig figs

Question			Expected Answer/s	Max Mark	Additional Guidance
12	**a**		220 000 N	**1**	Must have correct unit (1) or (0) **NOT** '220 001 N' **NOT** 'same as weight'
12	**b**	**i**	distance = area under graph (½) (or implied formula) $= \left(\frac{1}{2} \times 240 \times 16\right) + (480 \times 16) + \left(\frac{1}{2} \times 480 \times 16\right)$ (½) $= 1920 + 7680 + 3840$ $= 13440$ m (1)	**2**	(0) marks for use of d = v × t If there is an incorrect substitution then ½ max for (implied) formula
12	**b**	**ii**	$v = \frac{d}{t}$ (½) $= \frac{13440}{1200}$ (½) $= 11 \cdot 2\,\text{m/s}$ (1)	**2**	
13	**a**		To reduce power loss **OR** to reduce energy loss (in the cables) **OR** to reduce heat loss **OR** to reduce current	**1**	
13	**b**	**i**	$\frac{N_S}{N_P} = \frac{V_S}{V_P}$ (½) $\frac{N_S}{2000} = \frac{132000}{20000}$ (½) $N_S = 13200$ (turns) (1)	**2**	Intermediate rounding should be treated as arithmetic error. Unit not required but deduct (½) if wrong unit given eg t or T

Question			Expected Answer/s	Max Mark	Additional Guidance
13	**b**	**ii**	$\frac{I_S}{I_P} = \frac{N_P}{N_S}$ (½) $\frac{I_S}{5000} = \frac{2000}{13200}$ (½) $I_S = \frac{5000 \times 2000}{13200}$ $I_S = 758\text{A}$ (1) **OR** $V_P \times I_P = V_S \times I_S$ (½) $20000 \times 5000 = 132000 \times I_S$ (½) $I_S = 758\text{A}$ (1) 1 – 3 sig figs {800, 760, 758}	**2**	
13	**c**		R = $220 \times 0 \cdot 31$ (= 68·2 (Ω)) (1) P = I^2R (½) = $758^2 \times 68 \cdot 2$ (½) = 39·2 MW (1) 1 – 4 sig figs: {40, 39, 39·2, 39·19}	**3**	if I = 800 A then gives 40 MW (s.f 44, 43·6) if I = 760 A gives 39 MW (s.f. 40, 39·4, 39·39) Power loss can be worked out for 1 km (2 marks) and then multiplied by 220 (1 mark) NOT $P = V^2/R$ unless the voltage drop over 220 km has been calculated.
14	**a**		 	**2**	(1) for passably straight lines (1) for **converging** on heating container. (do not penalise for reflected rays drawn beyond container) Minimum of two completed rays. If additional direction arrows are included they must be in the correct direction otherwise lose second mark.

Question			Expected Answer/s	Max Mark	Additional Guidance
14	**b**		$E = c \times m \times \Delta T$ (½) $= 902 \times 8000 \times (660 - 160)$ (½) = 3 608 000 000 J (1) (= $3 \cdot 608 \times 10^9 \text{ J} (3 \cdot 608 \text{ GJ})$) Ignore significant figure issues	**2**	If work out E for 660 ºC and E for 160 ºC and then subtract energies, treat as wrong physics – 0 marks
14	**c**	**i**	$l_f = 3 \cdot 95 \times 10^5$ (J/kg) (1) $E = ml$ (½) $= 8000 \times 3 \cdot 95 \times 10^5$ (½) $= 3 \cdot 16 \times 10^9$ J (3·16 GJ) (1) 1 – 3 sig figs { 3 , 3·2, 3·16 }	**3**	If any other value for l_f is used from the data table for *Specific latent heat of fusion of materials*, then do not award data mark, but can use this value in final calculation to obtain (2) marks max. If any other value for l_f is used then award (½) max for equation, if given or implied.
14	**c**	**ii**	$P = \frac{E}{t}$ (½) $800 \times 10^3 = \frac{3 \cdot 16 \times 10^9}{t}$ (½) t = $3 \cdot 95 \times 10^3$ s (1) 1 – 3 sig figs { 4, 4·0, 3·95}	**2**	
14	**c**	**iii**	Heat is lost/radiated/escapes from the furnace **OR** Heat is lost/radiated/escapes to the surroundings **OR** Some of the heat energy is used to heat the container	**1**	Explanation should indicate that <u>heat</u> energy is lost from/to…… **NOT** 'it could be cloudy/not sunny' **NOT** 'the mirrors might be dirty' etc.

Question			Expected Answer/s	Max Mark	Additional Guidance
15	**a**		$F = m \times a$ (½) $a = \frac{1400000}{(117000 + 8000)}$ (½) $a = 11{\cdot}2\ m/s^2$ (1)	**2**	
15	**b**		Launch vehicle (uses fuel/jettisons stages so) loses <u>mass</u> **OR** Less/no friction (from air) **OR** Less/no air resistance **OR** Weight is reducing due to fuel being used up/stages being jettisoned	**1**	(1) for a correct explanation **NOT** 'lighter' **NOT** 'less resistance' 'Weight reducing' alone – 0 marks
15	**c**		Answer should be based on the following two points: statement relating to vertical motion, eg 'falling (towards the moon)', or force (of gravity) (1) statement relating to horizontal motion, eg 'probe moves forward', or curvature of Ganymede, eg 'surface curves away' (1)	**2**	NOT 'gravity' alone
15	**d**		Newton III: The thrusters force gas one way (1) So the gas exerts an equal and opposite force on the probe. (1)	**2**	Explanations in terms of Newton I and Newton II are also acceptable. Newton I: mention of balanced forces (1) would not slow down/indication of constant speed (1) Newton II: <u>unbalanced force</u> (1) in the opposite direction/opposing motion (1) Quoting NI, NII or NIII **alone** is insufficient, the answer must relate to the thrusters/probe.

Question			Expected Answer/s	Max Mark	Additional Guidance
16	**a**	**i**		**2**	(1) for extrapolated ray **through centre** undeviated (½) for ray parallel to principal axis (½) for this ray to then pass through focus and be extrapolated back Allow some tolerance for where the two lines meet
16	**a**	**ii**	<u>Larger</u> diameter produces <u>brighter</u> image OR converse	**1**	Must link larger diameter with brighter image (both) for (1) mark 'brighter and clearer' ignore 'clearer' **NOT** 'clearer' alone
16	**b**	**i**	(Radio waves are) longer/greater/bigger/larger OR light has a shorter wavelength	**1**	**NOT** 'wider'
16	**b**	**ii**	Aerial **OR** Radio telescope	**1**	**NOT** satellite dish **NOT** telescope (on its own)
16	**b**	**iii**	Different frequencies/wavelengths/signals require different detectors/telescopes OR Certain detectors/telescopes can't pick up certain frequencies/wavelengths/signals	**1**	eg different telescopes detect different signals **NOT** 'types of wave' or 'waves' – too vague **NOT** 'types of radiation' – ambiguous could be alpha or beta Any mention of **sound** – 0 marks

[END OF MARKING INSTRUCTIONS]