2014 Physics

Higher

Finalised Marking Instructions

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Part One: General Marking Principles for: Physics Higher

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.

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

GENERAL MARKING ADVICE: Physics Higher

The marking schemes are written to assist in determining the "minimal acceptable answer" rather than listing every possible correct and incorrect answer. The following notes are offered to support Markers in making judgements on candidates' evidence, and apply to marking both end of unit assessments and course assessments.

Detailed Marking Instructions − Higher Physics

1. General Marking Instructions

SQA published Physics General Marking Instructions in July 1999. Please refer to this publication when interpreting the detailed Marking Instructions.

2. Recording of marks

The following additional advice was given to markers regarding the recording of marks on candidate scripts.

(a) The total mark awarded for each question should be recorded in the outer margin. The inner margin should be used to record the mark for each part of a question as indicated in the detailed Marking Instructions.

(b) The fine divisions of marks shown in the detailed Marking Instructions may be recorded within the body of the script beside the candidate's response. Where such marks are shown they must total to the mark in the inner margin.

(c) Numbers recorded on candidate scripts should always be the marks being awarded. Negative marks or marks to be subtracted should not be recorded on scripts.

(d) The number out of which a mark is scored should **never** be recorded as a **denominator**. (½ mark will always mean one half mark and never 1 out of 2)

(e) Where square ruled paper is enclosed inside answer books it should be clearly indicated that this item has been considered by the marker. The mark awarded should be transferred to the script booklet inner margin and marked G.

(f) The mark awarded for each question should be transferred to the grid on the back of the script. When the marker has completed marking the candidate's response to all questions, the marks for individual questions are added to give the total script mark.

(g) The total mark awarded for an individual question may include an odd half mark − ½. If there is an odd half mark in the total script mark, this is rounded up to the next whole number when transferred to the box on the front of the script.

3. Other Marking Symbols which may be used

TICK	–	Correct point as detailed in scheme, includes data entry
SCORE THROUGH	–	Any part of answer which is wrong. (For a block of wrong answers indicate zero marks.)
INVERTED VEE	−	A point omitted which has led to a loss of marks.
WAVY LINE	–	Under an answer worth marks which is wrong only because a wrong answer has been carried forward from a previous part.
"G"	–	Reference to a graph on separate paper. You MUST show a mark on the graph paper and the SAME mark on the script.

4. Marking Symbols which may <u>NOT</u> be used.

"WP"	−	Marks not awarded because an apparently correct answer was due to the use of "wrong physics".
"ARITH"	−	Candidate has made an arithmetic mistake.
"SIG FIGS" or "SF"	−	Candidate has made a mistake in the number of significant figures for a final answer.

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

2014 Physics Higher

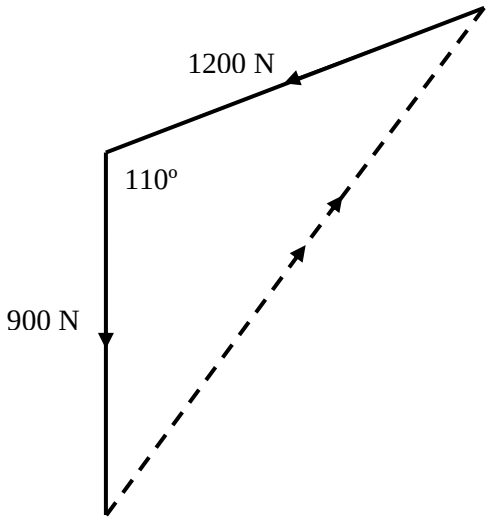
Marking scheme

Section A

1.	A	11.	B
2.	B	12.	C
3.	A	13.	B
4.	C	14.	D
5.	D	15.	B
6.	A	16.	D
7.	C	17.	E
8.	B	18.	C
9.	D	19.	E
10.	E	20.	C

Part Two: Marking Instructions for each Question

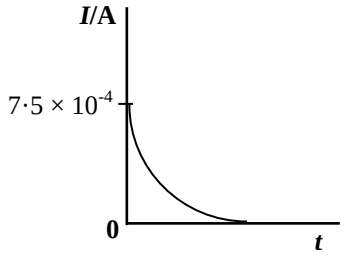
Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
21	**(a) (i)**	$\text{Mean} = \frac{0\cdot164 + 0\cdot190 + 0\cdot188 + 0\cdot155 + 0\cdot163}{5}$ Mean = 0·172 m **(1)**	Deduct **(½)** for arithmetic error. Deduct **(½)** for wrong or missing unit.	**1**	**4**
	(ii)	$\text{Random error} = \frac{\text{Max - Min}}{\text{n}}$ $\text{Random error} = \frac{0\cdot190 - 0\cdot155}{5}$ **(½)** Random error = 0·007 m **(½)**	Don't penalise the same unit error in both (a)(i) and (a)(ii) Deduct **(½)** for demonstrated arithmetic error (i.e. substitution line must be shown correctly).	**1**	
	(b)	$s = ut + ½at^2$ **(½)** $0\cdot172 = ½ \times 9\cdot8 \times t^2$ **(½)** $t = 0\cdot19$ *s* **(1)** **OR** $v^2 = u^2 + 2as = 0 + 2 \times 9\cdot8 \times 0\cdot172$ $(v = 1\cdot8361)$ $t = (v - u)/a$ **(½)** $= 1\cdot836/9\cdot8$ **(½)** = 0·19 s **(1)**	Or consistent with (a)(i) '*s*' and '*a*' must have the same sign 'secs' is not acceptable - no marks until <u>both</u> formulae are shown	**2**	

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
22	**(a) (i)**	A **<u>single force</u>** which will have the **<u>same effect</u>** as all the other forces. **(1)**	'Same effect' could be described e.g. 'same acceleration (in same direction)'. **or** the <u>vector</u> sum of all the forces (or equivalent, e.g. by suitable diagram)	**1**	**6**
	(ii)	 Correct diagram method: Both the 900 N and 1200 N vectors drawn to scale **(½)** Correct angle between vectors **(½)** 1730 ± 30 N **(1)** 41± 2º from vertical or 49 ± 2º from horizontal **(1)**	Alternative method using the cosine and sine rules: $a^2 = b^2 + c^2 - 2bc \cos\theta$ **(½)** $a^2 = 900^2 + 1200^2 - 2 \times 900 \times 1200 \cos 110^\circ$ **(½)** $a = 1728{\cdot}8$ $a = 1730$ N **(1)** $a/sinA = b/sinB$ $1728{\cdot}8/sin110^\circ = 1200/sin\theta$ $\theta = 40{\cdot}7^\circ$ $\theta = 41^\circ$ from the vertical. **(1)** 1700 N gives $\theta = 41{\cdot}6^\circ$ $\theta = 42^\circ$ from the vertical Any bearings taken from North gets **(0)** for direction, i.e. max mark for part (a)(ii) is **(2)**	**3+**	
	(b)	**<u>The vertical component</u>** of the force exerted by the parasail is **<u>greater</u>** than the **<u>weight</u>** of the parascender. **(2)**	Upward force is greater than downwards force. **(1)** **Or** "There is now an unbalanced force (upwards)" **(1)** (these are partial explanations)	**2•**	

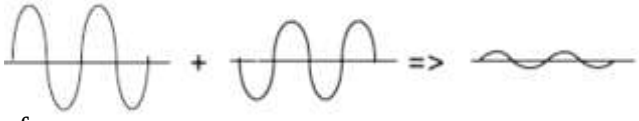
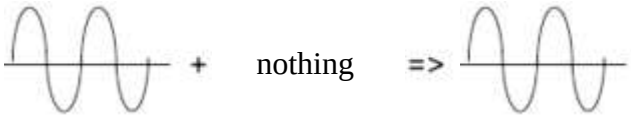
Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
23	**(a)**	Total momentum before = 0 (kg m s^{-1}) **(½)** Total momentum after = $m_X v_X + m_Y v_Y$ **(½)** = (0·70 × 0·51) + (0·30 × -1·19) **(½)** = 0 (kg m s^{-1}) **(½)** (same answers)	units are not required here, but deduct **(½)** if wrong units given. **not** $m_X v_X - m_Y v_Y$ If $m_X v_X$ and $m_Y v_Y$ are worked out separately, marks are only awarded if one is <u>negative</u> and they are <u>combined</u>.	**2**	**7**
	(b) (i)	$½mv^2 = mgh$ **(½)** ½ × 0·25 × v^2 = 0·25 × 9·8 × 0·15 **(½)** v = 1·7 (m s^{-1}) **[MUST BE SHOWN]**	Must have both formulas somewhere to get first **(½)**, otherwise **(0)**. Unit not required here, but deduct **(½)** if wrong unit given.	**1•**	
	(ii)	<u>Total</u> momentum before = <u>Total</u> momentum after **(½)** 0·05u + 0 = (0·20 + 0·050) × 1·7 **(½)** u = 0·25 × 1·7/0·05 u = 8·5 m s^{-1} **(1)**	Must have 'total' on both sides. If a candidate forgets to add the mass of the dart (0·050 kg), they will get u = 6·8 m s^{-1} as their answer. This gets a max of **(½)** for the full formula, <u>but only if it is written down</u>.	**2•**	
	(iii)	Change in momentum of the dart is greater. **(½)** Impulse given to the block is greater. **(½)** Velocity of the block is greater. **(½)** Block has greater kinetic energy. **(½)** (Therefore the block swings higher)	**or** 'impulse on dart greater' **or** 'momentum of block greater' Candidate needs either of the first two **(½)** marks to gain access to the last two **(½)**s. These are then independent.	**2+**	

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
24	**(a) (i)**	$P_1V_1 = P_2V_2$ **(½)** $1{\cdot}01 \times 10^5 \times 5 \times 10^{-4}$ $= P_2 \times 1{\cdot}25 \times 10^{-4}$ **(½)** $P_2 = 4{\cdot}04 \times 10^5$ Pa **(1)**	If the full gas law relationship is used, any substitution must have 'T' in kelvin for more than the first **(½)** to be awarded.	**2**	**7**
	(ii)	$\rho = m / V$ **(½)** $\rho = 1{\cdot}45 \times 10^{-3} / 1{\cdot}25 \times 10^{-4}$ **(½)** $\rho = 11{\cdot}6\,\text{kg m}^{-3}$ **(1)**		**2**	
	(iii)	Particles strike the walls **(½)** more often. **(½)** Greater (average) force **(½)** Pressure increases **(½)**	Somewhere in the answer there must be the basic concept of the kinetic model, i.e. particles (or atoms or molecules) colliding with the walls (or syringe or container etc.). This gets first **(½)** and is needed before any other marks can be gained. Any mention of greater velocity or kinetic energy. **(0)** Any mention of harder <u>individual</u> collisions. **(0)**	**2**	
	(b)	remains the same **(½)** neither the mass nor the volume have changed **(½)**	must have this first **(½)** mark first 'm' and 'V' are constant is accepted 'nothing has changed' - is <u>not</u> accepted	**1•**	

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
25	**(a) (i)**	(Extend the line until it cuts vertical axis.) *e.m.f.* = 12 V **(1)**	Deduct **(½)** for wrong or missing units.	**1**	**7**
	(ii)	Gradient = $-r = \frac{(V_2 - V_1)}{(I_2 - I_1)}$ **(½)** $-r = \frac{(6-10)}{(240-80)}$ **(½)** $\left\{\frac{10-6}{240-80}\text{ is wrong}\right\}$ $-r = -0{\cdot}025$ $r = 0{\cdot}025\ \Omega$ **(1)** Alternative methods: using $E = I(R + r)$ (also $E = V + Ir$) $12 = 80\ (0{\cdot}125 + r)$ **(1)** $r = 0{\cdot}025\ \Omega$ **(1)** **OR** $r = \frac{e.m.f.}{I_{short\ circuit}}$ $r = \frac{12}{480}$ **(1)** $= 0{\cdot}025\ \Omega$ **(1)**	**Or** r = − gradient $r = -\frac{(V_2 - V_1)}{(I_2 - I_1)}$ **(½)** $-r = \frac{(6-10)}{(240-80)}$ **(½)** [or other appropriate substitutions] r = 0·025 Ω **(1)** V | I | R 11 | 40 | 0·275 10 | 80 | 0·125 9 | 120 | 0·075 8 | 160 | 0·050 7 | 200 | 0·035 6 | 240 | 0·025 **OR**, $r = V_{(lost)}/I$ $= (12 - 10)/80$ **(1)** [or other appropriate substitutions] $= 0{\cdot}025\ \Omega$ **(1)**	**2**	
	(iii)	$I = \frac{e.m.f.}{r}$ **or** $\frac{E}{r}$ **(½)** $I = \frac{12}{0{\cdot}025}$ **(½)** $I = 480\text{A}$ **(1)**	**Or** consistent with (a)(i) and (a)(ii) Accept $I = \frac{V}{R}$ as long as correct substitution, i.e. by itself it does not get first **(½)**.	**2**	
25	**(b)**	Total resistance in circuit decreases**(½)** Current increases **(½)** Larger value of lost volts**(½)** So less voltage across headlight**(½)** (Therefore headlight dimmer)	Independent **(½)** marks If candidate says voltage "through" or "flowing", then zero marks for whole of part (b). If candidate says current "across", then zero marks for whole of part (b)	**2+**	

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
26	**(a)**	$I_{max} = \frac{V}{R} = \frac{9}{12\times10^{3}} = 7\cdot5\times10^{-4}\text{A}$ Starts at a maximum value of $7\cdot5 \times 10^{-4}$A And gradually falls/decreases until zero.  **(2)**	There are no marks for the calculation - the value must appear correctly on the graph. Must have the correct shape of curve and at least one identifying label on axes to access any marks. Max **(2)**, then deduct **(½)** for: - origin not labelled - max current value wrong - line not starting at max current value or not on vertical axis - line not finishing on time axis (e.g. crossing the axis or curving up again) - missing unit for current [minimum mark is **(0)]**	**2**	**8**
	(b)	Electrons flow in all the wires because they are repelled from negative terminal of power supply to bottom/one plate of the capacitor and they are attracted off the top/other plate towards positive terminal of power supply.	Any description of electrons going through the insulator (or dielectric) is wrong physics and gets **(0)** marks.	**1**	
	(c)	$V_R = IR$ $V_R = 5 \times 10^{-4} \times 12 \times 10^{3}$ $V_R = 6$ **(½)** $V_C = 9 - 6 = 3$ **(½)** $C = \frac{Q}{V}$ **(½) (stands alone)** $2200\times10^{-6} = \frac{Q}{3}$ $Q = 3 \times 2200 \times 10^{-6}$ **(½)** $Q = 6\cdot6 \times 10^{-3}$ C **(1)**	If there is not an attempt to find V_C from V_S and V_R, then the final **(1½)** marks are not accessible	**3+**	
	(d) (i)	No change AND It only depends on the supply voltage **(1)**	'No change' on its own **(0)**	**1•**	
	(d) (ii)	Maximum current reduces/decreases AND It depends on the supply voltage and series resistance **(1)**	'Maximum current reduces/decreases' on its own gets **(0)**	**1•**	

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
27	**(a) (i)**	(number of divisions = 3) (Y−gain setting = 0·2 V/div) V_p = 0·6 V **(1)**	deduct **(½)** for a demonstrated arithmetic error. deduct **(½)** for any wrong or missing unit.	**1**	**8**
	(ii)	$I_p = \frac{V_p}{R}$ **(½)** $I_p = \frac{0{\cdot}6}{1000}$ **(½)** $= 6{\cdot}0 \times 10^{-4}$ $I_{rms} = I_p/\sqrt{2}$ **(½)** $I_{rms} = \frac{6{\cdot}0\times10^{-4}}{\sqrt{2}}$ **(½)** I_{rms} = 4·2 × 10^{-4} A **(1)**	Or consistent with (a)(i) *Alternative:* $V_{rms} = V_p/\sqrt{2}$ **(½)** $V_{rms} = 0{\cdot}6/\sqrt{2}$ **(½)** = 0·4243 $I_{rms} = \frac{V_{rms}}{R}$ **(½)** = 0·4243/1000 **(½)** = 4·2 × 10^{-4} A **(1)**	**3•**	
	(iii)	$V_{rms} = I_{rms} \times R_{total}$ **(½)** = 4·2 × 10^{-4} × (2200 + 1000) **(½)** = 1·3 V **(1)**	*Alternative:* V_{rms} across 2200 Ω resistor $= I_{rms} \times 2200$ **(½)** = 4·2 × 10^{-4} × 2200 = 0·9 Total V_{rms} = 0·4 + 0·9 **(½)** = 1·3 V **(1)**	**2•**	
27	**(b)**	Inverted **(½)** Square waves **(1)** at 12 to 15 V **(½)**	**or** consistent with (a)(i) - <u>not</u> a clipped sine wave There should be three half cycles but accept a minimum of two half cycles – else **(0)**. For only two half cycles or anything more than three – deduct **(½)**, i.e. max mark is then **(1½)**.	**2+**	

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
28	**(a)**	$d \sin\theta = n\lambda$ **(½)** $5{\cdot}0 \times 10^{-6} \sin\theta = 3 \times 589 \times 10^{-9}$ **(½)** $\theta = 21^{o}$ **(1)**	deduct **(½)** for wrong or missing units	**2**	**6**
	(b) (i)	Path difference = 500 − 425 Path difference = 75 mm **(½)** number of wavelengths 75/30 number of wavelengths 2·5 **(½)** Destructive interference **(1)** Look for this first – must be this (or a demonstrated arithmetic error) for any marks. A demonstrated arithmetic error could allow **(1½)** marks to be awarded.	If there is no calculation shown – no marks can be awarded. do not accept "a minimum" **or** 'deconstructive'. Must be 'destructive' to gain any marks (unless there is a demonstrated arithmetic error).	**2•**	
	(ii)	increases **(1)** (dest.) interference no longer occurs. **(1)** **OR** /'now only one set of waves, so they cannot cancel out'/suitable diagram e.g. before:  after:  nothing	- look for this first There must be an attempt at a justification (and not wrong Physics) to get first mark.	**2+**	

Question		Sample Answers and Mark Allocation		Notes	Inner Margin	Outer Margin
29	**(a)**	$\sin\theta_1 / \sin\theta_2 = n$	**(½)**	this mark anywhere in part(a)	**2•**	**4**
		$n = 1{\cdot}615$	**(½)**	this mark is awarded anywhere (e.g. the value might appear in the substitution)		
		$\sin\theta_1 / \sin 38^o = 1{\cdot}615$	**(½)**	if there is a wrong value for n here, then max **(½)** for formula if it is shown (e.g. in first line of answer)		
		$\theta_1 = 83{\cdot}9^o$	**(½)**	deduct **(½)** for wrong or missing units		
	(b)	Refractive index larger.	**(½)**	Must have v_g smaller, else **(0)** (You cannot justify a wrong answer)	**2+**	
		$v_{air} / v_{glass} = {}_a n_g$ **or** $n = v_1/v_2$ **or** "there is a greater decrease/change in speed"	**(½)**			
		$v_{(glass)}$ smaller	**(1)**	- look for this first - it stands alone Do not accept up and down arrows. If a candidate uses $v = f\lambda$ and says "v is smaller because is λ smaller and f is constant on refraction" – this is wrong Physics in this situation.		

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
30	**(a) (i)**	$E_k = hf - hf_0$ **(½)** $E_k = (6{\cdot}63\times10^{-34}\times6{\cdot}74\times10^{14}) - 3{\cdot}78\times10^{-19}$ **(½)** $E_k = 6{\cdot}89\times10^{-20}$ J **(1)** Accept $6{\cdot}9\times10^{-20}$ $6{\cdot}89\times10^{-20}$ $6{\cdot}886\times10^{-20}$ $6{\cdot}8862\times10^{-20}$	"$E = hf$" on its own **(0)**	**2•**	**6**
	(ii)	$E_k = ½\ mv^2$ **(½)** $v^2 = \frac{2\times6{\cdot}9\times10^{-20}}{9{\cdot}11\times10^{-31}}$ **(½)** $v = 3{\cdot}89\times10^5$ m s^{-1} **(1)**	**Or** consistent with (a)(i)	**2**	
	(b)	The maximum velocity remains the same **(1)** one photon releases one electron **(½)** each photon has same energy as before **(½)**	- look for this first Do not accept a statement such as 'changing the irradiance has no effect on the rate of emission of photoelectrons'. The candidate must explain <u>why</u> this is true in order to gain the second two **(½)** marks.	**2+**	

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
31	**(a)**	6 **(1 or 0)**		**1**	**7**
	(b)	Q_3 to Q_2 **(1 or 0)** accept $Q_3 \longrightarrow Q_2$	<u>do not accept</u>: Q_2 to Q_3 Q_3 — Q_2 or 'between Q_3 and Q_2'	**1**	
	(c)	P_2 to P_0 $\Delta E = (21{\cdot}8 - 2{\cdot}4) \times 10^{-19}$ $= 1{\cdot}94 \times 10^{-18}$ (J) **(1)** $E = h f$ and $v = f\lambda$ **(½)** $E = h\frac{v}{\lambda}$ $\lambda = \frac{hv}{E}$ $\lambda = \frac{6{\cdot}63 \times 10^{-34} \times 3 \times 10^{8}}{1{\cdot}94 \times 10^{-18}}$ **(½)** $\lambda = 1{\cdot}03 \times 10^{-7}$ m **(1)**	- this **(½)** mark anywhere	**3•**	
	(d) (i)	Energy gap <u>same</u> size **(½)** Frequency of light emitted is same **(½)**	not 'similar' independent **(½)** marks	**1**	
	(ii)	(P_2 to P_1 is brighter because) <u>more</u> electrons make this transition <u>per second</u> **(½)** and so more photons are emitted per second **(½)**	'<u>per second</u>' (or another description of **rate**) needs to be mentioned at least once, otherwise maximum of **(½)**.	**1**	

[END OF MARKING INSTRUCTIONS]