2007 Physics

Higher

Finalised Marking Instructions

Scottish Qualifications Authority

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 answer 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.

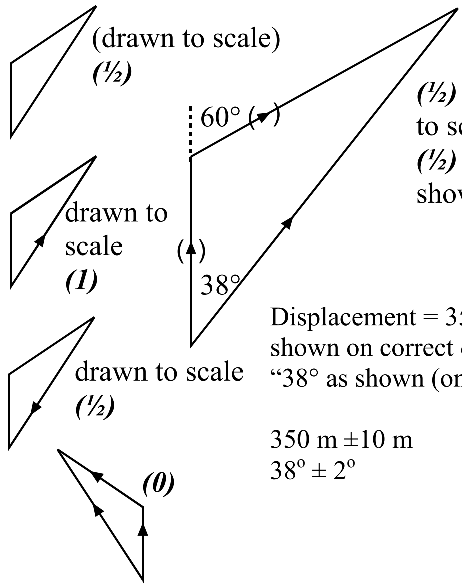
	Answers	Mark +comment	Issue
1.	V=IR 7·5=1·5R R=5·0Ω	(½) (½) (1)	Ideal Answer
2.	5·0Ω	(2) Correct Answer	GMI 1
3.	5·0	(1½) Unit missing	GMI 2(a)
4.	4·0Ω	(0) No evidence/Wrong Answer	GMI 1
5.	_____Ω	(0) No final answer	GMI 1
6.	$R=\frac{V}{I}=\frac{7{\cdot}5}{1{\cdot}5}=4{\cdot}0\Omega$	(1½) Arithmetic 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 7·5 = 1·5 × R R=0·2Ω	(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

2007 Physics Higher

Marking scheme

Section A

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

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
21. (a) 1 cm: 50 m  *(½)* for correct diagram to scale, length and angle *(½)* for adding correctly showing resultant direction *(½)* *(½)* Displacement = 350 m at 038 / 38° E of N / shown on correct diagram "38° as shown (on diagram)" 350 m ±10 m 38° ± 2°	*(½)* $a^2 = b^2 + c^2 - 2bc.\cos A$ $= 150^2 + 250^2 -$ $(2 \times 150 \times 250 \times \cos 120°)$ a = 350 m *(½)* $\frac{a}{\sin A} = \frac{b}{\sin B}$ $\frac{350}{\sin 120°} = \frac{250}{\sin B}$ *(½)* B = 38° E of N *(½)* 038(°) watch for 400 sin60 = 346m *(0)* Can add rectangular components to get answer	2	7
(b) *(½)* *(½)* *(½)* *(½)* $v = \frac{s}{t} = \frac{350}{66} = 5{\cdot}3\ ms^{-1}$ at 038 *(°)*	's' or 'd' acceptable Direction as (a) Or correct answer (038)	2	
(c) $v = \frac{s}{t}$ *(½)* $6{\cdot}5 = \frac{400}{t}$ *(½)* $t = \frac{400}{6.5} = 61{\cdot}5$ (s) *(½)* (62) *(½)* Car y arrives first.	Symbol 's' or 'd' acceptable No calculation *(0)* or Av. Speed of x: $v = \frac{d}{t}$ *(½)* $= \frac{400}{66}$ *(½)* $= 6 \cdot 1 (ms^{-1})$ *(½)* Car y arrives first *(½)*	2•	
(d) *(½)* *(½)* 350 m at 218 218 SW (0) 38 W of S *(½)* -350m at 218 *(½)* -350m *(½)* -350m at 038 *(½)*	or Consistent with (a) If measured from a correct diagram, accept 218 ± 2	1•	

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Sample Answer and Mark Allocation	**Notes**	Inner Margin	Outer Margin
22. (a) Component of weight = $mg\sin\theta$ *(½)* = $60 \times 9{\cdot}8 \times \sin22(^{\circ})$ = 220 (N) *(½)*	use g = 10 or 9·81 deduct *(½)* 200, 220·3 accept 220·27 deduct *(½)*	1	7
(b) Unbalanced force = 220 – 180 = 40 N *(1)* $a = \frac{F}{m}$ *(½)* ← anywhere consistent with wrong (a), max *(1½)* $= \frac{40}{60}$ *(½)* = 0·67 (m s^{-2})	<u>Must</u> show unbalanced force a = 220/60 can get *(½)* max final line required - otherwise deduct *(½)*	2•	
(c) $v^2 = u^2 + 2as$ *(½)* Max *(½)* if 'a' not 0·67 = 0 + (2 × 0·67 × 50) *(½)* v = 8·2 m s^{-1} *(1)* (8·185) (8·19) (8) or $E_w = E_k$ $F_us = ½ mv^2$ *(½)* $40 \times 50 = ½ \times 60 \times v^2$ *(½)* v = 8·2 ms^{-1} *(1)*	*(½)* for all 3 formulae *(½)* for all substitutions E_p = mgh = 60 × 9·8 × 18·7 = 11013 J E_w = F.s = 180 × 50 = 9000 J E_k = 2013 J = ½ mv^2 v = 8·2 m s^{-1} *(1)*	2	
(d) Smaller mass → smaller component of weight → smaller unbalanced force → smaller acceleration (not "slower acc") → smaller speed at the bottom of the slope Speed less *(½)* E_p less, E_w against friction, same, E_k less *(½)* But E_p less, E_k less, speed less *(½)*	Must have smaller speed − look for this first, otherwise *(0)* Force down slope/force parallel to slope − not "smaller weight" 4 × *(½)* 3 independent *(½)*'s Can do calculation with a smaller mass − look for conclusion first if wrong *(0)*	2+	

2007 Physics − Higher			
Sample Answer and Mark Allocation	**Notes**	Inner Margin	Outer Margin
Energy argument $E_k = E_p - Fd$ $\frac{1}{2} m_1 v_1^2 = m_1gh - Fd \qquad \frac{1}{2} m_2v_2^2 = m_2gh - Fd$ larger $v_1^2 = 2gh - \frac{2Fd}{m_1} \qquad v_2^2 = 2gh\ m_2 = \frac{2Fd}{m_2}$ smaller so $v_2^2 < v_1^2 \quad \rightarrow \quad v_2 < v_1$			

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
23. (a) $P_1V_1 = P_2V_2$ ***(½)*** $750 \times 8{\cdot}0 \times 10^{-2} = 125 \times V$ ***(½)*** $V = 0{\cdot}48\ m^3$ ***(1)***		2	6
(b) Volume of gas available = 0·48 – 0·08 = $0{\cdot}40\ m^3$ ***(1)*** Number of balloons = $\dfrac{0 \cdot 40}{0 \cdot 02}$ = 20 (balloons) ***(1)***	no. = $\dfrac{0 \cdot 48}{0 \cdot 02}$ = 24 ***(0)*** but if followed by 0·08 in cylinder = 4 ***(1)*** so 24 – 4 = 20 ***(1)***	2+	
(c) • As <u>mass</u> of the helium gas is <u>constant</u> from the cylinder into the balloons, • then as the <u>volume increases</u>, • and as density = $\dfrac{mass}{volume}$, $\rho = \dfrac{m}{v}$ • then <u>density</u> must <u>decrease</u> in the balloons. OR As pressure has decreased, • Number of collisions **per second** decreases ***(½)*** • Fewer molecules per **unit volume** ***(½)*** • density = $\dfrac{mass}{volume}$ ***(½)*** } 4 × ***(½)*** • Density decreases ***(½)***	Must have density <u>decreases</u> or ***(0)*** 3 statements are independent 4 × ***(½)*** density decreases ***(½)*** as P = ρgh ***(0)*** if argued in converse, must then explicitly say that 'original density in cylinder is greater'.	2 +	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
24. (a) At A, $E_k = \frac{1}{2} mv^2$ ***(½)*** $= \frac{1}{2} \times 6{\cdot}64 \times 10^{-27} \times (2{\cdot}60 \times 10^6)^2$ ***(½)*** $= 2{\cdot}24 \times 10^{-14}$ (J) ***(½)*** Increase in E_k = work done between the plates $= 3{\cdot}05 \times 10^{-14} - 2{\cdot}24 \times 10^{-14}$ ***(½)*** $= 8{\cdot}1 \times 10^{-15}$ (J)	Must show squaring in 2nd line − otherwise ***(½)*** final line required - otherwise deduct ***(½)*** - $8{\cdot}1\times10^{-15}$ J W.P. ***(½)*** so ***(1½)*** max	2•	6
(b) $W = QV$ ***(½)*** $8{\cdot}1 \times 10^{-15} = 3{\cdot}2 \times 10^{-19} \times V$ ***(½)*** $V = 2{\cdot}5 \times 10^4$ V ***(1)*** Acceptable sig. fig. 25310V, 25300V	$E_{(w)} = QV$ acceptable Must use $8{\cdot}1\times10^{-15}$ J - otherwise ***(½)*** max Deduct ***(½)*** for 25312 V 25313 V	2	
(c) (Same p.d.) But the charge is smaller ***(½)*** } independent → less work is done ***(½)*** } → smaller (increase in) kinetic energy ***(1)***	Look for conclusion first E_k less, then …. 'Smaller mass' is irrelevant. Can be done by calculation but must have final statement	2+	

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Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
25. (a) $E = 12\ \text{V}$ ***(1)***	Deduct ***(½)*** for no units	1•	6
(b) (i) $E = V + Ir$ ***(½)*** $12 = 9{\cdot}6 + (I \times 2{\cdot}0)$ ***(½)*** $2{\cdot}4 = I \times 2{\cdot}0$ $I = \dfrac{2{\cdot}4}{2{\cdot}0} = 1{\cdot}2\ \text{A}$ ***(1)***	Lost volts = Ir ***(½)*** $(12 - 9{\cdot}6) = 2I$ ***(½)*** $I = 1{\cdot}2\ \text{A}$ ***(1)*** <u>or</u> consistent with (a) $v = IR$ ¦ $V = IR$ $2{\cdot}4 = I \times 2$ ¦ $9{\cdot}6 = I \times 2$ $I = 1{\cdot}2\text{A}$ ***(2)*** ¦ $I = 4{\cdot}8\ \text{A}$ ***(0)***	2•	
(ii) $R = \dfrac{V}{I} = \dfrac{9{\cdot}6}{1{\cdot}2} = 8\ \Omega$ ***(1)***	<u>or</u> consistent with b(i) If negative in final answers, deduct ***(½)***	1	

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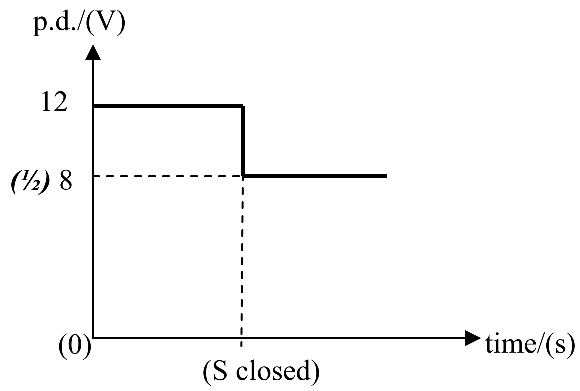
Sample Answer and Mark Allocation | **Notes** | Inner Margin | Outer Margin

Question 25 (continued)

(c)



(½) – shape <u>and</u> 12V or consistent with (a)

(1) – 8 calculation

(½) – 8 on graph

Partial marks:

Must have at least labels on axes of V and t − otherwise deduct ***(½)***

Check graph − if all values correct then ***(2)***

Check calculations − go on to allow other than 8V only if consistent with (a) and (b) (ii) or arith error

R = 4 (Ω) ***(½)***

I = 1·2 (A) ***(0)*** W.P. stop

V = 4·8V

Could get ***(1)*** with no graph

Notes:

$R_{ext} = 4\ \Omega$ ***(½)***

$E = I\,(R_{ext} + r)$

$12 = I\ (4 + 2)$

$I = 2\ A$ ***(½)***

$V = IR$

$= 2 \times 4$

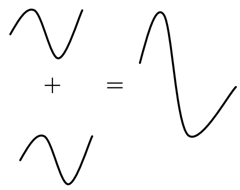
$= 8\ (V)$

Copy original shape and values - max ***(½)***

Inner Margin: 2+

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
26 (a) $I = \frac{V}{R}$ ***(½)*** $= \frac{12}{480000}$ ***(½)*** $= 2{\cdot}5 \times 10^{-5}$ A ***(1)***	Wrong power of 10 − deduct ***(½)***	2	7
(b) $V_C = 12 - 3{\cdot}8 = 8{\cdot}2$ V ***(1)*** $Q = CV$ ***(½)*** independent $= 2200 \times 10^{-6} \times 8{\cdot}2$ ***(½)*** $= 1{\cdot}8 \times 10^{-2}$ C ***(1)*** (accept $1{\cdot}804 \times 10^{-2}$ C)	max (½) if 3.8 or 12 used for V if to be treated as arith error, <u>must</u> show subtraction	3+	
(c) $E = \frac{1}{2} CV^2$ ***(½)*** $= \frac{1}{2} \times 2200 \times 10^{-6} \times 12^2$ ***(½)*** $= 0{\cdot}16$ J ***(1)*** (accept 0.1584 J) Prefix error: Once per prefix in each question ie value of R in (a) value of C in (b) or (c)	$Q = CV$ $= 2200 \times 10^{-6} \times 12$ $= 2{\cdot}64 \times 10^{-2}$ C $E = \frac{1}{2} QV$ ***(½)*** $= \frac{1}{2} \times 2{\cdot}64 \times 10^{-2} \times 12$ ***(½)*** $= 0{\cdot}16$ J ***(1)*** ***(½)*** – both formulae ***(½)*** – both substitutions	2	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
27. (a) $\frac{X}{R_{Th}} = \frac{Y}{Z}$ ***(½)*** $\frac{2200}{R_{Th}} = \frac{5000}{750}$ ***(½)*** $R_{Th} = 330\ \Omega$ ***(1)***	But $R_1/R_2 = R_3/R_4$ acceptable	2	7
(b) (i) Differential (mode) ***(1)***	Difference mode ***(0)***	1	
(ii) As temperature decreases: 1st statement { • voltage across 2 decreases • voltage at Q decreases • voltage across thermistor increases } • potential at Q decreases • potential difference between P and Q increases • amplified (by the op amp) • MOSFET/transistor switches on/conducts when voltage reaches threshold/certain/sufficiently high voltage But <u>not</u> "at 0·7V"	4 × ***(½)*** independent ***(½)***'s ***(½)*** instead of first 2 (½ marks) • Bridge out of balance causes p.d. ie if this ans then • amplified by op amp • MOSFET on (max 1½) Voltage "flowing" loses the ***(½)*** each time	2+	
(iii) $V_o = \frac{R_f}{R_1}(V_2 - V_1)$ ***(½)*** $3{\cdot}0 = \frac{100}{40}(V_2 - V_1)$ ***(½)*** $3{\cdot}0 = 2{\cdot}5 \times V_{PQ}$ $V_{PQ} = 1{\cdot}2\ V$ ***(1)***	$V_o = -\frac{R_f}{R_1}(V_1 - V_2)$ accept Watch for inverting mode equation W.P. ***(0)*** Unless using it twice and subtracting answers to get difference $V_{PQ} = (V_2 - V_1)$ accept	2	

2007 Physics − Higher Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
28. (a) maximum - constructive interference bigger crest and bigger trough bigger amplitude Waves meet - in phase / in step ***(1)*** or crest & crest <u>and</u> trough & trough or path difference is nλ	Waves <u>must</u> "meet"/"combine"/ "overlap" Or by diagram 	1	8
(b) (i) (A) Mean AB = $\frac{1\cdot11+1\cdot08+1\cdot10+1\cdot13+1\cdot11+1\cdot07}{6}$ $= \frac{6\cdot60}{6}$ = 1·10 m ***(1)***	Deduct ***(½)*** if no unit 1·1m ***(1)*** 1m ***(0)*** outwith range	1•	
(B) Random uncertainty = $\frac{1\cdot13-1\cdot07}{6}$ = 0·01 m ***(1)***	Do not deduct ***(½)*** for no unit in <u>both</u> A and B	1•	
(ii) $\% AB = \frac{0\cdot01}{1\cdot10} (\times 100) = 0\cdot9\,\%$ ***(½)*** ***(½)*** $\% BC = \frac{10}{270} (\times 100) = 3\cdot7\,\%$ ***(½)*** ***(½)*** (BC has the larger percentage uncertainty) Must have percentage answers	Missing "%" − deduct ***(½)*** <u>once</u>	2•	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
Question 28 (b) continued			
(iii) $n\lambda = d \sin\theta$ ***(½)***	Uncertainty must be consistent decimal places or deduct ***(½).***		
$2 \text{ x } \lambda = 4{\cdot}00 \times 10^{-6} \times \dfrac{0{\cdot}270}{1{\cdot}10}$ ***(½)***	4% of $4{\cdot}91 \times 10^{-7}$ $= 0{\cdot}20 \times 10^{-7}$ m		
$\lambda = 4{\cdot}91 \times 10^{-7}$ (m) ***(½)***	$4{\cdot}91 \times 10^{-7} \pm 3{\cdot}7\%$ (max ***1½***)		
$3{\cdot}7\%$ of $4{\cdot}91 \times 10^{-7} = 0{\cdot}18 \times 10^{-7}$ ***(½)***	$(4{\cdot}9 \pm 0{\cdot}2) \times 10^{-7}$ m		
$\lambda = (4{\cdot}91 \times 10^{-7} \pm 0{\cdot}18 \times 10^{-7})$ m ***(1)*** $\pm\ 1{\cdot}8 \times 10^{-8}$	$4{\cdot}91 \times 10^{-7}$ m $\pm\ 0{\cdot}18 \times 10^{-7}$ m	3+	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
29. (a) $\frac{\sin\theta_1}{\sin\theta_2} = n$ ***(½) or*** $\frac{\sin\theta a}{\sin\theta g}$ $\frac{\sin 50^{(\circ)}}{\sin\theta_2} = 1{\cdot}50$ **(½)** $\theta_2 = 31^\circ$ **(1)** $(30\cdot 7^\circ)$	$\frac{\sin 40}{\sin\theta_2} = 150$ $\Rightarrow\ \theta_2 = 25\cdot 4^\circ$ ***(½)*** for formula deduct ***(½)*** if degree sign missing in final answer	2•	5
(b) $n = \frac{\lambda_1}{\lambda_2}$ ***(½)*** $\quad \frac{\sin\theta_1}{\sin\theta_2} = \frac{\lambda_1}{\lambda_2}$ $1{\cdot}50 = \frac{\lambda_1}{420}$ ***(½)*** $\quad \frac{\sin 40}{\sin 25\cdot 4} = \frac{\lambda_1}{420}$ $\lambda_1 = 1{\cdot}50 \times 420$ $\quad \lambda_1 = 625\text{nm}$ ***(2)*** $= 630$ nm ***(1)*** $\quad$ if 40° used also in (a)	$\frac{\sin\theta_1}{\sin\theta_2} = \frac{\lambda_1}{\lambda_2}$ ***(½)*** $\frac{\sin 50}{\sin 31} = \frac{\lambda_1}{420}$ ***(½)*** $\lambda_1 = 625\text{nm}$ ***(1)*** or consistent with (a)	2	
(c) Blue light has a $\left\{\begin{array}{l}\text{higher/larger frequency}\\\text{different frequency}\end{array}\right\}$ ***(½)*** due to $\left\{\begin{array}{l}\text{a different refractive index}\\\text{a larger refractive index}\\\text{refracts more}\\\text{refracts at greater/different angle}\end{array}\right\}$ ***(½)***	independent ***(½)'s*** not 'bends' not 'different path' (in question)	1+	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
30. (a) $f = \frac{v}{\lambda}$ ***(½)*** $= \frac{3\times10^{8}}{605\times10^{-9}}$ ***(½)*** $(= 4{\cdot}96 \times 10^{14}$ Hz$)$ $E = h f_{(o)}$ ***(½)*** independent $= 6{\cdot}63 \times 10^{-34} \times 4{\cdot}96 \times 10^{14}$ ***(½)*** $= 3{\cdot}29 \times 10^{-19}$ (J) OR $E = h\frac{v}{\lambda}$ ***(1)*** $= \frac{6\cdot63\times10^{-34}\times3\times10^{8}}{605\times10^{-9}}$ ***(1)*** $= 3{\cdot}29 \times 10^{-19}$ (J)	final line required - otherwise deduct ***(½)*** If: $E = hf_{(0)}$ $= 6{\cdot}63 \times 10^{-34} \times 4{\cdot}96 \times 10^{14}$ $= 3{\cdot}29 \times 10^{-19}$J ie frequency has just 'appeared' − max ***(½)*** for equation	2•	5
(b) (i) $E_k = 5{\cdot}12 \times 10^{-19} - 3{\cdot}29 \text{ x } 10^{-19}$ $= 1{\cdot}83 \times 10^{-19}$ J ***(1)***	Negative answer W.P. ***(0)***	1•	
(ii) Current/Ammeter reading decreases ***(1)*** Irradiance decreases: • fewer photons hitting plate per second ***(½)*** • fewer electrons released/one electron per photon ***(½)*** • Rate required for 2 marks Max ***(1½)*** if this is not mentioned anywhere in the answer • If go on after correct answer with W.P. then deduct ***(½)***	Look for A reading first. I α I not justified Ignore intensity (the word) I = Nh*f* − on own ***(0)*** Less radiation on plate ***(0)***	2+	

(½)

2007 Physics − Higher Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
31. (a) Decrease in mass = $398{\cdot}626 \times 10^{-27} - (391{\cdot}970 \times 10^{-27} + 6{\cdot}645 \times 10^{-27})$ ***(½)*** $= 1{\cdot}1 \times 10^{-29}$ (kg) ***(½)*** $E = mc^2$ ***(½)*** independent $= 1{\cdot}1 \times 10^{-29} \times (3 \times 10^8)^2$ ***(½)*** $= 9{\cdot}9 \times 10^{-13}$ J ***(1)***	If truncated mass values used, then max (½) for $E = mc^2$. If don't show square value $E = 1{\cdot}1 \times 10^{-29} \times 3 \times 10^8$ - then max ***(1½)*** $E = mc^2$ before and after and then subtract energies without rounding can get ***(3)***	3	6
(b) $(D = \dot{D}\,t)$ $= 4{\cdot}0 \times 10^{-6} \times 2$ ***(½)*** $= 8{\cdot}0 \times 10^{-6}$ (Gy) ***(½)*** $H = D\,w_R$ ***(½)*** anywhere $= 8{\cdot}0 \times 10^{-6} \times 3$ ***(½)*** $= 2{\cdot}4 \times 10^{-5}$ Sv ***(1)*** = (24 μSv) or $\dot{H} = \dot{D}\,W_R$ ***(½)*** $= 4 \times 3$ ***(½)*** $= 12\ \mu Svh^{-1}$ ***(½)*** $\dot{H} = \frac{H}{t}$ $12 = \frac{H}{2}$ ***(½)*** $H = 24\ \mu Sv$ ***(1)***	All ($\times 10^{-6}$) terms may be omitted and final answer given in μSv. $H = D.W_R$ anywhere ***(½)*** $H = D.W_R$ ***(½ max)*** $= 4 \times 10^{-6} \times 3$ (WP) Can change to seconds, but if only change one quantity then ***(2½)*** max - gives $H = 1{\cdot}7 \times 10^{-1}$ Sv Accept $\left.\begin{matrix}Q\\W\end{matrix}\right\}$ Instead of W_R	3	

[END OF MARKING INSTRUCTIONS]