2006 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 NOT 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.	$R=\frac{V}{I}=\frac{7\cdot5}{1\cdot5}=4\cdot0\Omega$	(1½) Arithmetic error	GMI 7
7.	$R=\frac{V}{I}=4\cdot0\,\Omega$	(½) Formula only	GMI 4 and 1
8.	$R=\frac{V}{I}=$_____Ω	(½) Formula only	GMI 4 and 1
9.	$R=\frac{V}{I}=\frac{7\cdot5}{1\cdot5}=$_____Ω	(1) Formula + subs/No final answer	GMI 4 and 1
10.	$R=\frac{V}{I}=\frac{7\cdot5}{1\cdot5}=4\cdot0$	(1) Formula + substitution	GMI 2(a) and 7
11.	$R=\frac{V}{I}=\frac{1\cdot5}{7\cdot5}=5\cdot0\Omega$	(½) Formula but wrong substitution	GMI 5
12.	$R=\frac{V}{I}=\frac{75}{1\cdot5}=5\cdot0\Omega$	(½) Formula but wrong substitution	GMI 5
13.	$R=\frac{I}{V}=\frac{7\cdot5}{1\cdot5}=5\cdot0\Omega$	(0) Wrong formula	GMI 5
14.	V=IR 7·5 = 1·5 x R R=0·2Ω	(1½) Arithmetic error	GMI 7
15.	V=IR $R=\frac{I}{V}=\frac{1\cdot5}{7\cdot5}=0\cdot2\Omega$	(½) Formula only	GMI 20

2006 Physics Higher

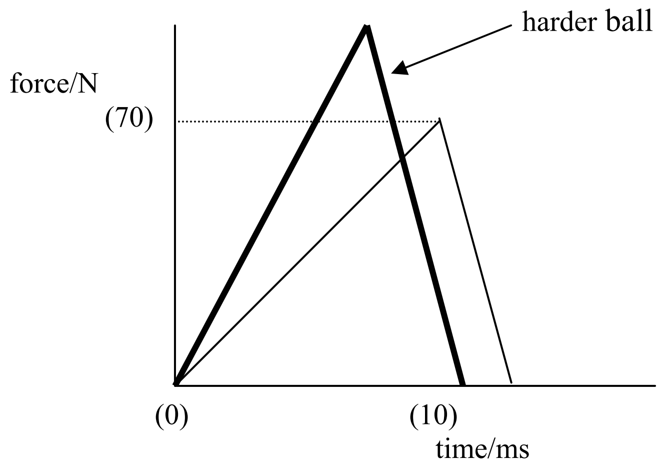
Marking scheme

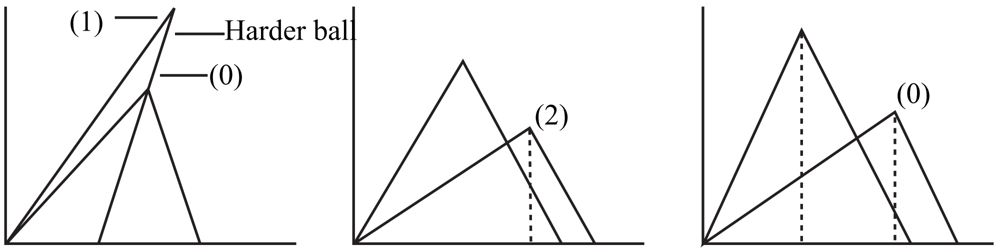
Section A

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

2006 Physics - Higher

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
21. (a) Component = mgsinθ *(½)* $= 2600 \times 9 \cdot 8 \times \sin 12^0$ *(½)* $= 5 \cdot 3 \times 10^3$ N or $5 \cdot 298 \times 10^3$ N *(1)* 5297·6N *(-½)* (5298 N) Rounding 5000 N *(1)* mg = 254 80 N *(0)* F = 24080 = 2600a a = 9·3 m s^{-2}	*(-½)* wrong/missing unit g = 10 m s^{-2} *(-½)* (5406N) a = 1·54 m s^{-2}	2	7
(b) Unbalanced force = ma *(½)* Consistent with (a) [5300 – 1400 = 2600 × a 3900 = 2600 × a] *(½)* a = 1·5 m s^{-2} *(1)*		2·	
(c) $v^2 = u^2 + 2as$ *(½)* $= 5^2 + (2 \times 1{\cdot}5 \times 75)$ *(½)* $v^2 = 1420$ (= 250 [$(m\,s^{-1})^2$]) $E_k = 1{\cdot}846 \times 10^6$ J $E_k = ½ mv^2$ *(½)* (anywhere in answer) $= ½ \times 2600 \times 250$ *(½)* $= 3{\cdot}25 \times 10^5$ J *(1)* 3·248<u>19</u> J *(-½)* (sig, figs – 3×10^5 J ⟶ 4 figs if error) **OR** (final) E_k = (orig) E_p + E_k - Work done against friction *(½)* $= mgh + ½ mv^2 - Fd$ *(½)* $= (2600 \times 9{\cdot}8 \times 75\sin 12^0) + (½ \times 2600 \times 5^2)$ $- (1400 \times 75)$ *(1)* = 397319 + 32500 – 105000 $= 3{\cdot}25 \times 10^5$ J *(1)*	If calculate more and use wrong one then treat as wrong substitution If use v = 5 m s^{-1}, formula *(½)* only $E_k = 3{\cdot}25 \times 10^4$ J Watch out for this *(1) 3 correct substitutions* *(½) 2 correct substitutions*	3+	

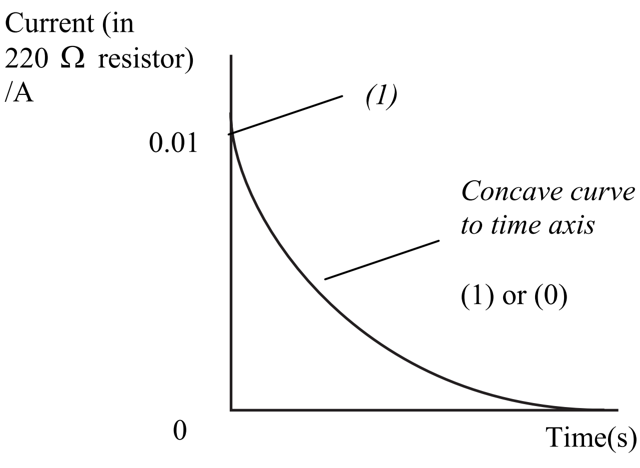
Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
22.(a) (i) Impulse = area under F-t graph ***(½)*** = ½ × 0·010 × 70 ***(½)*** $\frac{0\cdot7}{2}$ Must have 1st line = 0·35 N s Impulse = $\overline{F}t$ ✓ Calculate using rectangles then ***(×½)*** – accept (bad form)	*Two triangles added **(½)*** Impulse = Ft = 0·7 Ns Impulse = $\frac{0\cdot7}{2}$ = 0·35 N s ***(0)*** $[(½\times70\times8)+(½\times70\times2)]\times10^{-3}$ 0·28 +0·07 = 0·35 (N s) ***(-½)*** if last line missing *(– ½) if unit omitted / incorrect*	**1**	**6**
(a) (ii) Change in momentum = 0·35 kg m s^{-1} N s ***(½)*** Upwards ***(½)*** Accept: ↑/ -0·35 kg m s^{-1}/opposite direction/upwards North/ 180° to original direction	0·35 or consistent with units required Independent ***(½)***s 180° ***(0)*** North ***(0)***	**a(i)** **1·**	
(a) (iii) Impulse = mv - mu ***(½)*** 0·35 = 0· 05 (v – (–5·6)) ***(½)*** v = 1·4 m s^{-1} ***(1)*** **OR** ½ Ft = mv - mu ***(½)*** ½ × 70 × 0·002 = 0·05 v - 0 ***(½)*** v = 1·4 m s^{-1} ***(1)***	*Watch use of signs.* Need to use 0·35 N s or consistent with a(ii) V = 12·6 m s^{-1} ***(½)*** max Signs wrong *Watch correct use of* v *and* u. Could get –ve value if consistent	**2·**	
(b)  	*Must identify graphs* – by labels Or values on axis ***(1)*** *force greater than 70 N* ***(1)*** *time less than 10 ms* Independence *Lines may be curved* } Enough to discern difference If graph 1 not drawn then <u>fully</u> detailed graph required – no origin ***(-½)*** – no labels on axis ***(-½)*** – no values ***(0)***	**2+**	

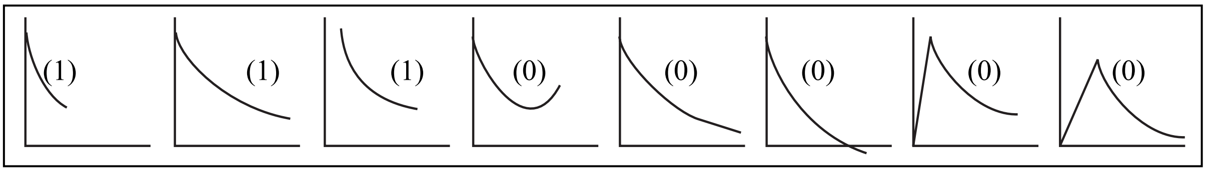
Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
			

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
23.(a) (i) $\frac{P_1(V_1)}{T_1} = \frac{P_2(V_2)}{T_2}$ *(½)* $\frac{1{\cdot}01 \times 10^5}{306} = \frac{9{\cdot}05 \times 10^4}{T_2}$ *(½)* T_2 = 274 K (1 ^{0}C) ***(1)*** 274·19K ***(-½)*** Accept: 270 K 274·2 K 274·188 K *(–½)*	T not Kelvin *(½)* only Values of V - if cancel ok 274·19 K = 1·19 °C *(2)* 274·19 K or 1·19 °C *(2)* 1·2 °C, 1·188 °C } Accept *(2)*	**2**	**10**
(a) (ii) Speed/energy/momentum/E_k of particles in air (air particles/molecules) smaller/decreases *(½)* Collisions with walls less often/<u>frequent</u> *(½)* Collisions with walls less <u>hard</u>/softer/less force/ Δm *(½)* P decreases dependent on 2 or 3 *(½)*	Vibrate/<u>excited</u> ***(0)*** *Must refer to molecular <u>collisions with walls</u>. If not **(½)** max* – with each other ***(0)*** *- one of frequency/force required for last (½)*	**2**	
(b) (i) Downward force = PA *(½)* N.B. <u>show</u> (½) Area (½) For both Pressures (½) For subtractions = 1·01 × 10^5 × 0·30 × 0·20 *(½)* = 6060 (N) Upward force = 9·05 × 10^4 × 0·30 × 0·20 *(½)* = 5430 (N) Resultant force on lid = 6060 - 5430 *(½) show subtraction* = 630 (N)	**OR** Resultant force = ΔPA *(½)* sub A = 0·03 – volume *(½)* max = (1·01 × 10^5 - 9·05 × 10^4) × 0·30 × 0·20 } *1½* Area = 0·06 *(½)* sub of Pressure value *(½)* subtraction *(½)* = 630 (N) Wrong arith, can get *(1½)* *No final line – deduct (½)* *Wrong unit in final line –deduct (½)*	**2**	
(b) (ii) Minimum force = Resultant force + mg = 630 + (1·50 × 9·8) 14·7 = 645 N *(1)* or **(0)** 644·7 N	*Consistent with* (b) (i) 14·7 N *(0)* g = 10 m s^{-2} 645 N *(-½)*	**1·**	
(b) (iii) Air passes <u>into</u> the box *(½)* Pressure inside box is the same as outside/pressure *(½)* Resultant force on the lid is reduced. *(½)* Accept: Increases pressure in box Decrease pressure difference Lower less force to lift lid Pressure difference is zero Equalises pressure	*Any two independent as long as no W.P. Air passes out **(0)*** *Any W.P. **(0)*** Do not accept: Air out Lid pushes off Releases Pressure on container	**1+**	

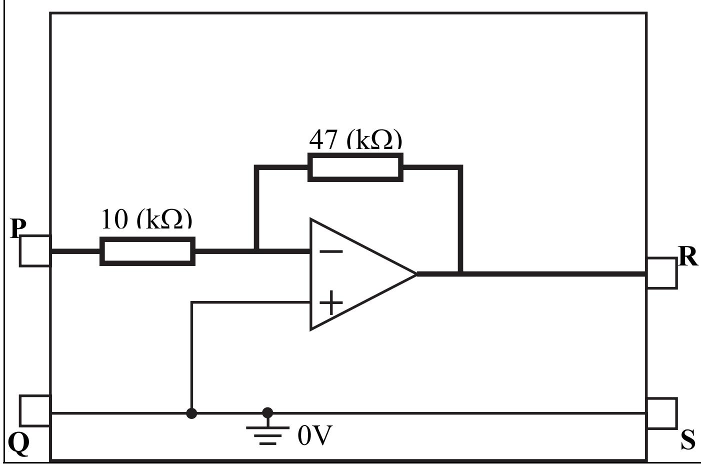
Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
(c) Power required = 0·80 x 12 ***(½)*** = 9·6 (W) ***(½)*** No. panels = 9·6/ 3·4 = 2·8 ***(½)*** Minimum panels = 3 ***(½)***		**2·**	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
24.(a) 200 kJ 200 000 joules of energy transferred to each coulomb of charge. **(1) or (0)** The energy given to a coulomb is 2×10^5 J/200 000 J is transferred by each coulomb passing between P and Q. .	***(-½)*** *if* 200 000 J *not given.* Energy given to each coulomb ***(½)*** 200 000 J on own ***(0)***	**1**	**8**
(b) Protons have a positive (+) charge ***(½)*** **AND** { Charged particles/bodies in an electric field experience a force. **OR** Positive charge travels in direction of the field **OR** Positive charge attracted to negative tube/plate. } ***(½)***	<u>Must</u> have	**1·**	
(c) (i) E or W = QV ***(½)*** $= 1{\cdot}6 \times 10^{-19} \times 200 \times 10^3$ ***(½)*** $= 3{\cdot}2 \times 10^{-14}$ J ***(1)***	Ignore -ve sign for voltage	**2**	
(c) (ii) $\frac{1}{2} mv^2 = W$ ***(½)*** $\frac{1}{2} \times 1{\cdot}673 \times 10^{-27} \times v^2 = 3{\cdot}2 \times 10^{-14}$ ***(½)*** $(v^2 = 3{\cdot}83 \times 10^{13})$ $v = 6{\cdot}2 \times 10^6$ m s^{-1} ***(1)***	*Consistent with* (c) (i) (including -ve) Ignore –ve, but if $v = -6{\cdot}2 \times 10^6$ m s^{-1} ***(1)*** max Omit ***(1)*** max	**2+**	
(d) No effect/none ***(1)*** − look for this first. Can gain this mark if W.P. in explanation Q and V are constant ***(1)*** 'little or no effect' ***(0)***		**2+**	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
25. (a) $V = \frac{R_1}{R_1 + R_2} \times V_s$ *(½)* $= \frac{220}{220+680} \times 9$ *(½)* $= 2{\cdot}2$ V *(1)* Lose final (1) if they go on and do more calculations	I = V/R = 9/900 = 0.01 (A) V = IR = 0.01 X 220 = 2·2 V *Equation used twice for first (½)* *Both substitutions (½)* *Final answer (1)*	**2**	**8**
(b) (i) (As p.d. builds up on the plates) work/force/energy is required to move electrons/charge <u>against</u> the field between the plates/<u>against</u> force due to charge on plates ***(1)*** /against repulsive force of other electrons /energy transferred to the field between the plates	Work needed to move charge <u>against</u>….	**1**	
(b) (ii) $V_c = 2{\cdot}2$ V ***(1)***	*Consistent with* (a)	**1·**	
(b) (iii) Energy = $\frac{1}{2}CV^2$ ***(½)*** Let Vc = 2·9 V Correct as error carried forward $= \frac{1}{2} \times 33 \times 10^{-6} \times 2{\cdot}2^2$ ***(½)*** $= 8{\cdot}0 \times 10^{-5}$ J ***(1)*** ($7{\cdot}986 \times 10^{-5}$ J) Use $10^{-3}/10^{-9}$ for µ ***(-½)***	9V = ***(0)*** $E = 1{\cdot}34 \times 10^{-3}$ J **OR** ½ QV etc (Two equations) *Consistent with* (b) (ii) Cannot use 9V unless carried forward $Q = CV = 33 \times 10^{-6} \times 2{\cdot}2$ $= 726 \times 10^{-5}$C $E = \frac{1}{2} QV = \frac{1}{2} \times 7{\cdot}26 \times 10^{-5} \times 2{\cdot}2 =$ 8×10^{-5} J ***(½)***	**2**	
(b) (iv) 	*Shape correct* ***(1)*** *then* *Curve starting at* 0·01A *on current axis.* ***(1)*** *Consistent with (b) (ii)* *Vc = 9V,* I_{max} *= 0·041A* *Axes not labelled* ***(- ½)*** *Origin omitted* ***(- ½)*** *Allow 'inverted' graph*	**2+**	

Sample Answer and Mark Allocation	Notes	Inner Margi	Outer Margin
			

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
26.(a) (i) $f = \frac{1}{T}$ *(½)* $= \frac{1}{0{\cdot}001 \times 4}$ *(½)* = 250 Hz *(1)*	$F = \frac{\text{No.waves}}{\text{time}}$ (across screen $= \frac{2 \cdot 5}{0 \cdot 01}$ *(1)* = 250 Hz *(1)*	2·	8
(a) (ii) $V_{gain} = \frac{V_0}{V_i}$ *(½)* V_0 and V_i anywhere identified $= - \frac{4{\cdot}5 \times 2}{1{\cdot}5 \times 0{\cdot}5}$ *(½)* *(½)* = - 12 *(½)* `	Range: V_0 = (4·4 to 4·6) × 2 V_i = (1·4 to 1·6) × 0·5 = > V_{gain} = 11 to 13·1 *Unit given* ***(- ½)***	2·	
Correct ratio $\frac{45}{3 \cdot 75} = 12$ *(1)* 45 ***(0)*** (a) (iii) V_0 rms $= \frac{V_0}{\sqrt{2}}$ *(½)* $= \frac{4{\cdot}5 \times 2}{\sqrt{2}}$ *(½)* = 6·36 V *(1)* (6·4) Ignore -ve	V_0 error can be carried forward if ratio method used in a (ii) then must show calculation for V_0 (apart from 9V) Range V_0 = 4·4 to 4·6 = >V_{rms} = 6·22 V to 6·51 V $\frac{1}{\sqrt{2}} = 0 \cdot 7$ V_0 rms = 6·3 V	2	

Sample Answer and Mark Allocation	**Notes**	Inner Margin	Outer Margin
26.(b) (i) 10 (kΩ) and 47 (kΩ) ***(1)* or *(0)*** 10 Ω and 47 Ω ***(½)*** (no values − lose (b)(ii) mark)	*Both answers required* -10 and 47 10 and -47 10 Ω and 47 kΩ ***(0)***	**1·**	
(b) (ii) 	R_f and R_1 Identified from b(i) ok **(1) or (0)** *Consistent with values in* (b) (i) *with larger value in* R_f *position to gain mark.* Wrong/extra wiring/missing connections − would it work? if not ***(0)*** No "box"; P, Q, R,S required	**1+**	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
27.(a) (i) Join/combine/fill/jump into electrons (re)combine with holes at the junction releasing photons ***(1) or (0)***	All 4 words used correctly travel to/meet ***(0)*** Reference to electron-hole pairs ***(0)*** Depletion layer used wrongly ***(0)***	**1**	**9**
(a) (ii) (**A**) $\lambda = {}^{v}/_{f}$ ***(½)*** $= \frac{3 \cdot 0 \times 10^{8}}{6 \cdot 7 \times 10^{14}}$ ***(½)*** $= 4 \cdot 5 \times 10^{-7}$ m ***(1)*** (448 nm) 447·8nm ***(2)*** 447 nm ***(1½)***		**2**	
(a) (ii) (**B**) Colour – Blue/to Blue-violet/indigo ***(1)***	Must be consistent with a(ii) A Violet ***(0)*** blue–green ***(0)***	**1**	
(a) (iii) Photon energy = hf ***(½)*** $= 6 \cdot 63 \times 10^{-34} \times 6 \cdot 7 \times 10^{14}$ ***(½)*** $= 4 \cdot 44 \times 10^{-19}$ (J) ***(1)*** $\left(\begin{array}{c} 4 \cdot 44 \times 10^{-19} \text{ (J) is greater than the work function} \\ \text{of caesium and strontium} \end{array} \right)$ Caesium and strontium both emit photoelectrons ***(1)*** **OR** $f_o = {}^{E}/_{h}$ ***(½)*** Caesium $3 \cdot 4 \times 10^{-19}$ J → $5 \cdot 1 \times 10^{14}$ (Hz) ***(½)*** Strontium $4 \cdot 1 \times 10^{-19}$ J → $6 \cdot 2 \times 10^{14}$ (Hz) ***(½)*** Magnesium $5 \cdot 9 \times 10^{-19}$ J → $8 \cdot 9\ 10^{14}$ (Hz) ***(½)*** $\left(\begin{array}{c} \text{Threshold frequencies of caesium and strontium} \\ \text{are less than } 6 \cdot 7 \times 10^{14} \text{ (Hz)} \end{array} \right)$ Caesium and strontium both emit photoelectrons ***(1)***	no calculation ⟶ ***(0)*** Consistent with unit / arith } error *(½) for any one* *Need all three for conclusion* **(1)**	**3+**	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
(b) $n\lambda = d \sin\theta$ ***(½)*** $2 \times 6{\cdot}35 \times 10^{-7} = 5{\cdot}0 \times 10^{-6} \sin\theta$ ***(½)*** ($\sin\theta = 0{\cdot}254$) $\theta = 14{\cdot}7^{0}$ ***(1)*** Accept $\theta = 15°$ No "°" (-½)	Early rounding $\sin\theta = 0{\cdot}25$ $\theta = 14{\cdot}5°$ ***(-½)***	**2**	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
28. (a) Energy per second/power (incident) square metre/on unit area. ***(1)*** Produced ***(0)*** $I = P/m^2$ ***(0)*** *on own.* $I = P/A$ $I = nhf$ ***(0)*** Watts per square metre (1)	***(1) or (0)*** *Need to define* P *and* m or A *to gain mark.* = Intensity	1	**6**
(b) d 0·20 0·30 0·40 0·50 I 675 302 170 108 Id^2 27·0 27·2 27·2 27·0 ***(1)*** ***(½)*** Accept 27 for all 4 sets Statement: Id^2 = constant **OR** $I \alpha 1/d^2$ ***(½)*** $Id^2 = 27$ **OR** $I_1 d_1^2 = I_2 d_2^2$ **OR** Plot graph I against $1/d^2$ ***(½)*** Values $1/d^2$ 25 11·1 6·25 4 Use <u>all four points</u> to obtain a <u>straight graph through the origin</u>. ***(1)*** Statement: $I \alpha 1/d^2$ **OR** Id^2 = constant ***(½)***	<u>Must</u> use data *Three values* ***(-½)*** *One or two values* Id^2 ***(½)*** *only.* $\sqrt{I}\, d = 5{\cdot}2$ *Plot I – d graph* ***(0)*** *Ignore units − looking for points* *Three points plotted* ***(-½)*** *One or two values* $1/d^2$ ***(½)*** *only.* *Axes omitted* ***(-½)***	2·	
(c) Black cloth absorbs light/ Black cloth prevents reflections (from the bench top) ***(1)*** Reduce glare from bench **OR** Meter receives light only from the bulb. ***(1)***	Cancel { background light ***(0)*** extra light ***(0)***	1+	
(d) (approx.) the same reading. ***(1)*** Laser beam – does not spread out/diverge/is parallel ***(1)*** **OR** Intensity of laser light is the same over a (short) distance Expect reading to be <u>slightly</u> less. ***(1)*** − look for first Laser beam - shows very little divergence ***(1)***	Look for conclusion first Can award mark even if followed by W.P. *Laser beam is very narrow* ***(0)*** *Laser beam is focussed* ***(0)*** Scatter ***(0)***	2+	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
29. (a) (i) Number at X (very) a lot/much larger than Y. ***(½)*** ***(½)*** Need comparison	More/greater/larger ***(½)*** Almost all detected at X ***(1)*** + wrong explanation ***(0)***	**1**	**8**
(a) (ii) Small nucleus compared to volume (size) of atom ***(1)*** /Most of the atom is empty/(space). /Mass of the atom is concentrated in the nucleus. /Nucleus has a positive charge. /atoms have a nucleus Massive nucleus ***(0)*** + compared to $\propto$ ***(1)*** Small nucleus ***(0)*** + compared to size of atom ***(1)***	*Only one answer required.* *Additional incorrect answer* ***(0)***	**1**	

Sample Answer and Mark Allocation	**Notes**	Inner Margin	Outer Margin
29.(b) (i) Induced – because a <u>neutron</u> added ***(1) or (0)*** fired in on LHS of the equation	*No justification* ***(0)***	**1·**	
(b) (ii) ***r*** - 55 ***(½)*** ***s*** - 95 ***(½)***	55, 95 ***(1)*** 95, 55 ***(0)***	**1**	
(b) (iii) Element ***T*** – Rubidium or Rb ***(1)***		**1·**	
(b) (iv) Mass l.h.s. = $(390{\cdot}219 + 1{\cdot}675) \times 10^{-27}$ $= 391{\cdot}894 \times 10^{-27}$ (kg) ***(½)*** Mass r.h.s. = $(227{\cdot}292 + 157{\cdot}562 + (4 \times 1{\cdot}675)) \times 10^{-27}$ $= 391{\cdot}554 \times 10^{-27}$ (kg) ***(½)*** Loss in mass = $0{\cdot}34 \times 10^{-27}$ "defect" (ignore) $= 3{\cdot}4 \times 10^{-28}$ (kg) $E = mc^2$ ***(½)*** $= 3{\cdot}4 \times 10^{-28} \times (3{\cdot}0 \times 10^8)^2$ ***(½)*** $= 3{\cdot}06 \times 10^{-11}$ J ***(1)*** Energy before $= mc^2$ $= 3{\cdot}527046 \times 10^{-8}$ (J) Energy after $= mc^2$ $= 3{\cdot}523986 \times 10^{-8}$ (J) Loss in Energy $= 3{\cdot}06 \times 10^{-11}$ J ***(1)***	Cancelling neutron $(390219 - 389{\cdot}879) \times 10^{-27}$ $= 3{\cdot}4 \times 10^{-28}$ (kg) If mass rounding off before finding loss formula ***(½)*** max. If arith error can get ***(2½)*** eg drop $\times 10^{-27}$ or $3{\cdot}4 \times 10^{-27}$ (in loss mass) ***(½)*** $E = mc^2$ if Δ mass is –ve, max ***(1½)***	**3·**	

[END OF MARKING INSTRUCTIONS]