SCOTTISH
QUALIFICATIONS
AUTHORITY

2004 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 scheme 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.

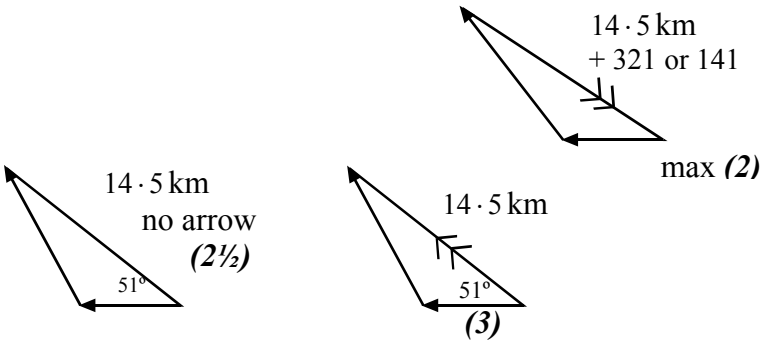
(g) The total mark awarded for an individual question may include an odd half mark - ½. If there is an odd half mark in the total script mark, this is rounded up to the next whole number when transferred to the box on the front of the script.

2004 Physics Higher

Marking scheme

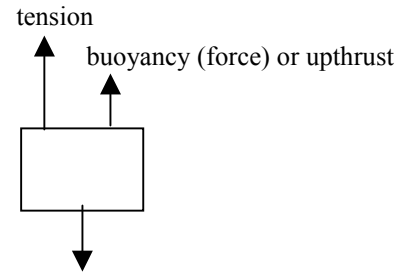
Section A

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

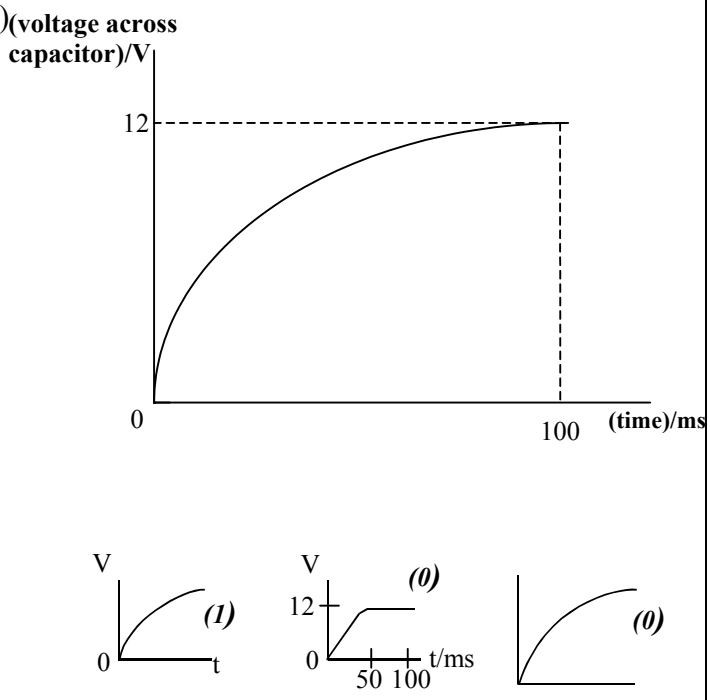
Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
21. (a) speed is a scalar OR has magnitude/size only velocity is a vector OR has speed/size + direction OR vel needs direction ***(1)*** do not accept 'unit'	$\text{speed} = \frac{\text{distance}}{\text{time}}$ ***1*** or ***0*** $\text{vel} = \frac{\text{displacement}}{\text{time}}$ no mention of time ***(0)***	***1***	***9***
(b)(i) distance = 10 x 0·5 ***(½)*** + 8 x 1·5 ***(½)*** = 17 km If give direction ***(0)***	Accept 5 + 12 = 17 km wrong/no unit deduct ***(½)*** no final statement deduct ***(½)***	***1***	
(ii) 14·5 km at 39°W of N or 51° N of W ***(3)*** or 321 (± 0·4 km) and (± 2°) <u>For partial marking look for</u> Scale ***(½)*** or lengths of lines proportional to distances Correct vector addition (arrows not required) ***(½)*** 14·5 km (± 0·4 km) ***(½)*** + ***(½)*** 51° (± 2°) ***(½)*** N of W ***(½)*** OR 321 (± 2°) ***(1)*** OR 39° (± 2°) W of N ***(½ + ½)***  	Allow 321° $a^2 = b^2 + c^2 - 2bc \cos A$ ***(½)*** $a^2 = 5^2+12^2-2x5x12\cos110°$ ***(½)*** a = 14·5 km ***(½ + ½)*** $\left[\frac{\sin 110}{14.5} = \frac{\sin \theta}{12}\right]$ θ = 51° ***(½)*** N of W ***(½)*** OR 321 ***(1)*** OR 39° W of N ***(½)*** + ***(½)*** Accept rounding to 15 km	***3+***	
(iii) Av. velocity = $\frac{\text{displacement}}{\text{time}}$ ***(½)*** = $\frac{14.5}{2}$ ***(½)*** = 7·25 (km h^{-1}) ***(½)*** at 51° N of W ***(½)*** $\bar{v} = \frac{17}{2}$ ***(0)***	consistent with b(ii) wrong unit ***(-½)*** $v = \frac{d}{t}$ (on own) ***(0)*** $v = \frac{s}{t}$ (on own) ***(½)***	***2***	

Sample Answer and Mark Allocation		Notes	Inner Margin	Outer Margin
(c) For Leeuvin $v = \frac{s}{t}$ $7{\cdot}5 = \frac{14.5}{t}$ *(½)* $t = 1{\cdot}93$ (h) *(½)* total time = 1·93 + 0·25 = 2·18 (h) *(½)* hence Mir is first *(½)*	Leeuvin 2 -0·25 = 1·75 (h) *(½)* s = vt = 7·5 × 1·75 *(½)* = 13·125 (km) *(½)* ∴ Mir first (½) <u>OR</u> Leeuvin 2 -0·25 = 1·75 (h) *(½)* $v = \frac{s}{t} = \frac{14 \cdot 5}{1 \cdot 75}$ *(½)* = 8·3 (kmh^{-1}) *(½)* ∴ Mir first *(½)*	consistent with b(ii) OR 1 h 56 min OR 2 h 11 min If use 0·15 (h) for 15 minutes –(WP) from that point	***2+***	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
22. (a) (i) $a = \frac{v-u}{t} = \frac{0-60}{40} = -1{\cdot}5\ (m\ s^{-2})$ Do not need to show but must appear in 2nd equation $s = ut + \frac{1}{2}at^2$ *(½) for both a and s equations* $s = 60 \times 40 + ½ (-1{\cdot}5) \times 40^2$ *(½)* If use u = 0 max (½) s = 1200 m *(½) + (½)* OR $v^2 = u^2 + 2as$ *(½) for both a and s equations* $0 = 60^2 + 2 \times (-1{\cdot}5)\ s$ *(½)* s = 1200 m *(½)+(½)*	Must be negative or WP OR $s = (\frac{u+v}{2})t$ *(½)* $s = \frac{1}{2} \times 60 \times 40$ *(½)* s = 1200 m *(½)+(½)* If $s = (\frac{v-u}{2})t$ (WP) If $s = ut + \frac{1}{2}at^2$ $= \frac{1}{2}(-1{\cdot}5)\ 40^2$ max (½) for implied formula Similarly for $v^2 = u^2 + 2as$	***2***	*7*
(a) (ii) $[a = \frac{v-u}{t} = \frac{0-60}{40} = -1{\cdot}5\ m\ s^{-2}]$ F = ma *(½)* $F = 7{\cdot}5 \times 10^5 \times (-)1{\cdot}5$ *(½)* (signs must be consistent) $F = (-)\ 1{\cdot}13 \times 10^6$ N *(½)+(½)* If add statement force $= 1{\cdot}13 \times 10^6$ N ***(2)*** OR $E = Fd = \frac{1}{2}mv^2$ *(½)* both equations needed $F \times 1200 = 0{\cdot}5 \times 7{\cdot}5 \times 10^5 \times (60)^2$ (½) $F = 1{\cdot}13 \times 10^6$ N *(½)+(½)*	v, u mixed up max (½) If F= ma shown acceleration consistent with (a) (i) unless $9{\cdot}8\ ms^{-2}$ OR Ft = mv – mu (½) $F \times 40 = 0 - 7{\cdot}5 \times 10^5 \times 60$ (½) $F = -1{\cdot}13 \times 10^6$ N *(½)+(½)* If add weight (WP) max ***(1)***	***2***	
(b) P = IV *(½)* ← Accept this formula anywhere in the answer $8{\cdot}5 \times 10^6 = 2{\cdot}5 \times 10^3$ V *(½)* $V = 3{\cdot}4 \times 10^3$ (V) $V_{rms} = \frac{Vp}{\sqrt{2}}$ *(½)* Accept this formula anywhere in answer $3{\cdot}4 \times 10^3 = \frac{Vp}{\sqrt{2}}$ *(½)* $V_p = 4{\cdot}8 \times 10^3$ V *(½)+(½)* = 4808V *(½)+(½)* but 4808·3V (max 2½) (sig figs)	OR E = IVt *(½)* $8{\cdot}5 \times 10^6 = 2{\cdot}5 \times 10^3 \times V \times 1$ *(½)* $V = 3{\cdot}4 \times 10^3$ (V) OR Q = It $V = \frac{E}{Q} = \frac{E}{It}$ } *(½)* $I_{rms} = \frac{Ip}{\sqrt{2}}$ (irrelevant) $= 3{\cdot}4 \times 10^3$ (A) not ≡ $V_{rms} = \frac{Vp}{\sqrt{2}}$	***3+***	

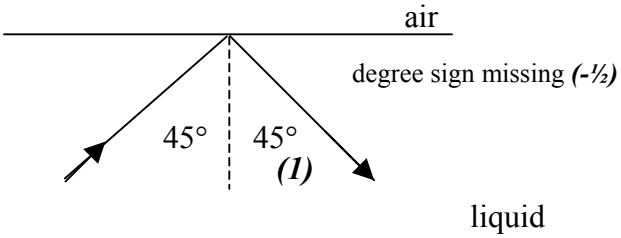
Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
23. (a) Tension = (weight) = mg = 5 x 10^4 x 9·8 Tension = 4·9 x 10^5 N ***(½)+(½)***	g = 10ms^{-2} (½) once per question W= mg = 4·9 x 10^5 N ***(½)+(½)*** but if continues on (WP) ***(0)***	***1***	*7*
(b)(i)  OR pull of gravity force of gravity Gravitational force	All 3 labels + 3 correct direction ***(2)*** (***–1 each incorrect or missing force)*** symbols T, W, U ***(0)*** gravity, gravity force, uplift ***(0)***	***2•***	
(b) (ii) Upthrust = Weight – Tension Upthrust = 4·9 x 10^5 – 2·5 x 10^5 ***(½)*** Upthrust = 2·4 x 10^5 (N) ***(½)*** P = $\frac{F}{A}$ ***(½)*** P = $\frac{2.4 \times 10^5}{8}$ ***(½)*** P = 3·0 x 10^4 Pa If use P = $\frac{F}{A}$ ***(½)*** $= \frac{2.5 \times 10^5}{8} = 3 \cdot 125 \times 10^4$ N $= 3 \times 10^4$ N max (½)	consistent with (a) P = $P_1 - P_2$ P = $\frac{F}{A}$ ***(½)*** $= \frac{F}{A} - \frac{F}{A}$ (½) $= \frac{4.9 \times 10^5}{8} - \frac{2.5 \times 10^5}{8}$ ***(½)*** ***(½)*** ***(½)*** P = 3·0 x 10^4 Pa Each substitution ***(½)*** Subtraction ***(½)*** no unit or final line deduct ***(½)***	***2•***	
(c) No change or difference in pressure same ***(1)*** → difference in pressure depends on height/thickness/ shape difference ***(½)*** and P = h ρ g or P ∝ depth ***(½)*** as { no thickness change / (h_2-h_1) same } ***(½)*** Do not accept size	No explanation attempt ***(0)*** Pressure change between top and bottom is same ***(1)*** No change + explanation but not (WP) ***(1)***	***2+***	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
24. (a) (i) lost volts = E – V = 9 - 7·8 = 1·2 (V) ***(½)***	$\frac{V_1}{V_2} = \frac{R_1}{R_2}$ ***(½)***		***6***
lost volts = Ir			
1·2 = I x 2·0 ***(½)***			
I = 0·6 (A) ***(½)***	***(½)*** $\frac{1 \cdot 2}{7 \cdot 8} = \frac{2}{R_2}$		
$R = \frac{V}{I} = \frac{7.8}{0.6}$ ***(½)***	Remaining values in correct place ***(1 or 0)***		
R = 13·0 Ω ***(½)+(½)***	R_2 = 13 Ω ***(½) + (½)***	***3***	
If goes on eg $13 - 2 \Rightarrow R_2 = 11\Omega$			
deduct ***(1)*** max ***(2)***			
(a) (ii) Current in internal resistor gives 'lost volts'	***(1 or 0)***)		
(so external voltage reduced) ***(1)***	No explanation ***(0)***		
	Lost volts on own ***(0)***		
OR External voltage or tpd = E – Ir			
but as I increases and E and r constant then V decreases	Voltage flowing/moving through (WP) ***(0)***	***1•***	
OR Voltage divider explanation			
eg voltage is divided across R and r so smaller reading on meter	Voltage/energy lost across/in internal resistance (r) ***(1)***		
	Energy lost <u>in</u> the cell ***(1)***		
	Voltage lost <u>in</u> the cell ***(1)***		
(b) (External) Resistors in parallel gives	If voltmeter reading increases/or same then ***(0)***		
lower total resistance ***(½)***			
current increases ***(½)***	OR by calculation consistent with a(i) flowing voltage ***(-½)***		
so lost volts increases ***(½)***			
* reading on voltmeter decreases ***(½)***		***2+***	
* look to see if this appears in answer before starting awarding marks			

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
25. (a) 	Shape *(1)* 12 V *(½)* } units and labels 100 ms *(½)* } origin omitted deduct *(½)*	*2*	*9*
(b) (i) $V_R = IR = 20 \times 10^{-3} \times 400$ *(½)* $V_R = 8$ (V) $V_c = 12 - 8$ *(½)* $V_c = 4$ V *(½)+(½)*	If V = 8 V max *(½)*	*2*	
(b) (ii) $E = ½ CV^2$ *(½)* $E = ½ \times 100 \times 10^{-6} \times 4^2$ *(½)* $E = 8 \times 10^{-4}$ J *(½)+(½)* OR $Q = CV = 100 \times 10^{-6} \times 4 = 4 \times 10^{-4}$ (C) $E = ½QV$ *(½) for both Q and E equations* $E = 0{\cdot}5 \times 4 \times 10^{-4} \times 4$ *(½)* $E = 8 \times 10^{-4}$ J *(½)+(½)*	consistent with b (i) No square or 16 shown formula *(½)* only List of formulae *(0)* (if no selection made)	*2*	
(c) resistor value less than 400 Ω *(1)* OR Use larger voltage supply but do not charge above 12 V *(1)* Remove resistance *(1)* Remove resistor *(0)* Remove resistor and close the gap *(1)*	smaller, lower } resistor *(0)* smaller, lower } **resistance** *(1)* Use larger supply only *(0)*	*1•*	

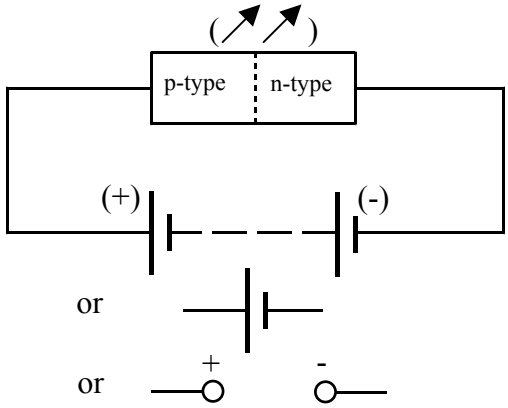
Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
(d) charging current on for shorter time ***(1)***	If give ≥ 100 μF ***(0)***		
(so smaller charge required to reach 12 V)	No explanation ***(0)***		
(so value of C) less/smaller than 100 μF ***(1)*** * look for this first		***2•***	
OR			
smaller area under graph ***(1)***	If value of C less and justification not (WP) ***(1)***		
(so less charge stored for same V)			
so smaller value of C ***(1)***			
Smaller capacitor – accept as bad form			
If discharge (WP) ***(0)***			

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
26. (a) $V_o = \frac{R_f}{R_1}(V_2 - V_1)$ ***(½)*** $V_o = \frac{120 \times 10^3}{10 \times 10^3}$ (7·52 –7·50) ***(½)*** V_o = 0·24 V ***(½)+(½)***	OR $V_o = \frac{R_f}{R_1} \Delta V$ ***(½)*** $V_o = \Delta V \times$ gain ***(½)***	***2***	***6***
(b) (Temperature rises, $R_{thermistor}$ decreases so) voltage across thermistor decreases ***(½)*** (voltage across variable resistor/V_2) increases ***(½)*** (V_2 -V_1) becomes more positive or increases ***(½)*** – Bridge becomes <u>more</u> out of balance (V_o [= (V_2 -V_1) x gain] increases) transistor switches on ***(½)*** OR relay switches on the alarm mention of voltage flowing (WP) stop marking		***2+***	
(c) V_o = gain x ΔV or $\frac{R_f}{R_1}$ ($V_2 - V_1$) 0·72 = 12 x (V_2 – 7·50) V_2 = 7·56 (V) ***(1)*** From graph, temperature = 36°C ***(½)+(½)*** $\pm 0 \cdot 05 \circ C$	36ºC on own ***(2)***	***2+***	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
27 (a) (i) $n = \frac{\sin\theta_1}{\sin\theta_2}$ or $\frac{\sin\theta_{air}}{\sin\theta_{liquid}}$ ***(½)*** $n = \frac{\sin 82°}{\sin 45°}$ ***(½)*** n = 1·40 ***(1)***	watch for $\frac{1}{\sin 45} = n = 1 \cdot 41$ ***(0)***	***2***	***6***
(a) (ii) n x sin θ_{liquid} = sin θ_{air} (But sin θ_{liquid} = constant and $n_{blue} > n_{red}$ sin θ_{air} is now greater hence θ_{air} greater (than 82°) ***(½)*** } ***(½)*** OR Since 45° constant then n α sin θ_{air} ***(½)*** then sin θ_{air} larger so θ_{air} larger than 82° ***(½)*** must have attempt at explanation before first (½) awarded	OR by calculation using n > 1·4 ***(1)*** Alternative Larger RI gives greater change in direction/bending ***(½)*** so $\theta_{air} > 82°$ ***(½)*** $\theta_{air} > 82°$ + explanation (not (WP) **(½)** eg λ_2 is smaller than λ_1 in air If use diffraction ***(0)***	***1+***	
(b)  degree sign missing ***(-½)*** ***(1)*** $\sin\theta_c = \frac{1}{n}$ ***(½)*** $\sin\theta_c = \frac{1}{1.44}$ ***(½)*** $\theta_c = 44^{(\circ)}$ ***(1)*** (43° (-½) arith) 45° > 44° so total internal reflection	Diagram with no calculation **(0)** Calculation + no diagram (max 2) OR $1{\cdot}44 = \frac{\sin\theta air}{\sin 45^0}$ ***(½)*** sin $\theta_{air} > 1$ ***(½)*** θ_{air} = error/not possible OR hence TIR } ***(1)***	***3+***	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
28 (a) (i) Radiation/photons of energy ***(½)*** equal to difference between 2 energy levels triggers an electron (in its excited state) to drop from higher to lower energy level ***(½)*** with emission of an identical ***(½)*** photon ***(½) (1)*** OR photon ***(½)*** of the same value/energy ***(½)*** <u>OR</u> radiation OR Diagram – (look for same 4 points) • labelled electron in higher level • incident photon – labelled with energy difference level • electron dropping to lower level • photon emitted – same energy difference or in phase with original	atoms/particles falling ***(0)*** stop at (WP)	***2***	***8***
(a) (ii) Photons (are reflected by mirrors) light/radiation causes/triggers/to induce more electrons to drop from higher to lower energy level ***(1)*** Amplification is produced by a series of stimulated emissions (1) More energy is given out than absorbed (1) Content statement 3.3.20	Photons producing more photons ***(1)*** Photons give more chance of stimulated emission ***(1)***	***1***	
(b) d sin θ = nλ ***(½)*** * might be there by implication d sin $\frac{37}{2}$ ***(½)*** = 1* ***(½)*** x 633 x 10^{-9} ***(½)*** d = 1·99 x 10^{-6} (m) no. of lines per m = $\frac{1}{d}$ = 5·01 x 10^5 (lines/m) ***(1)*** $\frac{1}{d}$ = 5·03 x 10^5 (lines/m) also possible (allow $5 \rightarrow 5\cdot0251\times10^5$)	OR d sin θ = nλ ***(½)*** $\frac{\sin\theta}{n\lambda} = \frac{1}{d}$ $\frac{\sin37°/2\ (½)}{1\ (½) \times 633 \times 10^{-9}\ (½)} = \frac{1}{d}$ $\frac{1}{d}$ = 5·01 x 10^5 ***(1)*** If use 37° max ***(1½)***	***3+***	

Sample Answer and Mark Allocation		Notes	Inner Margin	Outer Margin
(c) (fringe width less) 1 so θ (or sin θ) less ***(½)*** 2 so d sin θ less ***(½)*** 3 but d and n are constant ***(½)*** 4 therefore λ less ***(½)*** 2, 3, 4 ***(2)*** 1, 3, 4 ***(2)*** 1, 2, 4 ***(1½)*** 1, 4 ***(1)*** 3, 4 ***(1)*** 4 must be correct before any marks awarded, but must have attempt at explanation	<u>Alternative</u> path difference = nλ ***(½)*** path difference less ***(½)*** n is constant **(½)** ∴ λ is less ***(½)***	OR by calculation d sin θ = nλ ***(½)*** since d, n values same ***(½)*** sin θ smaller ***(½)*** so λ smaller ***(½)*** use diffraction ***(0)*** λ longer/larger/same ***(0)***	***2+***	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
29 (a)  	a.c. supply ***(0)*** ***(1) or (0)*** If diode symbol drawn ***(0)***	***1•***	***6***
(b) Electrons and holes (re)combine ***(½)*** (at junction) energy released as photons ***(½)*** OR photons given out OR light photons combine – join together, combine, falls into hole Cannot get second ***(½)*** without first ***(½)*** Creating energy ***(0)*** for second ***(½)*** forming electron/hole pairs ***(0)*** Electrons and holes meet ***(0)***		***1***	
(c) (i) $E = hf$ $3{\cdot}68 \times 10^{-19} = 6{\cdot}63 \times 10^{-34} f$ $f = 5{\cdot}55 \times 10^{14}$ (Hz) $v = f\lambda$ ***(½)*** *for both E and v equations* $3 \times 10^{8} = 5{\cdot}55 \times 10^{14} \lambda$ ***(½)*** $\lambda = 5{\cdot}40 \times 10^{-7}$ m ***(½)+(½)*** OR $5{\cdot}41 \times 10^{-7}$ m Accept $5{\cdot}40 \times 10^{-7}$ m ⟶ $5{\cdot}4054 \times 10^{-7}$ m	$E (= hf) = \frac{hc}{\lambda}$ ***(½)*** $3{\cdot}68 \times 10^{-19} = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{\lambda}$ ***(½)*** $\lambda = 5{\cdot}40 \times 10^{-7}$ m ***(½)+(½)*** OR 540 nm (541nm) Too many figures ***(-½)***	***2***	
(c) (ii) $E = QV$ ***(½)*** $3{\cdot}68 \times 10^{-19} = 1{\cdot}6 \times 10^{-19}$ V ***(½)*** $V = 2{\cdot}3$ V ***(½)+(½)***		***2+***	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
30 (a) (i) 92 = number of protons (in nucleus) ***(1)*** (ii) 235 = protons + neutrons (in nucleus) OR total number of nucleons in nucleus. ***(1)*** OR 92p + 143 n	mass no (0) atomic no (0) 92 –electrons (0)	***2***	***6***
(b) neutrons released are absorbed/captured by/collide with another Uranium nucleus producing another fission/more splitting (1) (more neutrons released to continue/repeat process) chain reaction on its own (0)	***(1 or 0)*** not reactions if use atom (0) **fission – correct spelling**	***1***	
(c) mass before $^{235}_{92}U$ 390·173 x 10^{-27} $^{1}_{0}n$ 1·675 x 10^{-27} 391·848 x 10^{-27} (kg) ***(½)*** mass after $^{140}_{58}Ce$ 232·242 x 10^{-27} $^{94}_{40}Zr$ 155·884 x 10^{-27} $2\,^{1}_{0}n$ 3·350 x 10^{-27} 391·476 x 10^{-27} (kg) ***(½)*** mass loss = 0·372 x 10^{-27} (kg) $E = mc^2$ ***(½)*** – Independent mark $E = 3{\cdot}72 \times 10^{-28} \times (3 \times 10^{8})^2$ ***(½)*** $E = 3{\cdot}35 \times 10^{-11}$ J ***(½)+(½)***	Watch for single neutron only on RHS mass then 389·801 x 10^{-27} kg 3·72 x 10^{-28} (kg) Truncating of masses or mass loss ⇒ WP but $E = mc^2$ ***(½)*** available No square or 9 x 10^{16} formula ***(½)*** only	***3•***	

[END OF MARKING INSTRUCTIONS]