SCOTTISH QUALIFICATIONS AUTHORITY

2002 Physics
Higher
Finalised Marking Instructions

Strictly Confidential

These instructions are **strictly confidential** and, in common with the scripts entrusted to you for marking, they must never form the subject of remark of any kind, except to Scottish Qualifications Authority staff. Similarly, the contents of these instructions must not be copied, lent or divulged in any way now, or at any future time, to any other persons or body.

Markers' Meeting

You should use the time before the meeting to make yourself familiar with the question paper, instructions and any scripts which you have received. Do **not** undertake any final approach to marking until **after** the meeting. Please note any points of difficulty for discussion at the meeting.

Note: These instructions can be considered as final only after the markers' meeting when the full marking team has had an opportunity to discuss and finalise the document in the light of a wider range of candidates' responses.

Marking

The utmost care must be taken when entering and totalling marks. Where appropriate, all summations for totals must be carefully checked and confirmed.

Where a candidate has scored zero marks for any question attempted, "0" should be entered against the answer.

Recording of Marks

The mark for each **question**, where appropriate, should be entered **either** on the grid provided on the back page of the answer book, **or** in the case of question/answer books, on the grid (if provided) on the last page of the book. Where papers assess more than one element, care must be taken to ensure that marks are entered in the correct column.

The **Total** mark for each paper or element should be entered (in red ink) in the box provided in the top-right corner of the front cover of the answer book (or question/answer book).

Always enter the **Total** mark as a **whole number**, where necessary by the process of rounding up.

The transcription of marks, within booklets and to the Mark Sheet, should always be checked.

Markers are reminded that they must not write comments on scripts.

22 May 2002

HIGHER PHYSICS

INSTRUCTIONS

1 The marks awarded for each part as indicated in the marking scheme should be recorded in the right hand inner margin. The total mark awarded for each question should be recorded, in the outer margin, at the start of the answer for that question.

2 The fine division of marks shown in the marking scheme **may** be recorded within the body of the script beside the candidate's answer. If such marks are shown they **must** total to the mark in the inner margin.

3 Negative marks or marks to be subtracted should not be shown. An inverted vee may be used instead.

4 The number recorded should always be the mark awarded.

The number out of which a mark is scored SHOULD NEVER BE SHOWN AS A DENOMINATOR ($\frac{1}{2}$ will always mean one half mark and never 1 out of 2).

5 Make sure that "6" can be distinguished from "0" and a "1" from a "7".

6 Fractional marks, if awarded to individual questions, should be recorded in the right hand inner margin of the script.

7 Where square ruled paper is enclosed inside answer books it should be clearly indicated that this item has been considered. Marks awarded should be transferred to the script inner margin and marked "G".

8 The individual question totals that are transferred to the grid on the cover of the answer book should be those shown in the outer margins of the answer book.

9 Fractional marks if awarded to individual questions should be recorded in the grid. The total, including fractional marks, should be shown at the bottom of the grid.

10 The total script mark, if necessary rounded up to the next whole number, should be transferred to the box at the top of the front page of the script.

11 Check all additions carefully by summing marks from the first page to the last page of the script then from the last to the first page.

For General Instructions on Marking refer to "*Physics General Marking Instructions*", version 1, July 1999 published by SQA.

2002 Physics Higher
Section A
Finalised Marking Instructions

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

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
21. (*a*) (i) 0·2 (0) m **(1)**	Accept 0·18 m to 0·22 m		8
(ii) 1·6 (0) m **(1)**	Accept 1·58 m to 1·62 m		
(iii) $S = ut + \frac{1}{2}at^2$ **(½)**	S and t to be consistent		
$1{\cdot}6 = 0 + \frac{1}{2}a \times 0{\cdot}6^2$ **(½)**	S consistent with (ii)		
$a = 8{\cdot}9\ (\text{m s}^{-2})$ (½ off for wrong unit)	(½ off for wrong unit)	3•/+	
(*b*) (i)	Not sum on own or total on own		
mean = $\frac{\text{sum of total results}}{\text{number of results}}$	clear statement on own (½)		
OR mean = $(8{\cdot}9 + 9{\cdot}1 + 8{\cdot}4 + 8{\cdot}5 + 9{\cdot}0)/5$ **(½)**			
$= \frac{44 \text{ or } 43{\cdot}9}{5}$ **(½)**			
$= 8{\cdot}8\ (\text{m s}^{-2})$ (½ off for wrong unit) **(½)**			
(ii)			
error = $\frac{\text{max} - \text{min } \textbf{OR} \text{ range } \textbf{OR} \text{ highest - lowest}}{\text{number of results}}$ **(½)**	clear statement on own (½)		
$= \frac{9{\cdot}1 - 8{\cdot}4}{5}$ **(½)**			
$= 0{\cdot}14$ **OR** $0{\cdot}1\ (\text{m s}^{-2})$ **(½)**	Accept 1·6%	3•	
(*c*) Any **two** from			
Top of flat part/slightly raised part is higher as there is more compression of the sponge **(1)**			
OR final levelling off at higher displacement as more kinetic energy is lost **(1)**			
OR Flat part/slightly raised part is longer because the time of contact of basketball with sponge is longer **(1)**	**Must** make reference to the graph.		
OR initial gradient on rebound is less as more kinetic energy is lost **(1)**	Clear sketch showing difference OK.	2+	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
22. (*a*) $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (½) $\frac{109}{288} = \frac{P_2}{318}$ (½) $P_2 = 120$ kPa (½), (½)	120·3 kPa lose ½ significant figures W.P. if worked through using celsius (formula ½ only)	2	8
(*b*) Molecules/particles have more kinetic energy/speed/momentum (½) collide harder/with greater force with the **walls** of the flask (½) (need mention of walls) and more often/more frequently/ with more collisions **per second** (½) (need indication of time) so pressure increases (½) **OR** molecules/particles have more kinetic energy/speed/momentum (½) (so v increases, hence momentum of particles/molecules increases) (½) **OR** $F = \frac{\Delta mv}{t}$ (½) so F on the wall of flask increases (½) $\left(P = \frac{F}{A}\right)$ so P increases (½)	Mention of volume change is WP (0) Can answer "other way round" but must say "P actually increases since things happen other way round" **Last** (½) **only if first line is there** Must clearly indicate collision is with flask if not (½) for first line only	2	

General Marking Instructions to be applied.

$F = PA$ (½)

No working

$= 1000$N (½)

OR

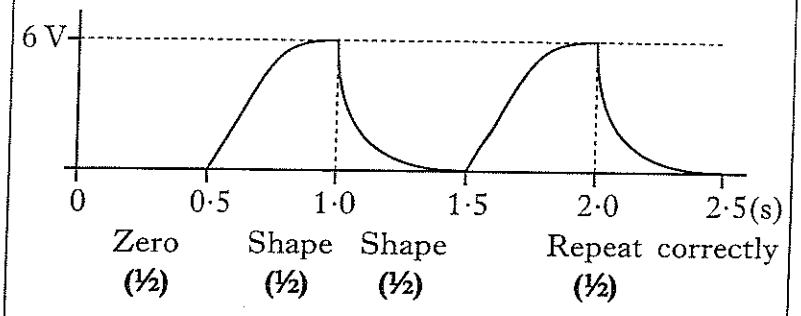
$F =$ any number N (½) for unit

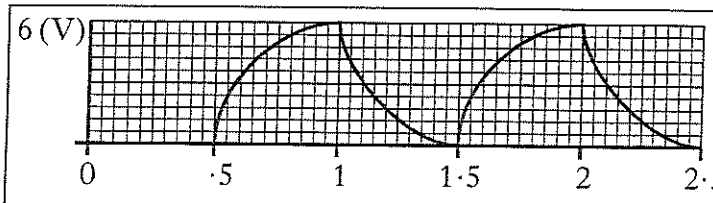
Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
(*c*) (i) $F = P \times A$ (½) $= 1{\cdot}75 \times 10^{5} \times 4 \times 10^{-6}$ (½) $= 0{\cdot}7$ N (½), (½)			
(ii) 35 mm **(1)** 35 m **(0)** 35 **(0)**	Consistent with answer in (*c*)(i) (Allow +/– half a division)	3	
(*d*) Temperature of nitrogen can be measured directly **(1)**	More precise temperature or more accurate temperature (0). More accurate temperature of gas nitrogen (1). More accurate temperature measurement in flask (1).	1•	

Sample Answer and Mark Allocation		Notes	Inner Margin	Outer Margin
23. (*a*) Total momentum before = total momentum after **OR** $mu_1 + mu_2 = mv_1$ $1250 + 1500u_2 = 800$ $u = -0{\cdot}3\ \text{ms}^{-1}$	(½) (½) (½), (½)	Can use any sign convention.	2	7
(*b*) (i) Probe	**(1)**		1	
(ii) $F.t = mv - mu$ $-500 \times t = 0 - 4000 \times 0{\cdot}2$ $t = 1{\cdot}6\ \text{s}$ **OR** $F = ma$ $(-)500 = 4000 \times a$ $a = (-){\cdot}125$ $v = u + at$ $0 = 0{\cdot}2 - 0{\cdot}125t$ $t = 1{\cdot}6\ \text{s}$	(½) (½) (½), (½) (½) (½) (½), (½)	$F = \frac{mv}{t}$ WP $F = \frac{mu}{t}$ is OK F and u must have opposite signs. for **both** formulae If u and a have same sign (½) for both formulae only	2+	
(*c*) Fire rocket engine of space vehicle **then** fire probe engine for twice as long. **OR** Fire both engines then fire probe engine only for same time	**(2) or (0)**	Must clearly indicate correct sequence. No attempt to explain sequence (0). If time of fire of probe engine is given as "almost twice as long" it must be justified ie "because mass is being lost" Accept calculation which shows correct answer.	2+	

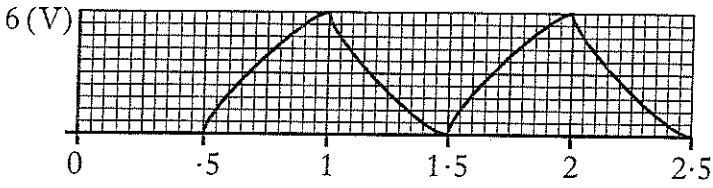
Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
24. (*a*) (6 joules of) energy given to each coulomb of charge as it passes through the battery **OR** maximum voltage across battery **OR** supply voltage when current is zero **OR** supply voltage + lost volts **OR** open circuit voltage **(1)**	total voltage across battery (0) quoting formula not enough for marks.	1	7
(*b*) (i) $E = I(R+r)$ **(½)** $6 = 0{\cdot}2(R+2)$ **(½)** $R = 28$ **(½)** $R_2 = 28-20$ **(½)** $= 8\ (\Omega)$ lose ½ if final answer not shown	**OR** $R_T = \frac{E}{I}$ **(½)** $R_T = \frac{6}{2000\times10^{-3}}$ **(½)** $= 30$ **(½)** $R_T = 30-2-20$ **(½)** $= 8\ \Omega$	2•	
(ii) $V = I\times R$ **(½)** $= 0{\cdot}2\times28$ **(½)** $= 5{\cdot}6$ V **(½), (½)**	lost volts $= 0{\cdot}2\times2 = 0{\cdot}4$ $V =$ emf $-$ lost volts $= 6-0{\cdot}4$ $= 5{\cdot}6$ V **(½), (½)** **OR** $V = \frac{R_1+R_2}{R_T}E$ **(½)** $= \frac{28\times6}{30}$ **(½)** $= 5{\cdot}6$ V **(½), (½)**	2•	
(*c*) Load resistance/external resistance/ total resistance goes down **(½)** causing the current to increase **(½)** **EITHER** $V = (E-Ir)$ (or in words) **(½)** so voltmeter reading goes **down** **(½)** **OR** lost volts increases **(½)** voltmeter reading goes down **(½)**	Voltage through or flowing is WP (0) This statement on its own (0) must have an attempted explanation which is not wrong physics.	2+	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
25. (*a*) (i) 6 V **(1)**		1	7
(ii) $E = \frac{1}{2}CV^2$ **(½)**			
$= \frac{1}{2}\times 2000\times 10^{-6}\times 6^2$ **(½)**	Consistent with (*a*)(i) except taking $V = 0$		
$= 3{\cdot}6\times 10^{-2}$ J **(½), (½)**		2	
OR	$E = \frac{1}{2}CV^2$		
$Q = CV$ $\quad E = \frac{1}{2}QV$ **(½)**	$= \frac{1}{2}\times 2000\times 10^{-6}\times 6$		
$= 2000\times 10^{-6}\times 6$	$= 3{\cdot}6\times 10^{-2}$ J — treat as slip		
$= 1{\cdot}2\times 10^{-2}$			
$E = \frac{1}{2}QV$			
$= \frac{1}{2}\times 1{\cdot}2\times 10^{-2}\times 6$ **(½)**	For both equations		
$= 3{\cdot}6\times 10^{-2}$ J **(½), (½)**	Consistent with (*a*)(i)		
(iii) $R = \frac{V}{I}$ **(½)**			
$= \frac{6}{7{\cdot}5\times 10^{-3}}$ **(½)**			
$= 800\,\Omega$ **(½), (½)**		2	

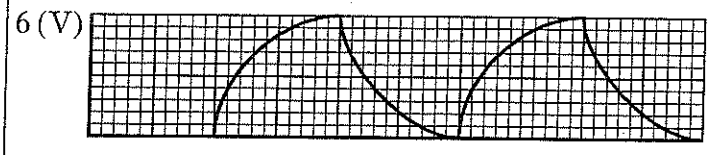
Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
(*b*)  Zero (½) Shape (½) Shape (½) Repeat correctly (½)	If continues on after 2·5 s and is incorrect lose (½)	2+	



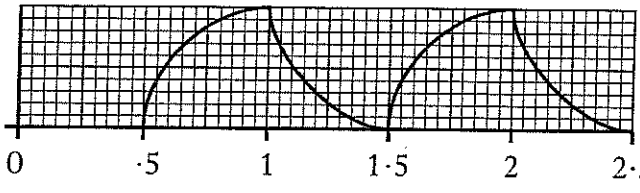
(2)



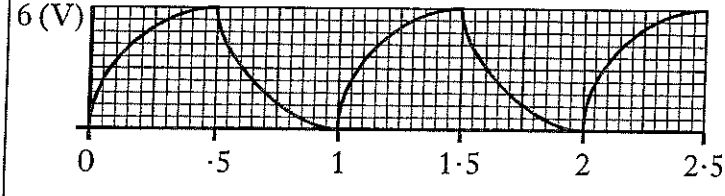
(2)



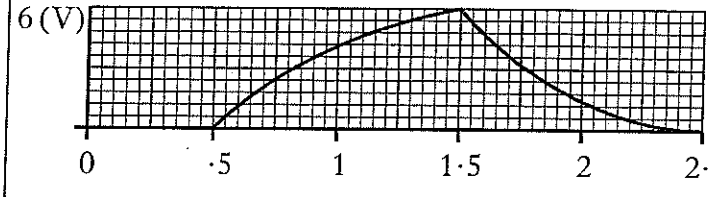
(1½) No base numbers



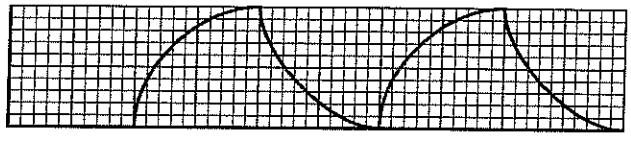
(1½) No voltage given



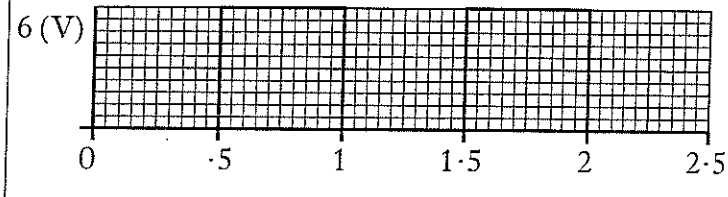
W.P. (0)



(½) for 0 → 0·5 (s)

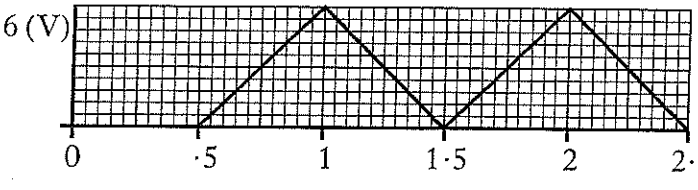


(1) No base
No voltage numbers

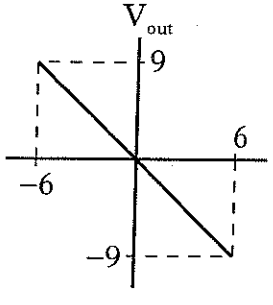


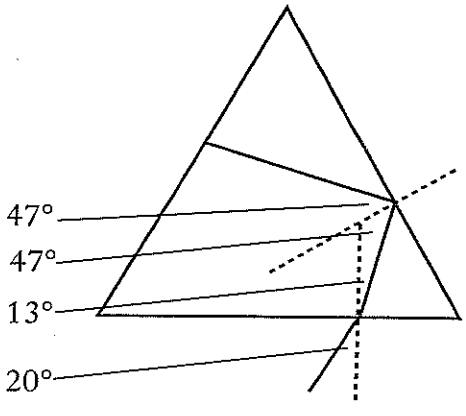
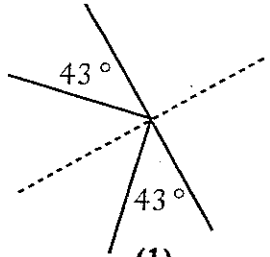
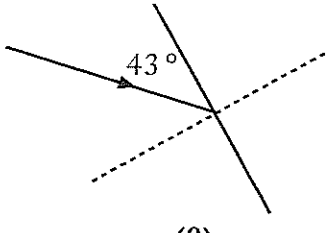
(½) for 0 – 0·55 (s)

SAWTOOTH



(½) for 0 – 0·5 (s)

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
26. (*a*) $f = \frac{1}{T}$ (½) $= \frac{1}{8\times10^{-3}}$ (½) = 125 Hz (½), (½)	If not 8×10^{-3} or 8 (WP, formula ½ only) 0·125 Hz (1½)	2	9
(*b*) (i) Inverting **(1)**	Inverted O	1	
(ii) A inverted (½) indication of same frequency (½) $V_p = 9$ (V) **(1)**	same number of waves over top of "old" wave statement or using 1 cm boxes.	2	
B $V_{rms} = \frac{V_p}{\sqrt{2}}$ (½) $= \frac{9}{\sqrt{2}}$ (½) = 6·36 V (½), (½)	if use $\frac{6}{\sqrt{2}}$ WP unless Consistent with A		
OR  ½ for axes labels ½ for (−6, 9) ½ for (6, −9) ½ for straight line If saturation shown then (0)		2•	
(iii) (output voltage) increases **(1)** until saturation of op-amp **(1)** **OR** increases **(1)** to 13·5 V/15 V **(1)** **OR** supply voltage	output voltage saturates 0 signal saturates 0 graph saturates 0 } 2nd mark output V decrease to −15 V is OK	2+	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
27. (*a*) $n = \frac{\sin\theta a}{\sin\theta g}$ (½) $= \frac{\sin 20^\circ}{\sin 13^\circ}$ (½) $= 1{\cdot}52$ (– ½ if final answer not shown)	$_a n_g = \frac{\sin\theta_1}{\sin\theta_2}$ Formula could be implied Must show 1·52 or lose ½	1	7
(*b*) This is the angle of **incidence** (inside medium) which causes light to emerge into a vacuum at 90° to the normal or along surface **OR** incident angle at which total internal reflection takes place. **(1)**	Accept diagrams. Maximum incident angle at which refraction takes place.	1	
(*c*) $\sin\theta_c = \frac{1}{n}$ (½) $= \frac{1}{1{\cdot}52}$ (½) $\theta_c = 41^\circ$ (½), (½)	Formula could be implied (1·5 used, formula ½ only)	2	
(*d*)  By calculation 47° **(½)** 47° **(½)** Consistent with first **(½)** 13° **(1)** 20° **(1)** [–1 if 20° wrong side of normal] Angles must be clearly marked.  **(1)**  **(0)**	If 47° or 13° or 17° treat as WP. 0 for whole question otherwise work through If degree sign not shown deduct (½) in total By drawing 47° **(½)** 47° **(½)** 13° **(1)** (12° to 14°) sin θ = 1·52 sin 13° **(½)** θ = 20° **(½)** (18·4° to 21·6°)	3+	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
28. (*a*) Threshold **(1)**	Freshold (0)	1	7
(*b*) (i) $E = hf$ **(½)** $= 6{\cdot}63 \times 10^{-34} \times 3{\cdot}33 \times 10^{14}$ Substitution **(½)** Value for h **(½)** $= 2{\cdot}21 \times 10^{-19}$ (J)	Deduct ½ if unit wrong	1½	
(ii) $E = hf$ $= 6{\cdot}63 \times 10^{-34} \times 5{\cdot}66 \times 10^{14}$ Substitution **(½)** $= 3{\cdot}75 \times 10^{-19}$ Maximum kinetic energy of emitted electron $= 3{\cdot}75 \times 10^{-19} - 2{\cdot}21 \times 10^{-19}$ **(½)** $= 1{\cdot}54 \times 10^{-19}$ J **(½), (½)**		2+	
(iii) $E = QV$ **(½)** $= 1{\cdot}6 \times 10^{-19} \times 2{\cdot}00 \times 10^{4}$ Substitution **(½)** Value for Q **(½)** $= 3{\cdot}2 \times 10^{-15}$ J **(½), (½)**	Ignore negative sign for electron. If add or subtract $+ 1{\cdot}5 \times 10^{-19}$ (lose ½) If final answer $- 3{\cdot}2 \times 10^{-15}$ J (lose ½)	2½+	

2002 Physics Higher			
Sample Answer and Mark Allocation	**Notes**	**Inner Margin**	**Outer Margin**
29. (*a*) Decreases **(1)**	Mention of conductivity (0)	1	5
(*b*) (i) Electrons/negative charge carriers and holes/positive charge carriers combine **(1)** at junction layer **(½)** to release photon energy **(½)**	Need first statement before awarding other partial marks Lose ½ mark for depletion but continue marking.	2	
(ii) $n\lambda = d \sin\theta$ **(½)** $2x\lambda = 5 \times 10^{-6} \times \sin 11°$ **(½)** $\lambda = 477\,nm$ **(½), (½)**	$d = 1/5 \times 10^{-6}$ is WP (Formula ½ only)	2•	

General Marking Instructions to be appllied

λ = any number m

or any number km ½ for unit

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
30. (*a*) Mass T $= \frac{40\times0\cdot6}{100} = 0\cdot24$ (½) Activity $= 0\cdot24\times5\cdot9\times10^{6}$ (½) $= 1\cdot42\times10^{6}$ Bq (½), (½) continue on lose (½)	1 kg pure $5\cdot9\times10^{6}$ 0·6 kg pure $3\cdot54\times10^{6}$ (½) 0·6 kg 40% pure (½) $1\cdot42\times10^{6}$(Bq) (1) Apply significant figures, counts per second lose ½	2	5
(*b*) Alpha particle $H = D\times Q$ (½) $= 150\times10^{-6}\times20$ $= 3000\times10^{-6}$ (½) $\dot{H} = \frac{H}{t}$ $\dot{H} = \frac{3000\times10^{-6}}{6}$ $= 500\times10^{-6}$ (½) $H = \dot{H}\times t$ $= 500\times10^{-6}\times8$ $= 4000\times10^{-6}$ (½) $H = D\times Q$ $4000\times10^{-6} = 400\times10^{-6}\times Q$ $Q = 10$ (½) Fast neutrons (½)	Ignore intermediate unit. Justification must be clear.		
OR For last three half marks $H = D\times Q$ for gammas and neutrons $= 400\times1$ 400×10 $\dot{H} = \frac{400}{8}\times10^{-6}$ $\frac{4000}{8}\times10^{-6}$ (½) $= 50\times10^{-6}$ 500×10^{-6} (½) Fast neutrons (½)	gamma worked out on own, hence neutrons (3)	3+	