GCE

Physics B (Advancing Physics)

Advanced GCE **A2 7888**

Advanced Subsidiary GCE **AS 3888**

Mark Schemes for the Units

June 2006

3888/7888/MS/R/06

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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MARK SCHEMES FOR THE UNITS

Mark Scheme 2860
June 2006

Physics B (Advancing Physics) mark schemes - an introduction

Just as the philosophy of the *Advancing Physics* course develops the student's understanding of Physics, so the philosophy of the examination rewards the candidate for showing that understanding. These mark schemes must be viewed in that light, for in practice the examiners' standardisation meeting is of at least equal importance.

The following points need to be borne in mind when reading the published mark schemes:

- Alternative approaches to a question are rewarded equally with that given in the scheme, provided that the physics is sound. As an example, when a candidate is required to "Show that..." followed by a numerical value, it is always possible to work back from the required value to the data.
- Open questions, such as the questions in section C permit a very wide variety of approaches, and the candidate's own approach must be rewarded according to the degree to which it has been successful. Real examples of differing approaches are discussed in standardisation meetings, and specimen answers produced by candidates are used as 'case law' for examiners when marking scripts.
- Final and intermediate calculated values in the schemes are given to assist the examiners in spotting whether candidates are proceeding correctly. Mark schemes frequently give calculated values to degrees of precision greater than those warranted by the data, to show values that one might expect to see in candidates' working.
- Where a calculation is worth two marks, one mark is generally given for the method, and the other for the evaluation of the quantity to be calculated.
- If part of a question uses a value calculated earlier, any error in the former result is not penalised further, being counted as *error carried forwar*d: the candidate's own previous result is taken as correct for the subsequent calculation.
- Inappropriate numbers of significant figures in a final answer are penalised by the loss of a mark, generally once per examination paper. The maximum number of significant figures deemed to be permissible is one more than that given in the data; two more significant figures would be excessive. This does not apply in questions where candidates are required to show that a given value is correct.
- Where units are not provided in the question or answer line the candidate is expected to give the units used in the answer.
- Quality of written communication will be assessed where there are opportunities to write extended prose.

SECTION C

The outline mark schemes given here will be given more clarity by the papers seen when the examination is taken. Some of these scripts will be used as case law to establish the quality of answer required to gain the marks available.

It is not possible to write a mark scheme that anticipates every example which students have studied.

For some of the longer descriptive questions three marks will be used (in scheme called the 1/2/3 style).

1 will indicate an attempt has been made

2 will indicate the description is satisfactory, but contains errors

3 will indicate the description is essentially correct

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

1. Please ensure that you use the **final** version of the Mark Scheme.
   You are advised to destroy all draft versions.

2. Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (½) should never be used.

3. The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

   x = incorrect response (errors may also be underlined)
   ^ = omission mark
   bod = benefit of the doubt (where professional judgement has been used)
   ecf = error carried forward (in consequential marking)
   con = contradiction (in cases where candidates contradict themselves in the same response)
   sf = error in the number of significant figures

4. The marks awarded for each part question should be indicated in the margin provided on the right hand side of the page. The mark total for each double page should be ringed at the end of the question, on the bottom right hand side. These totals should be added up to give the final total on the front of the paper.

5. In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.

6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

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8. An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct and answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

m	= method mark
s	= substitution mark
e	= evaluation mark
/	= alternative and acceptable answers for the same marking point
;	= separates marking points
NOT	= answers which are not worthy of credit
( )	= words which are not essential to gain credit
____	= (underlining) key words which **must** be used to gain credit
ecf	= error carried forward
AW	= alternative wording
ora	= or reverse argument

Qn	Expected Answers	Marks	Additional guidance
	Section A		
1	(a) N m^{-2} (b) kg m^{-3}	2	
2(a)	polarisation	1	accept oscillations at 90° to propagation if stated aerial points at transmitter
(b)	(signal) increases / back to original intensity receiving aerial is parallel to direction of oscillation again / aerial is back in plane of polarisation	1 1	AW accept E or B vector
3	C ; A ; A	3	
4	$I = ne$ / = 20 x 10^{6} x 1.6 x 10^{-19} ; = 3.2 x 10^{-12} (A) OR = 3.2 p(A)	2	method ; evaluation
5	diameter Fe atom = length / no. of atoms / = 2.1 nm / 8 2.6 x 10^{-10} (m) / 0.26 n(m) 2 S.F. otherwise penalise	1 1	method evaluation allow ecf on 7 OR 9 atoms ∴ 0.30 nm OR 0.23 nm
6(a) (b) (c)(i)	σ = <u>2.5 x 10^{7}</u> correctly plotted point "within small square" ecf on (a) as σ rises λ rises / positive correlation / (directly) proportional / linear	1 1 1	in table / elsewhere correct grid intersection AW
(ii)	free <u>electrons</u> (contribute to both conductivities)	1	AW
7(a) (b)(i) (ii)	all 3 sampling points to correct nearest level 1 1 0 0 1 1 information is lost / higher frequencies are lost / square edges to the waveform / other sensible answers	2 1 1	2 correct 1 mark All correct AW but NOT spurious low frequencies
	Total section A	20	

Qn	Expected Answers	Marks	Additional guidance
	Section B		
8(ai)	$I = P / V$ / = 180 / 12 ; = 15 A	2	method ; evaluation
(ii)	$R = P / I^2$ / = V / I / = 12 / 15 ; = 0.80 Ω	2	method ; evaluation allow ecf on (i)
(b)	$A = \rho L / R$ / $(6.0 \times 10^{-7} \times 0.70) / 160$; = $2.6(3) \times 10^{-9}$ m^2 $D = \sqrt{(4A / \pi)}$ / = $\sqrt{(4 \times 2.63 \times 10^{-5} / \pi)}$; = 5.8×10^{-5}m	2 2	correct value scores 4 $r = 2.9 \times 10^{-5}$m scores 3
(c) i)	0.8 / 200 = 0.004 (Ω)	1	acc. 1 / 200 = 0.005 (Ω)
(ii)	much lower R / very low R / $R_s << R_p$ (so larger d) more detail : resistance ratio 1/ $(200)^2$ OR diameter ratio 200 / 1 new diameter = 1.(2) cm gets 2 marks	1 1 11	AW but quality needed for second mark /
9(ai)	strong / stiff / high Y.M. / tough	1	
(ii)	so does not: break / stretch too far / crack	1	appropriate to named property from (i)
(b)(i)	x-area one cable = (½ W)/ σ / = $1.8 \times 10^6 / (2 \times 1.3 \times 10^8)$ = 6.9×10^{-3} m^2	2 1	method ; correct use ½ evaluation ecf
(ii)	$\varepsilon = \sigma / E$ / = 1.3×10^8 / 2.1×10^{11} ; = 6.19×10^{-4} $x = \varepsilon L$ = $6.19 \times 10^{-4} \times 150$ = 9.3×10^{-2} (m)	2 1	method ; evaluation final evaluation
(c)(i)	due to self weight / wire at **P** supports greater length	1	AW
(ii)	**C**	1 10	
10ai)	fibres set in motion / many reflections reduce amp.	1	other: big surface area
(ii)	for strength / stiffening / support / fixing	1	ora wool too floppy
(b)(i)	(equal scale increments represent) equal factors / x 2	1	NOT "times" scale
(ii)	(covers most) of the range human hearing / music	1	AW
(iii)	drum - low f ; speech - high f ; high f reduced more	3	comparison of ranges scores first 2 marks
(c)	= 10 $\log_{10}$ (100) / $\log_{10}$ (100) = 2 20 (dB)	1 1 9	correct method / part evaluation
11ai)	correct point (-0.15, 0.3) ; correct error bar is ± 1 sq.	2	ecf on point
(ii)	good best fit curve through error bars	1	
(b)(i)	hard to judge best image focus / judging middle of lens / coloured image edges	1	AW any sensible comments to do with measuring distance
(ii)	use magnifying glass when image is small / use colour filter / repeated readings appropriate to (i)	1	
(c)(i)	-6.7 3.3 10	1	all correct for 1 mark
(ii)	data consistent with graph curvature added circa 10.0 D	1	curvatures consistent
(iii)	($f = 1/P$ = 1/10 =) 0.1 (m) ecf from (i) / (ii)	1	evaluation
(iv)	basic explanation: use uncertainty in v / spread in P OR f values / plot curvatures graph for straight line plot more detail: use extreme v / ± % in v / P hence ± in f / intercepts of linear plot	1 1 10	any sensible suggestion if numerical detail expect max ± 5% uncertainty
	Total section B	40	

Qn	*Expected Answers*	Marks	Additional guidance
	Section C		
12ai)	Named transducer appropriate to physical property	1	
(ii)	circuit diagram 1/2/3 style e.g. resistor – thermistor potential divider with output (Voltmeter) clear	3	-1 each error / omission
(b)	explanation of how circuit delivers electrical output 1/2/3	3	1/2/3 style
(c)(i)	sensitivity is change in output ÷ change in input / resolution is smallest detectable change in input / response time is time taken for sensor output to settle (after a change in input variable)	2	only one property good definition 2 part definition 1 mark
(ii)	sensible sensitivity e.g. 40 ; mV per °C sensible resolution e.g. 0.025 °C response time e.g. 5 ; s for small thermistor	1	sensible value and unit allow ecf from (i)
(iii)	experimental determination of above 1/2/3 style look for: what is changed ; what is measured ; how worked out credit diagrams and / or graphs	3 13	all measurements and how combined explicit for 3 marks allow ecf from (i)
13a)	correct labelled diagram for refractive index experiment 1/2/3 style e.g. ray box, glass block, correct ray, protractor	3	any feasible lab equipment incorrect / no ray max 2
(b)	experimental description 1/2/3 style look for: mark incident ray , mark refracted ray, measure angles	3	method must work for 3 if angles not clear from (a) / (b) max 2
(c)	description of how to use data 1/2/3 style e.g. tabulate and plot sin *i* against sin *r* draw best fit straight line and calculate the gradient for reliable averaged refractive index	3	look for: one value only max 1 averaged values max 2 full graph method max
(d)(i)	$v = c/n$ / $v \propto 1/n$; smaller index larger v	2	
(ii)	blue component of light refracted more (giving shorter *f*)	1	on diagram
(ii)	blurred / coloured edges to image	1 13	AW
	Q W C	4	
	Total section C	30	

QWC Marking quality of written communication

The appropriate mark (0-4) should be awarded based on the candidate's quality of written communication in Section C of the paper.

4 max The candidate will express complex ideas extremely clearly and fluently. Answers are structured logically and concisely, so that the candidate communicates effectively. Information is presented in the most appropriate form (which may include graphs, diagrams or charts where their use would enhance communication). The candidate spells, punctuates and uses the rules of grammar with almost faultless accuracy, deploying a wide range of grammatical constructions and specialist terms.

3 The candidate will express moderately complex ideas clearly and reasonably fluently. Answers are structured logically and concisely, so that the candidate generally communicates effectively. Information is not always presented in the most appropriate form. The candidate spells, punctuates and uses the rules of grammar with reasonable accuracy; a range of specialist terms are used appropriately.

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Qn	Expected Answers	Marks	Additional guidance
1	(i) **B** (ii) **A** (iii) **B**	3	
2(a)	5 (m s^{-1}) ✓ East ✓ accept arrow pointing →	2	55 (m s^{-1}) East (1 mark)
(b)	time (= 35/**5**) =7 (s) ✓ **ecf** from (a)	1	35/55 = 0.64 from (a) **ecf**
(c)	distance (= 25x**7**) = 175 (m) ✓ **ecf** from (b)	1	25 x 0.64 from (b) = 16 **ecf**
3(a)	for **using** f = c/λ to get f = **8.57 x 10^{14}** ✓ (Hz) then **using** E = hf (6.6 x 10^{-34} x 8.57 x 10^{14}) to get E = **5.66** x 10^{-19} (J) ✓ (calculator value)	2	f = c/λ and E = hf could be implicit in E= hc/λ to get E = **5.66** x10^{-19} ✓✓ (calculator value)
(b)	for calculating energy **E =** (= 8x10^4x1.2x10^{-13}) = **9.6 x 10^{-9}** (J) ✓ number = 9.6 x 10^{-9} / 5.7x10^{-19} = **1.7x10^{10}** $✓_e$	2	
4(a)	t^2 = (2 x 6.80) / 9.81 $✓_m$ t = **1.18** (s) $✓_e$ **3 s.f. only**	2	using g = 10 accept t = 1.17 here
(b)	v = 6.80 / Δt $✓_m$ correct evaluation $✓_e$ (m s^{-1}) (Δt = 1.20 – (a)) ***(note: erroneous answer for (a) can gain ✓✓ in (b))***	2	poss. evaluations: 340 (using t = 1.18) 309 (using t = 1.178) 227 (using t = 1.17) 200 (using t = 1.166)
5	**C** ✓	1	
6 (a)(i)	correct vertical arrows at Q,R and S ✓	1	arrows must point **downwards**
(ii)	0.5 1.0 (or 1) 1.5 ✓ **ecf** from **(a)(i)** for consistency	1	
(b)	attempting to use a = change in velocity / time ✓ correct evaluation of acceleration from data in (a)(ii)	2	any pairs of values of v and t

Section A Total 20

Qn	Expected Answers	Marks	Additional guidance
7(a)	40 x 10^{-9} / 120 ✓$_m$ (= 3.3 x 10^{-10})	1	ensure 10^{-9} features
(b)(i)	single loop ✓$_m$ 1 nodes and 1 antinode labelled ✓$_m$ (accept half loop)	2	for labelling a single N & A on the diagram as drawn ✓
(ii)	λ = 2 x 25 x 10^{-6} ✓$_m$ = 5.0 x 10^{-5} ✓$_e$(m) (λ =2L implied) (accept 50 x 10^{-6}m / 50 μm)) **ecf** from (b)(i)	2	look for link between λ and L if (b)(i) incorrect
(iii)	f (= v/λ) = 60 / 5.0 x 10^{-5} ✓$_m$ = 1.2 x 10^6 (Hz) ✓$_e$ **ecf** from (b)(ii)	2	
(iv)	beyond audible range / ultrasound / too high pitch ✓ amplitude/vibrations too small / not loud enough ✓ OAW	2	question is **not** about playing the instrument
	Total	9	
8(a) (i)	F = 0.5 x 0.4 x 1.2 x 2.5 x $(20)^2$ ✓$_s$ = 240 ✓$_e$ (N)	2	
(ii)	for k = 0.91x0.4 = 0.364 and A = 1.07x2.5 = 2.68 ✓ for **recalculating F**, <u>convincingly</u> and correctly (**233.7**), and **showing** it to be **0.97 of original** ✓ [or F_{new} = 0.91 x 1.07 F_{old} = 0.97 F_{old} ✓✓]	2	ecf from wrong (a)(i) ½ (0.91)kρ(1.07)Av^2 ✓$_m$ = 0.973(½kρAv^2) ✓$_e$ (implies 3% reduction)
(b)(i)	240 N ✓ forces must be **balanced** / equal **and opposite** or **resultant force** must be zero or acceleration = zero ✓	2	
(ii)	(P = 240 x 20) = 4800 ✓$_e$ W ✓$_u$	2	W or J s^{-1} or N m s^{-1}
(iii)	**drag** increases **x4** ✓ 2nd mark for **either** power α drag **or** drag α v^2 ✓	2	
	Total	10	

Qn	Expected Answers	Marks	Additional guidance
9a(i)	(50 / 12) = **4.2** ✓$_e$ (m s^{-1}) (4.17)	1	
(ii)	(32/60) = **0.53** ✓$_e$ (Hz) (0.5)	1	
(b)(i)	1.1 (m) <u>and</u> **3.3** (m s^{-1}) ✓ **2.0** (m s^{-1}) ✓$_e$ (3.28) (1.98)	2	1 mark for second row 1 mark for third row
(ii)	**v decreases**✓ λ **decreases** (shorter) ✓ ***f* same** ✓ (internal consistency from (b)(i) to (b)(ii))	3	
(iii)	4 elements: 1 parallel wavefronts ✓ 2 curvature at edges ✓ 3 λ smaller than before gap ✓ 4 λ decreasing from **B** to **D** ✓ (internal consistency from (b)(ii) to (b)(iii))	4	If curved (semicircular) wavefronts drawn … 1 mark for 'curvature at edges' …and points 3 and 4 may be covered
	Total	11	
10 (a) (i)	3 phasors arrows drawn tip-to-tail in or almost in phase✓ and correct rpa drawn ✓	2	for picture simply showing 3 phasors in phase (1 mark)
(ii)	**probability** of photons arriving α (rpa)^2✓ rpa is large ✓ (note, the question has asserted that 'this resultant phasor amplitude implies a high probability that photons arrive ……. '. so the **marks are for the LINK**)	2	emphasis is on **WHY** large rpa **means** high probability (chance) photons will go along such paths
(b)(i)	3 phasors arrows drawn tip-to-tail more out of phase than in (a)(i)✓ and correct rpa drawn ✓	2	for picture simply showing 3 phasors out of phase (1 mark)
(ii)	for direct paths high probability of arrival **/** large RPA **or** for indirect paths low probability of arrival **/** small RPA ✓ so blocked paths hardly change **no. of photons** at B ✓	2	very low proability of photons following 'blocked paths; so blocking paths hardly affects no. **photons**
(c)	to create many paths of equal length **/** trip times same ✓ so high probability photons arrive AW ✓	2	read carefully for comprehension
	Total	10	
	Section B Total	**40**	

Qn	Expected Answers	Marks	Additional guidance
11 (a)(i)	type of wave ✓	1	
(ii)	appropriate wavelength with unit ✓ sensible wave speed ✓	2	
(b)	clear labelled diagram ✓✓✓ …with some minor omissions or errors ✓✓ …. for some attempt made ✓	3	3 / 2 / 1
(c)	for 3 separate relevant and correct observations ✓✓✓ for explanation in terms of superposition ✓✓✓	6	
	Total	12	
12 (a)	for stating distance measurement to be made ✓	1	
(b)	for justification of usefulness, interest or importance ✓	1	
(c)	clear labelled diagram ✓✓✓ …with some minor omissions or errors ✓✓ …. for some attempt made ✓	3	‘echo sounding’, ‘parallax’, or ‘triangulation’ expected
(d)	**pulse** sent out✓ **reflected and received** from target ✓ trip **time measured** ✓ **s = vt** ✓ significance of **v** ✓ s (or t) **halved** ✓	6	or equivalent marking points for different technique
(e)(i)	factor limiting accuracy ✓ and the effect ✓	2	method or equipment
(ii)	for sensible way of improving ✓	1	
	Total	14	
	Section C Total	**26**	
	Quality of Written Communication	**4**	
	Paper Total	**90**	

QoWC Marking quality of written communication

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3 The candidate will express moderately complex ideas clearly and reasonably fluently. Answers are structured logically and concisely, so that the candidate generally communicates effectively. Information is not always presented in the most appropriate form. The candidate spells, punctuates and uses the rules of grammar with reasonable accuracy; a range of specialist terms are used appropriately.

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Mark Scheme 2863/01
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- Final and intermediate calculated values in the schemes are given to assist the examiners in spotting whether candidates are proceeding correctly. Mark schemes frequently give calculated values to degrees of precision greater than those warranted by the data, to show values that one might expect to see in candidates' working.
- Where a calculation is worth two marks, one mark is generally given for the method, and the other for the evaluation of the quantity to be calculated.
- If part of a question uses a value calculated earlier, any error in the former result is not penalised further, being counted as *error carried forwar*d: the candidate's own previous result is taken as correct for the subsequent calculation.
- Inappropriate numbers of significant figures in a final answer are penalised by the loss of a mark, generally once per examination paper. The maximum number of significant figures deemed to be permissible is one more than that given in the data; two more significant figures would be excessive. This does not apply in questions where candidates are required to show that a given value is correct.
- Where units are not provided in the question or answer line the candidate is expected to give the units used in the answer.
- Quality of written communication will be assessed where there are opportunities to write extended prose.

For some of the longer descriptive questions three marks will be used (in scheme called the 1/2/3 style).

1 will indicate an attempt has been made
2 will indicate the description is satisfactory, but contains errors
3 will indicate the description is essentially correct

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

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2. Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (½) should never be used.

3. The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

   x = incorrect response (errors may also be underlined)
   ^ = omission mark
   bod = benefit of the doubt (where professional judgement has been used)
   ecf = error carried forward (in consequential marking)
   con = contradiction (in cases where candidates contradict themselves in the same response)
   sf = error in the number of significant figures

4. The marks awarded for each part question should be indicated in the margin provided on the right hand side of the page. The mark total for each double page should be ringed at the end of the question, on the bottom right hand side. These totals should be added up to give the final total on the front of the paper.

5. In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.

6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

7. Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.

8. An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct and answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

m	= method mark
s	= substitution mark
e	= evaluation mark
/	= alternative and acceptable answers for the same marking point
;	= separates marking points
NOT	= answers which are not worthy of credit
( )	= words which are not essential to gain credit
___	= (underlining) key words which **must** be used to gain credit
ecf	= error carried forward
AW	= alternative wording
ora	= or reverse argument

Qn	Expected Answers	Marks	Additional guidance
1 a b	3.4 0.34	1 1	Accept correct calculated values
2	a = $4\pi^2 f^2 s$ = 4 x 9.87 x 22500 x 0.002✓ =1780 m s^{-2} ✓	2	Must show clear working and own answer. Beware and do not reward fudge.
3 a	distance = 3 x 10^8 x 55 x 0.5 ✓= 8.25 x 10^9 ✓ m	2	Use of formula can be implicit. Need own value. No marks for 1.65 x 10^{10} m. (candidate hasn't halved distance or time)
b	speed = 0.05 x 3 x10^8/ (35 x 60) ✓ = 7.1 x 10^3 ✓m s^{-1} OR: calculate new distance = 8.24 x 10^9 or 8.235 x 10^9 leading to Δs = 0.01 x 10^9 or 0.015 x 10^9 ✓ av. vel. = 4.8 x 10^3 or 7.1 x 10^3✓ IF 8.3 x 10^9 and 8.2 x 10^9 are used Δs = 0.1 x 10^9 ✓ av. vel. = 4.8 x 10^4 ✓	2	Ecf from (a) No marks if no conversion from hours to seconds. Don't penalise not halving distance twice. Penalise rounding error. Accept 2099.95 s.
4 a b c	pV =nRT✓ suitable p,V values ✓ calculation leading to 313 K ✓ (+/- 10K) volume = 260 ✓ smooth –ve gradient curve through (4,520) and (8,260) by eye✓	3 1 1	Need own value. Accept 259K no ecf
5a b c	Red shift 1/2.2 x 10^{-18} = 4.5 x 10^{17} s ✓ = 1.4 x 10^{10} years ✓ The Universe did not begin with galaxies AW✓	1 2 1	Allow more wordy answers but NOT Doppler shift. NOT microwave background background Non-linear expansion Uncertainty of *Ho*
6 a b	1.1. x 10^3 x 2200 x 10^{-6} = 2.4 (2) ✓ model suggests current steady over each 1.0 s. ✓ Iterate more frequently. ✓ AW	1 2	Must show clear working or own answer. NB this is a model not an experiment.

Section A total:20

Qn	Expected Answers	Marks	Additional guidance
7(a)(i) (a) (ii) (a) (iii)	$(1.8 \times 10^{-6}/40) \times 6 \times 10^{23}$ ✓= 2.7×10^{16}✓. $(1 / 2.7 \times 10^{16}) \times 0.48$✓ = 1.78×10^{-17} s^{-1} ✓. Half life = $0.693/1.8 \times 10^{-17}$ s^{-1} = 3.9×10^{16} s ✓= 1.2×10^{9} yrs✓.	2 2 2	 Need own value
(b) (i) b(ii)	2 half lives ✓= 2.4×10^{9} yrs ✓ . (If argon has escaped) the actual K:Ar ratio is smaller/more K decayed ✓more K decay means longer time/more half lives✓	2 2	Ecf AW - sensible physics
8(a)(i) (ii) (iii) (b) (c) (d)	(-10 -15) x 0.075 ✓= -1.87(5) ✓ $F = \Delta p/\Delta t = 1.9/0.12$ ✓= (-)16✓ N (15.6 or 15.8 acceptable) Same magnitude ✓ opposite direction✓ First two marks, any two of bulleted points (As T increases) : • (KE increases leading to) v/p increase. • more frequent collisions • Greater momentum change on collision /greater rate of change of momentum Third mark: greater force over a given area ✓ $1 \times 10^{5} / 5 \times 10^{-23}$ ✓= 2×10^{27} ✓ Any two of bulleted points: • number of collisions per second increases • molecules take less time to travel between walls/to the wall and back • momentum change per second depends on momentum change per collision and number of collisions per second. • Suggesting four-fold pressure increase OR: Using $pV = 1/3\ Nm <c^2>$ to show non-linearity ✓ stating how this shows p more than doubles ✓	2 2 2 3 2 2	Need clear calculation with correct signs and own value (one mark each) correct magnitude gains one mark. 'equal force' by itself gains nothing.
9a) (i) (a) (ii) (a) (iii) (b) (i) (ii)	From graph $-8.9 \times 10^{8} \times 6 \times 10^{24}$ ✓= -5.34×10^{33}✓ Evidence of tangent or pairs of points within range 12.5 to 20.0 ✓leading to answer in range beteen 5×10^{-3} N and 7×10^{-3} N✓. $F = 6 \times 10^{-3} \times 6 \times 10^{24} = 3.6 \times 10^{22}$ N ✓ mv^2/R ✓ required relationship obtained using k.e. = ½ mv^2 ✓	2 2 1 1 1	Range -5.1×10^{33} to -5.4×10^{33} J one mark lost for missing minus sign. No ecf within question a (ii) Range: 3×10^{22} N to 4.2×10^{22} N. ecf (a)(ii)
(c) (d)	k.e = $3.6 \times 10^{22} \times 1.5 \times 10^{11}/2$ ✓= 2.7×10^{33} J total energy = $2.7 \times 10^{33} + (-5 \times 10^{33}) = -2.3 \times 10^{33}$ ✓ J Lower orbit -> more negative g.p.e. ✓ Therefore greater k.e. ✓ therefore greater speed✓.	2 3	Use the value from a (iii) Accept calculation of ke even if given as total energy. Use value from a (i) Watch out for waffle Accept 'lose gpe' need link between gpe and k.e. for second mark.

Qn	Expected Answers	Marks	Additional guidance
10(a) (i)	6000 x 1.4 x 10^{-23} = 8.4 x 10^{-20} ✓J	1	Need own value or clear working. Accept 12.6 x 10^{-20}J
(a) (ii)	10 x 1.6 x 10^{-19} / 8.4 x 10^{-20} J✓ = 19 ✓. ORA	2	Must show working. Accept 20 only if 8 x 10^{-20} J used. Accept 13 (12.7) if 12.6 x 10^{-20}J used.
(b) (i)	Explanation in terms of 'getting lucky' / energy interchanges on collision✓.	1	
(ii)	e^{-20} ✓= 2 x 10^{-9} ✓.	2	
(iii)	Any of the following – one mark each. • f is likelihood of particle having sufficient energy • ionisation/sufficient energy will happen (on average) once every 1/ 2 x 10^{-9} = 5 x 10^{8} collisions. • (On average) each atom can be reionised twice every second. • Linking small probability to number of opportunities (can be arithmetical)	2	
(c) (i)	Either direct ratio of temperatures or by working through energy ratio to a value of 1070✓ .	1	Need own value or clear working
(ii)	Any of the following – one mark each • Even though there may be many many collisions every second • the chance of a collision having sufficient energy to fuse is (almost) vanishingly small, (see calculator value of zero) • hence rate is slow enough to keep stars burning for a long time.	2	Give marks for sensible physics

QWC taken from 7 b(ii), 8 (b), 8(d), 9 (d) (Pages 9,11, 13)
Section Total: marks 46 + 4 QWC = 50

QoWC **Marking quality of written communication**

The appropriate mark (0-4) should be awarded based on the candidate's quality of written communication in Section B of the paper.

4 max The candidate will express complex ideas extremely clearly and fluently. Answers are structured logically and concisely, so that the candidate communicates effectively. Information is presented in the most appropriate form (which may include graphs, diagrams or charts where their use would enhance communication). The candidate spells, punctuates and uses the rules of grammar with almost faultless accuracy, deploying a wide range of grammatical constructions and specialist terms.

3 The candidate will express moderately complex ideas clearly and reasonably fluently. Answers are structured logically and concisely, so that the candidate generally communicates effectively. Information is not always presented in the most appropriate form. The candidate spells, punctuates and uses the rules of grammar with reasonable accuracy; a range of specialist terms are used appropriately.

2 The candidate will express moderately complex ideas fairly clearly but not always fluently. Answers may not be structured clearly. The candidate spells, punctuates and uses the rules of grammar with some errors; a limited range of specialist terms are used appropriately.

1 The candidate will express simple ideas clearly, but may be imprecise and awkward in dealing with complex or subtle concepts. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling may be noticeable and intrusive, suggesting weakness in these areas.

0 The candidate is unable to express simple ideas clearly; there are severe shortcomings in the organisation and presentation of the answer, leading to a failure to communicate knowledge and ideas. There are significant errors in the use of language which makes the candidate's meaning uncertain.

Mark Scheme 2864/01
June 2006

Physics B (Advancing Physics) mark schemes - an introduction

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The following points need to be borne in mind when reading the published mark schemes:

- Alternative approaches to a question are rewarded equally with that given in the scheme, provided that the physics is sound. As an example, when a candidate is required to "Show that..." followed by a numerical value, it is always possible to work back from the required value to the data.
- Open questions permit a very wide variety of approaches, and the candidate's own approach must be rewarded according to the degree to which it has been successful. Real examples of differing approaches are discussed in standardisation meetings, and specimen answers produced by candidates are used as 'case law' for examiners when marking scripts.
- Final and intermediate calculated values in the scheme are given to assist the examiners in spotting whether candidates are proceeding correctly. Mark schemes frequently give calculated values to degrees of precision greater than those warranted by the data, to show values that one might expect to see in candidate's working.
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ecf	= error carried forward (in consequential marking)
con	= contradiction (where candidates contradict themselves in the same response
sf	= error in the number of significant figures
up	= omission of units with answer

4 The marks awarded for each part question should be indicated in the right-hand margin. The mark total for each double page should be ringed at the bottom right-hand side. These totals should be added up to give the final total on the front of the paper.

5 In cases where candidates are required to give a specific number of answers, mark the first answers up to the total required. Strike through the remainder.

6 The mark awarded for Quality of Written Communication in the margin should equal the number of ticks under the phrase.

7 Correct answers to calculations should obtain full credit even if no working is shown, unless indicated otherwise in the mark scheme.

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The following abbreviations and conventions are used in the mark scheme:

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e	= evaluation mark
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( )	= words which are not essential to gain credit
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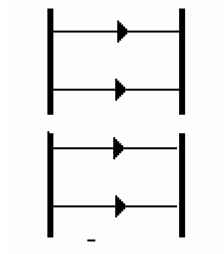
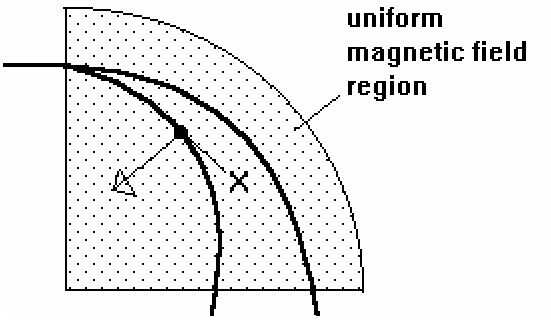
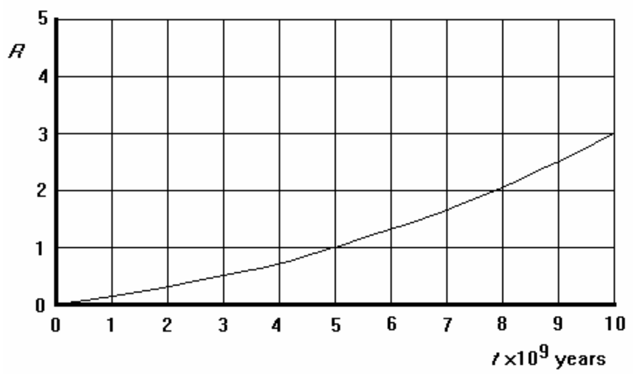
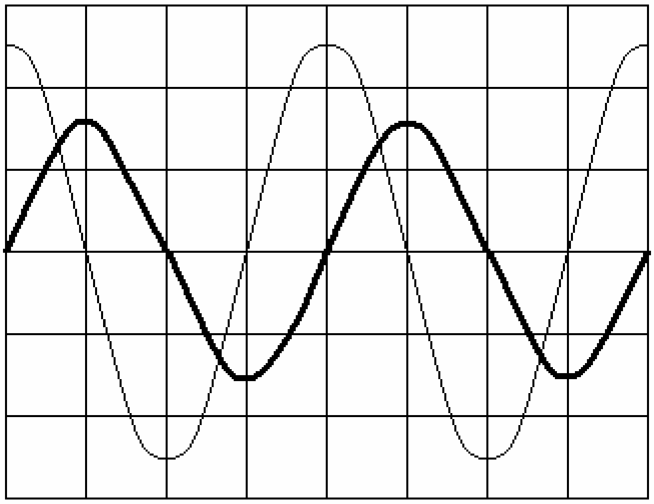
ecf	= error carried forward
ora	= or reverse argument
eor	= evidence of rule

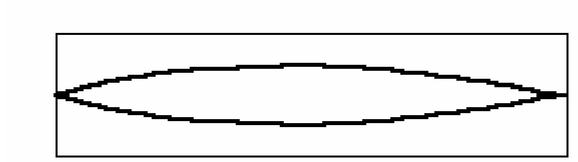
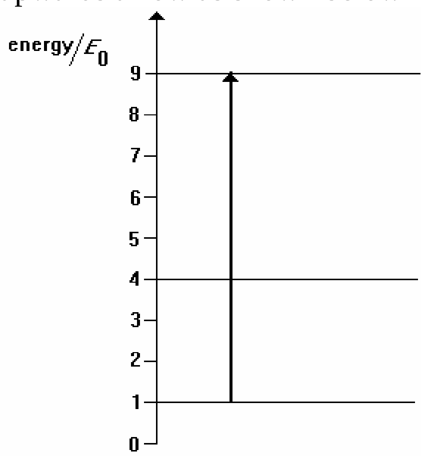
1 (a) 1 (b)	J C^{-1} N C^{-1}	1 1
2	<u>rest</u> energy of a particle (of mass *m*) / energy change associated with a change of mass *m* (wtte) / energy required to make a particle of mass *m* (wtte) NOT restatement of $E = mc^2$ in words	1
3	$^{90}_{38}\text{Sr} \rightarrow {}^{0}_{-1}\text{e} + {}^{0}_{0}\bar{\nu} + {}^{90}_{39}\text{Y}$ mass number of Y = 90 charge of electron = -1, proton number of Y = 39 NO ecf for wrong charge on electron	 1 1
4	$\lambda = 0.69/T_{½}$, $A = -\lambda N$ $\lambda = 0.69/8.9\times10^8 = 7.75\times10^{-10}$ s^{-1} ecf incorrectly calculated λ : $N = A / \lambda = 500 / 7.75\times10^{-10} = 6.5\times10^{11}$ ACCEPT 6.4×10^{11}, 6×10^{11}	0 1 1
5 (b) 5 (a)	neutrinos zero charge — interacts weakly no — no yes — yes yes — no yes — no [1] for each correct column	1 1 1

6 (a) 6 (b)	C B	1 1
7	total dose equivalent = $40 \times 0.1\times10^{-3} = 4\times10^{-3}$ Sv ecf incorrect dose equivalent: risk = $4\times10^{-3} \times 3 = 1.2\times10^{-2}$ % ACCEPT 10^{-2}% or 1 in 10 000	1 1
8 (a) 8 (b)	36 V any two of the following: • increase turns of coil • decrease air gap • increase strength of magnet • more iron (in the magnetic circuit) • increase permeance of core (wtte) • laminate the core (wtte) • increase cross-sectional area of core NOT bigger magnet / faster rotation	1 2
9 (a) 9 (b)	Q C somewhere before D D somewhere before A Can David Act?	1 1 1

10 (a) (i)	four equally spaced horizontal lines between plates (by eye) pointing to the right ACCEPT correct edge effects 	1 1
10 (a) (ii)	$eV = ½mv^2$ $v^2 = 2eV/m = 2 \times 1.6\times10^{-19} \times 2.0\times10^2 / 3.5\times10^{-25} = 1.83\times10^8$ $v = 1.35\times10^4$ m s^{-1} $p = mv = 3.5\times10^{-25} \times 1.35\times10^4 = \underline{4.7\times10}^{-21}$ N s ACCEPT reverse calculation or $eV = p^2/2m$ method [1], substitution [1], answer [1]	1 1 1
10 (b) (i)	at right angles to path, through X, pointing to bottom leftish (by eye) 	1
10 (b) (ii)	$Bqv = mv^2/r$ $r = mv/Bq$ (eor) $r = 4.7\times10^{-21}/0.12 \times 1.6\times10^{-19} = 0.24$ m (0.25 m for 4.73×10^{-21}) (ACCEPT 0.26 m for 5×10^{-21} Ns)	1 1 1
10 (c)	uranium ions have greater mass / momentum increasing m (or mv) in $r = mv/Bq$ means bigger r (wtte) IGNORE references to changes of v or forces	1 1

11 (a)	alphas have nucleon number of 4 (eor) alphas have proton number of 2 (eor) EITHER need 8 alphas to balance the top line (wtte) OR need 5 alphas to balance the bottom line (wtte) THEN but other line doesn't balance (wtte) ACCEPT correct argument in terms of neutron-proton ratio ...	1 1 1 1
11 (b)	any of the following, maximum [2] • lead-206 increases • rate of increase slows down as uranium-238 decreases • lead-206 equals uranium-238 after one half-life • lead-206 three times uranium-238 after two half-lives • because uranium-238 is halved twice	1 1
11 (c) (i)	curve starts at 0,0 curves (exponentially) up through 5,1 (by eye) <u>and</u> 10,3 (by eye)  	1 1 1
11 (c)(ii)	number of lead-206 = N_0 - N (eor) number of uranium-238 = $N = N_0e^{-\lambda t}$ $R = \frac{N_0 - N_0e^{-\lambda t}}{N_0e^{-\lambda t}} = \frac{1-e^{-\lambda t}}{e^{-\lambda t}} = \frac{1}{e^{-\lambda t}} - 1 = e^{\lambda t} - 1$ ACCEPT reverse argument	1 0 1
11 (c)(iii)	$\ln(R + 1) = \lambda t$ (eor) $t = \ln(1.81)/4.8\times10^{-18} = 1.2\times10^{17}$ s ACCEPT 1.35×10^{17} s from half life of 5×10^9 years	1 1

12(a)	any of the following, maximum [2] • (alternating emf produces) <u>alternating</u> current in primary • creates <u>alternating</u> magnetic field/flux • which links with secondary coil (wtte) ACCEPT alternatives to alternating	2
12(b) (i)	$N_p/N_s = V_p/V_s$ (eor) $V_p = V_s \times N_p/N_s = 5.0 \times (180/600) = 1.5$ V	1 1
12(b) (ii)	flux in the secondary coil less than in primary coil (because of poor magnetic circuit) (wtte) IGNORE eddy currents / energy loss	1
12(c) (i)	sinusoidal curve of period 40 μs, any constant amplitude, all across correct phase of ±π/2 (by eye) e.g. 	1 1
12(c) (ii)	emf = rate of change of flux linkage relevant data from graph: peak emf = 5 V, period = 40 μs (eor) EITHER peak emf / quarter period ≈ flux linkage (eor) OR emf = $2\pi f n\Phi$ EITHER $n\Phi \approx 5\times10^{-5}$ (Wb) OR $n\Phi = 5/(2\pi\times2500) = 3.2\times10^{-5}$ (Wb)	0 1 1 1

13(a) (i)	standing wave with nodes at end with one antinode in centre of box 	1 1
13(a) (ii)	$\lambda = 2L$ (eor) $p = h/\lambda$ $E = (h/2L)^2/2m$	1 0 1
13(b) (i)	upwards arrow as shown below 	1
13(b) (ii)	$f = c/\lambda = 3.0\times10^{8} / 5.1\times10^{-7} = 5.9\times10^{14}$ Hz $E = hf = 6.6\times10^{-34} \times 5.9\times10^{14} = 3.9\times10^{-19}$ J ecf incorrect (i): $E_0 = E/8 = \underline{4.9} \times 10^{-20}$ J	1 1 1
13(b) (iii)	$4.9\times10^{-20} = h^2/8mL^2$ $L^2 = (6.6\times10^{-34})^2 / 8 \times 9.1\times10^{-31} \times 4.9\times10^{-20}$ $L = 1.1\times10^{-9}$ m $E_0 = 5.0\times10^{-20}$ J gives 1.1×10^{-9} m $E_0 = 4.3\times10^{-20}$ J gives 1.2×10^{-9} m	 1 1
13(c)	molecule can lose energy by dropping to first excited state (wtte) so photons of longer wavelength / lower frequency / less energy Quality of Written Communication	1 1 4

Marking quality of written communication

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4 The candidate will express complex ideas extremely clearly and fluently. Answers are structured logically and concisely, so that the candidate communicates effectively. Information is presented in the most appropriate form (which may include graphs, diagrams or charts where their use would enhance communication). The candidate spells, punctuates and uses the rules of grammar with almost faultless accuracy, deploying a wide range of grammatical constructions and specialist terms.

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Mark Scheme 2865
June 2006

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- Open questions, such as the questions in section C permit a very wide variety of approaches, and the candidate's own approach must be rewarded according to the degree to which it has been successful. Real examples of differing approaches are discussed in standardisation meetings, and specimen answers produced by candidates are used as 'case law' for examiners when marking scripts.
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3. The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

   x = incorrect response (errors may also be underlined)
   ^ = omission mark
   bod = benefit of the doubt (where professional judgement has been used)
   ecf = error carried forward (in consequential marking)
   con = contradiction (in cases where candidates contradict themselves in the same response)
   sf = error in the number of significant figures

4. The marks awarded for each part question should be indicated in the margin provided on the right hand side of the page. The mark total for each double page should be ringed at the end of the question, on the bottom right hand side. These totals should be added up to give the final total on the front of the paper.

5. In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.

6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

7. Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.

8. An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct and answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

m	= method mark
s	= substitution mark
e	= evaluation mark
/	= alternative and acceptable answers for the same marking point
;	= separates marking points
NOT	= answers which are not worthy of credit
( )	= words which are not essential to gain credit
____	= (underlining) key words which **must** be used to gain credit
ecf	= error carried forward
AW	= alternative wording
ora	= or reverse argument

Qn	Expected Answers	Marks	Additional guidance
1 (a)	(i) $E = mc\Delta T$ $= 0.17 \times 4200 \times 4 = 2900$ J ≈ 3000 J ✓m✓e (ii) $P/A = 2900/3 = 950$ W m^{-2}✓ (iii) Energy absorbed by atmosphere/ other plausible mechanism✓ (iv)$P = 2.8 \times 10^{23}$ m^2 × 1400 W m^{-2} = 3.9×10^{26} W ≈ 4×10^{26} W ✓m ✓e	2 1 1 2	Ignore any unit error. Needs mechanism, not e.g. "lost"
(b)	(i) When $R_Y \geq 100R_X$, the second term is much smaller and can be ignored ✓ (ii) $GM/R_X = 6.7 \times 10^{-11} \times 2.0 \times 10^{30}/7.0 \times 10^{8}$ $= 1.9 \times 10^{11}$ J kg^{-1} ≈ 2×10^{11} J kg^{-1}✓s ✓e (iii) Loss of PE = answer to (ii) ✓ (iv) (iv) Mass/second = 3.9×10^{26} W/1.9×10^{11} J kg^{-1} $= 2.0 \times 10^{15}$ kg s^{-1}✓m ✓e	1 2 1 2	Can calculate values and compare Can use 2×10^{11} J kg^{-1} to give 1.9×10^{15} kg s^{-1}
		12	
2 (a)	${}^{2}_{1}$H ✓(both numbers) ${}^{0}_{(+)1}$e or ${}^{0}_{(+)1}\beta$ ✓ (numbers only needed)	2	Numbers in the order given.
(b)	(i) $\Delta m = (1.00728 + 2.01410) - 3.01605 = 0.00533$ u ✓ $= 0.00533 \times 1.67 \times 10^{-27}$ kg $= 8.90 \times 10^{-30}$ kg (ii) $E = mc^2 = 8.90 \times 10^{-30} \times (3.0 \times 10^{8})^2 = 8.01 \times 10^{-13}$ J	2 2	Using 9×10^{-30} kg gives 8.1×10^{-13} J
(c)	(i) $m = 4 \times 1.67 \times 10^{-27}$ kg $= 6.68 \times 10^{-27}$ kg No of reactions from 1 kg = $1/6.68 \times 10^{-27} = 1.5 \times 10^{26}$✓ Energy = $1.5 \times 10^{26} \times 4.3 \times 10^{-12}$ J $= 6.44 \times 10^{14}$ J ≈ 6×10^{14} J✓ (ii) $E = 6.44 \times 10^{14}$ J × 2.0×10^{29} = 1.29×10^{44} J ✓ $t = E/P = 1.29 \times 10^{44}$ J/4×10^{26} W = 3.2×10^{17} s $= 3.2 \times 10^{17}/ 3.2 \times 10^{7}$ years = 1.0×10^{10} years ✓	2 2	6×10^{14} J gives 9.9 Gyears. Calc. of years implies comparison.
		10	

Qn	Expected Answers	Marks	Additional guidance
3 (a)	(i) Rings around first and second terms ✓ (ii) *R* smaller so *v* larger ✓ moving faster <u>on shorter orbit</u> so shorter period ✓ (iii) Two arrows in correct directions ✓ (iv) equation only accounts for Sun's gravity ✓ Earth's gravity also affects SOHO ✓	1 2 1 2	 Ignore relative sizes: labels not needed (iv)or smaller force ✓so can't use Gmm/R^2✓
(b)	$\frac{1}{3600}$ ✓	1	
(c)	(i) Solar wind/solar radiation ✓ Collision of solar wind particles with dust in comet produces outward force✓ (ii) Particles in independent orbits ✓ Particles further from Sun orbit more slowly ✓	2 2	(i) Something from Sun ✓ more detail✓
		11	
4 (a)	250 years /23 periods = 10.9 years ≈11 years ✓ or 250 years /22periods = 11.4 years ≈11 years ✓	1	Must show 250 & 23/22 or give 10.9/11.4
(b)	(i) $P_{4000K}/ P_{5800K} = \sigma A\ (4000)^4/\sigma A\ (5800)^4$ $= (4000)^4/ (5800)^4 = 0.23 = 23\% \approx 20\%$ ✓m✓e (ii) Appearance is in contrast to background ✓ Mercury is against a dark background, the sunspot against a very bright one✓	2 2	
(c)	(i) Stronger because lines closer together ✓ (ii) Flux lines are in closed paths / loops ✓ Must leave and re-enter Sun (somewhere) ✓ (iii) $B = \phi/A = 2.0 \times 10^{13} / 1.3 \times 10^{14}$ $= 0.15$ ✓ T or Wb m^{-2} ✓	1 2 2	 (ii) Sunspots act as (opposite) poles✓ flux lines go N→ S✓
		10	
5 (a)	$t = s/v = 1.5 \times 10^{11}/ 500 \times 10^3 = 300\ 000$ s ✓ = 3.47 days ✓	2	Can compare 300 000s with 3 days in seconds
(b)	(i) Force is perpendicular to velocity ✓ Force towards centre results in circular motion ✓ (ii) Component perpendicular to field produces a circular motion ✓ Component parallel to field is unaffected ✓ (iii) Particles are channelled along field lines (as in Fig. 5.3) ✓and field lines reach atmosphere/Earth at poles ✓	2 2 2	
		8	

6(a)	(i) n = PV/RT = 1.3 × 10^{-4} × 1.0/(8.3 × 290) = 5.4 × 10^{-8} (ii) $N = nN_A$ = 5.4×10^{-8} × 6.0×10^{23} = 3.2×10^{16} particles ✓ (iii) Value in (ii) is ≈ 200 × bigger than solar corona ✓ so solar corona is far better vacuum than TV tube ✓	2 1 2	(iii) Ratio or order of magnitude comparison✓ reasoned conclusion ✓ Allow ecf
(b)	(i) 2.0 × 10^{-17} & 8.1 × 10^{-20} J ✓ (ii) 3.2 × 10^{-16} J /2.0 × 10^{-17} J = 16 kT while 3.2 × 10^{-16} J /8.1 × 10^{-20} = 4000 kT ✓ 16kT will 'go' while 4000 kT will not /is very unlikely. ✓ /range of energies present in protons ✓corona protons much closer to escape energy ✓	1 2	
		8	
7 (a)	Removes electrons from air/other molecules/produces + and - ions by splitting molecules/atoms ✓	1	
(b)	Electron beams need relatively massive equipment; electrons don't penetrate deeply; gamma rays difficult to shield; can't switch gammas off. ✓ for each of any two independent points	2	Allow any valid point
(c)	(i) Energy = 1.25 × 10^6 eV ✓ = 1.25 × 10^6 eV × 1.6 × 10^{-19} J = 2.00 × 10^{-13} J ✓ (ii) number s^{-1} = 50 000/ 2.0 × 10^{-13} J = 2.5 × 10^{17} s^{-1} ✓m✓e	2 2	
(d)	(i) Absorbed dose = Energy per kg ✓ (ii) Most gammas are not absorbed but pass through ✓ (iii) Gamma absorption does not affect structure of nucleus (in terms of proton and neutron numbers) ✓ to become radioactive would need changes in nuclear structure ✓	1 1 2	(ii) Or gammas go in all directions/ other valid point
(e)	(i) ***and*** (ii) appropriate physical property (e.g. tough, good absorber of gamma radiation/dense, strong, stiff)✓ explanation related to the context ✓	4	Must be physical properties. Any property not in list must be justified.
		15	

8 (a)	(i) $f = 1/T = 1/(0.2 \times 10^{-3}) = 5000$ Hz ✓m✓e (ii) Flux change✓ at a greater rate/more rapidly (induces large voltage) ✓	2 2	(i) obtaining T (from graph) ✓ calculations of f✓
(b)	(i) $E = V/d \Rightarrow d = V/E = 270/\ 3\text{x}10^{6} = 9.0 \times 10^{-5}$ m ✓m✓e (ii) Energy = $½CV^2 = 0.5 \times 100 \times 10^{-6} \times (270)^2 = 3.6$ J✓m✓e (iii) $P = E/t = 3.6/10 \times 10^{-3} = 360$ W ✓m✓e	2 2 2	Or calc Q✓ then ½QV✓ Ecf from (ii) Penalise > 3 s.f. once only in (ii) or (iii).
(c)	Reasonable application e.g. application of ionising gases, stroboscope, spark plug, electric fence, camera flash, heart defibrillator or similar ✓ Relate example to high voltage/short duration✓	2	(Original question was based on a taser.)
		12	

Quality of Written Communication Apply in Q3, 4, 5 or 7 where possible.	**4**	See QWC criteria (next page)

QWC Marking quality of written communication

The appropriate mark (0-4) should be awarded based on the candidate's quality of written communication in the whole paper.

4 max The candidate will express complex ideas extremely clearly and fluently. Answers are structured logically and concisely, so that the candidate communicates effectively. Information is presented in the most appropriate form (which may include graphs, diagrams or charts where their use would enhance communication). The candidate spells, punctuates and uses the rules of grammar with almost faultless accuracy, deploying a wide range of grammatical constructions and specialist terms.

3 The candidate will express moderately complex ideas clearly and reasonably fluently. Answers are structured logically and concisely, so that the candidate generally communicates effectively. Information is not always presented in the most appropriate form. The candidate spells, punctuates and uses the rules of grammar with reasonable accuracy; a range of specialist terms are used appropriately.

2 The candidate will express moderately complex ideas fairly clearly but not always fluently. Answers may not be structured clearly. The candidate spells, punctuates and uses the rules of grammar with some errors; a limited range of specialist terms are used appropriately.

1 The candidate will express simple ideas clearly, but may be imprecise and awkward in dealing with complex or subtle concepts. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling may be noticeable and intrusive, suggesting weakness in these areas.

0 The candidate is unable to express simple ideas clearly; there are severe shortcomings in the organisation and presentation of the answer, leading to a failure to communicate knowledge and ideas. There are significant errors in the use of language which makes the candidate's meaning uncertain.

Advanced GCE Physics B (Advancing Physics) 3888/7888
June 2006 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2860	Raw	90	66	59	52	45	38	
	UMS	100	80	70	60	50	40	0
2861	Raw	90	68	60	52	45	38	0
	UMS	110	88	77	66	55	44	0
2862	Raw	120	97	85	73	62	51	0
	UMS	90	72	63	54	45	36	0
2863A	Raw	127	100	89	78	67	57	0
	UMS	100	80	70	60	50	40	0
2863B	Raw	127	100	89	78	67	57	0
	UMS	100	80	70	60	50	40	0
2864A	Raw	119	91	81	71	61	52	0
	UMS	110	88	77	66	55	44	0
2864B	Raw	119	91	81	71	61	52	0
	UMS	110	88	77	66	55	44	0
2865	Raw	90	71	64	57	51	45	0
	UMS	90	72	63	54	45	36	0

Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3888	300	240	210	180	150	120	0
7888	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
3888	23.9	45.0	64.0	79.1	90.7	100.0	6498
7888	31.2	53.9	73.4	87.6	96.8	100.0	5057

For a description of how UMS marks are calculated see;
www.ocr.org.uk/OCR/WebSite/docroot/understand/ums.jsp

Statistics are correct at the time of publication

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