OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced GCE **A2 7888**

Advanced Subsidiary GCE **AS 3888**

Mark Schemes for the Units

January 2007

3888/7888/MS/R/07J

Oxford Cambridge and RSA Examinations

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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.

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annersley
NOTTINGHAM
NG15 0DL

Telephone: 0870 870 6622
Facsimile: 0870 870 6621
E-mail: publications@ocr.org.uk

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Advanced Subsidiary GCE Physics B (Advancing Physics) (3888)

MARK SCHEMES FOR THE UNITS

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January 2007

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.
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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.
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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.

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^	= omission mark
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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.

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;	= separates marking points
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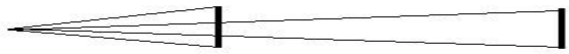
( )	= words which are not essential to gain credit
_	= (underlining) key words which **must** be used to gain credit
ecf	= error carried forward
AW	= alternative wording
ora	= or reverse argument

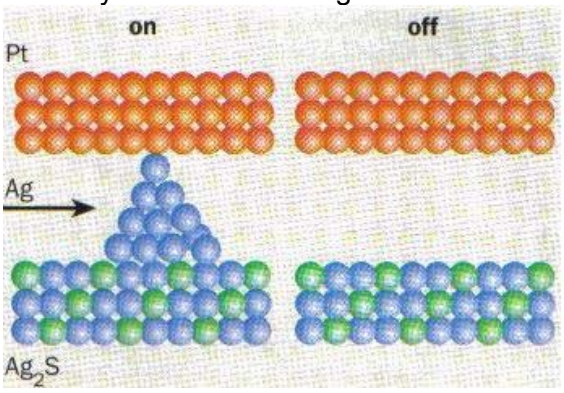
Qn	Expected Answers	Marks	Additional guidance
	Section A		
1	a) J s^{-1}; b) A s; c) Ω m	3	
2(a)	one complete oscillation of lowest f	1	judge by verticals
(b)	correctly indicated	1	bare answer OK ecf on box
	(eg time per cycle = 44 ms/6 cycles) =	1	± 10%
(c)	7.(3) ms (accept between 7 and 8 ms) ($f = 1/T$) accept between 143 and 125 (Hz)		evaluation ecf on 1/ (b)
3(a)	$\lambda = v/f$ /1500/2.5 x 10^6; 6.(0) x 10^{-4} (m)	2	method; evaluation
(b)	at least 3 more wavefronts showing correct direction and an increased constant spacing judged by eye	1	accept between 0.9 and 1.5 cm constant to ± 10% NOT gets
(c)	reflects/is absorbed/causes heating/is dissipated/lost as heat	1	less/lost/deflected/dispersed
4(a)	ceramics	1	
(b)	(compressive) stress/F/A/pressure **AND** to break/yield/shatter	1	NOT force/tension
(c)	because too brittle/not tough/cracks (in tension) ecf eg on metals/composites/rubbers/polymers/wood because tough enough/glass not tough enough	1	accept shatters ecf: (accept/reject) justified
5	4.(0) (mS)	1	
(a)	$I = G V$/= 4.0 mS x 6.0 V; = 24 mA/0.024	2	method; evaluation
(b)	(A)		allow ecf on G from (a)
6	$(10^{-2}/10^{-9})^2$ OR 10^{14} bits; 10^{14}/8 bytes = 12.5 Tbytes	2	method accept 10^{14}; evaluation
7(a)	(reconstructed signal shows) loss of: high f/detail/information/peaks and troughs OR is smoother AW	1	accept fewer harmonics NOT less noise/lower frequency
(b)	sample more frequently/use more levels/more bits per sample	1	NOT more samples
	Total section A	20	

Qn	Expected Answers	Marks	Additional guidance
	Section B		
8(ai)	(Force is) <u>proportional</u> (to extension)/$F \propto x$ / linear through origin	1	NOT just linear
(ii)	proportional graph of **double** gradient	1	
(iii)	(same modulus intensive property of) same material/modulus not depend on dimensions NOT same wire	1	through (2.0mm, 90N)
(bi)	$\sigma = (F/A) = 90/(2.5 \times 10^{-7}); = 3.6 \times 10^{8}$ (Pa)	2	accept
(ii)	$\varepsilon = (x/L) = 4.0 \times 10^{-3}/2.0; = 2.0 \times 10^{-3}$	2	correct
	$E = (\sigma/\varepsilon) = 3.6 \times 10^{8}/2.0 \times 10^{-3} = 1.8 \times 10^{11}$; Pa/ N m^{-2}	1 <u>1</u> 9	algebra L and x both ½'d substitution; evaluation substitution; evaluation evaluation ecf on (bi) unit mark stands alone
9(ai)	$I = V/R = 12/2.5 = 4.8$ A	1	evaluation
(ii 1)	total $R = 2.7\ \Omega$; ecf $I = (V/R = 12/2.7) = 4.4(4)$ A	2	SF penalty
(ii 2)	(circuit) resistance has increased	1	on recurring
(iii)	0 Ω/as small as possible/negligible NOT low (ammeter resistance) << circuit resistance	1	accept < 0.2 Ω
(bi)	equal resistors/share p.d. equally/1/2 total p.d. each	1	
(ii 1)	conductance is doubled/in parallel conductance adds/$1/R + 1/R = 2/R$ and R_{total} is halved/or calculated	1	NOT just
(ii 2)	$(V_{AB}) = 12 \times (12.5/37.5); = 4.(0)$ V	2	shared
(ii 3)	Vmeter drops resistance of its part of circuit so less p.d.	1	conducting
(iii)	∞ Ω/as large as possible/(voltmeter resistance) >> resistance of component it is measuring across	<u>1</u> 11	path is twice as good method; evaluation accept $R_{AB} < R_{BC}$ accept > 25 kΩ
10ai)	$400 \times 200 \times 5 = 4 \times 10^{5}$ bits;/8 = 5×10^{4} bytes	2	method;
	(data) compression/any compressed image file format	1	evaluation
(ii)	$(2^{5}) = 32$	1	jpeg/gif/tiff
(iii)	**A** = 80 <u>+</u> 10 pixels; 0.16 <u>+</u> 0.02 m ecf on close est	2	NOT bmp
(bi)	B is further; 3 x distance OR subtends smaller angle;	2	accept 2^{5}
(ii)	1/3 at camera OR at **B** pixel represents larger size; x 3	2	correct est. 2 marks in words or diagrams accept 6 mm pixel^{-1} 2nd mark for quantitative explantation



(c)	1/ *v* = 1/ (-0.85) + 60; = 58.8; *v* = 1/ (58.8) = 0.017m	3 11	correct ans. 3 marks
11ai)	(*I* = $\mathcal{E}$/*R* = 6/10) = 0.6(0) (A)	1	
(ii)	(±) 0.60 x 5/100; = 0.03 (A)	2	method; evaluation
(bi)	variations > 5%/up to 50%; (actual) results always lower than the expected results/show systematic error; not ± errors/not random	2	reward any two different points
(ii)	error resistance is greater than predicted/p.d. (across the terminals) is reduced; for all readings	2	expect quality reasoning
(iii)	eg current is half predicted so resistance is doubled; so *r* = *R* = 2 Ω OR r = (ε - *IR*)/*I* = (6 – (1.5 x 2))/1.5; = 2.(0) Ω	1 1	method; evaluation
		9	any valid method/data look at graph values
	Total Section B	40	

Expected Answers	Marks	Additional guidance
Section C		
eg FAX; telephone cable/electromagnetic wave	2	
accept block/system diagrams/direct representations	2	diagrams clearly labelled to gain credit
1 mark for clear indication of info: gathered/encoded; transmitted; stored/displayed and fourth mark for further quality somewhere	2	max 1 /4 for gathering info only
eg FAX uses scanner; to code script into 0/1 pixels; transmitted on telephone wires; different frequencies 0/1; stored in memory at receiving phone/pc as pixel codes 0/1; displayed by printing pixels in order/good for black and white text or graphics but not greyscale		Illustrates basic and possible extension marks
eg speed of e/m signals on wires about 2 x 10^8 m s^{-1}	1	award estimates to an order of magnitude
(= speed (i) x 10^{-6}) eg = 200 m	1	
eg 64 000 (bit s^{-1})	1	
time = 8 x 10^6/(i)/= 8 x 10^6/(64000); = 1.25 x 10^2 s	2 1	method; evaluation
increasing the carrier frequency/bandwidth of signal	1	expect quality
another suggestion or detail relevant to their example: eg increasing the scanning rate for bottleneck part of system	13	
eg silver sulphide Ag_2 S for a nano-switch circuit	1	relevant application
two relevant properties named eg conductivity; reduction of Ag ions to Ag metal	2	accept non-physical properties : economic/chemical/aesthetic
1 mark for simple property explanations 2 for quality in one, explanations linked to application	3	max 2 marks for each explanation
eg solid Ag_2 S conducts due to mobile Ag ions; deposition of metallic Ag by reversible electron capture		

appropriate scale eg 0.1 nm per atom 1/2/3 style for labelled diagram and text  	1 3	The silver atoms move in response to a small voltage between the ionic Ag_2S surface and the platinum metal electrode. This produces a fast (10 MHz) but reversible nano-switch, which changes from on/off with the sense of the applied voltage, which can be as small as 10 mV.
1/2/3 style for explanation of **one** chosen property	3	
	13	
Quality of written communication	4	
Total Section C	40	

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 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.

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.

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Mark Scheme 2861
January 2007

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Qn	Expected Answers	Marks	Additional guidance
1	B ✓	1	
(a)			
(b)	A ✓	1	
(c)	C ✓	1	
2(a)	60 x 9.8 x 1.7 $\checkmark_{m,s}$ = 1000 $\checkmark_e$ (J)	2	accept g = 10 N kg^{-1}
(b)	Idea of increased distance/time to stop ✓ Idea of work done = force x distance/or idea of F=ma – decreased rate of deceleration ✓	2	
3(a)	A – red; B – green; C – blue ✓	1	all correct required accept R, G, B
(b)	for **using** E = hf (hc/λ) $\checkmark_{m,s}$ = 3.8 x 10^{-19} (J) $\checkmark_e$	2	watch for power of ten mistakes.
4(a)	Amplitude/frequency/wavelength ✓✓	2	Only two from list required
(b)	velocity (speed)/direction/shape (of the wave)/both start in phase/both have a constant amplitude ✓	1	
5	sin θ x $\sqrt{V}$ = constant $\checkmark_m$	1	treat as independent marks
	0.36; 0.35; 0.35 (11.39, 11.00, 11.03) $\checkmark_e$ (test on ALL three pieces of data for the mark)	1	
.	conclusion consistent with test result ✓	1	conclusion (always)= 0 for test on only two pieces of data
6(a)	2.0 = ½ x 9.8 x t^2 **used** $\checkmark_{m,s}$ t = 0.638 $\checkmark_e$	2	allow for ecf
(b)	horizontal velocity = 7.7/0.64 $\checkmark_m$ = 12 $\checkmark_e$ (m s^{-1})	2	0.6 s gives 13 m s^{-1} (12.8)
	Section A Total	**20**	

7(a)	□ = 3.0 x 10^8/ 1.0 x 10^9 ✓$_{m,s}$ = 0.3 m …. ✓$_e$	2	
(b)(i)	path difference is whole no. of wavelengths ✓ waves superimpose in phase/constructive interference ✓	2	accept answers in terms of phase change
(ii)	extra path difference (□/2) ✓ waves 'out of phase'/destructive interference✓	2	don't accept 'not in phase'
(iii)	Amplitudes (intensities) may be different … ✓ waves do not completely cancel/ or reason for diff amplitudes ✓	2	second point either explanation or consequence of diff. amplitudes Do not accept 'not completely' out of phase arguments. Incomplete cancelling MUST be related to diff. amplitudes.
(iv)	total path diff changed by □2 ✓ so d = 7.5 cm ✓	2	7.5cm with no working scores 1 mark
	Total	10	
8(a)	a = 3.0/0.80 ✓$_m$ = 3.75 m s^{-2} ✓$_e$	2	accept 3.7 - 3.8
(b)(i)	drag force (air resistance) increases (with speed) ✓ so resultant/effective/total force decreases …. ✓	2	
(ii)	drag force & forward thrust identified✓ resultant force = 0/balanced forces/equal & opposite ✓	2	take (i) and (ii) together accept 'forces in equilibrium'
(c)(i)	velocity decreases rapidly then at a decreasing rate ✓ then travels at a constant velocity ✓	2	
(ii)	drag force (air resistance) becomes greater than thrust✓ drag force (again) balances/equal & opposite to thrust ✓	2	take (i) and (ii) together
	Total	10	

9 (a)(i)	1.3 (m) ✓	1	
(ii)	v = 280 x 1.3 $\checkmark_{m,\,s}$ = 364 (m s^{-1}) $\checkmark_e$ **ecf**	2	
(b)(i)	(f goes as √T so f increases by √ 2) f = √ 2 x 280 $\checkmark_m$ f = 396 (Hz) $\checkmark_e$ **3 s.f max**	2	
(ii)	higher frequency ✓ (μ) denominator becomes smaller ✓	2	average acceleration would be greater …..
(c)(i)	correct diagram of another standing wave on string ✓	1	
(ii)	<u>method mark</u> $\checkmark_m$ answer consistent with diagram $\checkmark_e$	2	
	Total	10	
10 (a)	distance = √ [$(54)^2$ + $(72)^2$] $\checkmark_m$ (= 90 km) tan θ = 72/54 $\checkmark_m$ (= 53^o)	2	scale diagram or appropriately qualified similar triangles argument are both acceptable
(b)(i)	for clear, correct method $\checkmark_m$ to obtain 1500 km h^{-1} $\checkmark_m$ identification/calculation/scale diagram of angle <u>53°</u> ✓ vector drawn towards K (linked with correct angle)/ or correct 'bearing'✓	2 1 1	Accurate, labelled with angle, scale diagram (correct vector arrows) can score all 4 marks
(ii)	L will reach M at the same time (OAW)✓ ecf from (b)(i)	1	
(c)	90 km apart so need to 'close' by 30 km $\checkmark_m$ t = 30/1500 = 0.02 h (1/50 h) $\checkmark_e$ t = 0.02 x 60 x 60 = 72 s $\checkmark_e$	3	Treat as independent marks. Watch for correct component variation.
	Total	10	
	Section B Total	40	

11 (a)	for a **situation** where a quantum phenomenon is observed✓	1	if not a quantum phenomenon … zero marks total
(b)	clear diagram ✓✓✓ …with some minor omissions or errors ✓✓ …. for some attempt made ✓ labelled ✓	3/2/1 1	
(c)	for four separate relevant and correct items of description ✓✓✓✓	4	
(d)	read as a whole … up to 4 marks for relevant **quantum** ideas ✓✓✓✓	4	Wave explanations score zero
	Total	**13**	
12 (a)	for a complete set of measurements required, <u>consistent</u> with (b)(ii). ✓✓	2	Deduct 1 mark for any omissions. Mark parts (a) and (b)(i) together
(b)(i)	for explaining each method of taking the specific measurements and stating appropriate measuring instruments ✓✓✓✓	2 2	
(ii)	for logical explanation as to how measurements used to calculate 'a' ✓✓✓	3	F=ma arguments score zero in this section but should be given credit elsewhere within the question.
(c)(i)	Credit two factors (reaction time/ parallax/etc as appropriate to method) which would affect the accuracy of the **method**	2	not friction …… as question refers to this motion
(ii)	relevant suggestion related to (c)(i) ✓ explained ✓	2	
	Total	13	
QoWC	✓✓✓✓	4	
	Section C Total	30	

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 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.

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.

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Mark Scheme 2863/01
January 2007

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.
- 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

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, (eg '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.

Abbreviations, annotations and conventions used in the Mark Scheme	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	Level	Expected Answers	Marks	Additional guidance
1 a b c		D A B	1 1 1	
2 a b		Arrow pointing to centre of Earth ✓ arc through P centred on centre of Earth ✓. Right angles to field.	2	
3 a b		$5.1 \times 10^{24} \times 5.4 \times 10^{-24}$ ✓= 28 ✓(N) 28/0.018 =1560 ✓ (Pa)	2 1	27.5 ok. Not 27 ecf 1530 & 1500 ok for 27.5, 1555, 1600 OK for 28
4 a bi ii		$9.7 \times 10^{-3} \times 10\ 000$ ✓= 97. Curve starting at same rate ✓but with decreasing grad. ✓ Student assumes constant decay rate ✓OR statement of what actually happens eg rate of decay falling with time✓	1 2 1	Clear method or own answer Must not hit x axis. Accept 'decay is exponential' or descriptive alternative. Don't accept woolliness.
5a b		$F = (-)GMm/r^2$ ✓ $= 6.7 \times 10^{-11} \times 6.0 \times 10^{24}$ kg x650/$(4.2 \times 10^7)^2$ ✓ = 148 N $F = mv^2/r$✓ => $v^2 = 150\ r/m = 150 \times 4.2 \times 10^7/650$ ✓ v = 3100 (m s^{-1}) ✓.	2 3	 Accept 3113 3090/3094 if 148 N used
6		pV = nRT ✓=> n= $2.2 \times 10^5 \times 1.1 \times 10^{-3}$/ 8.3 x 298 ✓= 0.098	2	Don't penalise 0.097
7		C = 5.6×10^{-3}/ 12 ✓ = 4.7×10^{-4}✓ F	2	No sf penalty Don't accept 4.6

Section A Total 21

Qn	Level	Expected Answers	Marks	Additional guidance
8 (a) (i)		$V = -GM/R = -6.7 \times 10^{-11} \times 7.4 \times 10^{22}/1.7 \times 10^{6}$✓	1	Need clear working or own value. Must be negative.
(a) (ii)		$= -2.9 \times 10^{6}$ J kg^{-1}	1	
a(iii)		GPE = 30 x(-)2.9×10^{6}✓ = (-) 8.7×10^{7} J At large distance V_g is zero✓ and p.e loss = k.e. gain ✓.	2	Need clear working or own value. Or value of PE change for 1st mark
(b) (i)		Q = 1 x 1.2 x 10^{3} x (1500 -90) ✓= 1.69×10^{6} J	1	Total energy required per kg = 2.2×10^{6} J □
(ii)		energy required = (30 x 1.7×10^{6}) ✓+(4.8 x 10^{5} x 30) = 6.5×10^{7} ✓ comparison with k.e ✓	3	Max material melted = $8.8 \times 10^{7}/2.2 \times 10^{6}$ □= 40 kg so the rock could be entirely melted.□ Attempt at summation compared to k.e worth one mark
(c)		Holes/craters □show that some k.e. goes to k.e. of ejected material. ✓	2	eg **energy** for compression/ejection. Justified bumps worth one mark
9 (a)(i)		*-kx* ✓= *ma* ✓.	2	Or alternative
(ii)		For shm, a is proportional to –x ✓. This is the case as k and m are constants✓.	2	Direction or –ve sign needed for 1st marking point
(iii)		Clear evidence of derivation ✓.	1	Expect *k/m = 4* □^{2} *f*^{2}
(b)(i)		F = 1/2□ *x* (2.8 x 10^{6} N m^{-1}/290 000)$^{1/2}$ ✓=	2	
(ii)		0.495 Hz ✓	1	Need clear working or own value.
(c)(i)		E = ½ x 2.8 x 10^{6} x 0.7^{2} ✓= 690 kJ after one oscillation $A^{2} = 0.7^{2}/2$✓ $A = (0.49/2)^{1/2}$ ✓ = 0.5 m 350 x 10^{3} = 0.5 x 2.8 x 10^{6} x A^{2} ✓: A = (2 x 350 x 10^{3} /2.8 x 10^{6})$^{0.5}$ ✓	2	0.7 /1.4□ = 0.5 □
(c)(ii)		E = ½ x 2.8 x 10^{6} x 0.5^{2} ✓ = 350 kJ ✓	2	One mark for energy falls to 1/64 of original value or calculation to that effect. (10718J)
(d)		Iteratively or otherwise: 0.7/8 = 0.0875 ✓ = $0.7/1.414^{n}$ via logs or otherwise N = 6 ✓. maximum amplitude of movement at top of building✓	1	

10(a)(i)		No. of particles = 1000 x 6 x 10^{23}/18 = 3.3 x 10^{25} ✓	2	Clear method or calculated value.
(a)(ii)		Energy = 2.3 x 10^{6}/3.3 x 10^{25} =✓ 6.9 x 10^{-20} J	1	
		6.9 x 10^{-20}/ 3.9 x 10^{-21} = 17.7✓	1	
b(i)			1	1.5 x 10^{-8} if 18 used.
b(ii)		f = $e^{-17.7}$ = 2.1 x 10^{-8} ✓	1	½ square tolerance & ecf
b(iii)		accurate plot, ecf ✓ sensible plot ✓ Straight line acceptable if candidate point suggest it. Not acceptable for f = 2.1 x 10^{-8}		
(c)(i)		E/KT becomes smaller ✓.-E/kT becomes less –ve. ✓AW eg symbolically: f =1/$e^{E/kT}$✓ increased T means smaller fraction ✓	2	Need to talk through maths here.
(ii)		Bigger f therefore greater	2	Do not accept 'more
(iii)		proportion/probability ✓with sufficient <u>energy</u> to escape. ✓AW Boltzmann factor nearly doubles, ✓ therefore rate doubles✓	2	particles' or 'more energy'. Independent marking points. More precise *f* ratio acceptable. Rate or 'in the same time' etc
11 (a)		Test described fully. ✓ performed on three sets of data✓✓, sensible conclusion✓.	4	One mark for two data tests. (values: 0.22, 0.096, 0.16 m s^{-1} ly^{-1}) or reciprocal: 4.5, 10.4,6.1
11 (b)		1. x 10^{7}/ 1.4 x 10^{8} x 3 x 10^{8} x 3.2 x 10^{7} ✓= 1.7 x 10^{-17} ✓ 1.7 x 10^{-17}/2.2 x 10^{-18} = 7.7 ✓	3	One mark for distance conversion :1.3(4) x 10^{24} clear comparision needed for (ii)
(c) (i)		Increase in wavelength ✓	1	Hope for more.(photon energy
(ii)		Light expands with (expanding) space, ✓ longer time of travel gives more expansion/lengthening.	2	answers, if seen, acceptable)

QWC on 8(a) (iii), 8 c, 9 (d), 11(c)(i) &(ii)

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
January 2007

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- 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.
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- 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.
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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

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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.

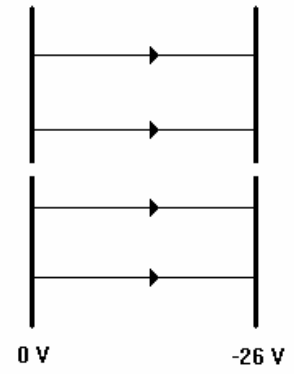
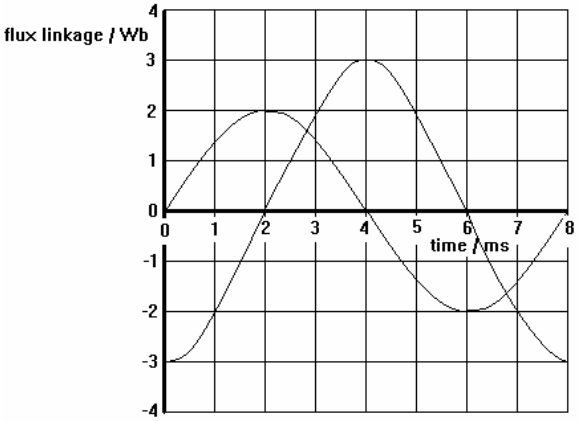
6 The mark awarded for Quality of Written Communication in the margin should equal the number of ticks under the phrase.

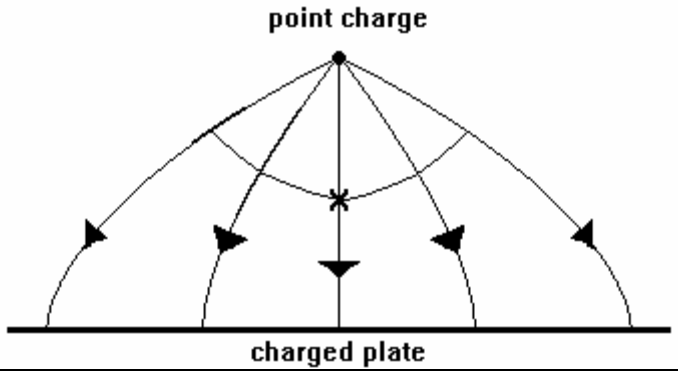
7 Correct answers to calculations should obtain full credit even if no working is shown, unless indicated otherwise in the mark scheme.

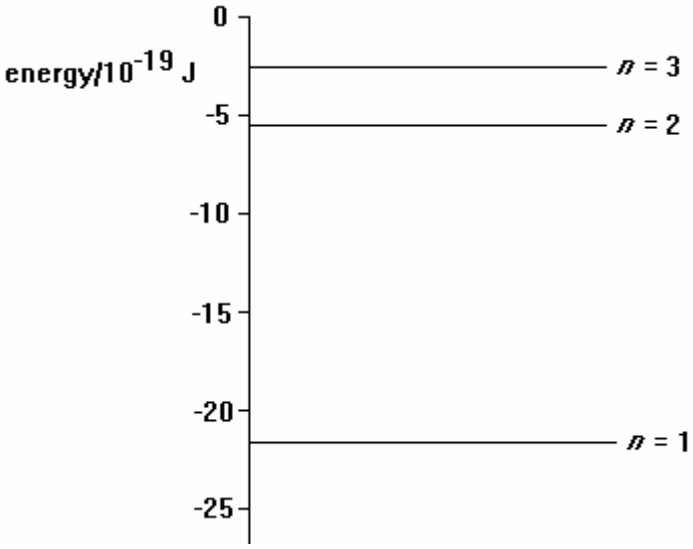
8 Strike through all blank spaces and pages to give a clear indication that the whole of the script has been considered.

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

m = method mark
s = substitution mark
e = evaluation mark
/ = alternative correct answers
; = 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
ora = or reverse argument
eor = evidence of rule

1 (a)	Wb m^{-2}	1
1 (b)	Wb s^{-1}	1
2 (a)	four parallel lines at right angles to plates IGNORE extra lines evenly spaced (by eye) arrow to the right ACCEPT correct edge effects	1 1 1
2 (b)	 14 eV	1
3 (a)	measures maximum gradient (= 1.5 ± 0.2 Wb per ms) ecf incorrect gradient: emf = 1.5 ± 0.2×10^3 V ACCEPT 2/2×10^{-3} = 1000 V for [1]	1 1
3 (b)	sine curve of correct period and constant amplitude correct phase (lead or lag)	1 1
3 (c)	 insert iron core/increase area of coil/frequency/flux/flux density/stronger magnet NOT increase width of coil wires/more turns of wire	1

4	$^{240}_{93}Pu + {}^{1}_{0}\underline{X} \rightarrow {}^{241}_{94}Am + {}^{0}_{-1}e + {}^{0-}_{0}\nu$ no ecf: neutron	1 1
5	B A	1 1
6	correct shape, curves up from X on both sides ecf: crossing each field line at right angles (by eye)  	1 1
7	$E_k = kQq/r$ (eor) $Q = 79e = 1.26\times10^{-17}$ C, $q = 2e = 3.2\times10^{-19}$C ecf incorrect *Q. q:* $E_k = 9.0\times10^9 \times 79 \times 2 \times (1.6\times10^{-19})^2/1.2\times10^{-13} = 3.0\times10^{-13}$ J	1 1 1

8 (a) (i)	$-14 \times 1.6\times10^{-19} = -\underline{2.2}\times10^{-18}$ J	1
8 (a) (ii)	[1] per correct line (by eye) n = 3 at between 2.0 and 2.5 n = 2 at between 5.0 and 6.0  	2
8 (a) (iii)	As the electron leaves the proton, its potential energy has to increase. When electron is separate from proton, potential energy is zero. ACCEPT energy for potential energy	1 1
8 (b) (i)	atom excited to n = $\underline{2}$ state by collision with electron leaving it with $18\times10^{-19} - (22\times10^{-19} - 5\times10^{-19}) = (1\times10^{-19}$ J) ACCEPT 5.5 rounded to 6 gives 2×10^{-19} J	1 1
8 (b) (ii)	ecf incorrect transition: $E = hf$, $c = f\lambda$ $\lambda = ch/E = 3\times10^{8} \times 6.6\times10^{-34}/(22\times10^{-19} - 5\times10^{-19}) = 1.2\times10^{-7}$ m ACCEPT $3\times10^{8} \times 6.6\times10^{-34}/18\times10^{-19} = 1.1\times10^{-7}$ m for [1]	1 1
8 (b) (iii)	electron raised to n = $\underline{3}$ by the collision photons emitted by n = 3 to n = 2, n = 2 to n = 1 and n = 3 to n = 1	1 1

9 (a) (i)	$m = 241 \times 1.7\times10^{-27} = 4.1\times10^{-25}$ kg $N = 2.0\times10^{-10}/4.1\times10^{-25} = 4.9\times10^{14}$ ACCEPT reverse calculation for [2] ACCEPT $2.0\times10^{-10}/(241 \times 1.7\times10^{-27})$ for [2] (look for sensible order of calculation NOT eg $2.0\times10^{-10}/241 = 8.3\times10^{-13}$ then $8.3\times10^{-13}/1.7\times10^{-27}$...	1 1
9 (a) (ii)	$\lambda = 0.69/T_{0.5}$ $\lambda = 0.69/1.5\times10^{10} = \underline{4.6}\times10^{-11}$ s^{-1}	0 1
9 (a) (iii)	$A = \lambda N$ $A = 4.6\times10^{-11} \times 4.9\times10^{14}$ $A = 2.3\times10^{4}$ Bq ACCEPT 2.5×10^{4} Bq for 5×10^{-11} s and 5×10^{14}	0 1 1
9 (b)	alpha particles stopped by the walls of the detector/a few cm of air because easily absorbed/low penetration/highly ionising/interact strongly with matter (wtte)	1 1
9 (c) (i)	ecf incorrect activity: energy absorbed = $2.3\times10^{4} \times 0.01 \times 8.7\times10^{-13} \times 3.2\times10^{7} = 6.4\times10^{-3}$ J $A = 2.5\times10^{4}$ Bq gives 7.0×10^{-2} Sv ecf incorrect energy absorbed: absorbed dose = $20 \times 6.4\times10^{-3}/2.0 = 6.4 \times10^{-2}$ Sv	1 1
9 (c) (ii)	risk calculation eg $6.4\times10^{-2} \times 3 = 0.2\%$ risk per year (with ecf) any of the following (wtte), maximum [2] • dose is large compared to background • dose unlikely to be shared evenly over whole lung • material possibly removed from lungs in a short time • all of material could be absorbed by one person, not just 1% • cancer is not certain over a lifetime (10 % risk in 50 years) NOT small risk compared to being burnt to death...	1 2

10 (a) (i)	two complete non-crossing loops through the coil which pass through the iron core and bar	1 1
10 (a) (ii)	any of the following, maximum [2] • current creates field/flux in coil • which magnetises iron • poles created where flux leaves/enters iron • different poles attract/flux loops try to contract • (upwards motion of bar) shortens flux loops	2
10 (b) (i)	improved magnetic circuit (wtte) eg less air so more permeability/less reluctance/more permeance NOT more flux NOT permittivity	1
10 (b) (ii)	any of the following, maximum [3] • more cells in battery/higher voltage • more turns of wire • lower resistance/greater conductance coil/thicker wires • shorter iron loop • remove lamp from circuit References to changes of area of the core are neutral NOT laminate the core/more current/tighter coil	3
10 (c)	flux linkage/density of coil decreases (wtte) NOT changes/increases generating emf/current in <u>coil</u>	1 1
10 (d)	(eddy) currents in the core (wtte) caused by changing/alternating flux in the core transfer <u>electrical/magnetic</u> <u>energy</u> to (heat energy) (wtte)	1 1 1

11 (a) (i)	$p = h/\lambda$ (eor) $p = 6.6\times10^{-34}/4.8\times10^{-15} = 1.4\times10^{-19}$ N s ecf incorrect p: $E = 1.4\times10^{-19} \times 3.0\times10^{8} = \underline{4.1}\times10^{-11}$ J ACCEPT only $6.6\times10^{-34} \times 3\times10^{8}/4.8\times10^{-15} = \underline{4.1}\times10^{-11}$ J for [1] ACCEPT correct answer via $c = f\lambda$ for [1]	1 1 1
11 (a) (ii)	$E = 4.1\times10^{-11}/1.6\times10^{-19} = 2.6\times10^{8}$ eV (conversion from J to eV) ecf: answer = $2.6\times10^{8}/100\times10^{3}$ = 2600 times 4×10^{11} J gives 2500 times	1 1
11 (b)	portion of the curve between 40° and 50° interference pattern caused by partial cancellation of electron phasors/waves passing both sides of proton NOT just diffraction	1 1
11 (c)	what is observed: large angle scattering increases lots of new particles created internal structure: proton made of three quarks	 1 1 1

Marking quality of written communication

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Mark Scheme 2865
January 2007

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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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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, (eg '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.

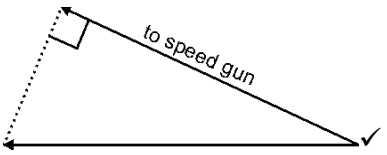
8 An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct and answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of 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) Spacing decreasing/non-linear owtte✓ / Specify constant ratio/equal spacing for doubling of y-values ✓ ✓ (ii) Gives a straight line ✓ Easier to confirm if straight✓ (iii) Suddenly/ around 1950✓ (Significantly) steeper after✓	2 2 2	ii Reward answer based on possible analysis of line eg gradient
(b)	(i) Population between 6 ×10^9 and 8 × 10^9 ✓ Consumption will be (7±1) × 10^9 × 68 × 10^9 = 4.1 × 10^{20} to 5.4 × 10^{20}≈ 5× 10^{20} J ✓ (ii) Lifetime = 4 × 10^{22}/5× 10^{20} = 80 years ✓ (iii) Energy demand per capita likely to increase/population will not be constant/price increase may cut consumption/ different sources may be found ✓	2 1 1	i Reverse argument OK ii ecf 4×10^{20}J→100 yrs 5.4×10^{20}J→74 yrs Any reasonable point
		10	
2 (a)	Ring around second cross from the right ✓	1	
(b)	Nucleus contains only one nucleon owtte ✓	1	Needs reference to other protons/neutrons/ nucleons, not eg atoms, electrons
(c)	Obtaining binding energy per nucleon from graph (between -7.0 and -7.1 MeV) ✓ so total binding energy = 4 × binding energy per nucleon ≈ -28 MeV ✓	2	
(d)	Δm = -(6.6240 – 2 × 1.6693- 2 × 1.6675) × 10^{-27} kg = -4.96 × 10^{-29} kg ✓m✓e So binding energy = mc^2 =-4.96 × 10^{-29} x 9 × 10^{16} = -4.46 × 10^{-12} J ✓	3	Confusion with 10^{-27} gets ✓m only. Quoting $E=mc^2$ not enough for method mark: needs values
		7	

Qn	Expected Answers	Marks	Additional guidance
3 (a)	Choosing point and finding constant from *PE*, *r* ✓ showing this is consistent for another point✓/Method involving inverse proportion (double one, halve the other) ✓ verification ✓	2	✓m✓e method mark requires two identifiable readings
(b)	(i) 1.44 MeV = 1.44×10^{6} x 1.6×10^{-19} J = 2.3×10^{-13} J = 1.2×10^{-13} J each ≈ 1×10^{-13} J each✓	1 1	
	(ii) $kT = 1.4 \times 10^{-23} \times 1.5 \times 10^{7} = 2.1 \times 10^{-16}$ J✓		Can attempt to calculate the
	(iii) $E/kT = 1.2 \times 10^{-13} / 2.1 \times 10^{-16} = 570$ ✓ This is well outside the 15 – 30 *kT* range so reaction is extremely unlikely✓	2	Boltzmann factor(≈0)
(c)	Equal and oppositely-facing pairs of arrows on each pair of protons✓ Lower arrows 4 × longer (by eye) than upper ones ✓	2	Right arrow reaches point level with 'the' in stem above ('…of the forces…')
(d)	(i) $pV=nRT$ ✓⇒ n = $pV/RT = 3.4 \times 10^{16}$ x $1/(8.3 \times 1.5 \times 10^{7})$ = $2.7 \times 10^{8} \approx 3 \times 10^{8}$ mol m^{-3}✓ Assume ideal gas behaviour owtte ✓	3	
	(ii) $N = nN_A = 2.7 \times 10^{8} \times 6.0 \times 10^{23}$ = $1.6 \times 10^{32} \approx 2 \times 10^{32}$ m^{-3}✓	1	3× 108 gives 1.8× 1032
	(iii) Volume of one particle = $1/2 \times 10^{32} = 6.1 \times 10^{-33}$ m^3 mean separation = $\sqrt[3]{(5 \times 10^{-33})} = 1.8 \times 10^{-11}$ m ✓	1	ecf from (i) and (ii) Avoiding rounding gives 1.87 × 10-11 m
		13	
4 (a)	Need a large (changing) flux in the plasma✓ Any relevant detail of magnetic circuit, eg need large cross sectional area/as short a circuit as possible/increase permeance ✓	2	Any one valid point
(b)	Plasma current produced by induced emf/need changing flux to induce emf in plasma/constant direct current produces constant flux ✓ ✓	2	Any two points.
(c)	Graph B ✓	1	
(d)	(i) and (ii). Movement parallel to flux lines has zero force ✓so no effect on motion ✓ movement at an angle to flux lines has a force perpendicular to flux ✓and also perpendicular to movement ✓so direction of movement will change ✓	3	Mark these two parts together. Any three valid points
		8	

Qn	Expected Answers	Marks	Additional guidance
5 (a)	(i) $P=I^2R = (3 \times 10^6)^2 \times 5.0 \times 10^{-7} = 4.5 \times 10^6$ W which is a few MW ✓m✓e (ii) Number $s^{-1} = 1.0 \times 10^6/1.6 \times 10^{-19} = 6.3 \times 10^{24}$ ✓m✓e	2 2	Can calculate V= 1.5 V and use $P=IV$.
(b)	f = 1/T = $1/(4 \times 10^{-8}) = 2.5 \times 10^7$ Hz (25 MHz) ✓	1	Ignore missing/incorrect units
(c)	(i) 60 kV/60 000 V ✓ (ii) ions entering (twisted) magnetic field will be affected by field/deflected off course✓ (iii) $9.6 \times 10^{-15} = 0.5 \times 3.3 \times 10^{-27} \times v^2$ $v = \sqrt{(9.6 \times 10^{-15}/(0.5 \times 3.3 \times 10^{-27}))}$ $= 2.4 \times 10^6$ m $s^{-1} \approx 2 \times 10^6$ m s^{-1} ✓m✓e	1 1 2	
		9	
6 (a)	(i) (Lengths 10,10, 50 and 10 mm: no mark for these) $2 \times 10 - 3 \times 10 = 4 \times 10 - 1 \times 50$ Appreciating vector nature of p ✓ Establishing same sum before and after ✓ (ii) $½ \times 2 \times 10^2 + ½ \times 3 \times 10^2 = 250$ $½ \times 4 \times 10^2 + ½ \times 1 \times 50^2 = 1450 > 250$ ✓m✓e	2 2	Allow 6 & 46 for arrow measured without heads Can do either or both parts algebraically in terms of v, $-v$, $-5v$ Must attempt to cal KE for all particles
(b)	No of neutrons/s = $100 \times 10^6/(15 \times 10^6 \times 1.6 \times 10^{-19})$ $= 4.2 \times 10^{19}$ s^{-1} ✓m✓e	2	2.4×10^{-12}J with no justification not acceptable
(c)	(i) Absorbed energy/year = $1 \times 10^{11} \times 2.4 \times 10^{-12}$ = 0.24 J✓ Absorbed dose /10 years =0.24J×10/55 kg = 0.044 Gy✓ (ii) Any two relevant points for increased damage eg create new radioisotopes in body ✓which produce ionising radiation✓ (iii) Any two clearly distinct methods **or** one method with further detail, eg greater shielding with good absorber of neutrons (such as boron) ✓/monitor dose received by workers on a regular basis✓ and move to less hazardous site if dose is becoming too high✓	2 2 2	iii Allow answer which reduces damage to worker without actually making environment safer.
		12	

7 (a)	(i) RGV on left/VGR on right ✓ (ii) Set of spectral lines nearest to straight-on direction/lines given by n = 1 in $n\lambda = d \sin\theta$ ✓ (iii) All wavelengths superpose constructively at this point/ $\theta = 0$ is a solution for all values of λ when n =0 ✓ (iv) $d = 1 \times 10^{-3}/600 = 1.67 \times 10^{-6}$ m ✓ $\lambda = 1.67 \times 10^{-6} \sin(19.1°) = 545$ nm ✓m✓e	1 1 1 3	Wrong on oe side and right on other = 0 Unreasonable λ does not gain ✓e
(b)	No distinct lines/continuous range of wavelengths ✓.	1	
(c)	(i) $f = c/\lambda$ ✓ $= 3 \times 10^8/(4.4 \times 10^{-7}) = 6.8 \times 10^{14}$ Hz (ii) $E = hf = 6.6 \times 10^{-34} \times 6.8 \times 10^{14} = 4.5 \times 10^{-19}$ J✓m✓e	2 2	 7×10^{14} Hz gives 4.6×10^{-19} J.
(d)	(i) Circuit with power supply & lamp + correct ammeter + voltmeter✓ (ii) Quote $P=IV$ ✓ Explain calculation and comparison ✓	1 2	Allow correct alternatives. Mark (i) and (ii) together.
		14	
8 (a)	Infrared ✓	1	
(b)	(i) extra pulse distance = $3 \times 10^8 \times 7 \times 10^{-9} = 2.1$ m ✓ This is there and back, so car has moved 1.05 m ≈ 1m ✓ (ii) Speed = $1.05/(60 \times 10^{-3}) = 17.5 \approx 18$ m s^{-1} ✓m✓e (iii) Pulse distance in 0.1ns = $3\times10^8\times0.1\times10^{-9}$ = 0.03 m there and back so uncertainty in distance ≈ 0.015 m so speed uncertainty = $0.015/(60\times10^{-3}) = 0.25$ m s^{-1}✓m✓e	2 2 2	Allow reverse argument 1.0 m gives 16.7 m s^{-1} Can do as fraction of (ii) = 18 × (0.1/7) m s^{-1} (e.c.f. possible)
(c)	(i) As  (ii) tan $\theta = 10/25$ so $\theta = 21.8° = 22°$ ✓ Component of car towards gun = cos θ × 30 m s^{-1} 30 × cos 22°= 28 m s^{-1} ✓m✓e (iii) zero under bridge (distance = 0) ✓ rises and levels off as distance increases ✓	1 3 2	Judge correct angle by eye. Component should not be loner than vector given. Allow close to 0 as zero
		13	

QoWC 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
January 2007 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2860	Raw	90	64	57	51	45	39	0
	UMS	100	80	70	60	50	40	0
2861	Raw	90	60	53	46	40	34	0
	UMS	110	88	77	66	55	44	0
2862	Raw	120	97	85	73	62	51	0
	UMS	90	72	63	56	48	36	0
2863A	Raw	127	96	85	75	65	55	0
	UMS	100	80	70	60	50	40	0
2863B	Raw	127	96	85	75	65	55	0
	UMS	100	80	70	60	50	40	0
2864A	Raw	119	87	77	68	59	50	0
	UMS	110	88	77	66	55	44	0
2864B	Raw	119	87	77	68	59	50	0
	UMS	110	88	77	66	55	44	0
2865	Raw	90	60	54	49	44	39	0
	UMS	90	72	63	56	48	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	12.4	34.0	59.2	81.2	95,2	100.0	251
7888	11.5	38.5	73.1	94.2	96.2	100.0	53

For a description of how UMS marks are calculated see;
http://www.ocr.org.uk/exam_system/understand_ums.html

Statistics are correct at the time of publication

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

(General Qualifications)
Telephone: 01223 553998
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Email: helpdesk@ocr.org.uk

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