OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced GCE **A2 7888**

Advanced Subsidiary GCE **AS 3888**

Mark Schemes for the Units

June 2007

3888/7888/MS/R/07

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.

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MARK SCHEMES FOR THE UNITS

Mark Scheme 2860
June 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.
- 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.
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- 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.

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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.

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Unit Code 2860	Session June	Year 2007	Version Final

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) strength ; stiffness ; brittleness	3	
	b) material can deform permanently (after stress) AW	1	idea of permanent
2(a)	4.4(4) x 10^{-2} / 0.044(4) (S) evaluation	1	S.F. penalty if not 2 or 3 S.F. only part(a) ecf on (b) – (a)
(b)	4.7(2) x 10^{-2} / 0.047(2) (S)	1	
(c)	3 x 10^{-3} / 0.003 (S)	1	
3	W J s^{-1} A C s^{-1}	2	
	Ω V A^{-1} V J C^{-1}	2	
4(a)	((5 x 200) + (3 x 100) + (1 x 0)) / 9 / = 1300 / 9 /= (144.4)	1	evidence averaging is understood
(b)i)	**mean** noise spreads/ edge blurs/gradual change	1	smoothing / blurring / lower contrast
(ii)	**median** noise removed / edge restored / sharp change	1	NOT contrast
5(a)	- 0.5 (D) / ½	1	accept + 0.5
(b)	- 4.0 (D)	1	accept + 4.0
(c)	+ 3.5 (D) ecf allow |(a) – (b)| allow fractions	1	NOT negative curvatures
6(a)	$i > C$ / 40° < C < 50° / ray is totally internally reflected at 50°	1	Allow T.I.R.
(b)	C = $\sin^{-1}(1/n)$; = 48.8°/49°	2	method ; evaluation of critical angle
	Total section A	20	allow for reversed rays

Qn	Expected Answers	Marks	Additional Guidance
	Section B		
7(a)	(i) 1.6 (μm)	1	
	(ii) only 1 bit at a time under spot / spot is about 1μm wide/ can't make spot smaller	1	any reasonable resolution / diffraction answer
	(iii) bytes to bits ; correct method ; evaluation Length = 650 x 10^6 x 8 x 10^{-6} m = 5.2 km to 10.4 km	3	AW full marks for correct evaluation
(b)	tracks have ½ spacing ; bits have ½ spacing ;	2	NOT resolution is x2
	¼ area per bit/ 4 x density of bits/ info ratio = 4	1	ecf on ½
(c)	digital maps on internet ; useful for route finding on move	2	any sensible suggestions ; societal justifications in context allow bod only once (c)
	video camera info from public places can be stored without knowledge or consent ; could be regarded as an invasion of privacy	2 12	
8(a)	**P / A**	1	
(b)	(i) equal scale increments represent equal factors / x 10	1 2	AW 2nd depends on first
(c)	(ii) graph value 5 ; 1000 / k (Ω)	2	allow ecf in b(ii) x 2
	(i) 10^4 ; Ω W m^{-2} /10 kΩ W m^{-2} both marks	1	
(d)	(ii) C	1	treat as comprehension of root of question qualitative arguments score 0 both parts if conductance is used G = 1/R gets 2nd mark
(e)	(free) electrons take about 50 ms to return to bonds / no new free electrons produced after light goes off	1	
	(i) double the number of photons / energy doubles the number of free electrons / charge carriers (per unit time)	1	
	(ii) current / conductance ∝ intensity / carrier density resistance ∝ 1/ current /*R* = *V* / *I* at fixed V	1 11	
9(a)	(i) (-) 4.8 x 10^{-18} (C)	1	evaluation
	(ii) nano - on atomic / 10^{-9} OR nm / nA / ns scale ;	1	
	switch - makes / breaks electrical contact	1	gives on / off action
(b)	(i) height = 2.0 (nm) from graph ; 2.0 / 0.29 = 7 / 6.9 ecf	2	accept 6
	(ii) as base widens more atoms required so subsequent layers take longer to form (∝ no. of layers)^2	1 1 7	different numbers of atoms per layer OK frequency is larger
	(iii) switching time is shorter / less energy etc. to switch / greater switch density/stronger field / force on ions		

10a)	(i) $R = (\rho L) / A$ (ii) $L = (R A) / \rho$ /120 x 8 x 10^{-10} / 4. x 10^{-7} = 0.2(0) (m) (iii) to make sensor shorter / more manageable / more sensitive (for same extension than single wire)	1 1 1 1	recall formula rearrange evaluate accept smaller sensor NOT to make bigger R
(b)	(i) $A = V / L \ / R = \rho L / (V / L)$; $= \rho L^2 / V$ (ii) ρ is constant (when strain alters) (iii) L rises by x (1.003) ; L^2 by x $(1.003)^2$ = 1.006(01)	2 1 2	any correct arrangement. OR % change is doubled
(c)	$\sigma = E$ x ε /= 4.6 x 10^{10} x 0.003 ; = 1.(38) x 10^8 Pa	2	Method ; evaluation
	Total section B	11 41	

Qn	Expected Answers	Marks	Additional Guidance
	Section C		
11ai)	eg i.r. satellite imaging system	1	
(ii)	diagram: 1/2/3 style eg satellite system / foetal scanner / digital camera/Hubble space telescope	3	(ii) max 5 for both diagram and description
	description / good annotation to diagram : 1/2/3 style	2	
(b) i)	eg resolution of i.r. satellite image = 100 ; m ($pixel^{-1}$)	2	allow ± 1 on sensible order of magnitude
(ii)	eg longer focal length system ; so that image on detector is larger / greater density of pixels on the detector ; so that length imaged on one pixel is smaller	2	
(c)	cloud patterns for use in weather / disaster prediction land use survey to check on crop distributions	1 1 12	
12ai)	eg Force	1	
(ii)	Circuit diagram with sensor / potential divider, Ameter, Vmeter and supply of p.d. correctly connected.	3	1/2/3 style lose 1 mark for each error
(iii)	Sensor is QTC (Quantum Tunnelling Composite) pill. When stressed its resistance drops exponentially, raising the p.d. across the series resistor, increasing the output p.d. to the Vmeter.	2	
(b) i)	response time : how long it takes the electrical output signal from the sensor to settle to final value after the physical variable is changed	1	expect good statements
	linearity : the graph of sensor electrical output signal plotted against the physical variable being sensed varying is a straight line graph.	1	$\Delta y / \Delta x$ = constant
(ii)	Change and ;state instrument (to measure the physical variable) (eg alter Force by using known weights) ; measure the output p.d. from the sensor for each F ; Plot a calibration graph of p.d. against Force ; and see if it is a straight line	2 1 1 1 13	NOT linear through origin
	Quality of written communication **Total section C**	4 29	

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.

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Mark Scheme 2861
June 2007

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Qn	Expected Answers	Marks	Additional Guidance
1(a)	C ✓	1	
(b)	B ✓	1	
2(a)	500 ✓	1	
(b)	5000 ✓	1	not 5040
3(a)	180^o or π radians ✓ **UP** if correct unit not given in either (a) or (b)	1	not just □2 or ½ a rotation
(b)	90^o (or 270^o) or $\pi/2$ radians (or $3\pi/2$ radians) ✓	1	
(c)	both A and B at 12 o'clock ✓	1	
4(a)	forces 'up' and 'down' balanced OAW ✓ (require more than stating 'vertical equilibrium')	1	or idea that $T\cos 30^o$ is the vertical component
(b)	27.7 or 28 $\checkmark_e$ (N) (3 s.f. max)	1	
(c)	θ larger,so cos θ smaller ✓ (arguing from the equation)	1	
5(a)	P/v^3 = constant ✓ carried out on all 3 sets of data- *(may find **k** and **use**)* (constant = 6.584 6.617 6.530) ✓	2	-accept v^3/P = 0.15 test - (deduct 1 mark if assertion is v^3/P = ***k***) **trivial** test = 1 mark max
(b)	conclusion consistent with arithmetical test ✓	1	
6(a)	**using** P (= Fv) =$5.2 \times 10^3 \times 24$ $\checkmark_m$ = 1.2×10^5 $\checkmark_e$ (W)	2	for using $5.2 \times 24 = 124.8$ $\checkmark_m x_e$
(b)	$F = (2.8 \times 10^5) / 40$ $\checkmark_m$ = 7000 $\checkmark_e$ (N)	2	
7(a)	1.9 $\checkmark_e$ ($m\ s^{-1}$)	1	not 2 $m\ s^{-1}$
(b)	t = 57 / 1.9 $\checkmark_m$ = 30 $\checkmark_e$ (s) **ecf** from (a)	2	0.5 $m\ s^{-1}$ gives 114 (s)
	Section A Total	**20**	

8 (a)(i)	wave having an antinode at each end and a **single** node in middle ✓ with ONE **A** and **N** labelled correctly ✓ [wave having antinode at each end **but** multiple nodes, with **A** and **N** labelled appropriately ✓]	2	accept only top half of correct wave shown * zero marks for diagram showing wave having Node at ends*
(ii)	λ = **4.0** ✓ (m) **ecf** from (a)(i) consistent with **the** diagram as drawn	1	here, assume diagram drawn in (a)(i) is correct
(iii)	v = 331 + (0.61x10) = **337.1** (340) ✓$_e$ (m s^{-1})	**1**	
(iv)	f = **337.1** / **4.0** ✓$_m$ = **84.3** ✓$_e$ (Hz) **ecf** from above	2	(a)(iii) / (a)(ii)
(b)(i)	**84.3** x 1.05 ✓$_m$ = **88.5** ✓$_e$ (Hz) **ecf** from (a)(iv) (may calc. 5% of (a)(iv) **then add it to (a)(iv))**	2	
(ii)	for calculating new **v** = **88.5** x **4** = **354** ✓$_e$ **ecf** for correct **rearrangement** θ = (**354** – 331) / 0.61 ✓$_r$ θ = 37.6 ^{o}C ✓$_e$ **Total**	**3** **11**	(b)(i) x (a)(i)
9 (a)(i)	6.6 x 10^{-34}x 3.0 x 10^8 / 9.2 x 10^{-8} ✓$_m$ = 2.15 x 10^{-18} ✓$_e$ (J)	2	likely route f = c̃□ then E = hf
(ii)	for **showing** that **'remaining'** energy (ΔE) is 1.8 x 10^{-18} J ….. i.e. (2.2 x 10^{-18} - 4.0 x 10^{-19}) = 1.8 x 10^{-18} J ✓$_e$ so ke of electron **cannot** be greater than ΔE ✓ **OAW**	2	
(iii)	v = [(3.6x10^{-18})/(9.1x10^{-31})] $^{1/2}$ ✓$_m$ = 2.0 x10^6 (m s^{-1}) ✓$_e$	2	
(b)(i)	λ =(6.6 x 10^{-34}) / (9.1x10^{-31})(2.0x10^6) ✓$_s$ = 3.6 x 10^{-10}(m) ✓$_e$	2	using 1.98x10^6 gives 3.7x10^{-10}
(ii)	for stating $\lambda \approx$ d / wavelength and spacing similar OAW✓ so rows of atoms act as a grating or behaves like Young's slits or get constructive and destructive interference or electrons diffract producing interference ✓ **Total**	2 **10**	read the explanation and judge the quality

10(a)	**using** v = u + at with u = 0 (ie 330 = 0 + 9.8t) ✓$_m$ t = 330/9.8 ✓$_r$ = **33.7** ✓$_e$ (s) (**calculator** value shown)	3	3 marking points
(b)(i)	1 distance (travelled) / displacement / height dropped ✓ 2 acceleration ✓	2	
(ii)	($t = 0$ to $t = t_1$) accelerates at decreasing rate ✓ OAW ($t = t_1$ to $t = t_2$) deceleration ✓ ($t = t_2$ to $t = t_3$) constant velocity ✓ ('terminal' velocity insufficient)	3	velocity increases at a decreasing rate velocity decreases constant velocity
(c)	the skydiver decelerates✓ velocity of skydiver is upwards relative to camera✓ OAW	2	
	Total	**10**	
11 (a)(i)	diffraction ✓	1	
(ii)	idea of disturbances adding together ✓ giving the resultant ✓ effect OAW	2	waves combine ✓ giving constructive and destructive interference✓
(b)(i)	waves superimpose IN PHASE ✓	1	
(ii)	each arrow perpendicular to wavefront ✓	1	penalise lack of care
(iii)	24^o and 53^o angles correctly shown and labelled ✓	1	different ways
(c)	**using** sin $\theta = \lambda / d$ ✓$_m$ $d = 1.25 \times 10^{-6}$ m ✓ sin $\theta = 0.4$ **or** $\theta = 23.57^o$ ✓$_e$ (evidence calculation done) similarly sin $\theta = 0.8$ **or** $\theta = 53.1^o$ ✓$_e$ **ora**	4	may use $\theta = 24^o$ and $\theta = 53^o$ and work backwards
	Total	**10**	
	Section B Total	**41**	

12 (a)	a **distance** measurement stated ✓	1	alternative methods might be classified as: 'echo sounding', 'parallax', or 'triangulation'
(b)	a sensible justification of a distance measurement ✓	1	
(c)	some attempt has been made ✓ diagram is satisfactory, but some errors/omissions ✓✓ diagram is essentially correct ✓✓✓ …… + important equipment labelled ✓	4	In (c) method **must be plausible** or **zero** for diagram
(d)	pulse ✓ reflected from target ✓ trip time measured ✓	3	mark as independent of parts (a) to (c) see appendix for parallax method points
(e)	s = vt idea ✓ t is half trip time ✓ significance of v in the calc, or its numerical value ✓	3	
	Total	12	
13 (a)	For a **situation** where a quantum phenomenon is observed✓	1	if not a quantum phenomenon … zero marks total
(b)	clear labelled diagram ✓✓✓ …with some minor omissions or errors ✓✓ …. for some attempt made ✓ sensibly **labelled** ✓	3 1	3/2/1
(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	
	Total	13	
	Quality of written communication **Section C Total**	4 **29**	

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.

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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 2863/01
June 2007

Unit Code 2863	Session June	Year 2007	Version Final

Abbreviations, annotations and conventions used in the Mark Scheme

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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
1 a	1.0 ✓	1	Accept 1.03
b	1.4×10^{-2}✓	1	Accept 0.014(1)
c	2.1×10^{-2}✓	1	Accept 0.021(15)
d	1.4×10^{-2}✓	1	Accept 0.0136
2 a	Area 'under'/'over'/between line and x-axis stated ✓ Evidence of counting squares ✓ Evidence of value of one square✓	1 1	(NB actual value is greater than 5×10^7) (range 5×10^7 -> 6×10^7)
b	$900 \times 5 \times 10^7$ ✓= 4.5×10^{10} J✓	1 2	Or other clear geometrical technique. ecf
3 a	Energy = 0.18 x 4200 x 10 ✓= 7 560 J	1	Clear working or evidence of calculation needed.
b	Mass = 7600/(4000 x 65) ✓ = 0.029 kg✓ (0.03)	2	One mark for (b) if 7.6 used
4 a	(Approx) energy of a <u>particle</u> at temperature *T* ✓AW	1	
b	<u>Much</u> greater than *kT* ✓(greater than 30 *kT* or above)	1	Need comparison and much AW
5a	$7 \times 10^{-3} \times 250$ ✓= 2 kg m s^{-1} ✓ accept 1.8,1.75	2	
b	thrust = $\Delta p/\Delta t$ = 1.75/0.2 ✓= 9 N✓	2	Ecf accept 8.8N,10 N, 8.75N
6	pV = nRT ✓ => V = $2 \times 8.3 \times 300/4.0 \times 10^5$ ✓= 0.012✓	3	Must see equation Accept 0.0125

Section A total: 21

Qn	Expected Answers	Marks	Additional Guidance
7 (a)	A going away /B coming towards Earth ✓	1	
(b) (i)	$T = 2\pi \times 1.8 \times 10^8 / 1.5 \times 10^4$ ✓$= 7.5 \times 10^4$ s ✓= 20.9 hours	2	Clear working or evidence of calculation needed for second mark.
b(ii)	$F = (-)\, mv^2/r$ ✓ $= 3000 \times (1.5 \times 10^4)^2 / 1.8 \times 10^8$ ✓= (-) 3750 N	2	Clear working or evidence of calculation needed for second mark.
b(iii)	F (or 3750) = (-) G Mm/r^2 ✓ $\therefore M = 3750 \times (1.8 \times 10^8)^2 / 3000 \times 6.7 \times 10^{-11}$ ✓$= 6 \times 10^{26}$ kg	2	6.0 OK as evidence of calculation 6.1(3) x 10^{26} kg if 3800 N used
c	$(-)mv^2/r = (-)G\, Mm/r^2$ ✓$\therefore v^2 = GM/r$ ✓$\therefore v = (GM/r)^{1/2}$	2	penalise lone negative signs in working
d	vel is proportional to $r^{-0.5}$ ✓so 4 x r decreases v by a factor of $4^{0.5}$✓ = 2 AW	2	Need clear derivation for second mark (ie use the fact that rock is <u>four</u> times the distance) calculation acceptable if correct.
8(a)	$dN/dt = \lambda N$ $N = 3.3 \times 10^4 / 4.8 \times 10^{-11}$ ✓$= 6.9 \times 10^{14}$	2	
(b)	half life = $0.693/4.8 \times 10^{-11}$✓ = 1.4×10^{10}s✓ $= 1.4 \times 10^{10}/3.2 \times 10^7$ ✓ = 451 years	3	Allow 457 or 458
(c)	$\Delta N = -\lambda N \Delta t$ $= 4.8 \times 10^{-11} \times 6.9 \times 10^{14} \times 5 \times 3.2 \times 10^7$ ✓ $= 5.3 \times 10^{12}$✓	2	5.4×10^{12} if 7×10^{14} must give own value.
(d)	Any two from: N will not change much over 5 year period/N will change considerably over longer period ✓ or ✓N/✓t constant over five year period/changes significantly over longer period ✓ or 5 years is much less than half life✓	2	
(e)	Hardly any difference in activity over a five year period. ✓ Other specific reasons: dust build up in detector, component failure ✓ AW	2	

9 (a)(i)	Energy = 3/2 kT = 1.5 x 298 x 1.4 x 10^{-23} ✓ = 6.3 x 10^{-21}	2	4 x 10^{-21} acceptable
(ii)	✓ J		
	v = (6.3 x 10^{-21} x 2/2.7 x 10^{-25})^{½} ✓ = 215 m s^{-1}✓	2	clear working or evidence of calculation
b(i)	s = vt = 480 x 200 = 96 000 m ✓	1	needed for second mark. Alternative answers: 210.8 ,
(ii)	96 000/(100 x 10^{-9}) ✓ ✓ = 9.6 x 10^{11} = 1 x 10^{12}✓	2	176,216
(c)	gas diffuses more rapidly ✓ Any two from: same energy/ greater v/less time between collisions	3	(accept 10 x 10^{11}) 1 sf as 'about 100 nm & 0.1m.
10 (a)i	weight = 1.2 x 9.8 ✓ = 1.18 N	1	clear working or
(a) (ii)	x = F/k = 1.2/3.1 = 0.38 m✓ total length = 0.95 + 0.38 ✓ = 1.33 m	2	evidence of calculation accept 0.39 & 1.34
a(iii)	tension in thread = weight of ball✓	1	name or direction needed
(b)(i)	k.e. gained = p.e. lost = 1.2 x 0.95 ✓ = 1.1 J. Or by area under line of graph.	1	clear working or evidence of calculation
(ii)	Further k.e. gain = PE lost – elastic strain energy = 1.2 x 0.4 – ½ x 3.1 x 0.4^2 = 0.23 J✓ total energy = 1.1 + 0.2 ✓ = 1.3 J	2	or area of triangle
c(i)	Condition for shm is acc. proportional to –ve displacement (from equilibrium). ✓ graph shows force proportional to (-ve) displacement ✓ for displacements up to +/-0.4m ✓ clear link between force and	4	accept 'goes slack' beyond 0.4m displacement AW
c(ii)	acceleration ✓ f = 1/2✓π x $(3.1/0.12)^{1/2}$ ✓ = 0.8 Hz✓	2	T = 1.2(4) s = one mark.

QWC: 4 marks. 10 c (i) 9 (c) 8 (d), 7 (d)
Section B total 49.

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.

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 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 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.
- 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 forward*: 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.

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. Ticks should **not** be placed in the right-hand margin. 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 ($^1/_2$) 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.

× = incorrect response (errors may also be underlined)
∧ = omission of mark
bod = benefit of the doubt (where professional judgement has been used)
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.

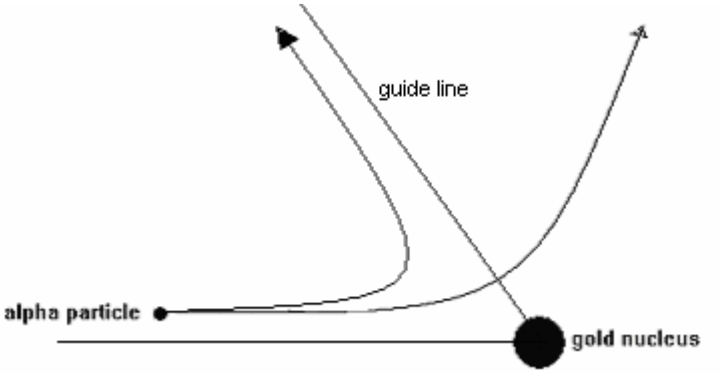
6 The mark awarded for Quality of Written Communication in the margin should equal the number of ticks under the phrase.

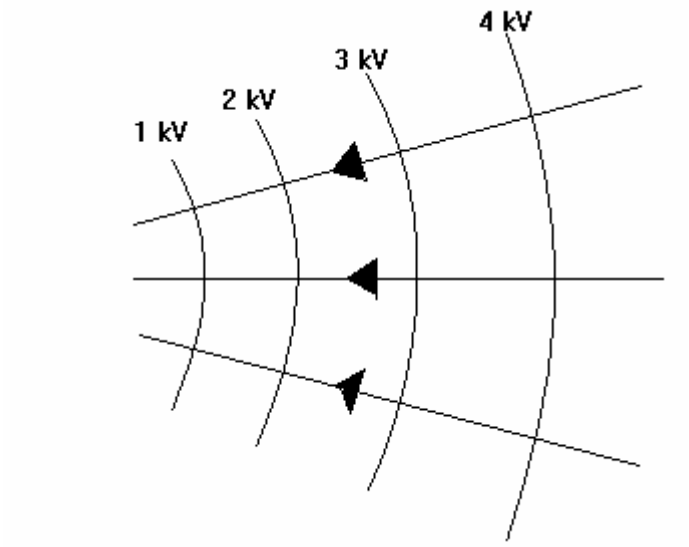
7 Correct answers to calculations should obtain full credit even if no working is shown, unless indicated otherwise in the mark scheme.

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:

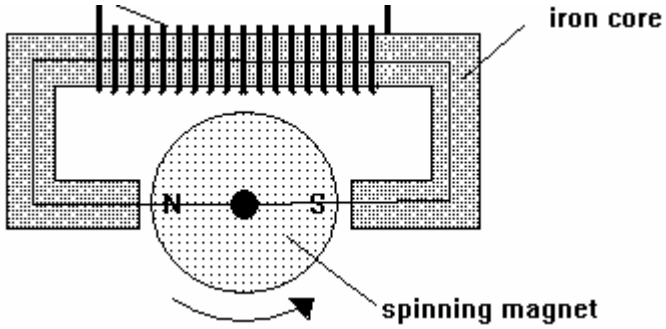
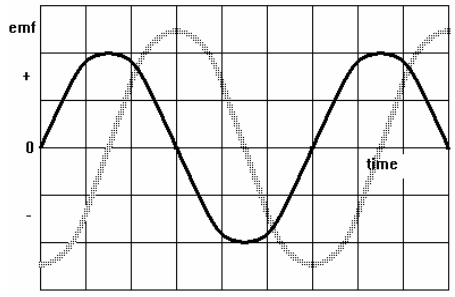
m = method mark
s = substitution mark
e = evaluation mark
/ = alternative correct answers
; = separates marking points
NOT = answers which are not worthy of credit
( ) = words which are not essential to gain credit
___ = (underlining) key words which **must** be used to gain credit
ecf = error carried forward
ora = or reverse argument
eor = evidence of rule

Qn	Expected Answer	Mark
1(a)	(electric) potential	1
1(b)	NOT voltage (magnetic) flux density NOT magnetic field strength	1
2	greater angular deflection of final path final path • within 10 mm to the left of the "guide line" (by eye) • has greater distance of closest approach  guide line parallel to final path, through centre of nucleus	1 1
3	$F = \frac{kq^2}{r^2}$ $F = 9.0\times10^9 \times (1.6\times10^{-19})^2 / (0.53\times10^{-10})^2$ $F = 8.2\times10^{-8}$ N incorrect initial formula leading to incorrect answer [0]	1 1 1
4	magnetic flux	1
5(a)	betas have low penetration / are more highly ionising / are less likely to escape the body / have a short range; (so) give the body or cells a larger (absorbed) dose / more risk of cancer / more chance of mutation; ACCEPT reverse argument for gamma photons	1 1
5(b)	$A = A_0e^{-\lambda t}$ $A = 300\times10^3 \times e^{-7.8\times10^{-10}\times56\times3.2\times10^7}$ $A = 7.4\times10^4$ Bq (74 kBq) ACCEPT $t_{0.5}$ = 0.693 / λ = 28 years (8.8×10^8 s) [1] this is 2.01 half-lives, so $A = A_0 \times (0.5)^2$ = 75 kBq [1] NOT $A\lambda t$ ie $300\times10^3 \times 7.8\times10^{-10} \times 3.2\times10^7 = 7.5\times10^3$ Bq [0]	0 1 1

Qn	Expected Answer	Mark
6(a)	B	1
6(b)	A	1
7	electric field (strength) / (electric) potential gradient in a uniform field / between parallel (conducting) plates ACCEPT electric intensity	1 1
8	risk (= $20\times10^{-3} \times 40 \times 3$) = 2.4% ACCEPT 0.024 with % crossed out risk per year (wtte) = $20\times10^{-3} \times 3$ (= 6.0×10^{-2} % yr^{-1}) [1] overall dose (wtte) = $20\times10^{-3} \times 40$ (= 0.80 Sv) [1] ACCEPT units as evidence of what they are calculating	2
9	three approximately straight lines: • approximately perpendicular to equipotentials • touching 1 kV and 4 kV equipotentials arrows to show correct direction, as shown  ACCEPT field lines meeting at a point ACCEPT any spacing of field lines	1 1

Qn	Expected Answer	Mark
10(a)	${}^{1}_{0}n$ NOT ${}^{1}_{0}N$	1
10(b)(i)	uud (in any order) (total charge =) $+\frac{2}{3}e + +\frac{2}{3}e + -\frac{1}{3}e = e$ ACCEPT calculation without *e*	1 1
10(b)(ii)	$u\bar{u}$, $d\bar{d}$ need both for the mark	1
10(c)(i)	4 protons 5 neutrons	1 1
10(c)(ii)	ecf 10(c)(i): $4 \times 1.673\times10^{-27}$ = (6.692×10^{-27} kg) $5 \times 1.675\times10^{-27}$ = (8.375×10^{-27} kg) so mass of separate nucleons = 1.5067×10^{-26} kg 1.4966×10^{-26} - 1.5067×10^{-26} = (-)1.0(1)$\times10^{-28}$ kg by correct method correct calculation of separate nucleons [1] 1.4966×10^{-26} - $4 \times 1.673\times10^{-27}$ - $5 \times 1.675\times10^{-27}$ = ... [1] 9.9×10^{-29} kg, 9.1×10^{-29} kg, [0]	2
10(c)(iii)	$E = mc^2$ $E = 1.01\times10^{-28} \times (3.0\times10^{8})^2 = 9.09\times10^{-12}$ J ecf incorrect *E*: $E = 9.09\times10^{-12} / 1.6\times10^{-19}$ (= 5.68×10^{7} eV) (eor) ecf: binding energy per nucleon = $5.68\times10^{7} / 9$ = 6.3 MeV 1.0×10^{-28} kg gives 6.25 MeV [3]	0 1 1 1
10(d)	less mass is equivalent to less energy (ORA) EITHER extra energy needed to separate the nucleons in a nucleus OR energy must be lost to form a nucleus from nucleons	1 1

Qn	Expected Answer	Mark
11(a)(i)	single line from source to detector along the centre of tube, through both holes, not hitting the sides	1
11(a)(ii)	to remove atoms which would collide with alpha particles ACCEPT alpha particles have short range in air	1
11(b)(i)	90	1
11(b)(ii)	$Bqv = \frac{mv^2}{r}$ combined in stages with $p = mv$ (eor) to final answer eg $Bq = \frac{mv}{r} \rightarrow Bq = \frac{p}{r} \rightarrow p = Bqr$	1 1
11(c)(i)	gives particles correct path to reach detector (wtte)	1
11(c)(ii)	background (radiation) is being detected NOT alphas can have different energies / velocities NOT background noise	1
11(c)(iii)	$p = Bqr$ B = 150 mT ecf incorrect B = 50 mT: B = 0.15 T (units conversion) ecf incorrect units conversion: $p = 0.15 \times 3.2\times10^{-19} \times 2.5 = 1.2\times10^{-19}$ kg m s^{-1} B = 50 mT gives 4.0×10^{-20} kg m s^{-1} [2] B = 150 T gives 1.2×10^{-16} kg m s^{-1} [2]	0 1 1 1

Qn	Expected Answer	Mark
12(a)(i)	single <u>loop</u> along iron core, passing from N to S eg  ACCEPT loop which avoids the black blob in the magnet	1
12(a)(ii)	good conductor of flux / high permeance / easily magnetised / guides flux through the coil / high permeability / good magnetic circuit / increases flux in the coil	1
12(b)(i)	spinning <u>magnet</u> increases and decreases flux in the <u>coil</u>; ACCEPT alternating flux, changes flux emf is positive as flux (linkage) increases, negative as flux (linkage) decreases ACCEPT decreasing flux for positive emf ACCEPT emf is rate of change of flux (linkage)	1 1
12(b)(ii)	sine wave of constant amplitude, correct period and phase, at least one cycle ACCEPT phase difference of $\pm\pi/2$  	1

Qn	Expected Answer	Mark
12(b)(iii)	$\varepsilon = N\frac{d\Phi}{dt}$	0
	dt = 0.25 period = 0.25 / 30 = 8.3×10^{-3} s	1
	$1.3 \approx 120 \times$ peak flux / 8.3×10^{-3} peak flux = 9×10^{-5} Wb (or 1×10^{-4} Wb)	1
	dt = 1/30 s gives 3.6×10^{-4} Wb [1] dt = 1/60s gives 1.8×10^{-4} Wb [1]	
	ACCEPT peak flux = peak emf / $2\pi fN$ = 6×10^{-5} Wb for [2] ACCEPT flux linkage change = area under emf-time graph [1] area $\approx 0.5 \times$ peak emf $\times$ 0.25 period = 5.4×10^{-3} Wb turns peak flux $\approx 4.5\times10^{-5}$ Wb [1]	
12(c)	any two of these modification-explanation pairs [1+1], maximum [3] • increase number of coils • to increase flux linkage • decrease gap between magnet and core • to improve magnetic circuit / increase flux (linkage) • increase dimensions of apparatus • to increase flux (linkage) • increase permeability of (iron) core • to improve magnetic circuit / increase flux (linkage) • laminate the core (wtte) • stops eddy currents reducing the flux	3
12(d)	to stop eddy currents in the core (wtte)	1
	EITHER which would reduce emf / flux (linkage) OR would dissipate energy (as heat) (wtte)	1

Qn	Expected Answer	Mark
13(a)	$^{4}_{2}He$	1
	ecf incorrect nucleon number for alpha particle: $^{236}_{92}U \rightarrow ^{232}_{90}Th + ^{4}_{2}He$	1
13(b)(i)	C anywhere before D	1
	D anywhere before B	1
	all **c**ats **d**esire **b**irds	
13(b)(ii)	$Q = It$	0
	$Q = 150\times10^{-9} \times 8.6\times10^{4} = 1.29\times10^{-2}$ C	1
	$N = 1.29\times10^{-2} / 1.6\times10^{-19}$	1
	$N = \underline{8.1}\times10^{16}$	1
	electrons per second (wtte) = $150\times10^{-9} / 1.6\times10^{-19} = 9.4\times10^{11}$ [1]	
	ions = electrons per second $\times$ 8.6×10^{4} (eor) [1]	
	ions = $\underline{8.1}\times10^{16}$ [1]	
	time to deposit an ion = $1.6\times10^{-19} / 150\times10^{-9} = 1.07\times10^{-12}$ s [1]	
	ions = 8.6×10^{4} / time for one ion [1]	
	ions = $\underline{8.1}\times10^{16}$ [1]	
	reverse calculation gives 148 nA	
13(c)(i)	each alpha particle emitted in a random direction	1
	(so half go down into the metal)	
13(c)(ii)	events from isotope = 22 146 - 420 = 21 726	1
	ecf incorrect events: $A = 2 \times 21\,726 / 600 = 72$ Bq	1
13(c)(iii)	$\lambda = A / N$	0
	ecf incorrect A, N: $\lambda = 72 / 8.1\times10^{16} = 8.9\times10^{-16}$ s^{-1}	1
	70 Bq and 8×10^{16} ions gives 8.75×10^{-16} s^{-1}	
	NOT $\lambda T_{0.5} = 0.693 = 8.66\times10^{-16}$ s^{-1} (from 25 million year half-life)	

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 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 2865
June 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.
- Open questions, such as the questions in section C in AS, 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 forward*: 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.

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

1 Please ensure that you use the **final** proof version of the Mark Scheme.
You are advised to destroy all draft Final proof 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 question should be ringed at the end of the question. 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.

Unit Code 2865	Session June	Year 2007	Standardisation 28/6/07

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
ue = unit error

Qn	Expected Answers	Marks	Additional Guidance
1 (a)	Same before and after owtte✓	1	Must compare before and after
(b)	(i) Energy conserved stated ✓ Mechanism or clear energy story ✓	2	Gravitational PE → KE, or KE → internal energy of water
	(ii) evidence of method✓	2	F × d, or mgh or full arithmetical expression eg 1 × 9.8 × 270 2600 J gives 0.62°C Reverse working OK.
	2646 J ≈ 3000 J ✓ (iii) evidence of method✓ ΔT = 3000 / (1 × 4200) = 0.7°C ✓		As (b)(i)
	(iv) Energy lost from water eg splashing, conduction into surroundings *idea✓ correctly explain✓* / Pool & surroundings form large sink to dissipate energy *idea✓ correctly explain✓*	2 2	Energy loss idea or Mixing idea
		9	
2 (a)	(i) Water freezes /solidifies at 273 K✓ (ii) 1 – 273/373 ✓ = 0.27 (<0.30 = 30%) ✓	1 2	Bald answer 0.268/26.8% = 1 mark Accept 273<T_{cold}<300 for 1 mark max
(b)	(i) ΔS = 6000/400 = 15 ✓ Units J K^{-1} ✓	2	Do not 'back credit' working in (ii)
	(ii) ΔS_{cold} = 4800/300 = 16 (J K^{-1}) ✓ ΔS_{cold} > S_{hot}, so net gain of entropy ✓	2	No ecf
	(iii) Suggestion, eg raise T_{hot}, lower T_{cold}, make use of waste heat (as in CHP schemes) ✓ Explanation in terms of Carnot relationship. ✓	2	Any reasonable suggestion. Justification can be arithmetic. Ignore entropy arguments.
		9	

Mark Scheme Page 2 of 4	Unit Code 2865	Session June	Year 2007	Standardisation 28/6/07

Qn	Expected Answers	Marks	Additional Guidance
3 (a)	(i) $pV=nRT$ (core) ✓ $n = pV/RT = 1.0 \times 10^5 \times 0.18/(8.3 \times 273)$ $= 7.9$ mol ≈ 8 mol ✓m✓e (ii) $N = 7.9 \times 6.0 \times 10^{23} = 4.8 \times 10^{24}$ molecules ✓	 3 1	Bald 7.9 mol gets 3 marks. Ecf from (i)
(b)	(i) (mean-square/rms) v is not changed✓ because T depends on v / T unchanged / no work done on or by gas/ no internal energy change✓ (ii) two sides of panel equal in size so a molecule would have the same number of ways of being placed on each side /having double the volume available provides twice the number of ways of arranging each molecule ✓ (iii) 2^N is an (extremely) large number✓ huge increase in number of ways will increase the entropy ✓	2 1 2	(Work is actually done on gas in this process) Must appreciate role o 2^N. Must have number of ways for second mark.
		9	
4 (a)	Same number of circles on the energy level diagrams on each side ✓	1	Not 'same number of atoms'
(b)	More atoms in higher energy level states ✓ Greater number of quanta present (eg cold solid has only 12x1 + 3×2 quanta, hot solid has many more) ✓	2	Argument in terms of BF acceptable to 2 marks.
(c)	(i) Each level has ¼ of the number in the level below ✓ (ii) $\exp(-\varepsilon/kT) = \exp(-5.8 \times 10^{-21}/(1.4 \times 10^{-23} \times 300))$ $= 0.251 = 0.25$ quoted in stem to (c)(i)✓m✓e (iii) Larger fraction so larger BF ✓; larger BF $\Rightarrow$ smaller $\varepsilon/kT \Rightarrow$ larger T ✓ / $BF_{hot} = 0.5$ ✓ $\Rightarrow T = 600$ K ✓	1 2 2	3/12 or 12/45 (12/48 Can use ln(0.25) =- ε/kT; allow ✓e 'show that' if values all substituted.
		10	

Mark Scheme Page 3 of 4	Unit Code 2865	Session June	Year 2007	Standardisation 28/6/07

Qn	Expected Answers	Marks	Additional Guidance
5 (a)	(i) Cosmic Microwave Background Radiation ✓	1	Allow any 3 out of the 4 CMBR eg MBR, CMB
	(ii) wavelength correctly related to (photon) energy ; (photon) energy correctly related to temperature ; Temperature now ~ 3 K / was once ~ 3000 K	2	Any two points NOT Doppler effect.
	(iii) (Cosmological) redshift ✓	1	
	Recession related to redshift/stretching of wavelength✓ Furthest galaxies receding faster/ biggest redshift✓	2	
(b)	$\lambda\uparrow \Rightarrow f\downarrow$ because $\lambda \propto 1/f$ ✓ $f\downarrow \Rightarrow E\downarrow$ because $E=hf$ ✓ $\lambda\uparrow 1000 \times \Rightarrow f\downarrow 1000 \times \Rightarrow E\downarrow 1000 \times$ ✓	3	
		9	
6 (a)	(i) $kT = 1.4 \times 10^{-23} \times 10^{7}$ J $= 1.4 \times 10^{-16}$ J ✓ $\frac{1}{2}mv^2 = 1.4 \times 10^{-16} \Rightarrow v^2 = 2\times1.4\times10^{-16}/1.7\times10^{-27}$✓ $= 1.6 \times 10^{11} \Rightarrow v = 4.1 \times 10^{5}$ m s^{-1} ✓	3	can use (3/2)kT Can use reverse working (passim) $pV=NkT \Rightarrow 1.4\times10^{15}$ ✓✓
	(ii) $pV=(1/3)\,Nmv^2$✓ $\Rightarrow p = (10^{31}\times1.7\times10^{-27}\times1.6\times10^{11})/3$ $= 9.1 \times 10^{14}$ Pa $\approx 10^{15}$ Pa)✓m✓e	3	
	(iii) ideal gas behaviour/no inter-particle interactions ✓	1	
(b)	(i) $50 \le A \le 60$ ✓	1	
	(ii) binding energy/nucleon = 8.5 to 9.0 MeV ✓ binding energy = $A \times$ (8.5 to 9.0) $\times 10^{6}$ eV✓ $= A \times (8.5 \times 10^{6}$ to $9.0 \times 10^{6}) \times 1.6 \times 10^{-19}$ J✓	3 2	✓ for method, ✓ for reading see table below
	(iii) total energy = answer to (ii) $\times 10^{56}$ ✓ Assumption = all nuclei were originally free protons/neutrons ✓		also e.c.f from (i)
		13	

A	(ii)/J	(iii)/J
50	7.2×10^{-11}	7.2×10^{45}
60	8.5×10^{-11}	8.5×10^{45}

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Qn	Expected Answers	Marks	Additional Guidance
7 (a)	(i) Gravitational force acting on satellite / weight of satellite ✓ (ii) centripetal force on satellite owtte ✓	1 1	
(b)	(i) Two correct force arrows✓ Labels correct: weight/gravitational force/gravitational pull/W/mg towards centre of Earth AND tensile force/tension/T in opposite direction ✓ (ii) equation applies only to object orbiting freely;10 kg is not orbiting freely; 10 kg is being pulled/restrained/acted on/held back by satellite; different *r*; no *M* in equation; *m* in equation is for satellite, not 10 kg ✓✓	2 2	Ignore lengths of arrows. Any two points
(c)	(i) $R = \rho L/A = 2.7 \times 10^{-8} \times 5000 / 8.0 \times 10^{-5}$ ✓ $= 1.7\ \Omega \approx 2\ \Omega$ ✓ (ii) Algebraic reasoning or quoting $\varepsilon = BLv$ ✓ $\varepsilon = 21 \times 10^{-6} \times 5000 \times 8000 = 840\ V \approx 800\ V$ ✓	2 2	Cand go via conductance Area 'cut' per second = Lv so $\varepsilon = \Delta\phi/\Delta t = BLv$
(d)	(i) $I = V/R = 840 / 1.7 = 490\ A \approx 500\ A$ ✓ (ii) $F = I\,LB = 490 \times 5000 \times 21 \times 10^{-6}$ ✓ = 51 N ✓ Unit error penalty here if N not stated. (iii) Effect ✓: Explanation✓	1 2 2	800/1.7=470; 840/2=420 800/2=400 (ecf from above also: 500A, 53N; 470A,49N; 420A,44N; 400A,423N) eg will fall to lower orbit /settle in new orbit; loss of energy; eg will slow satellite, force in opposite direction to v, quote Lenz's Law
		15	
8 (a)	(i) $\lambda = c/f = 2500/5.0 \times 10^6$ ✓$= 5.0 \times 10^{-4}$ m (0.50 mm) ✓ (ii) Stationary wave in crystal; resonance; has antinodes at ends; length of fundamental mode = ½ λ ✓✓ (iii) Pulse has 4-8 periods equally spaced✓ amplitudes drop (with envelope as concave curve) ✓	2 2 2	Any two points: may be shown in diagram;
(b)	depth = ½ ✓× 4200 × 25 × 10^{-6} = 5.2(5) × 10^{-2} m ✓	2	No ½ means that no marks are awarded.

(c)	(i) Recognising path length transmitter→crack→C is less than path length transmitter→crack→D ✓ (ii) Any point on the locus of an ellipse with C and transmitter as foci and crack on curve ✓ (iii) Delays at D will also have a number of different places where the crack might be ✓ Only one point will result in both measured delays ✓ (iv) How different depths are displayed ✓ How the information could be retrieved/display interpreted ✓	1 1 2 2	'closer' is enough In (iii), a clear diagram can score both marks. slices, perspective, contours or colour
		13	
QWC		**4**	

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
June07 Assessment Series

Unit Threshold Marks

	Unit	Maximum Mark	a	b	c	d	e	u
2860	Raw	90	61	54	47	40	34	0
	UMS	100	80	70	60	50	40	0
2861	Raw	90	70	63	56	49	42	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	97	86	76	66	56	0
	UMS	100	80	70	60	50	40	0
2863B	Raw	127	97	86	76	66	56	0
	UMS	100	80	70	60	50	40	0
2864A	Raw	119	94	84	75	66	57	0
	UMS	110	88	77	66	55	44	0
2864B	Raw	119	94	84	75	66	57	0
	UMS	110	88	77	66	55	44	0
2865	Raw	90	60	54	48	42	36	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	25.3	44.7	63.2	78.6	90.8	100	6692
7888	30.6	53.5	73.5	87.9	96.5	100	5132

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

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