GCE

Physics B (Advancing Physics)

Advanced GCE **A2 7888**

Advanced Subsidiary GCE **AS 3888**

Combined Mark Schemes And Report on the Units

June 2005

3888/7888/MS/R/05

Oxford Cambridge and RSA Examinations

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MARK SCHEMES FOR THE UNITS

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Mark Scheme 2860
June 2005

Physics B (Advancing Physics) mark schemes - an introduction

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

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

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

SECTION C

The outline mark schemes given here will be given more clarity by the papers seen when the examination is taken. Some of these scripts will be used as case law to establish the quality of answer required to gain the marks available.
It is not possible to write a mark scheme that anticipates every example which students have studied.

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

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

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

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

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. <u>No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.</u>

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

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

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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) C s^{-1} ; b) V A^{-1} ; c) J C^{-1}	3	
2(a) (b) (c)	sine wave / smooth curve through sample points ; lower frequency / pitch ; sample more frequently / sample at least twice per cycle	1 1 1	NOT square wave AW
3(a) (b)	low density / light ; so easy to move around OR flexible / not stiff / low Young modulus ; so cushions fall comparison: (as stiff but) less dense ; more manoeuvrable / less massive / less heavy	2 2	plot ; linked to explain reduces force / lengthens impact time AW
4(a) (b)	$(35 \times 10^{-3} \times 25 \times 10^{-3})/(12 \times 10^{-6})^2$; 6.08×10^6 evidence that 8 bits = 1 byte ; $(650 \times 10^6 \times 8) / 6.08 \times 10^6 = 855$ (OR Comp M 896) allow ecf on grains from (a)	2 1 1	method ; evaluation accept 866 using 6 M OR Comp M gives 908
5	8.9(4) S	1	only evaluation mark
6	many small crystals / regular (close) packing in each crystal (grain) / different orientations of packing / across grain boundaries AW	1 1	any 2 correct points
7(a) (b)	60 nC / 30 s = 2 nA $I / e = 2.0 \times 10^{-9} / 1.6 \times 10^{-19}$ (ecf on a) ; = 1.25×10^{10}	1 2	 method ; evaluation accept 1.3×10^{10}
	Section A Total	20	

Qn	Expected Answers	Marks	Additional guidance
	Section B		
8(a)(i)	$2^3 = 8$ / 000, 001, 010, 011, 100, 101, 110, 111	1	
(ii)	(8 levels with 7 intervals so) 3.0 / 7 ; = 0.43 V	1	accept 3.0 / 8 = 0.38V
(b)	$f = c / \lambda = 3.0 \times 10^8 / 0.68$; $= 4.4(1) \times 10^8$ Hz	2	algebra / numerical ; evaluation
(c)(i)	(V / 3 = R / 2R gives) V = 1.5V	1	accept bare answer
(ii)	Voltmeter draws negligible current ; so does not lower the p.d. it is trying to measure	2	
(d)	(i) D ; (ii) C	2	
	Total	9	
9(a)	ammeter in series ; voltmeter in parallel	2	correct symbols and position for each mark
(b)(i)	any 2 correct points current peaks where illumination peaks ; current decreases because some photons miss the cell ; more photons reduces resistance of cell	2	other plausible answers
		2	
(ii)		2	method ; evaluation
(c)	$P = I^2R = (1.4 \times 10^{-3})^2 \times 110$; $= 2.2 \times 10^{-4}$ W		
	same spacing by eye ; wavefronts opposite curvature	1	
(d)(i)	curvature leaving = 1/ 0.2 = +5.0 D	1	
(ii)	curvature added = + 5.0 – (– 4.0) = 9.0 D ;	1	
	f = 1/ 9 = 0.11 m ecf on 1/curvature	11	
	Total		
10(ai)	Young modulus = elastic stress/strain = initial gradient ;	1	method ;
	= 0.5 GPa / 0.005 ;	1	graph values ;
	100 GPa	1	evaluation
(ii)	initial gradient / linear region through origin is steeper	1	AW
	breaks at higher stress	1	accept yields
	area under the curve to breaking is less	1	energy per unit volume
(b)	stiffer so girders have less elastic deformation on load / stronger so girders/floors are less likely to collapse	1	expect quality explanation
(c)	pure metal has regular close packed planes which can slip over each other (by dislocation motion) ; causing large plastic deformation ; in alloy slip is prevented by impurity atoms (pinning dislocations) stopping slip	1 1 1	1/2/3 style marking full marks available for sensible attempts not mentioning dislocations / good discussion of ductility
	Total	10	
11(ai)	140 km / 250 pixels ; = 560 (± 60) m $pixel^{-1}$	2	estimate ; evaluate
(ii)	ratio (250 pixels) = 140 / 2.8 = 50 (±5)	1	ecf on (a) any method
(iii)	smaller pixels on CCD / greater density pixels ; gives less area $pixel^{-1}$ (better resolution is smaller m $pixel^{-1}$) longer camera / longer focal length lens ; greater v/u / less powerful lens ; gives larger image	2	valid suggestion ; explanation NOT more pixels
(bi)	false / random / unrelated data / black & white dots	1	any form of noise
(bii)	replace by median/mean value of neighbouring pixels	1	related to their noise
(c)	h = 2.5 tan 30° ; = 1.4(4) km ;	2	method ; evaluation
	Total	9	
	Section B Total	39	

Qn	Expected Answers	Marks	Additional guidance
	Section C		
12a)	e.g. television programme broadcast via sky satellite live images and sound commentary on a soccer match	1	both for one mark
(bi)	speed = distance / time for signal propagation ; info rate = amount of info transfer / time	1 1	for two reasonable estimates with units give one mark
(ii)	analogue signals have a continuous waveform / range of values ; digital signal is coded as a stream of 0/1 bits ; acceptable sketch graphs	1 1 1	OR mark 1/2/3 style full marks for well annotated sketch graphs
(c)	e.g. satellite t.v. can be used for education ; in under-developed countries / remote areas ; too many channels are overloaded with low quality programming / crammed full of advertising / encourage people to be lazy / avaricious	1 1 1	mark 1/2/3 style
(d)(i)	10.2×10^{12} / 256 = 3.98×10^{10} bit s^{-1}	1	evaluation accept 40 Gbit s^{-1}
(ii)	1/ (3.98×10^{10} bit s^{-1}) = $2.5(1) \times 10^{-11}$ s bit^{-1}	1	evaluation
(iii)	info rate per call = 8 x 8000 = 64 kbit s^{-1} 10.2×10^{12} bit s^{-1} / 64 kbit s^{-1} $call^{-1}$ = 1.59×10^{8} calls	1 1	evaluation method allow ecf (ii)
	Total	13	
13a)	normal at 90° to surface by eye ; both angles *i* and *r* correctly labelled	1 1	
(bi)	ray box aimed ; at glass block rectangular / semicircular; with protractor to measure angles		1/2/3 style
(ii)	impinge ray on block at measured angles *i* / every 10° ; mark angles *r* by pencil dots ; measure by protractor	5	1/2/3 style max 5
(c)	*n* = sin 80° / sin 42° = 1.47 ; 3 S.F. ;	2	evaluation ; S.F. mark accept 1.5 for 1 mark
	evidence that uncertainties considered e.g. max estimate *n* = sin 81° / sin 41° = 1.51 ; so *n* = 1.47 ± 0.04	1 1	method ; evaluation min *n* = 1.44 so accept ± 0.03
(di)	straight line through origin and the points by eye	1	
(ii)	*n* = gradient of line ; e.g. = 0.80 / 0.545 = 1.47	2	method ; evaluation
	Total	14	
	Quality of Written Communication	4	
	Section C Total	31	

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 2005

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Qn	Expected Answers	Marks	Additional guidance
1 (a)	C ✓	1	
(b)	B ✓	1	
(c)	D ✓	1	
2(a)	for **idea of** fringes ✓ for further detail ✓	2	accept diagrammatic representations
(b)	fringe separation <u>decreases</u> ✓	1	
3 (a)	for implying that **ALL** potential energy goes to k.e. ….. or **ALL** gravitational energy goes to k.e. ✓	1	could be 'no energy is wasted' ✓ but **NOT** 'energy is conserved'
(b)	v depends on h✓ and h decreases (with t)✓ (OAW) (must be an attempt to **use** √2gh in argument)	2	accept graphs of h vvs t and v vvs h
4(a)	max = 2.0 (m) ✓ min = 0.4 (m) ✓	2	
(b)	phasors are in phase every 30 s ✓ for a reasonable attempt to explain why this is so ✓ (no marks for the idea that 5 x 6 = 30 .....)	2	2 crests coincide every 30 s ✓**or** constructive interference every 30 s ✓
5(a)	$t^3 / m^2 = k$ (could be implicit in working) ✓ carried out on 3 sets of data ✓ (or find k from one set, then use k to predict t^3 or m^2) **MUST be an arithmetic test**	2	inappropriate test, carried out on 3 sets, to appropriate conclusion (2 marks) or m^2/t^3 = **a** constant….. carried through (3 marks)
(b)	conclusion based on test ✓ (7813, 7873, 7817 confirm)	1	
6(a)	9.0 ✓ 2.4 ✓ e.g. ENW (or EWE) tip-to-tail ✓	3	
(b)	look for **equilateral** triangle of phasors	1	
	Section A Total	20	

7(a) (i)	by $f = 3 \times 10^8 / 6.5\times10^{-7} = 4.62 \times 10^{14}$ (Hz) then $E=6.6 \times 10^{-34} \times 4.62\times10^{14}$ ✓$_m$ = 3.046×10^{-19} ✓$_e$ (J) **must** show calculator value	2	or directly by using $E = hc/\lambda$
(ii)	$P = 5.0 \times 10^{17} \times 3 \times 10^{-19}$ ✓$_m$ (= 0.15 W)	1	
(iii)	0.15 / 0.79 ✓$_m$ = 0.19 (W) ✓$_e$	2	
(iv)	**all three correct** ✓ 0.19, 19.95 (20) 15.75 (16) (possible ecf from (a)(iii))	1	**for ecf** check the 0.19 and 19.95 against (a)(iii)
(b)	1 (W) ✓	1	
(c)	**any 2 from :** less input required more output or brighter more efficient or less energy wasted cheaper to run less environmental impact no nweed to replace whole array if one 'goes' ✓✓	2	
	total	**9**	
8(a) (i)	λ = 1.3 (m) ✓ (1.28)	1	λ = 0.64 no marks but see below
(ii)	v = 330 x 1.3 ✓$_m$ = **430** (429) (m s $^{-1}$) ✓$_e$ **ecf** [330 x 1.28 gives 420 (**422**)] **3 sf max**	2	λ = 0.64 gives v = 211 ecf for 2 marks
(iii)	waves reflect ✓ (at fixed ends), superposition/interference ✓ antinodes and nodes ✓	3	for features of a standing wave, mark accordingly
(b)(i)	3 loops drawn ✓ . accept sine wave only)	1	
(ii)	(λ = 0.32 …so) f = 422/0.32 ✓$_m$ = 1320 Hz ✓$_e$ (or f = 429/0.32 gives 1340) **ecf** from (a)(i)	2	If (a)(i) wrong…. now … λ = 0.16 with v = 211 gives 1320✓✓ (ecf)
(c)	17/18 x 17/18 x 17/18 x17/18 x 17/18 ✓$_m$ = 0.7514 ✓$_e$	2	
	total	**11**	

9(a)(i)	½ x 8000 x $(20)^2$ ✓$_m$ = 1 600 000 (J) ✓$_e$	2	
(ii)	F x 50 = 1 600 000 ✓$_m$ F = 32 000(N) ✓$_e$	2	or by suvat for a = 4 then F = 8000 x 4
(iii)	sensible suggestion as to the **physical** cause of a change in resistive force by the gravel ✓ effect on stopping distance of the change of force ………….. ✓	2	**do not accept** air resistance arguments
(b)(i)	some ke changes to(gravitational) potential energy ✓ so less Fs required ✓	2	must be some reference to energy changes
(ii)	change in pot. en. = 352 800 (J) ✓ work reqd = (1 600 000 – 352 800) = 1 247 200 (J) ✓ x = 38.98 (m). ✓	3	consider stages completed
	total	**11**	
10(a)(i)	neglect / negligible / no air resistance	1	
(ii)	gravity (weight) acts downwards✓ causing deceleration✓	2	alternatives for 1 mark g pulls down ✓ because of weight ✓ weight is acting ✓ ke goes to gpe ✓
(b)(i)	(v = u – at) 0 = 3.5 – 9.8t (or 3.5/9.8) ✓$_m$ so t = 0.36 (s)✓$_e$	2	use of minus sign not important
(ii)	length = 10 x 0.36 x 2 ✓$_m$ = 7.2 (m) ✓$_e$ (or = 10 x 0.4 x 2 ✓ = 8.0 (m) ✓)	2	1 mark…. if x2 factor omitted
(c)(i)	same time t in air ✓ so $v_{(H)}$ x t greater ✓	2	
(ii)	longer time t in air✓ so $v_{(H)}$x t greater ✓	2	
	total	11	
	Section B Total	**42**	

11			Alternative methods might be classified as: 'echo sounding', 'parallax', or 'triangulation'
(a)	a **distance** measurement stated ✓	1	
(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)
(e)	s = vt idea ✓ t is half trip time ✓ **value** of v used ✓	3	
	total	**12**	
12			Alternative examples might include: 'standing waves or other sup. phen. with light / sound / radiwaves / microwaves etc
(a)(i)	for stating nature of wave ✓	1	
(a) (ii)	sensible order of magnitude of wavelength ✓ sensible order of magnitude of velocity ✓	2	
(b)	essentially correct ✓✓✓ satisfactory with some error/omission ✓✓ some attempt made ✓	3	
(c)	for three salient observations that could be made $✓_o✓_o✓_o$	3	
	for explaining each of the observations described $✓_e✓_e✓_e$	3	
	total	**12**	
	Quality of Written Communication	4	
	Section C Total	**28**	

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Mark Scheme 2863/01
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6. Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (½) should never be used.

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

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

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

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

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

9. 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	Expected Answers Section A	Marks	Additional guidance
1a 1b	C ✓ A ✓	1 1	
2 a 2b	$Q = CV = 470 \times 10^{-6} \times 270$ ✓ = 0.13 ✓ C ✓ E = ½ QV = ½ x 0.13 x 270 ✓ = 18 J ✓ (or 17 if 0.127 C used)	3 2	Lose one mark (over whole question) for power of ten error in capacitance. Bare answer for calculation worth two marks if correct. Or $E = ½ CV^2$ = 17 J
3a 3b 3c	3/3000 = 0.001 or 1/1000 ✓ 3000/3 = 1000 ✓ wavelength stretches because of expanding space ✓AW	1 1 1	1:1000 OK 1000: 1 OK
4	V/I x Q/V = Q/I ✓= coulombs/coulombs s^{-1} ✓= s	2	or: $T = J\,C^{-2}\,s$ ✓x $C^2\,J^{-1}$ ✓ = s
5a 5b	PV = nRT ✓ $V = 1 \times 8.3 \times 273/1.01 \times 10^5$ ✓= 2.25×10^{-2} m^3 $T = 1.01 \times 10^5 \times 2.45 \times 10^{-2}/ 8.31$✓ = 298 K✓ = 25 ^{o} c.	2 2	(cap N OK) own answer or clear working look for 298, 304, 295 depending on method.
6	$\Delta\theta = Q/mc = 900/(0.02 \times 4200)$ ✓ = 11 K ✓	2	10.7 K fine
7	$0.6 = 2\pi(m/9\,000)^{½}$ $0.36 = 4\,\pi^2\,m/9\,000$ ✓ $m= 9\,000 \times 0.36/4\,\pi^2 = 82$ kg ✓ mass of astronaut = 82 –15 = 67 kg ✓	3	Correct algebraic manipulation gains one mark.

Section A Total: 21

Qn	Expected Answers **Section B**	Marks	Additional guidance
8a	$v^2 = 3kT/m$ $v = (3kT/m)^{½}$ ✓ as T and k constant therefore $v \alpha m^{-1/2}$.	1	Or clear, correct derivation.
8b	Test: rms/$m^{-½}$ = constant✓ Carried out on three pairs of data correctly giving: 1.15 x 10^{-10}, 1.09 x 10^{-10} , 1.11 x x 10^{-10} ✓✓ (accept 3600, 3400, 3500 ✓✓) justified conclusion ✓	4	i.e. rms x $m^{1/2}$ = constant. Wrong test gains zero out of four. Minus one for each mistake in calculations.
8c (i)	***Two marks max from:*** • ***Range of energies*** • ***Colliding with each other*** • ***exchanging energy , velocities or momentum***	2	
8c (ii)	Relevant physical process ✓ (eg:This requires molecules gaining energy from a large number of collisions) relating process to probability✓ .	2	
8 d (i)	400 x 1.2= 480 ✓ 480^2= 2.3 x 10^5 m^2 s^{-2} ✓.	2	ecf
8 d (ii)	T = v^2 m/3 k = 2.3 x 10^5 x 5.3 x 10^{-26}/ 3 x 1.4 x10^{-23} ✓. = 290 K ✓. (291 K is acceptable) 295 K if 1.38 used	2	295 K if 1.38 used ecf (0.6 K) Accept 435 K if kT approx used)
9 a (i)	Spacing of equipotential lines increases✓. .	1	Underline errors
a (ii)	Line perpendicular to equipotentials ✓. direction shown✓. .	2	Needs to (at least reac) X.
b (i)	g = -GM/R^2 ✓= *-6.7 x 10^{-11} x 4.5 x 10^{19}/ (1.25 x 10^5)^2*✓ = - 0.19 N kg^{-1}	2	Negative sign not necessary for mark
(ii)	0.2 x 3 x 10^2 = 60 ✓N	1	Ecf
c (i)	V = 2 π x1.25 x 10^5/ (5 x 60 x 60) ✓ = 43.6 ms^{-1} ✓	2	Need own value for answer.
c (ii)	F = mv^2/r ✓ = 3 x 10^2 x 43.6^2 / 1.25 x 10^5 ✓= 4.6 N ✓	3	Formula and working can be implicit. Answer carried forward from (i) (40 gives 3.84 N) NB do not accept 4.4 as it is from a rounding error.
c (iii)	Weight greater than centripetal force required ✓AW	1	
10 a	Time = 40 x 1 x 10^{-11}/100 ✓= 4 x 10^{-12} s✓ .	2	
b	E = 1.4 x 10^{-23} x 300 ✓ = 4.2 x 10^{-21}✓ J	2	Accept 4 x 10^{-21} J or 6.(3) x 10^{-21} J
c	F = $e^{-1.5x 10^{-20}/4.2 x 10^{-21}}$ ✓ =0.028 (or 1/36) ✓ c.f. 1/40 = 0.025 ✓ ORA	3	37 if 1.38 used rather than 1.4 $e^{-E/kT}$ = 0.025 is not markworthy
d	Linking probability to number of attempts ✓	1	
e (i)	1/0.035 = 29 attempts ✓ .	1	s.f penalty
e(ii)	Any two from: Molecules break out of 'cage' more quickly/require fewer attempts✓ molecules have greater energy/velocity/BF ✓	2	AW

Qn	Expected Answers	Marks	Additional guidance
11 (a)	Linking activity to rate of decay ✓ as quantity decreases ✓ so does rate AW	2	Activity can be implied
(b)	$5 \times 10^{-18} \times 2.5 \times 10^{21} = 12\ 500\ s^{-1}$ ✓.	1	
(c) (i)	After 4.5 billion years ln number of atoms = 48.6 ✓ Therefore, number of atoms 1.28×10^{21} ✓so number halved. ORA	2	(49.3 -.693 = 48.6) evaluating λ (0.16 per billion years) ✓from gradient evaluating half life. ✓
(c)(ii)	As quantity has fallen to half ✓ the number decaying will also fall to half for a constant chance of decay per particle. AW	1	
c (iii)	Parallel line✓ starting from 48.6 ✓.	2	
(d)	Age of rocks less than half life (or less than half the uranium has decayed)✓.	1	
	Quality of Written Communication	4	

Section B Total: 49
Paper Total = 70

QoWC Marking quality of written communication

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

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

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

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

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

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

Mark Scheme 2864/01
June 2005

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

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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.

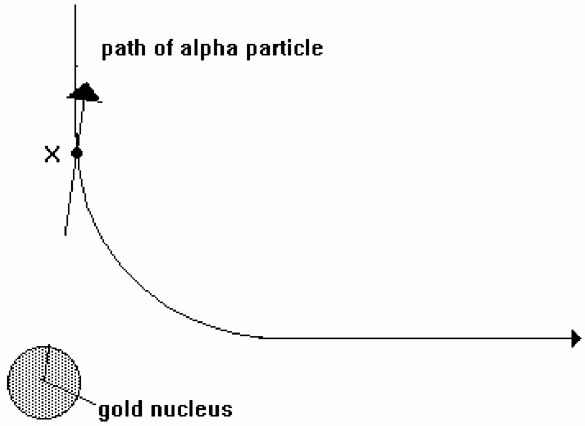
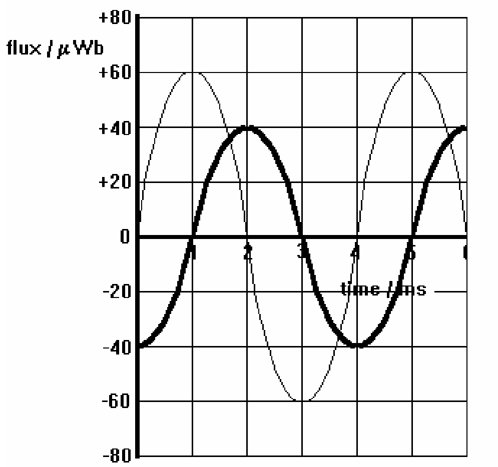
6 The mark awarded for Quality of Written Communication in the margin should equal the number of ticks under the phrase.

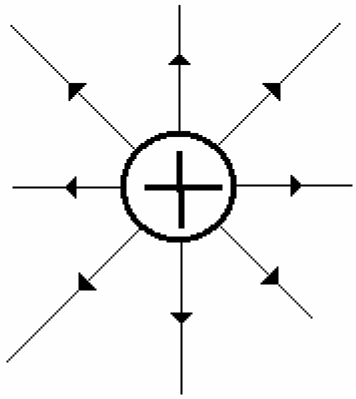
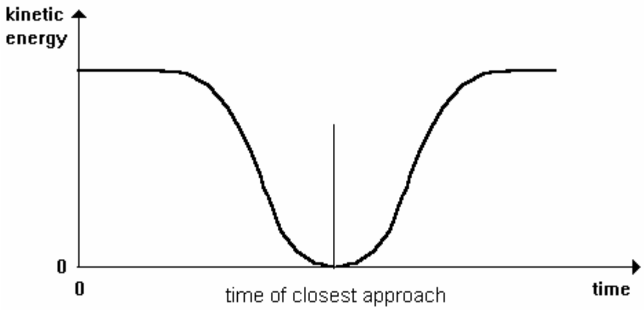
7 Correct answers to calculations should obtain full credit even if no working is shown, unless indicated otherwise in the mark scheme.

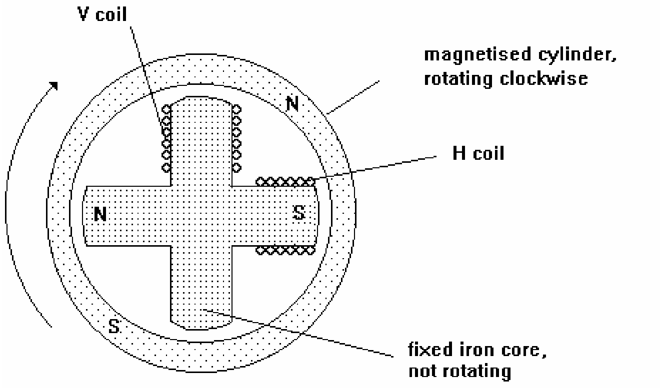
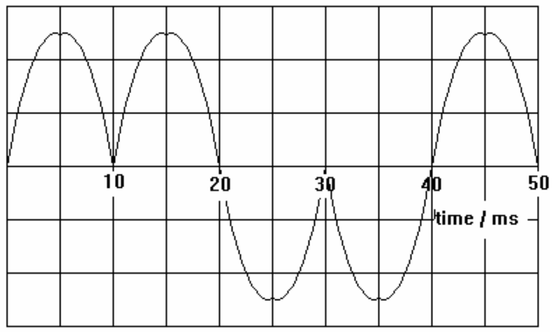
8 Strike through all blank spaces and pages to give a clear indication that the whole of the script has been considered.

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 Answers Section A	Marks	Additional guidance
1a 1b	N C^{-1} Wb m^{-2}	1 1	Accept N/C not NC
2a		1	Part of the line which passes through X and centre of nucleus, by eye. Must point away from nucleus. Doesn't have to touch X.
2b	$Q = 79 \times 1.6\times10^{-19}$ C, $q = 2 \times 1.6\times10^{-19}$ C (eor) $F = kQq/r^2$ (eor) ecf incorrect Q, q: $F = 9\times10^9 \times 1.3\times10^{-17} \times 3.2\times10^{-19} / (1.2\times10^{-13})^2$ $F = 2.5$ N $Q = 79$, $q = 2$ gives 9.9×10^{37} N	1 1 1	accept calculation of field followed by force
3a	correct shape and period, any constant amplitude correct phase (ahead or behind by $\pi/2$) 	 1	at least one cycle check zeroes and peaks are correct to one division
3b	gradient = $60 \times10^{-6} /0.5\times10^{-3} = 0.12$ Wb s^{-1} ecf incorrect gradient (e.g. $6\times10^{-6}/1\times10^{-3}$): emf = $75 \times 0.12 = 9.0$ ($\approx$ 10 V) accept between 7.5 V and 10.5 V if just $75\times0.13 = 10$, then [0]	1 1	accept between 0.10 and 0.14 Wb s^{-1}
4	B	1	

Qn	Expected Answers	Marks	Additional guidance
5	eight radial lines, rotational symmetry (by eye) arrow on each line, pointing away from nucleus e.g  .	1 1	ACCEPT 16 lines IF equipotentials as well as field lines , with no labels, then [0]
6	energy per coulomb (wtte) needed to take a unit charge from infinity (wtte)	1 1	ACCEPT energy per charge
7	[I] = C s^{-1} shown clearly $B = F/Il$ [B] = N A^{-1} m^{-1} (leading to [B] = N C^{-1} s m^{-1})	1 0 1	ACCEPT reverse argument
8	charge	1	
9	correct shape (goes down then up again) [3]  deduct [1], for each of the following errors: • doesn't start and end at same energy • not zero at time of closest approach • not tending to horizontal at start and end • not horizontal at closest approach	3	all judged by eye goes up then down [0] no negative final mark

Qn	Expected Answers Section B	Marks	Additional guidance
10ai		1	S at right-hand half of H coil accept N between left end and start of coil ignore poles on V coil
10aii	N pole (of cylinder) attracts S pole (of core) (wtte) If N at top of V coil, then accept repulsion of poles	1	accept answers using contraction of flux loops
10b	pulses of current only from 10 ms to 20 ms and 30 ms to 40 ms second <u>pulse</u> has opposite polarity to the first e.g. 	1 1	accept any amplitude
10c	one cycle of the current in the H coil EITHER is 40 ms OR corresponds to one rotation of the magnet THEN rps = $1/40\times10^{-3}$ (= 25)	1 1	accept $T = 40$ ms NOT $\frac{1}{40\text{ ms}} = 25$
10di	increase frequency of current in coils (wtte) EITHER so that magnetic field of core rotates faster (wtte) OR poles of core switch around faster (wtte)	1 1	ignore friction

Qn	Expected Answers	Marks	Additional guidance
10dii	any **one** of the following suggestion and explanation pairs • increase current in coils • increase magnetic field strength / flux • reduce gap between core and cylinder • increasing field strength / improving magnetic circuit • increase number of coils of wire • increasing magnetic field strength / flux • replace core with one made of thin sheets • to reduce eddy currents (which reduce field strength) • increase thickness of the core / cylinder • to improve the magnetic circuit / more flux • place more arms on the core and poles on the cylinder • increase number of opposite poles interacting (wtte) • decrease resistance of coils • increase current and flux (wtte) • increase permeability of core (wtte) • increase magnetic field strength	1 1	accept voltage accept increase conductance accept softer magnetic material

Qn	Expected Answers	Marks	Additional guidance
11a	four nucleons and two protons alpha (particle) / helium (nucleus) / α	1 1	accept $^{4}_{2}He$ for [2]
11bi	mass of nucleus = 178 × 1.7×10^{-27} kg = 3.0×10^{-25} kg	 1	ACCEPT 2.98×10^{-25} or 2.97×10^{-25} or 2.96×10^{-25}
11bii	$\text{nuclei} = \frac{\text{mass of sample}}{\text{mass of nucleus}}$ (eor) e.g. nuclei = 5×10^{-12} / 3.0×10^{-25} = 1.7×10^{13}	1	award mark for eor, not final answer.
11biii	$A = \lambda N$ ecf 11 b ii: EITHER $A = 7.1\times10^{-10} \times 2\times10^{16} = 1.4\times10^{7}$ OR $A = 7.1\times10^{-10} \times 1.7\times10^{13} = 1.2\times10^{4}$ Bq	1 1 1	 accept s^{-1} not Hz
11ci	$f = c / \lambda$ $f = 3\times10^{8} / 6.2\times10^{-11} = 4.8\times10^{18}$ Hz $E = hf$ ecf incorrect f: $E = 6.6\times10^{-34} \times 4.8\times10^{18} = 3.2\times10^{-15}$ J ecf incorrect E: $E = 3.2\times10^{-15} / 1.6\times10^{-19}$ (= 2×10^{4} eV)	0 1 0 1 1	 NOT $\lambda = 7.1\times10^{-10}$ accept reverse calculation
11cii	energy gap is equal to <u>photon</u> energy (wtte) photon has enough energy to go from M to K [1]	2	
11ciii	nucleus drops to lower level emitting photons (wtte) EITHER $A = \lambda N$ (wtte) OR shorter half-life	1 1	

Qn	Expected Answers	Marks	Additional guidance
12a	calculation of energy from mass: $E = mc^2$ conversion of J to eV comparison of mass or energy: EITHER $1.7\times10^{-27} \times (3.0\times10^8)^2 = 1.53\times10^{-10}$ J $1.53\times10^{-10} / 1.6\times10^{-19} = 9.56\times10^8$ eV $270\times10^9 / 9.56\times10^8 = 282$ ($\approx$ 300) OR $300\times1.7\times10^{-27} = 5.10\times10^{-25}$ kg $5.10\times10^{-25} \times (3.0\times10^8)^2 = 4.59\times10^{-8}$ J $4.59\times10^{-8} / 1.6\times10^{-19} = 2.87\times10^{11}$ eV (287 GeV)	1 1 1	in any order accept correct alternative calculation
12bi	$F = mv^2/r$ $F = Bqv$ $Bqv = mv^2/r$ ($r = mv/Bq$)	1 0 1	$Bqv = mv^2/r$ [2]
12bii	$B = E/cqr$ $B = 4.3\times10^{-8} / 3\times10^8 \times 1.8\times10^3 \times 1.6\times10^{-19}$ $B = 0.5$ T	0 1 1	ecf: $E = 270\times10^9$ gives 3.1×10^{18} T [1]
12ci	opposite charges (allow magnetic force to be in opposite directions)	1	NOT different charge
12cii	${}^{0}_{0}Z \rightarrow {}^{0}_{-1}e + {}^{0}_{+1}e$	2	award [1] if one error. ACCEPT β for e
12ciii	EITHER find the energies of electron and positron and finding that they add to 93 GeV OR energy of proton and antiproton / colliding particles must add to (at least) 93 GeV	 1 1	any plausible technique

Qn	Expected Answers	Marks	Additional guidance
13ai	$2.4\times10^{16} / 4\pi \times 100 = \underline{1.9}\times10^{13}$	1	
13aii	any of the following, maximum [2] • photons fired out from source in all directions • getting more spread out as they travel out • so photons passing through unit area decreases with increasing distance from source • all photons per second pass through surface of sphere radius *d* • fraction per unit area through this surface is $1/4\pi d^2$	2	NOT photons are absorbed / lose energy / decay NOT inverse square law
13aiii	beta absorbed by air / have limited range (wtte)	1	NOT beta particles have less energy
13bi	number of half-thicknesses = $1.2/4.0\times10^{-2} = 30$ $I = I_0(0.5)^n$ (eor) $I = 0.5^{30} \times 1.9\times10^{13} = \underline{1.8}\times10^4$ Bq m^{-2} 2×10^{13} gives $\underline{1.9} \times 10^4$ Bq m^{-2}	1 1	accept calculation using $I = I_o e^{-\mu x}$
13bii	ecf incorrect intensity: energy × intensity × area × time (eor) $1.8\times10^4 \times 0.8 \times 3600 \times 8 \times 1.8\times10^{-13}$ $= 7.5\times10^{-5}$ J 2×10^4 Bq m^{-2} gives 8.3×10^{-5} J 1.9×10^4 Bq m^{-2} gives 7.9×10^{-5} J	1 1	watch out for answers carried forward into the calculations
13biii	$\text{dose} = \dfrac{\text{energy} \times \text{quality factor}}{\text{mass}}$ (eor) ecf incorrect energy: dose = $7.5\times10^{-5} / 75 = 1.0\times10^{-6}$ Sv 1×10^{-4} J gives 1.3×10^{-6} Sv	1 1	accept reverse calculation
	Quality of Written Communication	4	

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.

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Mark Scheme 2865
June 2005

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

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

10. 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	Expected Answers	Marks	Additional guidance
1 (a)	p.d./potential difference / voltage ✓ (electrical) charge✓ current / rate of flow of charge✓	3	Accept units in this part.
(b)	(i) More powerful/stronger/faster pump✓ (ii) longer/narrower constriction	1 1	Or any change with the same effect.
(c)	Current-turns ✓ Flux ✓	2	
		7	
2 (a)	(i) $R = 0.40 + 0.30 \times 2^5 = 0.4 + 0.30 \times 32$ $= 0.4 + 9.6 = 10$ ✓m✓e (ii) Identifying problem with finding appropriate n ✓ further detail, e.g. need to have $2^n = 0$ ✓	2 2	
(b)	Early planetary data (including Uranus and Ceres) fitted values predicted by T-B Law ✓ but <u>Neptune</u> is well off the prediction✓	2	Second ✓ is for recognising Neptune was the discrediting factor. 'No theoretical/scientific basis' or similar gets ✓ only
(c)	(i) B ✓ (ii) A ✓	1 1	
		8	
3 (a)	alpha scattering: T cross + R tick ✓ photoelectric effect: both ticks ✓	1 1	Complete row for each mark
(b)	(i) 6.5 MeV = 6.5×10^6 J × 1.6×10^{-19} J eV^{-1} $= 1.04 \times 10^{-12}$ J $\approx 1 \times 10^{-12}$ J ✓ 1 pJ = 1×10^{-12} J confirming answer✓ (ii) $Q = 79e$ and $q = 2e$ ✓ $kQq/R = 1.0 \times 10^{-12}$ J $\Rightarrow R = kQq/(1.0 \times 10^{-12}$ J) $R = 9.0\times10^9\times(79\times1.6\times10^{-19})\times(2\times1.6\times 10^{-19})/(1.0\times10^{-12})$ m $= 3.6 \times 10^{-14}$ m (1.04 pJ gives 3.5×10^{-14} m) ✓m✓e (iii) no kinetic energy gained by gold nucleus /all KE of α converted to PE ✓	2 3 1	Must show calculated result. '1.0 pJ' gets ✓✓, implying 2 s.f. & 10^{-12}. Can use 1.04 pJ; can also use $V = kQ/R$ and $E = Vq$. Last two marks require correct physics Allow correct physics e.g. point charges
(c)	Neutron is $^1_0$n ✓ Nucleon **and** proton numbers add correctly ($^{12}_6$C)✓	2	e.c.f. from neutron
		10	

Qn	Expected Answers	Marks	Additional guidance
4 (a)	(i) ΔN: Change in number (of nuclei)/number of decays✓ λ: decay constant/ probability of decay per unit time ✓ N: number of nuclei ✓ Δt: time <u>interval</u> (over which change takes place) ✓ (ii) N would grow / AW ✓	4 1	Allow initial number
(b)	Concave curve from N = 1000 above the original ✓ Half-life doubles (near 500 at 7 s) ✓	2	
(c)	(i) Many parent decays ✓ few daughter decays ✓ (ii) Identifies balance between decay and production of daughter nuclei✓	2 1	*NB mark transferred from (ii) to (i)* (ii) Allow equal numbers of parent and daughter nuclei
		10	
5(a)	N is small ✓ so (by chance) ΔN can vary a lot ✓	2	Small must be explicit Mention of randomness
(b)	Not curved or not smooth/ N constant between 4 and 6 seconds/gradient varies randomly (any two distinct features)✓each	2	'Not exponential' without detail gets one mark only.
		4	
6 (a)	Any two reasonable points, e.g. temperature, pressure, wind speed, humidity, cloud cover/type, incoming/outgoing radiation ✓✓	2	
(b)	Reasonable method of detection ✓ How to detect at different heights e.g. balloon, satellite imagery✓	2	
(c)	Explaining resolution ✓ Smaller cells (volume or area) ✓ smaller time intervals ✓ Improved computers ✓ Smaller space & time divisions allow more accurate modelling of gradual change ✓ (any 3)	3	
(d)	**R**eason ✓ **E**xplanation relating to suggested reason✓ e.g. **R**: GB on edge of continent **E**:cloud/wind from Atlantic/European landmass can rapidly change condition; **R**: GB is windy **E**: weather patterns move rapidly; **R**: unpredictable cloud cover **E**: reflection/absorption of solar radiation affects weather; **R**: chaotic nature of atmospheric movements **E** changes become more unpredictable with time	2	
		9	

Qn	*Expected Answers*	Marks	Additional guidance
7 (a)	Fig. 7.1 shows pressure decrease with altitude ✓ As $P \propto \rho$, density decreases with altitude✓	2	(Assume isothermal).
(b)	Ratio test or other valid test using exponentials or logs (accept wide tolerance of interpolated *P* values due to difficulty of reading log scale) ✓ result of test (roughly halves every 5 km) ✓	2	Correct values *h* / km — *P* /kPa 0 — 100 5 — 54 10 — 26 15 — 12 20 — 5.5 25 — 2.6 30 — 1.2
(c)	(i) $E = mgh = 5.0 \times 10^{-26}$ kg × 9.8 N kg^{-1} x 1000 m $= 4.9 \times 10^{-22}$ J ≈ 5×10^{-22} J ✓ (ii) 1. $f = \exp(-4.9 \times 10^{-22}\ \text{J}/\{1.4 \times 10^{-23}\ \text{J K}^{-1} \times 295\text{K}\})$ = 0.89 ≈ 0.9 ✓ 2. $(0.89)^5 = 0.56 \approx 50\%$ ✓m✓e (iii) Temperature not constant/ any reasonable factor ✓	1 1 2 1	Can use 5×10^{-22} J
		9	
8 (a)	(i) Equally spaced parallel lines (possibly convex at edges) ✓ Arrows from anode to cathode✓	2	
	(ii) E_k gain = $eV = 1.6 \times 10^{-19}$ C × 24 000 V = 3.8×10^{-15} J ≈ 4×10^{-15} J ✓m✓e	2	*NB mark transferred from (ii) to (iv)*
	(iii) $f = E_k/h = 4 \times 10^{-15}$ J/6.6×10^{-34} J s = 6.1×10^{18} Hz ≈ 6×10^{18} Hz ✓m✓e	2	3.8×10^{-15} J gives 5.8×10^{18} Hz
	(iv) $f = c/\lambda = 3.0 \times 10^{8}$ m s^{-1}/500×10^{-9} m = 6.0×10^{14} Hz✓ $E = hf = 6.6 \times 10^{-34}$ J s × 6.0×10^{14} Hz = 4.0×10^{-19} J✓ Max. No. of photons = 3.8×10^{-15} J /4.0×10^{-19} J = 9500 ≈ 10 000 photons ✓m✓e	4	Can compare frequency with value of notional photon in (iii); allow rounded values of *E* or *f* from (ii) and (iii) ×sfe applied if more than 3 significant figures ✓e cannot be awarded for number < 1
(b)	(i) $F = PA$ ✓ = 1.0×10^{5} Pa × 0.50 m × 0.35 m = 17 500 N = 18 000 N ✓ (ii) Change of momentum on collision of molecule with screen✓ (Total) momentum change / (the time for the collisions) = the force above ✓	2 2	Must state or imply 'divided by time for collisions' for second mark.
		14	

Qn	Expected Answers	Marks	Additional guidance
9 (a)	(i) $I = P/V$ = 0.25 W / 3.6 V = 0.069 A ≈ 70 mA ✓m✓e (ii) $Q = It$ = 750 × 10^{-3} A × (60 × 60 s) = 2700 C ✓m✓e (iii) 750 /69.4 = 10.8 h ***or*** 2700 / 69.4 × 10^{-3} = 39 000 s = 10.8 h ✓m✓e (iv) Energy is transformed into thermal energy etc. ✓	2 2 2 1	70 mA gives 10.7 h: 3000 C and 70 mA gives 11.9 h
(b)	(i) 8000 × 8 = 64 000 bits s^{-1} ✓ (ii) Need enough information to characterise the signal/ voice contains high frequency components / need large bandwidth [due to range of frequencies contained in voice signal]. ✓	1 1	Can relate number of bits s^{-1} to quality
(c)	small number of possible characters (100) / a single word can be completely coded with about 1kbit ✓ A typical word takes more bits as an audio signal than as a txt msg.✓	2	First mark: recognising the bit-economy aspect of texting Needs a clear comparison with text bit rate and audio bit rate for 2nd mark
(d)	(i) $dT/dt = P / mc$ = 2/4200 = 4.7 × 10^{-4} ºC s^{-1} ✓m✓e (ii) Energy lost e.g. absorbed by skull, carried away by blood ✓ (iii) microwaves not ionising/ do not damage DNA/cells ✓	2 1 1	No penalty for wrong/missing units
		15	
	Quality of Written Communication: use whole script, but pages 8 – 11 are particularly indicative. Criteria are on the following page.	**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.

Report on the Units
June 2005

Chief Examiner's Report

The examination papers for the June 2005 session were comparable in demand to those set in previous sessions, and differentiated well between candidates of different abilities. Performances on both AS papers spread across the whole range of marks available up to, and including, the maximum mark of 90/90. At A2, candidates responded well to the challenges offered by the three papers and performances were broadly in line with those of previous cohorts. Well established and experienced teams of examiners provide the accurate and efficient marking that underpins the consistency of standards, year on year. Similarly, experienced teams of moderators carefully monitor the Centre-based assessment of the coursework assignments provide useful feedback and helpful advice which encourage the development and adoption of good practice in all our Centres. The detailed report for each component of the June 2005 examination is given below.

2860: Physics in Action

General Comments

The paper was of an appropriate standard of difficulty providing good discrimination. There was some evidence this summer that a greater proportion of candidates were rushed for time to complete the paper. Several did not attempt the graph question on the final page even when the previous page had been elegantly worked. The novelty of having an experimental technique of their own choice to describe in section C resulted in many good answers. There was much encouraging evidence that candidates had either used their time well or had left harder questions until the end. Such evidence of applied exam strategy to avoid time wasting / mild panic over a tough question part is admirable.

The range of marks ran from single figure scores out of 90 up to and including the maximum mark. The mean mark was pleasingly high, with a good standard deviation spreading out the candidates, and good differentiation was achieved.

Comments on Individual Questions

Section A

1. This question was meant to be a friendly starter, but lack of confidence with electrical units meant that it differentiated at a higher level than intended.
   A surprising number of candidates got at least one of the units wrong.

2. a) This was answered well, nearly all candidates drawing a smooth sine curve through the sampling points. The most common errors were: 'joining the dots' or to draw square step waves.

   b) & c) were generally answered well. A small number of candidates lost the b) mark with answers that were too vague and unscientific, such as 'the sound would be deeper'.

3. a) Most candidates gained at least one mark here, but many lost out by making two statements about the plot (e.g. has low density and low Young modulus) instead of producing one statement and an explanation. More candidates got both marks by writing about low Young modulus giving a softer landing, fewer wrote about a low density mat being easier to move around.

   b) Was answered well, the easiest route being that composite rackets are less dense and so lighter. Very few made the comparison here without providing the explanation, perhaps because they had correctly stated that the Young moduli were of comparable magnitude.

4. a) Some candidates did not attempt this question, but most that did either got 0 or 2 marks here. Few candidates who did not get both marks picked up the intermediate step mark by calculating the film area with units correctly. Sadly many incorrectly quoted the film area as 875 mm. Another common error was not to square the 12 μm to get the grain area. Some candidates showed the calculation and equated this to 6×10^6, and so missed the 'show that' evaluation mark.

   b) This was generally answered well, and some candidates got two marks without attempting a) because of the assistance offered to weaker candidates by the "show that" type question. The most common error in this part was to divide the CD information capacity in bytes by the picture information in bits, and such answers scored one mark ecf.

.

5. This question was a straightforward calculation of conductance, using a formula given on the formulae sheet. The calculation was complicated by many powers of ten in the data given, but it was pleasing to see so many candidates getting the mark.

6. This question asked for an explanation of the term ‘polycrystalline’. Weaker candidates took the poly prefix from their knowledge of plastic materials and incorrectly wrote about chains of molecules in the brass. Nearly half the candidates only got 1 mark here. Usually for stating that polycrystalline means ‘many crystals’ and leaving it at that. The second mark for further explanation was more discriminating than anticipated. Candidates should be trained to look at question totals and judge their responses accordingly.

7. a) This question about the current in an ion beam was answered well. Many sailed through the calculation ignoring the nano multiplier, but since it had been given in the answer line, it was naturally accepted. Sadly some better candidates lost the mark by putting 2×10^{-9} in the answer box, and getting a double dose of nano nano!
b) Candidates were asked to calculate the number of ions per second passing in the beam and this was answered better than on previous occasions. This is encouraging since the calculation does not involve a formula from the sheet, but rather a grasp of the concepts of current and charge. Quite a few who had got part a) wrong managed to get two marks here, by starting from scratch or by carrying forward a previously obtained, but incorrect, value for current from a), in which case ecf applied as usual.

Section B

8. This question was about a sensing system to monitor the oil-level in a domestic oil tank.

a) (i) about the number of levels coded by a three bit number was answered well.
The majority of candidates used the $2^3 = 8$ route. Fewer showed the complete 3 bit binary code options from 000 to 111.
a) (ii) was to show the voltage resolution of the sampler and was generally answered well.
b) Application of the GCSE equation $v = f\lambda$ was well answered.
Pleasingly few candidates were caught out by the S.F. penalty applied here.
c) (i) Nearly all candidates got the half way potential of the divider correct at 1.5 V.
c) (ii) was about the necessity of a very high resistance voltmeter and was not answered well, even by the better candidates. Weak candidates often left this question out. Some who attempted it got 1 mark, usually for saying “low current through the voltmeter”. Very few gave a clear explanation of the effect of the parallel resistance of the voltmeter on the potential divider. This part of the question was targeted at A grade level, and differentiated well.

d) (i) The linearity of the voltage with depth of oil in the tank was answered well.
(ii) Many got this difficult logical reasoning question wrong, for how the volume of oil in the tank changes the voltage from the divider.

9**.** This question was about the circuit and optics of a photovoltaic cell.

a) Drawing the test circuit diagram was answered well. A few put the voltmeter in series or added another power supply to the circuit, hence demonstrating a lack of appreciation of the active nature of a solar cell.
b) (i) Here the candidates did not express their answers well and quite a few simply described how current varies with distance from the graph, rather than trying to explain the variation using the changing light intensity at the cell. Most gained the first easy mark for saying that illumination varies with distance. Many then repeated this in some other words and did not gain the second mark. Better candidates answered by explaining the peak in the intensity due to the focusing effect of the lens.
b) (ii) Calculation of the power developed was answered quite well. A surprising fraction of candidates missed the fact that the current was in mA and got the method mark only. Some did the calculation with $I = 0.2$, misreading the distance axis for current.
c) A significant minority of candidates missed out this part, which required them to draw two wavefronts converging onto the solar cell. Much careless drawing was in evidence, without

sufficient care to represent the curvature and/or wavelength properly. Students need to be taught the physical significance of important features of physics diagrams.

d) (i) Asking for the curvature of wavefronts leaving the lens given the image distance was answered well, most candidates taking the reciprocal distance, and not changing the sign.

d) (ii) Weaker candidates now confused themselves, about the curvature added by the lens, using their own version of the lens equation. But some who had got (d) (i) wrong got the next mark ecf by adding 4.0 D to their previous answer. A further ecf mark was available for getting the final reciprocal for the focal length of the lens. Sadly many candidates either left their final answer expressed as a fraction, or expressed it as recurring decimal (implying an infinite number of significant figures). Physics examiners like neither approach. Candidates could be usefully reminded of the paper rubric to give answers to only a justifiable number of significant figures.

10. a) (i) Most candidates tried to evaluate a gradient and gained the first mark. Sadly a significant majority picked an inappropriate gradient “point” beyond the initial linear elastic portion of the graph where the Young modulus should be assessed (limiting them to the 1/3 mark maximum) others misread one or both graph axes and again lost credit. This part was much more discriminating than had been expected.

    Part (ii), about the graph features showing stiffness, strength, and ductility, was generally answered well, although weaker candidates were not specific enough about the initial gradient when discussing ‘stiffer’, and gave general definitions rather than relating their answers to the graphical information as requested.

    b) Only the better candidates suggested why the alloy was more useful for girders in buildings. Too many candidates regurgitated part a) and did not discuss the context of the ‘floors of buildings’, which was deemed necessary to gain this A grade-targeted mark.

    c) This part about explaining from microstructure diagrams of pure metal and alloy, why the alloy is less ductile, brought some superb answers. The candidates familiar with terminology such as dislocations and their pinning by alloying atoms scored many good marks here. But examiners were primed to fully reward any candidates who tried to express these ideas in their own terms, as many did, and good answers secured full marks for their efforts.

11. a) (i)& (ii) Resolution of images remains a difficult concept for many candidates. Despite the carefully designed prompts to help them through the question, weaker candidates found it easier to estimate the resolution in Fig. 11.2 where the distance marker went to the edge of the image. These candidates then expressed the final ratio of resolutions the wrong way round -being unable to believe that “smaller is better” as far as resolution is concerned. A method mark in (i) and an ecf mark in (ii) helped many to secure marks.

    In a) (iii), many scored only one mark here because they did not explain their suggestion about how the resolution of this system could be improved. Weaker candidates simply quoted “more pixels” which, without qualification implying greater density, was not rewarded. Several thought a more powerful lens would improve the resolution, but the opposite is in fact the case. The suggestion to fly the satellite closer to the planet was rewarded.

    Part b)(i) was about noise reduction and was well answered. The most common error was simply to just quote “interference” and this response was insufficient for the mark. Better candidates quoted “interference” and went on to gain the mark, by describing the appearance of noise in the image.

    b) (ii) Nearly all candidates answered well, quoting median or mean filtering or smoothing which were all accepted, as methods for reducing noise.

    c) This question about applying trigonometry to estimate the height of a crater from its shadow was answered pleasingly well by over half the candidates. The most common error was to attempt to use sin (or cos) instead of the tan function, for which no marks were awarded. However, a method mark was available for those who confused m and km in their answer.

Section C

12. a) Nearly all candidates could state an example of a signal transmission and state the kind of information carried.

Part b)(i) asked candidates to explain the difference between speed of transmission and rate of information transfer, and was only answered well by the best. Far too many candidates said the speed of transmission was the <u>time</u> taken for the signal to travel, but better candidates quoted light speed or a sensible fraction of it to gain the mark. Better answers were produced to explain the rate of information transfer, with the weaker ones quoting the units of bits/second, which was accepted.

b) (ii) Distinguishing between digital and analogue systems was generally answered well enough to score 2/3 but often lacked enough quality for the 3rd mark. A few wrote about a sampled/reconstructed analogue wave instead of writing about digital signals. Other common faults were to have diagrams representing digital signals which had more than the 2 levels (0 and 1) they had quoted; and for very rough analogue sketches showing signals "going back in time" over portions of the time interval.

c) Many candidates lost out by writing about technical advantages rather than advantages to society. This part turned out to be a good discriminator, with the full range of marks 0 to 3 being awarded.

d) (i) (ii) and (iii) involved calculations on an experimental record holding data link and was generally answered well. Candidates were more familiar than in the past about using time per bit as the reciprocal of bits per time, which was encouraging. Part (iii) discriminated well with weaker candidates clearly trying to juggle numbers to arrive at the 'show that' answer of 160 million simultaneous telephone conversations carried! Candidates could secure one method mark if they got as far as 64 kbit/s per conversation.

13 This question, about describing an experimental technique to measure the refractive index of a material such as glass, brought a good crop of marks for most students.

a) Too many got the angle labels *i* and *r* completely wrong, and some did not continue the normal into the glass. A majority scored 2 marks for the diagram.

b) (i) Many diagrams were very scruffy but, even so, recognisable details were credited by painstaking examiners. Some were no more than poor repeats of Fig 13.1, and such attempts were not credited.

b) (ii) In general the descriptions of the experimental procedure were good. Many who did this got 4 or 5 marks in total here. The most common error was not to mention the changing of the angle of incidence *i* as the main variable. Many other variables were unnecessarily mentioned by weaker candidates, such as intensity of light or distance of light from the block.

c) This question about handling experimental uncertainties was bravely attempted by most candidates. Many got the 4 marks for a best refractive index calculation followed by a sensible uncertainty estimate. Many, less familiar with the correct procedure (max/min or min/max), made a useful attempt - perhaps by using the wrong combination (max/max) for calculating errors; or by calculating the max and min values and taking an average to find n.

d) (i) The best fit line through the origin was an easy mark for nearly all who attempted it. The most common fault was not using a ruler.

d) (ii) Most candidates took a nice large triangle to estimate their gradient. The common errors here were misreading the graph scales, and many took the sine of the values from the graph, which were already sin values. Those that had drawn poor graphs often returned to data points to calculate the gradient rather than use their "best fit" line.

2861: Understanding Processes

General Comments

The paper was of an appropriate standard and provided good differentiation between candidates of different abilities. The structure of the section B questions encouraged candidates to see each context readily, and the way the questions were framed was aimed to reflect the way candidates are encouraged to think throughout the course. From relatively easy beginnings, each question became more challenging and involved, before demanding more from the candidates in closure. Performances in sections A and B were essentially sound, but answers to section C questions were disappointingly variable. Many candidates whose overall performances would have benefited from a good mark in Section C often seemed prepared to squander the opportunity through lack of preparation. It was pleasing to see that most scripts were fully worked, indicating that the candidates were able to find lots to do and complete the paper in the 90 minutes allocated.

Comments on Individual Questions

Section A

In this part of the paper, which contained the shorter questions, performances ranged widely across the mark range. But it was pleasing to see the number who scored the maximum 20 marks available. In general, clear working was shown and gained credit. Question 1 proved to be a challenging opener, requiring candidates to select three answers from four possible graphs. A common mistake in answering parts (a) and (b) was to select graph A. In question 2 (a), any reasonable description of the pattern was allowed and good responses, worthy of both marks, were provided by a majority of candidates. In part (b) the question required only a description of the change in the pattern but there were relatively few correct responses. Here, as elsewhere, those candidates who seemed unable to distinguish between questions that required them to 'describe' and those requiring them to 'explain' often managed to 'shoot themselves in the foot'. It was not uncommon to read that 'the separation of the fringes will decrease because blue light has a longer wavelength than red light'. One candidate felt that the pattern of fringes in blue light would be 'infinitely prettier'; a charming idea, though not a response the examiners were prepared to credit. Question 3 and question 4 part (b) discriminated well, and in question 5 a majority showed competence in the skill of carrying out arithmetical tests on data. Question 6 provided a novel and successful way of looking at phasors and probability. Most candidates responded well to the question set in this format, and produced good answers.

Section B

7 This question was about LEDs.

The most common approach to part (a)(i) was to calculate the frequency f, using $f = c/\lambda$., then substitute the value for f in $E = hf$. It was rare to see the calculation effected in one stage using $E = hc/\lambda$. In this part, examiners were looking to see evidence that the calculation had been carried out. Parts (a) (ii) and (iii) were quite discriminating. In (iii), a common error was to set about calculating the power input using the expression: power in = 0.15 x 121/100.
A majority of candidates completed the tables successfully, e.c.f. being allowed from (a)(iii). Having assembled the relevant information in the tables, candidates were then able to use the information to provide good and varied answers in part (c).

8 This question was about the vibrations of a guitar string.

Most, but by no means all, of the candidates appreciated that the internodal distance on a standing wave is half a wavelength. Errors from (a)(i) were allowed to be carried forward to part (ii) where many needlessly lost one of the two marks available for quoting their value for the speed of the waves to too many significant figures. The wording of part (a)(iii) was deliberately open to interpretation, and candidates were rewarded accordingly. Some talked in terms of progressive waves reflecting, superimposing and creating nodes and an antinode where the waves superimposed in antiphase and phase, respectively. Others talked in terms of the characteristics of the wave which made it a standing wave (as opposed to a progressive wave), and both approaches did produce fine answers. Parts (b)(i) and (ii) were well done, but part (c) then proved to be a bridge too far for all but the most able candidates.

9 This question was about the physics of an escape lane.

In many ways this question was perceived as the most difficult question on the paper. Answers from some were poor because they did not read the questions properly, whereas others expressed their ideas badly. Parts (a)(i) and (ii) were reasonably well done with few candidates troubled by the units of the answers required. Having said that, it was not uncommon to see candidates multiplying 8000 by 20, in part (i) and claiming that this meant a kinetic energy of 1.6 MJ. In part (ii) the most common approach was to calculate the deceleration a of the lorry (4.0 m s^{-2}), and then use $F = ma$ to obtain F = 32 kN. Part (a)(iii) was highly discriminating, and was answered well by only those candidates who addressed the question as framed. Parts (b)(i) and (ii) provided an incline of difficulty that caused many candidates' efforts to stall, but the better candidates produced convincingly complete answers.

10 This question was about modelling the physics of the long jump.

It was particularly in this question that we found a significant proportion of candidates were hampered in their responses by an inability to handle the language. Many of the ideas of physics rely on the use of language in a specific manner, and it is accepted that this usage is often beyond 'normal' everyday conversation. The more problematic issue seems to be that many candidates do not use the scientific language with the precision we hope for, but more like a pitchfork.

Part (a)(i) provided a gentle start to this question for all candidates, but offering an explanation in part (a)(ii) of the question posed difficulties for some. This reluctance, or inability, to explain familiar effects with confidence suggests that there are those for whom discursive activities still play too small a part in their learning experiences. For candidates to be encouraged to explore 'why' or 'how' is at the very heart of understanding processes. Calculations in parts (b)(i) and (ii) were competently executed by many candidates, and in part (c) the interesting nature of the context spurred all but the faint hearted to attempt to explain the physics, though only the stronger candidates were successful.

Section C

In this section there were two questions, each requiring candidates to choose the context in which they gave their answers. Question 11 was about a method of measuring the distance to a remote or inaccessible object. Question 12 required candidates to write about an effect caused by wave superposition.

Question 11 was answered very well by a majority of candidates, though to find that all the candidates from one centre had apparently 'chosen' the same example to write about, in almost identical words, must have been a somewhat disconcerting experience for the examiner concerned. Of course, there are many centres where imaginative learning and teaching are self evident from the innovative answers that the candidates produce. Many diagrams are well drawn and appropriately labelled, and the descriptions of how the methods work and explanations of how the data can be used to find the distance involved, are often of a very good standard. In the final question it was a pleasure to see the wide range of examples of wave superposition that this cohort of candidates chose to write about in their answers.

2862 – Physics in Practice

Centres are to be congratulated on the professional manner in which the vast majority of coursework portfolios were marked and presented. The majority of these portfolios arrived on time with all the necessary paperwork completed. The amount of time and effort that goes into this final submission of coursework is appreciated and this proves to be of great benefit to the candidates concerned; this is especially so for those Centres who highly annotate their candidates work so that the moderator is absolutely clear on how the various marking points have been made. The variety of coursework in all three tasks is truly amazing. A few administrative points are, again, worth noting to help centres in future years.

- Centres are asked to check the addition and transcription of marks from the candidates work to the final mark sheets. There were a surprising number of arithmetic and transcription errors and these do lead to disruption of the moderation process and inevitable delays.

- Centres with small entries (11 or less) should submit all the work of all their candidates for moderation without the need for the Moderator requesting a sample.

- Large centres with more than one teaching group and more than one teacher marking a given task should show evidence of internal moderation. When this internal moderation takes place then it should be clear to the Moderator which is the actual, final moderated mark. Often internal moderation was seen to have occurred but the Moderator was then left with a choice of two marks from the centre to choose from.

It is evident from the number of centres that do not have their marks adjusted that the majority of centres now understand the requirements of the specification and mark to within the tolerance level set by OCR. It is recommended to those few centres that have been heavily adjusted that a teacher from the Centre attend one of the OCR training sessions on the marking of Advancing Physics coursework.

The following points are written to help Centres provide good advice to their candidates in an attempt to allow them to maximise their module mark.

Instrumentation task:

This is often the first coursework task carried out at AS level and there is often a problem of candidates following a GCSE Sc. 1 approach. This will inevitably lead to making access to the assessment criteria far more difficult.

The key to this task is that it should be challenging. A simple thermocouple or thermistor across a multimeter is not considered challenging whereas a thermistor in a potential divider circuit with a resistor whose value has been carefully worked out in relation to the thermistor can be looked upon as giving candidates at this level a challenge.

In Strand A (i) candidates should provide a plan that shows alternatives were considered. Strand A(ii) requires candidates to give safety due regard and any candidate who does not write specifically, in their final document, about safety should not be given maximum marks.

In Strand D(i) repeat readings are required for maximum marks, it is not satisfactory to write, “Time prevented me from doing any repeat readings.” In Strand D(ii) the ‘Fitness of Purpose’ required is not whether a LDR will operate a street light or a thermistor will switch a heater on but rather those listed qualities of the sensor for example resolution, response time, systematic bias, systematic drift, sensitivity and random variation. For maximum marks candidates are expected to perform some quantitative analysis on at least two of these qualities.

Centres are encouraged to allow candidates freedom of choice in what sensor to investigate It is most distressing to see whole centres where everyone uses a thermistor. Also, candidates must be wholly discouraged from working in pairs and producing identical results. At this level candidates must be expected to do the whole task independently.

Some good instrumentation tasks seen this year are:

Optical smoke detector.
Regulating the temperature of a swimming pool.
Using a thermocouple to measure the temperature of mushroom compost.

Research and Presentation Task:

In general it is far better for candidates to start with a question, for example, “ Why is Steel used in the Angel of the North?” This gives the presentation an immediate focus and context as well as concentrating on the physical properties of steel. Contrast this with, say, a more general title such as ”The Uses of Steel.” It is also important to make the point that this is a Physics presentation not Chemistry so the extraction of a metal (for instance) should play only a minor part in the whole presentation.

Annotation by teachers is vital to the moderation of this task because the moderator was not present during the presentation. One centre had their candidates produce paper copies of their power point slides before the presentation and the teacher wrote on these copies during the presentation, this provided an excellent record /annotation and allowed the teacher to keep an immediate record of whether each slide was expanded upon or merely read from.

In Strand A(i) it is essential that a candidate provides a plan of the work covered. An outline planning sheet can be downloaded from the IoP Advancing Physics website. In Strand A (ii) it is necessary to indicate the contribution of each source to the presentation. Some of the best work done here is where candidates number their sources and then in, say, a power point presentation, use these numbers in the corner of each slide to show where the information came from. Likewise in a bibliography candidates may give a short précis on how a particular source was of use.

Discrepancies in Strand B(ii) are often difficult to mark and centres should put less emphasis on ‘discrepancies’ and award marks for good judgement in the selection of information from sources. If they have used several references and therefore information is confirmed by agreement between more than one source then the assumptions and discrepancies are covered. Critical appraisal of how trustworthy or reliable the candidate considered each source can also count towards satisfying this criterion.

In Strand C(ii) only illustrations which help with the understanding of the Physics in the presentation should be encouraged and marked highly. Candidates for whom English is a second language should not be marked more leniently in this section when compared to candidates where English is their first language. OCR has appropriate systems in place to make sure these candidates are not disadvantaged and these channels should be used.

For Strand D(ii) a candidate should provide talk notes, if used, as part of the paper record before maximum marks are allocated or if no notes are used then the centre should annotate such. Also in this skill a list of search engines such as ‘Google’ or ‘Ask Jeeves’ is not considered worth more than one mark. Also, candidates are not required to printout page after page from websites but they should be encouraged to give references down to web pages rather than just websites.

Good examples of presentations seen this year are:

Carbon fibre in Ellen MacArthur’s sailing boat.
Tempur (memory foam) for use in mattresses.
Spiders’ silk in webs.
Video animation on the properties of clay.

Making Sense of Data:

The most important feature of this task is that it should not be considered to be an Sc1 Investigation where candidates have to make predictions and then set out to prove or disprove them. The most successful data sets are often where candidates are allowed to perform or help in an experiment and are then issued with a common set of data. This can avoid spurious data that may occur if several candidates all collect their own data. It must also be noted that some experiments are simply not suitable for this task, for example, drawing cooling curves for beakers of hot water is not likely to allow candidates enough scope to develop their analysis. Similarly, by giving a title such as ‘Find ‘g’ by using a simple pendulum’ will restrict candidates along a very narrow line of analysis. The experiment carried out and the data given should allow a candidate to make progressive mathematical analysis.
In this task attempts should be made not to penalise candidates more than once for the same mistake. Thus in Strand A(ii) ‘Sensible use of ICT’ candidates should be penalised for lack of vertical and horizontal grid lines on graphs, very small graphs, too many or a variable number of decimal places in a table, tables split between different pages whereas Strand C is about what to calculate and record and Strand D is about what is actually plotted and whether the lines or curves are valid.

One good example of a task carried out this year is:

Motion of a bouncing football using an ultrasound sensor

2863/01: Rise and Fall of the Clockwork Universe

General Comments

This paper proved accessible to the vast majority of the candidates with scores ranging from below ten out of seventy to full marks. There was little evidence of candidates running out of time and nearly all papers were completed in all aspects. This suggests that the candidates were well prepared for the examination and that Centres were careful to cover all the specification.

Section A was once again the most accessible part of the paper with a significant number of candidates scoring full marks.

As in previous sessions, many strong candidates produced accurate answers to arithmetical questions but gave rather woolly responses to questions requiring descriptive responses. Candidates need to be given opportunities to discuss the physics covered in this part of the course. This will help them describe concepts with clarity and brevity – a skill that is tested at every sitting of this paper.

Comments on Individual Questions

Section A

1 It was pleasing to note that most candidates were sharp-eyed enough to choose graph (c) rather than (a) in the first part of the question.

2 Weaker candidates did not know the unit of charge and did not spot that the capacitance was given in microfarads

3 There were some signs of confusion here; a number of candidates gave the same ratio for both (a) and (b). Part (c) was very clearly answered by a significant proportion showing that many Centres are discussing the concept of cosmological redshift in some detail. However, the link between expansion and wavelength increase was not always made with sufficient clarity for the candidate to obtain the mark.

4 This question was omitted by a small proportion of the candidates – the only question in the paper where this happened. Those who attempted the question usually gained the marks though sometimes the path through the derivation was somewhat tortuous. This may be an area that some Centres need to focus on a little more.

5 This question was answered well – candidates are learning the required formulae.

6 A simple calculation that did not cause difficulty for any but the weakest candidates.

7 This was slightly more testing as a rearrangement of an equation involving a square root was required. This proved difficult for weaker candidates but, as expected, middle ranking candidates found little problem here.

Section B

8 This question was about the distribution of molecular speeds in a gas. It was a new context and the responses of the candidates showed that the majority were secure enough in their understanding of Chapter 13 to produce good answers.

8a The major cause of difficulty with this simple piece of algebra was a confusion between equality and proportionality. This may have been due to lack of care rather than misunderstanding.

8b This reasonably standard test and evaluation was well worked by most candidates but the weakest simply ignored the question or tried a number of spurious tests. Some candidates missed the fourth mark through not linking their conclusion to the results of the test.

8c There were a lot of good answers here although some candidates wrote of gas molecules of different masses – showing that they had not read the stem of the question.

8d This straightforward calculation caused few difficulties.

9 This question was about the gravitational field around an asteroid. Although it was generally well answered it is clear that this is an area of the course that is conceptually difficult. Many candidates managed to scrape marks but relatively few gave really convincing answers to a standard question.

9 a & b This was a simple test of knowledge and the majority of the candidates possessed the required knowledge. However, it was disappointing that many drew the field line in part (a) without an arrow showing direction and that although many recalled (-) GM/r^2 this was often confused with force (F) or potential (V).

9c The arithmetical sections of this part were answered well but a disappointing number of candidates still consider centripetal force to be outward-acting and hence wrote of the weight of the vehicle 'overcoming' the centripetal force. This concept may need greater emphasis in teaching.

10 This question presented candidates with another novel context, this time concerning the behaviour of a liquid using ideas covered in Chapter 14.

10 a & b These straightforward calculations caused few difficulties.

10c Candidates are getting good at evaluating the Boltzmann factor. Some lost marks by not making the comparison between their calculated answer and the given answer of 1/40 sufficiently clear.

10d Again, better candidates showed a good understanding of the Boltzmann factor or made an explicit link with probability. Weaker candidates merely restated the stem of the question.

10 e This part proved discriminating. Many candidates failed to gain two marks in part (ii) because they talked about 'the water' rather than 'water molecules'.

11 This question about radioactive decay included standard concepts that have been examined before but also used a ln graph to show decay. This is the first time such a representation has been used in this Unit.

11a Whilst many candidates recognised that activity is given by dN/dt the clarity of responses often left much to be desired. This is another example of candidates finding difficulty in putting concepts into words.

11b This standard calculation was well answered.

11c The answers to parts (i) and (iii) were very encouraging. Many candidates recognised that the time elapsed until ln N falls by ln 2 is the half life and described this clearly. Others followed the more pedestrian route given on the mark scheme. Still others used the gradient to evaluate the decay constant. Those candidates who scored on part (i) usually gained marks on part (iii)

11d This was a good discriminator. Weak candidates simply commented on the identity of the times. Good candidates recognised that the age of the Earth led to 50% of the initial uranium having decayed, leading to a 1:1 ratio. Very few considered that rocks must be younger than the Earth.

2863/02: Practical Investigation

There were approximately 2800 candidates from 300 Centres entered for the coursework component in the June session. A significant number of these entries were candidates from Centres that had been moderated in January 2005. Where this is the case candidates retaking the written paper 2863/01 in June do not need to have their coursework sent for moderation again. Registering such candidates as option B on the June entry form carries the coursework marks of candidates previously entered in January forward.

This session has seen a further rise in the number of Centres that have had their marks changed by the moderating teams. Sadly most have been moderated downwards and it is worth highlighting here why this is often the case. The assessment strands A & B (Initiative, Independence and the Use of Physics) assess the unique features of the Advancing Physics practical investigation. Here without the artificial confines of an examination or the straitjacket of a prescribed task, candidates are invited to demonstrate their practical skills and understanding of physics by undertaking independent investigative work in a topic of their choosing. For many of the Centres moderated downwards the reason is that the work sampled is not at the A2 level. This is not principally a matter of topic choice; I am firmly of the belief that any topic is suitable provided the candidate is able to show appropriate development. For example the resistivity of a material in the form of a wire is a topic often used as one of the AS coursework components, either for the “Instrumentation” or “Making sense of data” task. Frequently A2 Moderators find the same treatment and range of work presented as an A2 investigation. Perhaps the claimed extension is the determination of the resistivity of several different materials e.g. iron, copper, nickel etc. This is essentially one experiment showing no development. The data is harvested for no apparent purpose and the challenge of the task has not moved on from the AS level. Suitable development could be investigating, quantifying and accounting for the increase in resistivity with temperature. Copper has a 40% increase between 0 and 100^{o}C whilst iron and nickel almost double their resistivity over the same range. Alternatively the resistivity of copper is known to be increased by cold working; the questions are “why?” and “by how much?”. On the associated topic of resistance, what about the resistance of a common house brick? A colleague set this as an experimental design exercise recently. The resistance across the end faces is high, varies with temperature and something quite dramatic happens if the applied voltage is high enough. The resistance cannot be found simply by using a multimeter so some development of experimental technique is required; a Google search will unearth the concatenated ideas of his students, a reasonable starting point. Finally resistance measurements can be brought firmly into the twenty first century with quantum tunnelling pills. Not from the latest Harry Potter book but Maplin at £1.99 for three; worth investigating.

Moderators find that the work from Centres that are eventually moderated downwards is often “thin”. Perhaps as a consequence of what has been discussed above there is not much to show for ten hours of practical work and ten hours on other aspects (reference *OCR Physics B Teacher support : Coursework guidance*). Many candidates presenting this type of work show limited planning skills and often launch off into a line of investigation without any clear aim. They then come up against some difficulty and change direction. For example in an investigation entitled “Viscosity” a candidate may start off using water as the fluid in a falling sphere viscometer arrangement and finds that the (only ?) ball bearing falls too fast so a wall paper paste mix is used but either the candidate or the light gates can’t see the ball and that approach is abandoned. After several sessions the candidate hits on the idea of using engine oil, takes a set of readings and writes up the findings. This cannot be described as “development of experimental technique” or “overcoming difficulties” and should not be credited as such in Strand B. Often the better investigations have a title that poses a question. This helps candidates focus their ideas at the outset. Continuing the theme here a suitably challenging title might be: “What is the terminal velocity of pollen particles in air?”. How a candidate goes about measuring this velocity would be almost as interesting a challenge as the topic itself.

Assessment strands C and D have much in common with other physics syllabuses and aim to assess the basic tools of the trade in Communication, Evaluation and Conclusions. Many Centres that have been moderated downwards appear to reward candidates who show little understanding of these basic tools. The fact that candidates are not under exam conditions means that access to the higher ratings should be limited to those who use correct headings for tables including both quantity and unit. Significant figures should be under control and not at the whim of Mr Gates' software. Similarly graphs should be of a size sufficient to convince the reader that the claimed trend line is consistent with the plotted points. There should be both horizontal and vertical grid lines so that the accuracy of plotted points can be checked. Candidates frequently misinterpret the evaluation Strand D as an opportunity to wax lyrical about what went wrong and how the experiment could be improved. This is not what is required and candidates should concentrate on the analysis of their results to reveal the underlying relationships. Failure to do this debases what merit the experimental work may have had and this should be reflected in the ratings given in strand D.

Fortunately it is still the case that the majority of Centres do make assessments of their candidates' work in line with the agreed standards. These standards are revisited every year when the moderating teams assemble at the standardisation meeting. It is also reassuring to see that some candidates produce work of amazing intensity. Like beacons in the night these young navigators looked for knowledge not in books but in things themselves (after William Gilbert in *De Magnete*).

2864/01: Field and Particle Pictures

General comments

This paper's performance was broadly in line with that of previous years, providing good discrimination, yet also allowing weaker candidates the chance to show what they could do. It was good to see that even weak candidates could have a go at every question, even if they didn't earn the marks. As always, they tackle "show that" calculations on a trial-and-error basis, often stumbling upon combinations of numbers which deliver the correct answer but for the wrong reason. In previous years weak candidates' over-reliance on the Data Sheet to supply formulae has often resulted in them losing marks. This year was no exception. One wonders how much better these candidates would have performed if they had to rely on their memory instead.

Last-minute adjustments to the paper introduced an error in one of the section B questions. Fortunately, candidates either ignored it completely or pointed out the error and carried on regardless. The mark scheme was adjusted so that candidates who followed either route could earn full marks.

The comments below should be read in conjunction with the mark scheme. Most of the comments are about the failures of some candidates to earn marks. This can make for depressing reading as it fails to give due praise to the achievements of the many candidates who made few mistakes and were able to demonstrate an excellent understanding of physics.

Comments on Individual Questions

Section A

The questions in this section are intended to be generally straightforward and present no real difficulty to most candidates. Unfortunately a number of questions proved to more difficult than intended. Candidates had significant difficulty with four questions on basic physics, suggesting serious weaknesses in their understanding.

1 A surprising number of candidates selected J C^{-1} as the unit of electric field strength.

2 Weak candidates often had their arrow pointing to the right instead of from the centre of the nucleus. Too many candidates lost the mark through careless drawing of their arrow so that it didn't appear to pass through the centre of the nucleus. The calculation proved to be problematic for many candidates. Many used the formula for potential instead of force (probably because only the former is supplied in the Data Sheet). Others used 1/k instead of k, possibly because they had been taught to use $1/4\pi\varepsilon_0$ in similar calculations. Weak candidates often omitted to use the information about the proton numbers of the two particles.

3 It was good to see that many candidates can now sketch good sine curves. There was a lot of evidence that candidates were putting important points on the graph before sketching their curve. However, many candidates were unable to measure a gradient accurately, often failing to take account of the units on the axes. The many candidates who failed to use the 75 turns of wire in their calculation but still managed to obtain the required answer of 10 V, earned no marks for their efforts.

4 Although weak candidates often opted for the idea that a stable nucleus always contains more neutrons than protons (forgetting about hydrogen and helium), the majority of candidates knew that the emission of a gamma photon always results in a loss of mass for a nucleus.

5 The majority of candidates could do good sketches of the field lines and draw the arrows in the correct direction. Candidates who didn't use a ruler or who were careless often lost a mark for lack of symmetry. Weak candidates often drew equipotentials instead.

6 Amazingly, very few candidates were able to state that electric potential was about energy per unit charge. Some tried to define it in terms of the equation $V = kQ/r$. Others talked about force instead of energy, but the idea of anything per coulomb was rare indeed. Perhaps centres should pay more attention to ensuring that their candidates understand the precise meaning of the symbols in equations. It is a sobering thought that most candidates could have used the given formula to calculate a value for the potential without any real understanding of what it meant.

7 Weak candidates who worked backwards from the answer gave themselves away by stating that the units of force were Ns. It was often difficult to follow candidates' working when they failed to follow the left-to-right convention.

8 Many candidates correctly identified charge as the answer.

9 For a change, this question proved to be easier than expected, with many candidates picking up at least two of the three marks. As always, some candidates managed to lose the energy conservation mark through careless drawing.

Section B

The four questions in this section are each set in a different context. Good candidates are able to keep the context in mind as they work through the questions, following the story and are able to relate each new part to their answers of previous parts. Weak candidates are clearly unable to do this and often treat each part of a question independently of the others, losing marks heavily along the way. Perhaps they answer too many one-part questions as they follow the course?

10 There is always a question about the physics of a device, such as a motor, transformer or generator which relies on magnetism for its operation. As always, a significant minority of candidates fail to read the question clearly enough and get very confused. At least this year, no candidates thought that the motor was a generator! However, too many candidates assumed that the central core rotated inside a fixed outer magnet, despite the labels on the diagram, and labelled the poles incorrectly. Some even had one pole on the horizontal section and the other on the vertical section of the core. Weak candidates often spotted that the peak current in the coils (125 mA) divided by the time of the first peak (5 ms) gave an answer of 25, the answer required for the speed of the cylinder! As expected, only the best candidates were able to suggest and explain why increasing the frequency of the pulses would speed up the motor. However, the vast majority of candidates earned full marks for a modification of the motor which would increase its force.

11 Having correctly identified the particle X as a helium nucleus and established that the mass of a hafnium-178 nucleus is 3.0×10^{-25} kg, most candidates who spotted the error in the next question carried on confidently. Since the error occurred in a "show that" question, many weak candidates seem to have not noticed it at all. The next part required candidates to do a three step calculation to show that a photon with a wavelength of 6.2×10^{-11} m has an energy of 0.020 MeV. Too many candidates lost marks by failing to show each step clearly or demonstrate that they had actually carried out the calculation. Only the best candidates earned both marks for the final parts of the question, with many weak candidates clearly thinking that the question was about energy levels in an atom instead of a nucleus.

12 This question was probably the hardest one, although most candidates were able to write an answer, albeit an incorrect one, for each part. Poor layout of their answer often made it difficult for weak candidates to earn all of the marks for the first two parts. Working from right-to-left or top-to-bottom can be confusing for the reader. Too many candidates assumed that *E* was measured in GeV rather than J and obtained, without comment, a ridiculously high flux density of 3.1×10^{18} T. It was distressing to see how many candidates placed the mass and charge numbers in the wrong places, and even used the symbol p instead of e for a positron, in their completion of the equation for the decay of the ${}^{0}_{0}Z$ particle. As expected, only a minority of candidates realised that the rest energy of the $^{0}_{0}Z$ particle could be determined by measuring the kinetic energies of the positron and electron and adding them together.

13 It was good to find that most candidates seemed able to keep the context of this question straight in their minds as they worked through it. Although all of them could use the given formula to calculate the intensity of gamma rays, only a minority of candidates earned both marks for explaining how it changed with distance from the source. A worrying number tried to use the given formula as an explanation. Most candidates realised that 1.2 m of concrete was 30 half-thicknesses and knew how to use this to calculate the intensity on the far side of the wall. Candidates who tried to use $I = I_0 e^{-\mu x}$ were often less successful. Many candidates were unable to calculate the energy absorbed by each worker in an 8 hour day, often missing out the area of the worker or failing to convert hours into seconds correctly. Perhaps they were getting tired and careless by now.

The quality of language in Section B was usually tolerable, with most candidates earning three of the four marks. Answers with high quality of language were disappointingly rare.

2864/02: Research Report

In May 2005 over 400 Centres returned the marks of nearly 5000 candidates for this synoptic component of the A2 course. Most Centres were able to meet the 15th May deadline, some comfortably and most now appreciate the need to send all of the scripts when the number of candidates is small. With entries up to about 15 it makes sense to submit the whole sample without waiting for the request from the moderator as this avoids any unnecessary delay. There was an impressively wide range of topics submitted for scrutiny and the best Centres seem to be actively seeking diversity when approving report titles rather than encouraging safety first. The majority of Centres now seem to understand this component well and are able to explain the criteria for favourable assessment to their students.

One worrying trend was the increased number of centres who had failed to spot substantial plagiarism in some of their candidates' reports. The task of compiling a 3000 – 4000 word essay is daunting for many Physics candidates and some look to cut corners using published web site material in a rather unintelligent way. Cutting and pasting substantial chunks of source text without any editing or proper attribution is totally unacceptable for this assignment and runs contrary to the spirit of the course. The use of internet sources is of course perfectly acceptable and some sites offer first rate material on cutting edge topics that simply isn't available elsewhere. The care and expertise employed in any subsequent reworking of this material is what often makes the difference between the candidates scoring highly and simply paying lip service to the whole process. It is imperative from the Centres perspective that any plagiarism detected or suspected is identified and accounted for during assessment. It should be obvious to the student's teacher in some cases that the complexity of language employed is not likely to be their own and should cause alarm bells to ring. The Centre ignoring these signs risks at best, all candidates being downgraded as the moderator tries to make the appropriate adjustments or at worst, a complete remark of every script! On far too many occasions in this session Centres had to be asked to reconsider the marks awarded for a substantial number of the sample scripts submitted for moderation. Moderators are instructed only to return work to Centres when the rank order submitted is compromised by such issues and where these issues cannot be addressed by a suitable mark range adjustment. A large number of Centres now insist that all of their students print out the source material used in order to allow them to check for plagiarism. This blanket insistence helps centres alleviate suspicion about the work submitted by individual candidates where doubts may exist.

The skill of referencing the sources used adequately and evaluating their contribution to the report is still one that eludes all but the best candidates. The best accomplish this most effectively by recording important details about their sources as they are identified during the research phase. There was evidence that some candidates add bibliographies after they have written their reports which results in bibliographies of dubious integrity. Candidates in this category would undoubtedly benefit from being shown a suitable referencing technique in advance as this is not something they will know how to do automatically.

The need to embed the work in a wider context is now well understood with candidates including a good range of historical, social, economic and some more philosophical background material. The choice of topic and the formulation of the title can certainly ensure that this criterion is not ignored. Physics of suitable depth and relevance can also prove elusive in the work of candidates at the bottom end of the mark range but there is plenty of impressive material on show at the top.

By far the strongest criterion for most candidates remains the Communication section. Candidates who have successfully completed Research Presentation, Instrumentation Tasks and Data Analysis in the AS course are well versed in the need to layout their work in a logical order. The inclusion of relevant diagrams, charts, tables and other graphical devices all well integrated into the commentary was the hallmark of the best work. Virtually every report submitted for this assessment is now word processed and Centres should rightly be proud of the impressive quality of the material they elicit from their students.

2865: Advances in Physics

General Comments

It was pleasing again, this year, to note that most candidates had been prepared for the questions based on the Advance Notice Article. Fewer candidates gave the impression of having been rushed for time to complete the paper. Once again, extended answers in continuous prose (or equivalent: bullet-pointed lists are often as good or better) proved demanding for many, so that marks were lost due to lack of clarity in explanations. Questions 2 and 3 employed novel approaches to test understanding of concepts or algebraic skills, and these parts proved very taxing for most candidates.

Comments on Individual Questions

Section A

Question 1 (Modelling circuits)

This was mostly well done, but the final part, the magnetic circuit modelled on an electrical circuit, was correctly answered by very few.

Question 2 (Titius-Bode and Kepler's Laws)

Showing that the Titius-Bode prediction for the mean orbital radius of Saturn was close to the measured value was well done, but few candidates were clear and fluent in explaining the difficulty of an algebraic fit for Mercury. Many candidates, in part (c), did not use the 'new' orbital data given to explain the initial support but eventual demise of Titius-Bode, but did get some credit for extracting 'no theoretical basis' from the article. Few candidates were successful in identifying the algebraic expressions for gravitational field strength and centripetal acceleration from a fully worked traditional algebraic derivation; this could well have been due to the novelty of the approach in this question.

Question 3 (Nuclear model of the atom)

In part (a), most candidates correctly identified the alpha scattering as explicable only by Rutherford's model, but very few realized that both models of the atom could explain photoelectric effect. The calculation of the closest approach of an alpha-particle to a gold nucleus, lacking the prop of structuring, provided a range of possible errors: use of an incorrect charge for either or both of the particles; use of an incorrect equation (such as invoking inverse-square, or using the potential equation without a second charge); and omitting to use the energy in J rather than MeV. Better candidates were noticeable by their ability to steer clear of these pitfalls in getting the solution to this standard calculation.

Question 4 (Iterative model for nuclear decay)

Most candidates could identify the symbols in the modeling equation $\Delta N = -\lambda N \times \Delta t$ and explain the consequences of changing it to $\Delta N = +\lambda N \times \Delta t$ **,** although the terms 'particles', 'atoms' and 'molecules' were often used indiscriminately instead of 'nuclei'. Many of the sketched exponential curves were not accurate enough to gain full credit: a common (and inexplicable) error was that, instead of doubling the half-life, candidates drew a curve to bisect the space between the curve given and the top of the graph grid. Part (c), modelling parent-daughter decay, was done well by better candidates.

Question 5 (Iconic [Worldmaker] model for nuclear decay)

This proved difficult for many candidates, who did not appreciate that the nature of random variation in a small sample will invariably produce very different results in different 'runs' of a model. Explaining in continuous prose how the resultant graph differed from that expected (and indeed, found in the previous question) was done well by the best candidates only.

Question 8 (Weather forecasting)

This question was the least well done in the paper. Many candidates could suggest two suitable physical quantities describing the atmosphere – temperature, pressure and humidity were the most popular – but had difficulty in suggesting how one of these might be measured in practice at different heights. Where the variable chosen was 'incoming or outgoing radiation' (taken from the article) it was not unusual to see a Geiger counter suggested as a measuring instrument. Good answers to the last part of the question, about the inaccuracy of long range forecasts, either in terms of the compounding of errors over successive stages of modelling or of the position of Britain giving rise to greater and faster variability, were rare.

Question 7 (Modelling the atmosphere)

The diagram in this question, taken from the article, distracted many candidates with the detail of the different layers of the atmosphere used in the model. As a consequence, only a minority used the data on the axes to explain that, as pressure decreased with altitude, density would necessarily also become less. Tests for exponential dependence of pressure on altitude were often mistaken or very vague ('Draw a graph and see if it looks exponential' ….. followed by a rough sketch … was a typical answer from weaker candidates).

Section B

Question 8 (TV electron beams)

Most candidates successfully answered this question although a significant number failed to draw field lines on the diagram in part (a). Only the best candidates correctly calculated the number of photons produced per electron and rounded the answer to an appropriate number of significant figures: answers simply finding the ratio of the frequencies in (a) parts (iii) and (iv) did not gain full marks unless the reasoning was clear, which it rarely was. Only very good candidates gave clear explanation of the force on the television screen in terms of rate of change of momentum of rebounding air molecules.

Question 9 (Mobile phones)

Despite being the last question in the paper, this was well done by most candidates, although few gave any indication that the miniscule rate of rise of temperature of the brain of about 0.5 mK s^{-1} would not in fact take place for reasons of homeostasis; full credit was given for the commoner answers that the skull would absorb some of the microwaves or that the brain, being less than 100% water, would have a specific heat capacity different from 4200 J kg^{-1} K^{-1}. Few candidates were aware why absorption of gamma radiation (a lethal dose of 1 Sv) was different from absorbed microwaves: weaker candidates seemed unclear of any distinction between the two types of radiation.

Advanced Subsidiary GCE Physics B (Advancing Physics) (3888)
June 2005 Assessment Session

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2860	Raw	90	66	58	51	44	37	0
	UMS	100	80	70	60	50	40	0
2861	Raw	90	65	57	50	43	36	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

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

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

	A	B	C	D	E	U	Total Number of Candidates
3888	24.1	43.8	63.2	79.6	91.5	100.0	6742

Advanced Subsidiary GCE Physics B (Advancing Physics) (7888)
June 2005 Assessment Session

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2863A	Raw	127	103	92	81	70	59	0
	UMS	100	80	70	60	50	40	0
2863B	Raw	127	103	92	81	70	59	0
	UMS	110	88	77	66	55	44	0
2864A	Raw	119	91	80	69	59	49	0
	UMS	110	88	77	66	55	44	0
2864B	Raw	119	91	80	69	59	49	0
	UMS	110	88	77	66	55	44	0
2865	Raw	90	64	58	52	47	42	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
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
7888	30.7	52.4	71.6	87.6	97.2	100.0	5108

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