RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced GCE **A2 7888**

Advanced Subsidiary GCE **AS 3888**

Mark Scheme for the Units

June 2009

3888/7888/MS/R/09

Oxford Cambridge and RSA Examinations

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

MARK SCHEMES FOR THE UNITS

2860 Physics in Action

Section A

Question Number			Expected Answers	Marks	Additional Guidance
1			kg m^{-3} **(1)** N m^{-2} **(1)** N m^{-2} **(1)**	3	**not** alternative equivalent units Pa for density / Young mod. **do not allow** ↔ double headed arrows to swap posn.
2		a	= c / n / 3.0×10^8 / 1.5 **(1)** = 2.0×10^8 **(1)**	2	method symbols / numbers ; evaluation **allow** 2 marks for correct evaluation without method
		b	smallest angle of incidence	1	**allow** AW **-** must have idea of smallest **not** angle i incorrectly identified between boundary and ray scores 0/2
			for (which light is) totally internally reflected	1	**accept** <u>t.i.r.</u> abbreviation **allow** full credit for clear annotated diagrams **accept** clear description / diagram with angle of refraction at 90^o and correctly identified angle of incidence for 2 marks **MAX 1** for diagrams with gross critical angle unless “smallest” angle specified **accept** just C = $\sin^{-1}$ (1/n) for 1 mark
3			B **(1)** D **(1)** C **(1)**	3	**do not allow** ↔ double headed arrows to swap posn.
4			Identification of T between 1.25ms and 1.35ms	1	method
			770 ± 30 **(1)** Hz **(1)**	2	evaluation **allow** ecf from (a) **not** hz or HZ or hZ **not** waves per second / cycles per second **credit** 3/3 if for correct response even if no method shown

Section A

Question Number			Expected Answers	Marks	Additional Guidance
5	**a**		(metals contain) free electrons (which carry charge)	1	**not** just metallic bonding **accept** delocalised electrons
	b		(density) of free electrons is much lower (than for metals)	1	**must** have idea of "free" **accept** fewer free electrons / charge carriers **not** ions
	c		(density) of free electrons increases with temperature	1	**must** have idea of "free" **accept** more free electrons / charge carriers **allow** ions only as ecf from (b)
6			(polarising filters for each eye) must be crossed / at 90°	1	**allow** clear AW throughout
			(filters) must be parallel to the polarisation of projectors / lined up in same polarisation planes as projected light	1	**accept** clear annotated diagram for either/both marks **not** so each eye sees only one image
7	**a**		(1.20 / 0.15) = 8	1	evaluation **accept** bare answer for the mark
	b		(2.4 / 8) = 0.30 (m) ecf on (a)	1	evaluation **accept** bare answer for the mark **accept** 0.3 (m)
			Total: Section A	**20**	

Section B

Question Number			Expected Answers	Marks	Additional Guidance
8	a		$A = \pi r^2 = \pi(19 \times 10^{-6})^2 = 1.1(3) \times 10^{-9}$ (m^2)	1	part method & evaluation if completed separately
			$R = \rho L/A$ / $R = (1.10 \times 10^{-7} \times 0.100)/1.13 \times 10^{-9}$	1	method in symbols / numbers **allow** ecf on incorrect area – must be substituted correctly
			= 9.7 Ω (≈ 10 Ω)	1	only credit for R between 5Ω and 15Ω 9.7 with no method scores zero – answer given in part (b)
	b		sensible scaling of temperature axis	1	**not** using less than ½ available graph squares for plotted points axis must include zero
			correct <u>straight</u> line drawn through 0,9.7 and 100,13.5	1	**allow** ecf on inappropriate scale if their graph is correct **not** freehand graphs – must look like a ruled line **allow** plot points within half a square
	c	(i)	11.4 (Ω) from graph	1	**allow** ecf from b
	c	(ii)	sensitivity = $\Delta R / \Delta T$ / gradient / 3.8 /100	1	must have ΔR to score first mark **allow** ecf on graph from b
			= 0.038 **(1)** Ω °C^{-1} **(1)**	2	**accept** 0.04 **allow** full credit for 0.038 without working shown unit is standalone mark
	d		ΔT = ΔR / sensitivity / = 0.05 / 0.038	1	method in symbols / words / numbers **allow** ecf from c(ii)
			= ± 1.3 (°C)	1	evaluation **accept** if answer rounded to ± 1 °C **accept** ± 1.32 °C MAX 1 for alternative methods involving estimates from graph as long as between ± 1°C and ± 2 °C
			Total Question 8	**11**	

Section B

Question Number			Expected Answers	Marks	Additional Guidance
9	a	(i)	gradient of the graph is not constant / graph curves	1	**allow** slope changes
	a	(ii)	(≈) 1.1 MPa / 0.2 = 5.5 MPa	1 1	method – must be working in the region below 0.5 strain **allow** use of loading or unloading curve evaluation must have x10^6 or Mega **allow** values between 4 and 6 MPa from correct values for loading curve **allow** values between 2.5 and 6 MPa if unloading curve chosen
	b		(initial stiffness) decreases then increases again (as stress increases), then (on unloading) it (increases,) decreases then increases	1 1	AW credit any other correct statement about stiffness – must be clear which part of graph **not** just stiffness changes **allow** AW or more detailed explanation **allow** other valid comparisons of loading / unloading stiffness
	c	(i)	(σ x ε) = $F\,x\,/\,(A\,L)$ = work done or energy per volume	1 1	**must** get this far for first mark in words / symbols / dimensions **must** recognise that Force x extension = work done for 2nd mark **not** Nm = J
	c	(ii)	represents the energy per <u>unit</u> volume that the rubber dissipates (in one loading-unloading cycle)	1	**accept** heat produced / energy lost per <u>unit</u> volume (per cycle **accept** per m^3 as AW for per unit volume **not** just energy lost / energy lost per cycle **not** just Jm^{-3}
	c	(iii)	(counting graph squares) ≈ 5 (±1) / 0.5 x 0.5x10^6 / =2.5 x 10^5 (J m^{-3} per square) = 1.3 x 10^6 J m^{-3}	1 1	allow other method of area estimate for first mark **accept** 1 MJ m^{-3} or values in range 1.0 to 1.5 x 10^6 J m^{-3}
			Total Question 9:	**10**	

Section B

Question Number			Expected Answers	Marks	Additional Guidance
10	**a**	**(i)**	$N = I / e$ / $= 2 \times 10^{-9} / (1.6 \times 10^{-19})$ $= 1.3 \times 10^{10}$ (s^{-1})	1 1	method in words / symbols / numbers evaluation **allow** 1.25×10^{10}
	a	**(ii)**	(current) gets larger as *V* increases	1	**must** include correct direction of change in V **not** implication that p.d. is dependent on current
	b	**(i)**	to spread large range of (current) values	1	AW must have idea of spread, not just range **not** to fit the points in or AW
	b	**(ii)**	correct linear vertical scale exponential decay type through $(2, 10^5)$ **and** { $(3, 10^4)$ **or** sensibly asymptotic to x-axis}	1 1	**accept** only one further correct scaling point eg 50 000 / 25000 **not** any incorrect scaling point if multiple points indicated
	c		resolution = distance / linear no. pixels / 2 nm / 150 $= 1.3 (\pm 0.1) \times 10^{-11}$ m $pixel^{-1}$	1 1 1	method in words / numbers AW evaluation **allow** 1×10^{-11} units **allow** 0.013 nm $pixel^{-1}$
			Total Question 10:	**9**	

Section B

Question Number			Expected Answers	Marks	Additional Guidance
11	a		230 / 46 = (5.0 V)	1	method
	b	(i)	(power = 5 x 0.25) = 1.25 (W)	1	evaluation **accept** 1.3 (W) **not** any other value **-** i.e. misread value from graph
	b	(ii)	(R = *V* / I) = 5 / 0.25 / ($R=V^2 / P$) = $5^2 / 1.25$ / ($R = P / I^2$) = $1.25 / 0.25^2$ = 20 (Ω)	1 1	method evaluation **accept** ecf on current from bi and answers correct to 3 SF
	c	(i)	If one filament blows remaining lamps stay on / damaged one can be replaced / (safer) less *V* at gap	1	AW **allow** other sensible answers
	c	(ii)	each bulb 1/*R* = 1/20 + 1/60 gives *R* = 15 Ω each / total *R* = 15 x 46 = 690 Ω (*I* = 230 / 690 / = 5 / 15) = 0.33 (A)	1 1 1	**substitution allow** other methods **allow** ecf on incorrect R_{lamp} value from b(ii) part evaluation final evaluation **allow** ecf on incorrect *R* values giving *I* < 3 A
	c	(iii)	brightness dims (slightly) (a parallel path is removed) so resistance (in this position) rises and (circuit) current drops	1 1	 **accept** p.d. across this holder rises so p.d. across all other lamps decreases (slightly) **accept** correct full numerical justification
	d		brightness rises because: resistance at this position rises (from 15 to 20 Ω) so voltage across lamp increases / no longer a parallel resistor to take some of the current	 1	no mark but must be stated must have rises, and some justification linking *R* to increase in *V* or *I* **accept** AW or any correct explanation
			Total Question 11:	**11**	
			Total Section B:	**41**	

Section C

Question Number			Expected Answers	Marks	Additional Guidance
12	a	(i)	image choice: e.g. satellite radar of sea surface e.g. microwave e.g. 10 GHz (appropriate) e.g. 0.03 m ($\lambda = v / f$)	0 1 1 1	**any** useful image sets context to be followed **no mark** radiation named must be appropriate to image estimates must be within an order of magnitude of limits of range for that radiation and include units **allow** for SEM / STEM e.g. for 10 kV electrons $f\ (= E_{kinetic} / h) \approx 10^{18}$ Hz or wider energy values $\lambda\ (= h / mv) \approx 10^{-11}$ m
	a	(ii)	usefulness of image info mark 1/2/3 style e.g. radar gives sea height and info about wave height speed and length, useful for warning shipping of dangerous sea conditions and saving lives	3	usefulness must be explicit and non-trivial **not** to remind me of my favourite pet
	b		1/2/3 style e.g. detector is a parabolic reflector on satellite which focuses reflected microwave pulses onto a receiving aerial or diode to detect return pulses which are amplified for measurement of amplitude and or time of flight. These values can be converted to greyscale or pixel values on a scale typically from 0 to 255	3	**not** credit for image processing techniques omission of either gathering/focussing or conversion to values scores 2 MAX **expect** a clear annotated diagram for full marks must be consistent with example in (a)
	c		image process named e.g. edge detection quality description of process: e.g.. edge detection works by replacing each pixel with 4x its original value (x 4) minus NSEW surrounding pixels. purpose: e.g. could be used to look for details such as wavelengths or the outlines of super tankers for position monitoring	1 1 1	credit best process if more than one given image process method clear, must include reference to each pixel. **not** mean / average for noise removal benefit explained in clear detail
			Total Question 12:	**12**	

Section C

Question Number			Expected Answers	Marks	Additional Guidance
13	**a**	**(i)**	e.g. optic fibre cable connection for home communication / telephone / t.v. / internet	1	need **two** descriptors for one mark to set context **allow** email / text / image / voice / fax / fibre optic / radio / tv / mobile phone etc. **accept** analogue / digital information **not** just waves / electromagnetic / light / sound / data or other vague responses
	a	**(ii)**	e.g. 100 Mbit s^{-1}	1 1	estimate to an order of magnitude of the limit of a sensible bandwidth ; unit **no** credit for number without unit
	b	**(i)**	(sampling) regular / periodic measurement of signal (digitising) to nearest level added quality in words / sketch graphs e.g. ascribing binary values for each sample as 000 001 010 etc. on y-axis	1 1 1	**allow** words or regular intervals by eye on time axis of diagram **allow** words or diagram third mark for **quality** **not** just turns signal into 0/1's

Question Number	Expected Answers	Marks	Additional Guidance
b(ii)	two examples: mark both 1/2/3 style e.g. 1. sampling rate / frequency too low so missing higher frequency variations / introducing spurious lower frequencies / aliasing 2. insufficient binary levels / lack of resolution / too few levels / with too few bits per sample and approximating information / introducing digitisation errors / noise corruption during the digitisation third marks for **quality** description / diagram illustrating the nature of the errors / how they are introduced in each case	 3 3	**allow** full credit from well annotated diagrams **not** just fewer samples **expect** additional quality explanation/diagram e.g. sampling $f < 2 \times f_{max}$ causes high f loss or discussion of Nyquist criterion for full marks **expect** additional quality explanation/diagram for full marks e.g. quantisation error introduced by sampling labelled / 2^{bits} = levels etc **accept** noise from voltage spike during digitising **not** noise / attenuation during transmission
c	e.g. the coherence time for the cable, so that individual signal bits do not spread and overlap with adjacent bits / 1 /(response time of photodiode) sets upper limit on bit rate	1	**expect** non-trivial physics based answers **not** just noise in the system **not** answers which reduce amount of information sent
	Total Question 13:	**13**	
	Quality of Written Communication	**4**	See notes on final page
	Total Section C:	**29**	

QoWC Marking quality of written communication assess section C only

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

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

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

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

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

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

OR the candidate has written nothing in section C of the paper.

2861 Understanding Processes

Qn	Expected Answers	Marks	Additional guidance
1 (a)	A ✓	1	
(b)	C ✓	1	
(c)	D ✓	1	
2(a)	$K = v^2/d$ ✓ $(m\ s^{-1})^2$ / m = m s^{-2} ✓	2	must be evidence of substitution
(b)	C	1	
3 (a)	Red Green Blue (downwards) ✓	1	
(b)	$6.6 \times 10^{-34} \times 4.3 \times 10^{14}$ ✓$_m$ = $2.8(4) \times 10^{-19}$ (J) ✓$_e$	2	
4(a)	980 ✓$_e$ (N)	1	Accept 1000
(b)	B	1	
5	$(15 \times 10^{-3}) / (2.5 \times 10^{-19})$ ✓$_{m+s}$ = 6.0×10^{16} ✓$_e$ (photons/s)	2	
6(a)	waves 'out of phase' ✓ destructive interference/amplitudes cancel ✓	2	accept path difference arguments
(b)	higher frequency or shorter λ or increase separation L_1 to L_2 or move L_1 and L_2 closer to XY ✓$_e$	1	
7	**(using** s = vt) 330 x 0.67 ✓$_m$ = 221 ✓$_e$ halving distance to get 111 m ✓$_e$	3	**SF** penalty, max 3 sig figs
8(a)	probability α (resultant phasor amplitude)^2 ✓	1	Accept prob = RPA^2
(b)	16 ✓$_e$	1	Allow ecf from (a)
	Section A total	21	

Qn	Expected Answers	Marks	Additional guidance
9(a) (i)	(**using** $s = {}^1/_2 at^2$) $3.0 = ½ \times 9.8 \times t^2$ ✓$_m$ t = 0.78 ✓$_e$ (s)	2	✓$_e$ calculator value ora
(ii)	(using v = u + at) = 9.8 x 0.78 ✓$_m$ = 7.6 ✓$_e$ (m s^{-1}) ($v^2 = 2 \times 9.8 \times 3.0$ gives v = 7.7 m s^{-1})	2	9.8x0.8 = 7.8 (m s^{-1})
(iii)	fraction of energy remaining = 0.84 per bounce ✓$_m$ 0.84^7 = 0.295 (of original remains) ✓$_e$ (so 70% gone)	2	alternative working possible
(b)(i)	(2.2 / 0.78) ✓$_m$ = 2.8 (2) (ms^{-1})	1	2.75 m s^{-1} from 0.8 s
(ii)	by Pythagoras $\sqrt{(2.8)^2 + ((a)(ii))^2}$ ✓$_m$ = **8.1** ✓$_e$ (m s^{-1}) **ecf** from (a)(ii) (tan θ = 2.8 / (a)(ii)) θ = **20°** to the vertical ✓$_e$ (or 70° to the horizontal) **ecf** from (a)(ii) by *scale drawing*: velocity = **8.0 ± 0.3** (m s^{-1}) and θ = **20° ± 3** °	3	'to vertical' or 'to horizontal' may be evident in diagram .penalise (-1) for wrong diagonal for resultant. by *scale drawing* – method mark for appropriate diagram
	total	**10**	
10 a (i)	10^{-3} (m) / 500 ✓$_m$ (= 2.0×10^{-6})	1	1/500 = **0.002 mm** ✓$_m$
(ii)	$\theta = \sin^{-1}(660 \times 10^{-9})/2.0 \times 10^{-6})$ ✓$_m$ = 19° ✓$_e$	2	19.3
(iii)	find largest n to give θ ≤ 90° : sin θ = 1 = (**n** x 6.6 x 10^{-7})/(2.0 x 10^{-6}) ✓$_m$ gives n = 3.03 ✓$_m$ so n=3 highest order ✓$_m$ OAW or for 3rd. order: sin θ = (**3** x 6.6 x 10^{-7})/(2.0 x 10^{-6}) gives θ = 82° ✓$_m$ so n=4 unlikely ✓$_m$ some explanation ✓ OAW	3	A calculation with n= 3 or 4, plus n = 4 would give θ >90° , plus physical explanation of why this cannot occur. Other algebraic approaches acceptable
(b)(i)	$\lambda_{blue} < \lambda_{red}$ ✓$_m$ $\theta_{blue} = \sin^{-1} (\lambda_{blue}/d) < \theta_{red}$ ✓$_m$ OAW (or path difference between successive slits has to be λ ....so $\theta_{blue} < \theta_{red}$.)	2	
(ii)	All colours in white light present ✓ Explanation of why all wavelengths in same place ✓	2	
	Total	**10**	

Qn	Expected Answers	Marks	Additional guidance
11 (a)(i)	600 (N) ✓e	1	
(ii)	as height decreases F increases/ or as height increases F decreases ✓	1	
(iii)	cross sectional **area presented to wind** increases as height / θ decreases ✓	1	Do not accept arguments related to force components
(b)(i)	$F/v^2 = k$ test carried out ✓m correctly on **all four** sets of data [13.8 13.7 13.6 14.0] ✓e k is constant to accuracy of data ✓	3	k = 14 = constant to 2 s.f. For third mark, conclusion consistent with results of their test
(ii)	$F \sin 60^o = 760$ ✓m $F = 878$ N ✓e (using $kv^2 = F$) $v = \sqrt{\frac{878}{14}} = 7.9$ ✓ (m s^{-1})	3	850 (from table) x cos30 gives 736N may point out that when F = 850 N wind speed is 7.9 m s^{-1} from table ✓
	Total	**9**	
12 (a)(i)	(**using** k.e.=$\frac{1}{2}mv^2$) = $\frac{1}{2}$x 1200 x $(20)^2$ ✓m = 240 000 (J)	1	
(ii)	F x 34 = 2.4 x 10^5 ✓m F = 7058 (N) ✓e (force to weight ratio =) 7058 / (1200 x 9.8) = 0.6 ✓ (QED)	3	calc a = 5.88(m s^{-2}) ✓ then F= ma = 7056 (N) ✓ etc
(b)(i)	14 (m)	1	Accept 15
(ii)	(**using** v = s/t) t = 14/20 ✓m = 0.7 (s)	1	accept 0.75 (s) ecf from (b)(i)
	(**using** $v^2 = u^2 - 2as$) a = $(20)^2$/(2 x 34) ✓m = 5.9 (m s^{-2}) ✓e	2	may have already been done in (a)(ii) ✓✓ use of 15 from (b) (i) leads to 6.06 m s^{-2}
(iii)	reaction distance **AND** braking distance longer ✓ reaction distance = 17.5 m ✓m ecf from (b)(i) stopping distance 70.6 (m) ✓m (braking distance = 53 m)	3	reaction distance = 25 x (b)(ii) **ecf** For 15m: 18.75 and 71.85 stopping
	Total	**11**	
	Section B total	**40**	

Qn	Expected Answers	Marks	Additional guidance
13 (a)	diagram is essentially correct ✓✓✓ diagram is satisfactory, but some errors/omissions ✓✓ some attempt has been made ✓ ……… labelled ✓	3/2/1 1	
(b)	sufficiently detailed statement of adjustments ✓✓ **or** statement partially adequate. some important omission ✓ how to identify existence of standing wave ✓	3	2/1/0 quality mark
(c)	representation/description of standing wave generated✓ N and A mentioned as appropriate to diagram/description ✓ different standing wave modes ✓	3	credit for other features that could be observed
(d)	progressive waves reflect ✓ idea of superposing ✓ Attempt to explain **A** and **N** in terms of interference ✓	3	
	Total	**13**	
14 (a) (b)	example of quantum behaviour stated ✓ photon / electron as appropriate to example chosen	1 1	
(c)	clear labelled diagram ✓✓✓ …with some minor omissions or errors ✓✓ …. for some attempt made ✓ sensibly **labelled** ✓	3 1	
(d)	for three separate relevant and correct items of description ✓✓✓	3	
(e)	read as a whole … up to 3 marks for relevant quantum explanations ✓✓✓ total	3 12	
	Quality of written communication	4	
	Section C total	**29**	

QoWC Marking quality of written communication

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2863/01 Rise and Fall of the Clockwork Universe

Qn	Expected Answers	Marks	Additional guidance
1	Distance = $1.1 \times 10^{17}/(3.0 \times 10^{8} \times 3.2 \times 10^{7})$ ✓ = 11.5 light years ✓ (11 ly OK)	1 1	Only accept 12 years or other value if 3.16×10^{7} or own value used
2 a b	B ✓ The rate of temperature fall <u>drops</u>/<u>decreases</u> during the minute AW✓	1 1	Accept 30 W Need concept of rate. Rate of fall is exponential is OK
3 a b	Number of atoms on one energy level is half of that of the level below AW ✓ $f = e^{-3.5 \times 10^{\wedge}-21/360 \times 1.4 \times 10^{\wedge}-23}$ ✓ = 0.499 ✓	1 2	Beware of fudge Must have working for 2 marks. 0.494 if 1.38 used. 0.50 OK, 0.49 OK if 1.38 used Accept reverse calculation
4 a	$pV = nRT$ ✓ $n = 1.1 \times 10^{-2} \times 4.1 \times 10^{-3}/8.3 \times 300 = 1.8 \times 10^{-8}$ ✓ $N = 1.8 \times 10^{-8} \times 6 \times 10^{23} = 1(.1) \times 10^{16}$ atoms ✓	3	Or use $pV = NkT$✓ $N = pV/kT$ $= 1.1 \times 10^{-2} \times 4.1 \times 10^{-3}/(1.4 \times 10^{-23} \times 300)$ ✓ $= 1 \times 10^{16}$ atoms✓
5a b	Reasonable curve✓ Clear 1/r behaviour (eg asymptotes) ✓	2	
6	Redshift (accept relativistic Doppler shift) ✓ $d = 800 \times 4.5 \times 10^{20}/1000$ ✓ $= 3.6 \times 10^{20}$ km ✓	1 2	calculating Hubble constant gets the first mark ($2.2 \times 10^{-18}\ s^{-1}$) lose one mark for power of ten error.
7	$\lambda = 300/ 6 \times 10^{19}$ ✓$= 5 \times 10^{-18}\ s^{-1}$ ✓	2	Only one mark for -5×10^{-18}
8a b	$E = ½ \times 140 \times 0.078^{2}$ ✓ = 0.43 J $v = (2 \times 0.43 \times 0.6 /0.015)^{1/2}$ ✓= 5.9 m s^{-1} ✓(5.66 up to 5.9)	1 2	1 mark if 60% omitted (range 7.3 – 7.6 m s^{-1})

Section A total:20

Qn	Expected Answers	Marks	Additional guidance
9 a(i) (ii) (iii)	On line at t = 0, 0.8,1.6 or 2.4 s ✓ a = - 9.8 x 0.1/0.6 ✓ = -1.6 m s^{-2}✓ Condition for shm is that a is proportional to – s✓ This is met by the equation as L and g are constants ✓AW Example of oscillator with correct statement of whether or not shm ✓explanation of whether or not condition for shm met. ✓	1 2 4	vertical line to point OK. Ignore sign Don't accept another pendulum
(b)	T = 1.6 s ✓ +/- 0.05s L = 9.8 x $1.6^2/4\pi^2$ ✓= 0.63 m (range 0.60 – 0.68)	2	Accept reverse calculation
(c)	a = 0.8 m s^{-2}, ✓(half of value calculated in a(ii)) v = 0.195 or 0.2 m s^{-1}, ✓ E = 0.95 x 10^{-3} J (or 1 10^{-3}) ✓	3	Accept either sign for acceleration and velocity. Negative sign for energy is incorrect.

10(a) (i) (ii)	Area (under graph) ✓ sensible method✓answer in range 8 – 10 Ns.✓	1 2	Sensible method includes crude triangle
b(i) (ii)	Units of impulse Ns = kg ms^{-2} ✓x s = kg ms^{-1} ✓ 8 kg ms^{-1} = m v ∴ v = 8/0.5 ✓= 16 m s^{-1}✓	2 2	ORA Look for own values (i.e (a)(ii) x 2) expected range 16 to 20
c	Three marks from any of the following: • Momentum before collision = 8 M, momentum after = 5M + 3M = 8M. • Showing knowledge of what conservation means • K.E. before = 32M • K.E. after = 17M Fourth mark: Energy loss in sound or other reasonable	4	
11(a)i (ii)	+0.5 ✓ Q = 1000 x 10^{-6} x 9.0✓ = 9 x 10^{-3} C. ✓	1 2	
(b)(i) (ii)	Correctly connected in parallel ✓ Half the charge has left original capacitor✓ (therefore) both capacitors have same value (as p.d. across each is the same in parallel) AW✓	1 2	Many ways to explain this. Use of total capacitance = 2000 μF is a valid method.
c(i) (ii)	I = V/R = 9/100 000 ✓= 9 x 10^{-5} A RC = 100 s. ✓After 100s I = 0.37 x 9 x 10^{-5} = 3.3 x 10^{-5} ✓	1 2	(100 kΩ OK) Need full argument Or use $I = I_o e^{-t/RC}$ M ✓E✓
12 (a) (i) (ii) (iii)	Energy per kg of an object✓ due to its position in the gravitational field /presence of another mass✓ Vg = - 6.7 x 10^{-11} x 2 x 10^{30}/1.9 x 10^{11} ✓= - 7(.1) x 10^{8}✓ -1.6 x 10^{8} – (- 7 x 10^{8}) = 5.4 x 10^{8}J/kg ✓assuming g.p.e. transferred to k.e. ✓	2 2 2	AW – accept equation with explanation of symbols for one mark. Accept 1.6 x 10^{8} x 8.6/1.9 = - 7.2 x 10^{8} J kg^{-1} Ecf from (a)(ii)
(b)(i) (ii)	Arrow pointing to centre of comet ✓ F = (-)mv^2/r ✓= 2900 x 0.15^2/25000 ✓= (-) 2.6 x 10^{-3}N✓	1 3	Use of equation can be implicit km instead of m lose one mark giving 2.6 N.
(iii) (iv)	F = (-) GMm/r^2✓ M = Fr^2/Gm ✓= 2.6 x 10^{-3} x25000^2/6.7 x 10^{-11} x 2900 ✓ =8.4 x10^{12} kg✓	1 3	Or acceptable variants Algebra can be implicit. ECF km instead of m lose one mark Power of ten error loses one mark.

QWC: 9(a)(iii), 10 (c), 12 a(i)

2864/01 Field and particle Pictures

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- Where a calculation is worth two marks, one mark is generally given for the method, and the other for the evaluation of the quantity to be calculated.
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- Where units are not provided in the question or answer line the candidate is expected to give the units used in the answer.
- Quality of written communication will be assessed where there are opportunities to write extended prose.

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

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

2 Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. Ticks should **not** be placed in the right-hand margin. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks ($^1/_2$) should never be used.

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

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

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

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

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

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

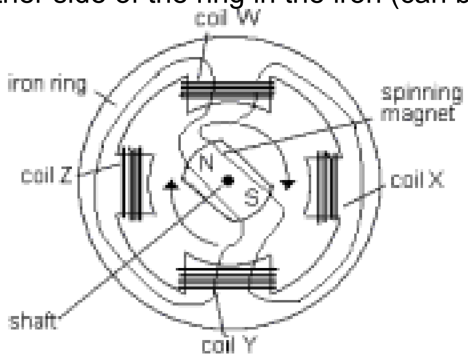
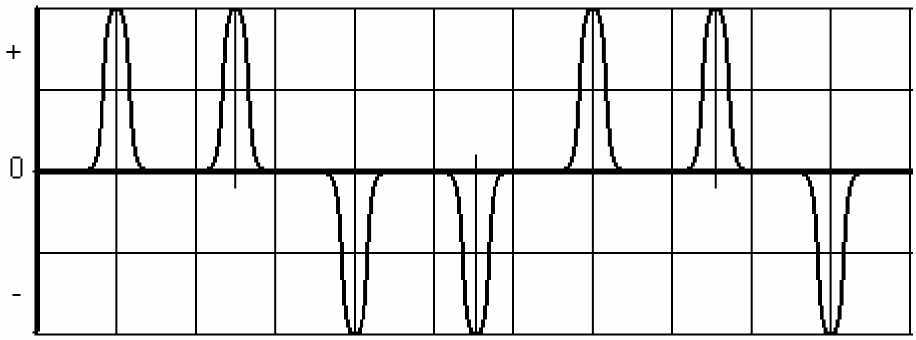
8 Strike through all blank spaces and pages to give a clear indication that the whole of the script has been considered.

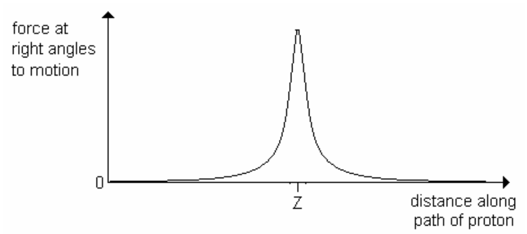
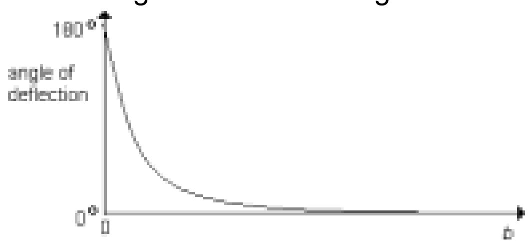
The following abbreviations and conventions are used in the mark scheme:

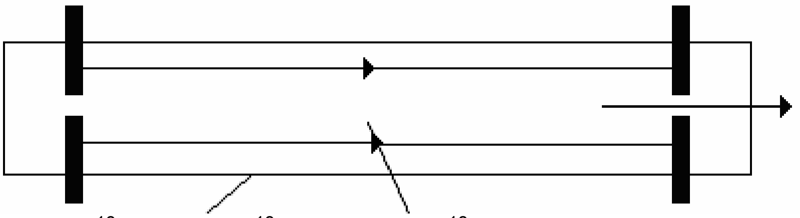
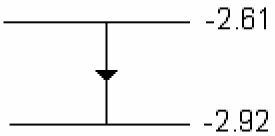
m = method mark
s = substitution mark
e = evaluation mark
/ = alternative correct answers
; = separates marking points
NOT = answers which are not worthy of credit
( ) = words which are not essential to gain credit
___ = (underlining) key words which **must** be used to gain credit
ecf = error carried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

1 a 1 b	N C^{-1} J kg^{-1}	1 1
2	emf = N$d\Phi$/dt $d\Phi = 4\times10^{-6}$ Wb, dt = 3×10^{-3} s emf = 420 × 4×10^{-6} / 3×10^{-3} = 0.56 V ....accept 0.6 V correct answer scores [2] ecf on incorrect powers of ten scores [1]	0 1 1
3	electric field (strength) around a point charge / charged (conducting) sphere / charged particle / proton / electron ... NOT small charge	1 1
4	mass change = 233.99045 - 229.98373 - 4.00151 = 0.00521 u mass change = 0.00521 × 1.7×10^{-27} kg = 8.857×10^{-30} kg (eor) $E = mc^2 = 8.857\times10^{-30} \times (3.0\times10^8)^2 = 7.97\times10^{-13}$ J (accept 8×10^{-13}) ecf incorrect m: 4.69×10^{14} J worth [2] ...	1 1 1
5 a 5 b	3% × 25 × 2.0×10^{-2} = 1.5 % accept 1.5×10^{-2} ~~%~~ for [1] any two of the following, [1] each • limit worker's exposure time (wtte) • increase distance from the source (wtte) • place shielding between worker and X-ray machine (wtte) • use more sensitive film / recording media NOT protective clothing	1 2
6 a 6 b	$E = 6.0\times10^6 \times 1.6\times10^{-19} = 9.6\times10^{-13}$ J (eor) ecf: $v = \sqrt{\frac{2E}{m}}$ = 1.7×10^7 m s^{-1} accept reverse calculation 2×10^7 m s^{-1} gives 8.25 MeV NOT 1.6X10^{-19} / 6.6×10^{-27} = 2.4×10^7 m s^{-1} $F = Bqv = 0.4 \times 3.2\times10^{-19} \times 1.7\times10^7 = 2.2\times10^{-12}$ N accept ecf from 6a, so 2×10^7 m s^{-1} gives 2.56×10^{-12} N	1 1 1

7 a 7 b	the spacing between the (field) lines three circles centred on electron (by eye) (accept dots) spacing increasing with distance from electron	1 1 1
8	90 90 140	1
9	gamma photons have high penetration (owtte) / are weakly ionising ACCEPT alpha / beta have low penetration alpha / beta have high quality factor / are highly ionising	1

10 a i	non-crossing loops pass through W, N , S and Y (must enter and leave magnet through curved ends) and return along either side of the ring in the iron (can be same side) 	1 1
10 a ii	loops become shorter / straighter (as magnet rotates)	1
10 a iii	any three of the following modifications, [1] each: • stronger magnet • more turns per coil of wire • smaller gap between magnet and ring • increase all dimensions / thicker ring • increase permeance / permeability of stator • laminate stator (to reduce eddy currents) NOT increasing current / more coils	3
10 b i	three pulses as shown (ACCEPT opposite polarity) 	1
10 b ii	flux / (magnetic) field <u>changes</u> in <u>rotor</u> (wtte) induces <u>current</u> in the rotor (not just emf) which interacts with the flux / field to provide a turning force	1 1 1

11 a	atom / nucleus is much heavier than a proton because of elastic scattering / lose little energy nucleus is small / most of the atom is empty because few protons are reflected / most go straight through ACCEPT nucleus is positive because repulsive force needed for reflection	1 1 1 1
11 b i	direction from nucleus to point indicated by X must touch point labelled X  	1
11 b ii	$F = kQq/r^2$ (eor) $F = 9.0\times10^{9} \times 4.2\times10^{-18} \times 1.6\times10^{-19} / (3.2\times10^{-14})^2$ F = 5.9 N accept 6 N, not 6.0 N	1 1 1
11 b iii	sharp peak at Z (use template supplied) tending to zero. or zero at start and end  	1 1
11 c	180 degrees when b = 0 (by eye) value and gradient decreasing for increasing b  	1 1

12 a	two horizontal lines from anode to cathode, at right angles to them pointing to the right (accept correct edge effects) 	1 1
12 b i	$(3.46\times10^{-18} - 2.14\times10^{-18}) = +1.32\times10^{-18}$ J	1
12 b ii	EITHER $-3.93\times10^{-18} + 1.32\times10^{-18} = -2.61\times10^{-18}$ OR $3.93\times10^{-18} - 2.61\times10^{-18} = 1.32\times10^{-18}$	 1
12 c i	$c = f\lambda$ (eor) $f = 3.0\times10^{8} / 633\times10^{-9} = 4.74\times10^{14}$ Hz ecf incorrect f: $E = hf = 6.6.\times10^{-34} \times 4.74\times10^{14} = 3.1\times10^{-19}$ J	1 1 1
12 c ii	 arrow must point down	1
12 d	trapped electrons form standing waves (owtte) for only certain values of wavelength and wavelength determines energy accept labelled diagrams of standing waves	1 1 1

13 a i	both neutron numbers correct positron and neutrino numbers correct ecf: first and second equations balanced correctly $^{196}_{80}\text{Hg} + {}^{1}_{0}\text{n} \rightarrow {}^{197}_{80}\text{Hg}$ $^{197}_{80}\text{Hg} \rightarrow {}^{197}_{79}\text{Au} + {}^{0}_{1}\text{e} + {}^{0}_{0}\nu$	1 1 1
13 a ii	creation of an antiparticle, such as a positron from a family of particles requires the simultaneous creation of a particle (from the same family) ACCEPT to conserve lepton number	1
13 a iii	fission of (nucleus in) uranium / plutonium triggered by a neutron results in emission of many neutrons stable chain reaction results in steady population of neutrons ACCEPT for [1] each control rods absorb surplus neutrons to control reaction moderators slow neutrons to increase chance of fission	1 1 1
13 b i	$\lambda = \ln 2 / T_{0.5}$ $\lambda = 0.69 / 2.3\times10^{5} = 3.0\times10^{-6}\ \text{s}^{-1}$ $A = \lambda N$ (eor) $N = A / \lambda = 17\times10^{3} / 3.0\times10^{-6} = 5.6\times10^{9}$ accept reverse calculation: 6×10^{9} nuclei gives $T_{0.5} = 2.45\times10^{5}$ s or $A = 18$ kBq	0 1 1 1
13bii	mass of a mercury atom = $\underline{196} \times 1.7\times10^{-27} = 3.33\times10^{-25}$ kg (eor) EITHER ecf: atoms in sample = $2.4\times10^{-3} / 3.33\times10^{-25} = 7.2\times10^{21}$ ecf: percentage gold = $(5.6\times10^{9} / 7.2\times10^{21}) \times 100 = 7.9\times10^{-11}$ % OR ecf: mass produced = $3.33\times10^{25} \times 5.6\times10^{9} = 1.9\times10^{-15}$ kg ecf: percentage of gold = $(1.9\times10^{-15} / 2.4\times10^{-3}) \times 100 = 7.9\times10^{-11}$ % 6×10^{9} nuclei gives 8.3×10^{-11} % for [3] if $A = 196$	1 1 1

Marking quality of written communication

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

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

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

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

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

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

2865 Advances in Physics

Physics B (Advancing Physics) mark schemes - an introduction

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

- Alternative approaches to a question are rewarded equally with that given in the scheme, provided that the physics is sound. As an example, when a candidate is required to "Show that..." followed by a numerical value, it is always possible to work back from the required value to the data.
- Open questions, such as the questions in section C 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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6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

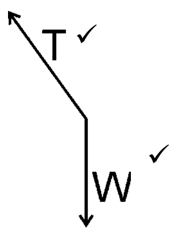
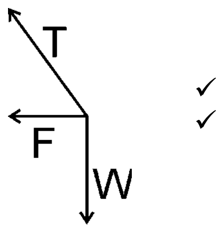
7. Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.

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

Qn	Expected Answers	Marks	Additional guidance
1 (a)	continuous loops through both coils ✓ loops don't cross✓	2	Treat diagram as 3D Ticks by diagram
(b)	(i) ϕ graph similar to current ✓ (ii) V = 0 for regions of constant ϕ ✓ $V \neq 0$ ONLY when ϕ changes ✓ Changes of ϕ in opposite directions produces V of opposite sign ✓	1 3	V negative for increase in ϕ not needed. Max 1 for ecf from (i) Two opposite pulses 1
(c)	(i) ϕ increases (can be shown on graph (i))✓ (ii) V increases <u>because</u> greater (rate of) flux change✓	2	Correct reference to permeance
	Total:	**8**	
2 (a)	(i) $E = 90\times10^3/1.2 \times 10^{-2} = 7.5 \times 10^6$ N C^{-1} ✓ (ii) Separation between anode and cathode not constant/ anode is oblique / non uniform field. ✓ (iii) Lines with arrows from anode to cathode ✓ Lines **clearly** spaced closer at top / Lines leave anode at right angles✓	1 1 2	Accept 8×10^6 N C^{-1} Any point recognising non-uniformity Ticks by diagram
(b)	(i) reference to joule heating/P=IV /more joules per coulomb✓ (ii) at higher temperature, electrons have more energy ✓ T↑⇒ BF↑ ✓ (iii) (more electrons ⇒) more X-rays (photons) / greater intensity of X-rays ✓	1 2 1	Accept E/kT argument
(c)	(i) $P = 0.010 \times 90 \times 10^3$ W = 900 W ✓ (ii) $P_{heat} = 0.99 \times 900$ W = 891 W ≈ 900 W✓ (iii) $dT/dt = P/(mc) = 900 / (0.80 \times 390) = 2.9$ °C s^{-1}✓m ✓e Use of melting point to infer it will (start to) melt the anode ✓ Calculation of time to reach melting point ≈ 400s or 6 minutes ✓	1 1 4	Allow <u>explicit</u> justification of 100% Allow ecf Allow ecf
	Total:	**14**	

Qn	Expected Answers	Marks	Additional guidance
3 (a)	(i)λ = 0.014 nm ✓ $f = 3.0 \times 10^{8} / 0.014 \times 10^{-9} = 2.1 \times 10^{19}$ Hz $E = 6.6 \times 10^{-34} \times 2.1 \times 10^{19} = 1.4 \times 10^{-14}$ J $\approx 1 \times 10^{-14}$ J ✓m✓e (ii) $V = 1.4 \times 10^{-14} / 1.6 \times 10^{-19}$ = 88 000 V ✓	3 1	Allow ecf only if λ between 0.014 and 0.04 nm 62500 V Using E = 1 x 10^{-14} J
(b)	(i) Reference to the two peaks on the graph ✓ (ii) 59 keV ✓ Longer λ means smaller E ✓ (iii) Level drawn at -69 keV ✓ Level drawn at -59 **or** -10 keV ✓ Appropriate <u>downwards</u> arrows between the two levels ✓	1 2 3	Must give -59 & -69 keV
	Total:	**10**	
4 (a)	(i) sin θ = 0.10/0.28 = 0.36 $\Rightarrow$ θ = 21° ≈ 20° ✓m ✓e (ii) Spots would be broadened owtte ✓ Different wavelengths give spots at different angles present ✓	2 2	
(b)	(i) dots – in phase/constructive and/or clear bits – not in phase/destructive interference✓ dots represent the few directions where scattering from very many/all atoms is in phase, while phases are random / tend to cancel at other places ✓ (ii) larger horizontal spacing/ smaller separation of atoms vertically✓ justified ✓	2 2	
	Total:	**8**	
5 (a)	N = 2 J s^{-1}/2 × 10^{-15} J $photon^{-1}$ = 1 × 10^{15} photon s^{-1}✓	1	
(b)	(i) quality factor allows for different types of radiation✓ larger Q factor means particles (of the same energy) do more damage to human body ✓ (ii) Only a small fraction of the X-rays are absorbed by the body owtte ✓ (iii) number of X-rays = 2 × 60 = 120 ✓ dose = 0.2 x 10^{-3} Sv × 120 = 0.024 Sv /24 mSv ✓ risk = 3% × 0.024 = 0.072% ✓	2 1 3	Allow spreading so not all pass through chest One error loses 1 mark
(c)	Fitting shoes correctly is relatively trivial compared with the purposes for which medical X-rays are done ✓ Children are particularly at risk from ionising radiation✓ Children have frequent shoe fitting✓ Repeated exposure of staff✓	2	Any two points; allow any well-made independent points about risk.
	Total:	**9**	

Qn	Expected Answers	Marks	Additional guidance
6 (a)	'the patient is exposed to X-rays for a longer time'✓	1	Scan consists of multiple exposures
(b)	(i) Hydrogen has an odd nucleon number ✓ Comparison with quantity of phosphorus ✓ (ii) Any example of resonance **described**. Can be microscopic, e.g. absorption of radiation by atoms, or macroscopic, e.g. Tacoma narrows bridge collapse driven by wind vortices or similar. ✓	2 1	Any two independent points. It must be clear that there is an enhanced response to driving frequency matching the natural frequency of an oscillating system..
(c)	(i) soft tissues distinguished more clearly✓ skull tissue distinguished more clearly✓ better resolution in MRI✓ more grey levels✓ (ii) Method ✓ explanation/description of process✓ e.g. increase contrast ✓ increase range of pixel values✓ e.g. remove noise/removes'speckle'✓ by median filter/smoothing✓ e.g. increase brightness ✓ add/subtract from pixel values to change to nearer 'white'✓ e.g. edge detection✓ 'remove' pixel codes where they are like neighbours owtte✓ e.g. adding false colour to reveal detail / density slice ✓ code pixel values with colour✓	2 2	Allow any sensible statement relating to the images
	Total:	**8**	

Qn	Expected Answers	Marks	Additional guidance
7 (a)	Need to know distance to Sun✓ Find area of sphere of that radius and use 1.4 kW m^{-2}× area ✓	1 1	 Correct use of inverse square law OK
(b)	(i) (ii) any two independent factors, e.g., angle of panel, atmospheric absorption including clouds, atmospheric scattering, atmospheric reflection, reflection of energy from panel ✓✓	2	Not extra distance from top of atm. to roof Not blocked, stopped by cloud
(c)	(i) graph starts (with emf) on y-axis ✓ V decreases as I increases✓ (ii) high internal resistance means p.d. may drop below acceptable value for powering load / energy dissipated in internal resistance, causing heating of source/ waste of energy ✓ (iii) semiconductors have lower conductivity / higher resistivity than conductors ✓ (iv) parallel has emf *E* while series has 100 *E* ✓ parallel: internal resistance lower, while series higher /parallel allows greater current to be drawn than series✓	2 1 1 2	
(d)	Calculation of output during operation: 0.12 × 1kW × 6 = 720 W ✓ Est: mean operating time per day = e.g.12 hours ✓ Output = 12/24 × 720W = 360 W✓	3	Needs reason Unit penalty
	Total:	**13**	
8 (a)	(i)  (ii) 	2 2	(i) W vertical, T parallel to cable (by eye), (ii) F to left ✓ (may use R) F horizontal <u>and</u> correct length (by eye)✓
(b)	(i) $T\cos\theta$ is vertical component of tension ✓ vertical component of tension = weight ✓ (ii) $T\sin\theta$ is horizontal component of tension ✓ horizontal component of tension provides centripetal force ✓ (iii) (ii) ÷ (i) gives $\tan\theta = \dfrac{mv^2}{mrg}$ $\Rightarrow v^2 = mrG\tan\theta \Rightarrow v = \sqrt{rg\tan\theta}$ ✓m✓e	2 2 2	Idea of balanced forces 'must hold up weight' is enough for second mark Not two forces in equilibrium

(c)	Use of data ✓ correct inference. ✓ e.g. $T\cos\theta$/ vertical component of tension is same from A to B, $\theta\uparrow \Rightarrow (\cos\theta\downarrow) \Rightarrow T\uparrow$	2	
(d)	(i) F = stress × A = 310×10^{6} x 1.3×10^{-5}= 4030 N≈4 kN ✓m✓e (ii) More flexible ✓ In case of fracture, other strands still support load✓	2 2	Allow 1 point developed further for 2 marks
	Total:	**16**	

4	

QWC Marking quality of written communication

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

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

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

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

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

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

Grade Thresholds

Advanced GCE Physics B (Advancing Physics) (3888/7888)
June 2009 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	A	B	C	D	E	U
2860	Raw	90	56	50	44	39	34	0
	UMS	100	80	70	60	50	40	0
2861	Raw	90	64	57	50	43	37	0
	UMS	110	88	77	66	55	44	0
2862	Raw	120	97	85	73	62	51	0
	UMS	90	72	63	54	45	36	0
2863A	Raw	127	101	90	79	68	57	0
	UMS	100	80	70	60	50	40	0
2863B	Raw	127	101	90	79	68	57	0
	UMS	100	80	70	60	50	40	0
2864A	Raw	119	90	80	71	62	53	0
	UMS	110	88	77	66	55	44	0
2864B	Raw	119	90	80	71	62	53	0
	UMS	110	88	77	66	55	44	0
2865	Raw	90	55	49	43	37	32	0
	UMS	90	72	63	54	45	36	0

Specification Aggregation Results

Overall threshold marks in UMS (ie after conversion of raw marks to uniform marks)

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

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

	A	B	C	D	E	U	Total Number of Candidates
3888	30.8	53.7	75.6	90.6	98.7	100	1327
7888	31.1	53.7	72.1	87.3	97.0	100	5352

For a description of how UMS marks are calculated see:
http://www.ocr.org.uk/learners/ums_results.html

Statistics are correct at the time of publication.

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