Oxford Cambridge and RSA Examinations

OCR

RECOGNISING ACHIEVEMENT

ADVANCED GCE A2 7888
ADVANCED SUBSIDIARY GCE AS 3888

PHYSICS B
(ADVANCING

COMBINED MARK SCHEME AND REPORT FOR THE UNITS
JANUARY 2005

[redacted]

3888/7888/MS/R/05J

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

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

The report on the Examination provides information on the performance of candidates which it is hoped will be found helpful in their preparation of candidates for future examinations. It is also intended to be constructive and informative and to promote better understanding of the operation of the scheme of assessment and of the relationship between papers.

Mark schemes and Reports should be read in conjunction with the published question papers.

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

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annersley
NOTTINGHAM
NG15 0DL

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

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MARK SCHEME ON THE UNITS

REPORT ON THE UNITS

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 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.

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

Abbrieviations, annotations and conventions used in the Mark Scheme

m = method mark
s = substitution mark
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/= alternative and acceptable answers for the same marking point
; = separates marking points
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___ = (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	steel = B ; biscuit = C ; cast iron = A	3	
2(a)	400 ± 100 (m pixel^{-1}) 300 - 500	1	no method needed
(b)	25 ± 10 (km) 15 - 35	1	no method needed
(c)	Global warming / sea level rising / climate change / icebergs danger to shipping lanes etc.	1	any sensible attempt to make physics "connect" NOT just icebergs moving
3(a)	Area of cross-section / circle	1	NOT just area accept labelled sketch
3(b)	x ½ ; x ¼	2	accept halved; quartered
4(a)	semiconductor(s) ;	1	
4(b)	$\rho = 1/\sigma$ / = 1/ 9x10^5 m ;= 1.(1)x10^{-6} e ; Ω m / S^{-1}m	3	accept 1.1 μΩ m
5(a)	any 2 valid and distinct comparisons e.g. eee has higher frequencies / aaa has higher amplitude components / aaa has lower fundamental frequency / eee has more harmonics	2	
5(b)	consistent lower amplitude between 1V and 1.5V ;	1	by eye
	1 reasonable sine wave per time divison	1	allow any phase
6(a)	$R_{parallel} = 50\Omega$ / $R_{total} = 100 + R_{parallel}$ m ; 150 (Ω) e	2	100.02(Ω) scores 1
6(b)	(I = V/ R = 12/150) = 0.08 A or 80 mA	1	evaluation only no method mark ecf from (a) on R_{total}
	Total section A	20	

	Section B		
7(a)	elastic ; tough	2	
(b)	$A = F / \sigma_B$ / 550 / 2 x 10^9 m ; = 2.8 x 10^{-7} e	2	accept 2.75 x 10^{-7}
(ci)	Permanent stretch / yield AW	1	or better
(ii)	($E = \sigma / \varepsilon$ =) 1.6 x 10^9 / 0.35 m ; = 4.6 x 10^9 e	2	by number substitution 2 or 3 SF otherwise SF penalty
(d)	molecule(s) tangled / twisted / coiled / zig-zagged	1	accept 4.57 x 10^9
	molecule(s) untangled / untwisted / uncoiled / straighter	1	stick / ball+stick / line
	molecule(s) untangled / untwisted / uncoiled / bond	1	
	rotation allows different shapes / effect of cross-links / effect of side chains	10	quality mark could come from good labels
8(ai)	$\mathcal{E}$ rises as T rises / starts proportionally ;	1	
	slight upward curve / increase in gradient AW	1	
(ii)	method (such as Δ or gradient = 0.23 mV / 40°C) ;	1	
	evaluation = 5.8 $\pm$ 0.3 (μV / °C)	1	Accept 6 μV / °C
(bi)	e.g. $V = \varepsilon - \varepsilon \{r / (R+r)\}$; $V = \varepsilon(R+r-r) / (R+r) = \ldots$	2	1st mark for valid subn V = IR route scores 1
(ii)	V = ε {10 / 10.2} ; = 0.98 (ε)	2	
(c)	any **two** reasons for moving coil or against the other instruments: e.g. gives a measurable deflection (65 mm) / meter resistance only affects emf by 2% / c.r.o. deflection too small (0.7 mm) / DVM is overloaded with 700 μV	2 10	NOT low resistance NOT more or most sensitive
9(ai)	sampling ; levels ;	2	credit annotated
	further quality e.g. binary levels labelled 000 to 111 / quantisation errors indicated / regular sampling	1	diagram / description or 1/2/3 style
(ii)	(2^{10}) = 1024	1	accept 1023
(iii)	resolution = p.d. / intervals / = 9 / 1023 m ; = 8.8 mV e	2	accept 1024/ ecf (ii)
(b)	4 sensors x (10/8) bytes x (4 x 24 x 30) samples m ;	1	method in words /
	14.(4) kbytes e / accept 115200 bits	1	numbers
(c)	$t = Q / I$ / = 500 / 0.02 m ;	1	ora 30 d $\approx$ 2.6 x 10^6 s
	= 25000 s e ; = 25000/(60x60) hrs = 6.9 hrs / 0.29 days e	2 11	ora Q = 51840 C scores 3 marks
10ai)	F where rays parallel to principal axis meet	1	if principal focus OK
(ii)	rays cross over at F or better	1	
(bi)	straight line through points by eye	1	
(ii)	intercept = 0.1 (m)	1	allow $\pm$ 0.01 (m)
(iii)	it is the closest to the lens a real image can be formed / object at ∞ / $1/v = 1/f$ / incoming waves zero curvature	1	AW NOT h = 0 NOT $v = f$
	= 1/ -0.2 (= - 5.0 D)	1	
(ci)	$1/v = 1/u + P$ = 5 / $1/v$ = -5 + 10 = (+) 5 ;	1	method in words or
(ii)	$\therefore v$ = 1/5 = 0.20 m e	1	number
(iii)	$v = u$ / (magnification =) v/u = 1 / object at $2f$	1	
	Total section B	9 40	

	Section C		
11ai)	image e.g. the planet Jupiter		NO mark for example
(ii)	**two** kinds of information identified e.g. Giant red spot in Jupiter's atmosphere ; bands of coloured gases in the atmosphere	1 1	allow one mark for two weak / similar responses
	two explanations of usefulness e.g. study of the large cyclone enables planetary atmospheric modelling to be tested ; study of light spectra enables deduction of composition of Jupiter's atmosphere	1 1	allow one mark for two weak / similar explanations
(b)	1/2/3 style according to quality of answer e.g. Hubble space telescope uses a large concave reflecting mirror to gather reflected sunlight from Jupiter and its moons. Mirror focuses image onto a CCD camera that records colour pixel values forming the image.	3	full marks available for: well annotated diagrams of imaging system / good descriptions only
(c)	image processing technique identified e.g. contrast enhancement ; description of process e.g. range of pixel values used can be stretched ; improvement clear e.g. to make bright colours brighter and dark colours darker so that features are clearer	1 1 1	use 1/2/3 style marking if students answers don't fit this model
(d)	sensible estimate of number of pixels e.g. 2 Megapixels sensible estimate of number of bits / pixel e.g. = 24 bits combination for amount of information e.g. = 2 M x 24 = 48 Mbits / 6Mbytes	1 1 1 13	evidence in numbers (for colour pixels) not essential accept bits or bytes plausible value without method scores 1
12a)	material chosen e.g. silicon details e.g. used in the manufacture of microprocessor chips in the form of an integrated circuit containing millions of discrete electrical components	1 1 1	vague or unqualified references e.g. 'in electronics' max 1 mark
(b)	physical property identified e.g. semiconduction explanation of importance e.g. doped areas can be used to construct diodes / transistors to build circuits	1 1 1	must be relevant ' easy ' mark ' quality ' mark
(c)	scale of structural diagram correct 1/2/3 style tetrahedral / "diamond" structure / each Si atom having four bonds in 3-d ; bonds formed by shared pair of electrons a few of which are free to move through the crystal and conduct a current ; the low density of free electrons compared to a typical metal gives a much lower conductivity	1 1 1 1	UP full marks available for a well annotated diagram
(di)	second physical property e.g. doped Silicon junctions can emit light when excited electrically	1	
(ii)	application e.g. light emitting diode explanation: as a low power warning light for battery circuits	1 1 13	' easy ' mark ' quality ' mark
	QoWC	4	
	Section C Total	30	

QoWC Marking quality of written communication

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

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

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

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

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

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.

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1 (a)	A ✓	1	
(b)	C ✓	1	
2	B ✓	1	
3 (a)	20 ✓ ($m\ s^{-1}$)	1	
(b)	0.5 ✓ (s)	1	
(c)	(20 x 0.5) + ($^1/_2$ x 20 x 3.5) ✓ = 45 ✓ (m)	2	45 m ✓✓
4 (a)	energy (= $6.6 \times 10^{-34} \times 3.2 \times 10^{14}$) = 2.1×10^{-19} ✓ (J)	1	2 or 3 **s.f** only
(b)	$(1.0 \times 10^{-7})/(2.1 \times 10^{-19})$ ✓ = 4.8×10^{11} ✓ **ecf** from (a)	2	
5	$s = {}^1/_2at^2$ $t^2 = (2 \times 0.15)/9.8$ ✓✓ t = 0.18 s ✓ g = 10 gives 0.17 s	3	using t = 0.2 s to find s = 0.196 m ✓✓ then explained ✓
6(a)	F = 10 000 x 3.1 ✓ = 31 000 ✓ (N)	2	
(b)	weight = 75 000 – 31 000 = 44 000 (N) ✓	1	
(c)	g = 44 000 / 10 000 = 4.4 ✓ ($N\ kg^{-1}$) ecf from (b)	1	no ecf if g = 9.8 $N\ kg^{-1}$ assumed in (b)
7	test proposed $k = y/x^2$ ✓ carried out on all data ✓ conclusion based on test ✓ (lack of clarity will be penalised)	3	test can be implicit in working internal consistency✓✓
	Section A total	**20**	

Qn	Expected Answers	Marks	Additional guidance
8 (a)(i)	$v^2 = 2gh$ approach $v^2 = 2.\ 9.8.\ 169$ ✓ $v = 57.6$✓ (m s^{-1})	2	
(ii)	resistive force idea ..... ✓	1	air(wind) resistance/ drag/drag force/friction/energy loss ✓
(b)	$v = 100/2.12$ ✓ = 47.2 m s^{-1} ✓	2	47.2 ✓✓
(c)(i)	weight = 72 x 9.8 = 706 N ✓	1	accept 720 N
(ii)	706 sin 15° ✓ = 182.7 N ✓ **ecf** from (c)(i) (720 sin 15° = 186.3 N)	2	
(iii)	balanced forces idea (resultant force = zero) ✓	1	argued in terms of forces
	total	**9**	
9 (a)(i)	symmetrical about central max central maximum is brightest intensity decreases with 'order' maxima are equi-spaced peaks narrower than spacing ✓✓	2	maximum 2
(ii)	A: constructive interference (or waves add) .... waves superimpose IN PHASE ✓ B: destructive interference (or waves cancel) ... waves in ANTIPHASE (out of) ✓ (for just constructive and destructive interference ✓)	2	pd is a whole number of λ pd is an odd number of half wavelengths
(b)(i)	1 / 80 000 or $(1 \times 10^{-3})/80$ ✓ (= 1.25×10^{-5})	1	
(ii)	tan θ = 0.06 / 1.2 ✓ θ = 2.86 ° ✓	2	for **sin** θ = 0.06/1.2 $\mathbf{x_m}$ = 2.87 ✓$_e$
(iii)	λ = 1.25×10^{-5} x sin 3° ✓ = 6.5×10^{-7} **m** ✓ **[UP]** (2.86° gives 6.2×10^{-7})	2	λ = d sin θ or λ = xd/D
(c)	More lines mm^{-1} ✓ larger spacing to measure ✓ or move screen further ... smaller % error in distances measure to higher order ... smaller % error in distances	2	sensible change ✓ justified ✓
	total	**11**	

Qn	level	Expected Answers	Marks	Additional guidance
10 (a)	E/U B	N/kg x kg/m^3 x m^2 = N m^{-1} ✓ (beware fudge) J = N m so N = J m^{-1} etc ✓	2	Stages must be **shown** clearly
(b)(i)	E/U	0.9 m ✓	1	
(ii)	E/U	½ x 9.8 x 1030 x (0.9)^2 ✓ = 4089 ✓ (J m^{-2}) ~ 4100 **ecf** from (b)(i)	2	
(iii)	D B	4089 x 12 ✓ = 49 068 ✓ (W) (ecf from (b)(ii) ✓$_m$ ✓$_e$)	2	
(iv)	E/U E	49 068 x 500 ✓ = 24 534 000 = 25 MW ✓ **ecf**	2	
(v)	E/U	lots of damage/erosion / for conversion to electrical power ✓	1	
		total	**10**	
11 (a)	E/U C A	increases and decreases ✓ 16% mentioned ✓ cyclic/repeating / no sign of dying out ✓	3	varies between 16% and 0% ✓✓
(b)(i)	E/U D B	for x: rpa = 4 ✓ for y: rpa = (4 + 4)^{½} ✓ = 2.8 ✓ (scale drawing tolerance 2.6 to 3.0)	3	for missing scale factor 2 marks max
(ii)	C A	prob related to (amplitude)^2 idea ✓ 16 for x, 8 for y ✓	2	4 for x, 2 for y ✓ (ecf) from (b)(i)
(iii)	C A	Phasors antiphase ✓ so prob (or RPA) is zero ✓ (quantum explanation only)	2	'photons' are out of phase (no marks)
		total	**10**	
		Section B total	**40**	

Qn	level	Expected Answers	Marks	Additional guidance
12 (a)(i)	E/U	distance measurement stated ✓	1	
(ii)	E	correct order of magnitude for distance with unit ✓	1	
(b)(i)	E/U E D A	diagram is essentially correct ✓✓✓ diagram is satisfactory, but some errors/omissions ✓✓ some attempt has been made ✓ ..... + important equipment labelled ✓	4	
(ii)	E/U E D	description is essentially correct ✓✓✓ description is satisfactory, but some errors/omissions ✓✓ some attempt has been made ✓	3	
(c)(i)	E B A	method is essentially correct ✓✓✓ method is satisfactory, but some errors/omissions ✓✓ some attempt has been made ✓	3	
(ii)	B	factor limiting accuracy in this measurement ✓	1	
		total	**13**	
13 (a)	E/U	standing wave example stated ✓	1	
(b)	E/U D C A	diagram is essentially correct ✓✓✓ diagram is satisfactory, but some errors/omissions ✓✓ some attempt has been made ✓ ..... labelled ✓	4	
(c)	E B	description sufficient to execute ✓✓ description satisfactory, but some errors/omissions ✓	2	e.g blow across top of pipe until loud sound ..
(d) (i)	E D	fundamental standing wave (for situation described) ✓ **N** and **A** in appropriate places on standing wave shown✓	2	any representation accepted
(ii)	B A	2 progressive waves superposing idea ✓ **A** and **N** explained ✓	2	
(e)	A E	harmonic shown (ecf from (c)(i)) ✓ higher frequency ✓ must refer to **same** physical situation (e.g. **closed** pipe)	2	
		total	**13**	
		Quality of Written Communication	**4**	
		Section C total	**30**	

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

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Qn	Expected Answers	Marks	Additional guidance
1	Force, spring or stiffness constant ✓ Energy stored or work done or strain energy ✓	1 1	Not just 'energy' or p.e.
2	B ✓	1	
3a	1200 x 1.4×10^{-23} ✓ = 1.7×10^{-20} J	1	Can use 3/2 kT to give 2.5×10^{-20}J
b	$9 \times 10^{-20} / 1.7 \times 10^{-20} = 5.3$ ✓	1	5.4 if 1.68×10^{-20} J used 3.6 if 2.5×10^{-20}J used.. 4.5 if 2.0×10^{-20}J used.
c	$f = e^{-5.3}$ ✓ = 5×10^{-3}✓	2	carry forward answer to (b) Common answer is 0.01 if 2.0×10^{-20}J used
4a	pV = nRT ✓so n = pV/RT = $4.5 \times 10^5 \times 8 \times 10^{-4} / 8.31 \times 293$ ✓ = 0.148 mol	2	Must give own value of answer if working not clear. Evaluation only is worth one mark.
b	$4.5 \times 10^5 / 293 = 4.6 \times 10^5 / T_2$ ✓ = 300 K ✓ (295 for 0.15) 295 if using pV = nRT	2	Can use alternative methods. ECF
5a	velocity tangential to path ✓	1	Doesn't have to be clockwise!
b	force acting towards Sun ✓	1	
6a	mv - (- mv) = 2 mv or in words ✓	1	
b	$V = \frac{0.0051}{(2 \times 5.0 \times 10^{-4})}$ ✓ = 5.1 m s^{-1}	1	Own value or clear method
c	Area under line less for damaged pea ✓	1	
7a	wavelength has 'stretched'✓ with the expansion of space✓ AW	2	
b	Small temperature variation/almost uniform temp AW ✓ Link between current background and past temp/density✓ AW	2	

Qn	Expected Answers	Marks	Additional guidance
8a	volume = $\pi r^2 h = \pi \times 13^2 \times 1.6 = 850\ m^3$ ✓ mass = density x volume = 1000 x 850= ✓ 8.5×10^5 kg	2	Must show working clearly if own value not given.
b	$Q = 8.5 \times 10^5 \times 4200 \times 21$✓ = 7.5×10^{10} J ✓	2	
c	Rate of fall in degrees per sec= 90 000/($8.5 \times 10^5 \times 4200$) ✓ = 2.5×10^{-5} rate of fall in degrees per hour = x 3600 ✓ = 0.09	2	Many acceptable routes to answer.
d	k = 0.09/19 ✓ = 4.7×10^{-3} ✓ If 0.1 used: 0.0053	2	If per second 1.3×10^{-6} one mark
e	Temperature difference will reduce during the 24 hour period ✓	1	Allow implicit
f	e.g. lower air temperature, effect of cloud cover, decreased humidity, wind, snow... ✓✓	2	
9a (I)	Q = I t argument ✓/ dimensions argument	1	
a(ii)	Counting squares ✓gives answer in range 2.5 – 3.5 mC✓	2	Other methods acceptable
a(iii)	C =Q/V = $2.8 \times 10^{-3}/6$✓ = 4.7×10^{-4} ✓F✓ 5×10^{-4} F if paper value used. (If 1/3 used for RC proportion answer is 5.5×10^{-4} F)	3	µF fine. Other methods acceptable
b	E = ½ Q V = ½ x 2.8×10^{-3} x 6 ✓= 8.4×10^{-3} J ✓ (ecf)	2	Other methods acceptable.
c	y intercept 0.3 mA ✓ time constant✓ shallower curve✓ (valid method)	3	0.11 mA at 10 s or 0.15 at 7 s. accept displaced curve.
10a	r = $6.4 \times 10^6 + 4 \times 10^5 = 6.8 \times 10^6$ m ✓	1	
b (i)	Gmm/r✓ = $-6.7 \times 10^{-11} \times 6.0 \times 10^{24} \times 9.5 \times 10^4 / 6.8 \times 10^6$✓ = (-) 5.6×10^{12}	2	Formula can be implicit. Evaluation only is worth one mark.
b (ii)	½ m v^2 = ½ x $9.5 \times 10^4 \times 7700^2$ ✓ = 2.8×10^{12} ✓	2	
b (iii)	- 2.8×10^{12} or - 3.2×10^{12} ✓	1	e.c.f. with b (i) as –ve
c	Gpe becomes more negative ✓ and (some of) this gpe is transferred to ke✓ AW	2	accept decreases
d (i)	Particles bounce off shield, (rate of) change of momentum ✓ gives decelerating force. Or clear Newton 3 argument. (kinetic) energy transformed into thermal energy, ✓ increasing particle vibrations and raising the temperature of shield. ✓	3	One mark for first bullet. One for energy transform from atmosphere to SHIELD. One mark for link to microscopic effect in heat shield. NB this question is more complex than it looks – the shuttle loses translational ke as the heat shields gains vibrational energy.
d (ii)	E/K = 1 x10^{-19}/1.4×10^{-23} ✓= 7×10^3 K✓	2	

Qn	Expected Answers	Marks	Additional guidance
11a i	period =1/2500 = 4×10^{-4} s ✓	1	
a (ii)	Period ✓ amplitude ✓shape ✓	3	Shape includes phase (sin or –sin) ecf from a i
a (iii)	$a = 4\pi^2 f^2 A = 4\pi^2 \times 2500^2 \times 1 \times 10^{-7}$ ✓= 24.7 m s^{-2} ✓	2	
b	$F = PA = 4 \times 10^{-5} \times 20 \times 10^{-6}$✓ $= 8 \times 10^{-10}$ N ✓	2	8×10^{-7} N worth one mark
c (i)	Large amplitude at specific frequency ✓due to matching with driving frequency ✓AW	2	Must have external driver / forced for second mark
(ii)	Amplitude of oscillations (of drum) at this frequency will be larger than at other frequencies✓ AW	1	Look at both parts of question.

Physics B (Advancing Physics) mark schemes - an introduction

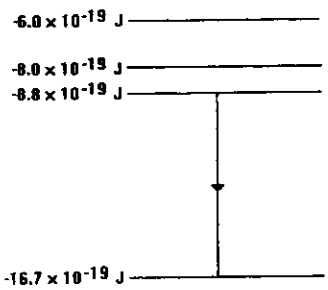
Just as the philosophy of the *Advancing Physics* course develops the student's understanding of Physics, so the philosophy of the examination rewards the candidate for showing that understanding. These mark schemes must be viewed in that light, for in practice the examiners' standardisation meeting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

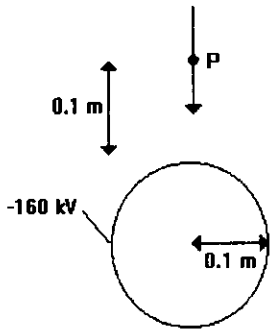
The following points need to be borne in mind when reading the published mark schemes:

- 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.

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

Question	Expected Answer	Mark
1 (a)	In any order: uud ACCEPT +2/3e, +2/3e, -1/3e	1
(b)	In any order: udd ACCEPT +2/3e, -1/3e, -1/3e	1
2	mass change = 3.00160 - 2.00141 - 1.00867 = -0.00848 ecf incorrect u: m = 0.00848 × 1.7×10^{-27} = 1.44×10^{-29} kg ecf incorrect m: E (= mc^2) = 1.44×10^{-29} × $(3\times10^{8})^2$ = $\underline{1.3\times10^{-12}}$ J ACCEPT reverse calculation	1 1 1
3 (a)	$E = hf = 6.6\times10^{-34} \times 1.2\times10^{15} = \underline{7.9}\times10^{-19}$ J	1
(b)	ignore direction of arrow  	1
(c)	A	1

Question	Expected Answer	Mark
4 (a)	vertical	1
	downwards	1
		
(b)	-80 kV	1
(c)	At right angles to field arrow	1
	Complete circle through P centred on sphere	1
	(IGNORE arrows on equipotential)	
5 (a)	5 cm = 5×10^{-2} m, 25 mT = 25×10^{-3} T	1
	ecf incorrect conversion:	
	$F = IlB = 2.0 \times 5\times10^{-2} \times 25\times10^{-3} = 2.5\times10^{-3}$ N	1
(b)	C	1
6 (a)	B	1
(b)	A	1
(c)	C	1
7	C	1
		[20]