ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme June 2002

GCE

Physics B

Unit PHB4

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Unit 4: Further Physics

Notes for guidance

Letters are used to distinguish between different types of marks in the scheme.

M indicates OBLIGATORY METHOD MARK
This is usually awarded for the physical principles involved, or for a particular point in the argument or definition. It is followed by one or more accuracy marks which cannot be scored unless the M mark has already been scored.

C indicates COMPENSATION METHOD MARK
This is awarded for the correct method or physical principle. In this case the method can be seen or implied by a correct answer or other correct subsequent steps. In this way an answer might score full marks even if *some* working has been omitted.

A indicates ACCURACY MARK
These marks are awarded for correct calculation or further detail. They follow an M mark or a C mark.

B indicates INDEPENDENT MARK
This is a mark which is independent of M and C marks.

Note: Where a correct answer only (c.a.o.) is required, this means that the answer must be as in the Marking Scheme, including significant figures and units.

Where an error carried forward (e.c.f.) is allowed by the Marking Scheme for an incorrect answer, e.c.f. must be written on the script if an error has been carried forward.

Instructions to Examiners

1 Give due credit to alternative treatments which are correct. Give marks for what is correct; do not deduct marks because the attempt falls short of some ideal answer. Where marks are to be deducted for particular errors specific instructions are given in the marking scheme.

2 Do not deduct marks for poor written communication. Refer the script to the Awardsmeeting if poor presentation forbids a proper assessment. In each paper candidates may be awarded up to two marks for the Quality of Written Communication in cases of required explanation or description. However, no candidate may be awarded more than the total mark for the paper. Use the following criteria to award marks:

2 marks: Candidates write with almost faultless accuracy (including grammar, spelling and appropriate punctuation); specialist terms are used confidently, accurately and with precision.

1 mark: Candidates write with reasonable and generally accurate expression (including grammar, spelling and appropriate punctuation); specialist terms are used with reasonable accuracy.

0 marks: Candidates who fail to reach the threshold for the award of one mark.

3 An arithmetical error in an answer should be marked A.E. thus causing the candidate to lose one mark. The candidate's incorrect value should be carried through all subsequent calculations for the question and, if there are no subsequent errors, the candidate can score all remaining marks (indicated by ticks). These subsequent ticks should be marked C.E. (consequential error).

4 With regard to incorrect use of significant figures, normally a penalty is imposed if the number of significant figures used by the candidate is one less, or two more, than the number of significant figures used in the data given in the question. Themaximum penalty for an error in significant figures is **one mark per paper**. When the penalty is imposed, indicate the error in the script by S.F. and, in addition, write S.F. opposite the mark for that question on the front cover of the paper to obviate imposing the penalty more than once per paper.

5 No penalties should be imposed for incorrect or omitted units at intermediate stages in a calculation or which are contained in brackets in the marking scheme. Penalties for unit errors (incorrect or omitted units) are imposed only at the stage when the final answer to a calculation is considered. The maximum penalty is **one mark per question**.

6 All other procedures, including the entering of marks, transferring marks to the front cover and referrals of scripts (other than those mentioned above) will be clarified at the standardising meeting of examiners.

Question 1

(a)	stress/strain		M1	
	further detail: defined stress and strain / tensile / Pa / $\frac{Fl_0}{A\Delta l}$ etc.		A1	**2**
(b)(i)	**A**		M1	**1**
(ii)	stiffer or bigger E – steeper gradient	**must be comparison and relate to graph**	A1	
	more brittle – smaller breaking strain		A1	
	stronger – greater breaking stress		A1	
	less ductile – smaller curved region		A1	
			max	**2**
(c)	**extension measured using vernier/micrometer/travelling microscope ***		B1	
	sample shown must be long or distance to pointer long (1 m + ; horizontal or vertical) infer this by bench		B1	
	measurement of initial length		B1	
	diameter using micrometer		B1	
	cross-sectional area = $\pi d^2/4$ etc.		B1	
	graph of force/extension or stress/strain or calculation of E from $E = \frac{Fl_0}{\Delta l A}$		M1	
	further analytical detail – correct relation between E and gradient **or** repeated and averaged calculation of E from equation		A1	
			max	**4**
	The use of Physics terms is accurate; the answer is fluent/well argued with few errors in spelling, punctuation and grammar and 3 or 4 marks for Physics.			**2**
	The use of Physics terms is accurate but the answer lacks coherence or the spelling, punctuation and grammar are poor and a minimum of 1 mark for Physics.			**1**
	The use of Physics terms is inaccurate; the answer is disjointed with significant errors in spelling, punctuation and grammar.			**0**
			max	**2**
		Total for Question 1		**11**

*** this must be scored otherwise max 3 + Q marks**

Question 2

(a)	displacement negative cosine	B1	
	velocity consistent with first graph	B1	
	acceleration consistent with first or second graph	B1	
	at least one cycle, constant amplitude (condone small decay), include A for displacement, reasonably drafted	B1	**4**
(b)	use of $T = 2\pi\sqrt{\frac{m}{k}}$ i.e. substituted values or 0.74 seen	C1	
	use or implied use of $T = \frac{1}{f}$	C1	
	1.34 Hz	A1	**3**
	Total for Question 2		**7**

Question 3

(a)	**increase** in internal energy	B1	
	heat / thermal energy supplied **to** the system **or** energy supplied to system by heating	B1	
	work done **on** the system	B1	**3**
(b)(i)	constant temperature	B1	**1**
(ii)	heat supplied to system = work done by system (or on surroundings)	B1	
	work done on the system = heat transferred to surroundings (or from system)	B1	**2**
(c)(i)	$pV = nRT$	M1	
	choice of point on curve and correct substitution giving e.g., 602(K) or 581(K) (all half a small square tolerance)	A1	**2**
(ii)	**smooth** curve below first curve not touching curve of axes	B1	
	correct point (need not be marked as dot provided curve passes through correct point – e.g. (0.2, 2))	B1	
	2nd correct point e.g. (0.4.,1)	B1	
	supporting evidence – e.g., $\frac{2}{3}p_1V_1$ or $pV = 4$ (=3.98)	B1	**4**
	Total for Question 3		**12**

Question 4

(a)	½ mv^2 or substitution ignoring powers of 10	C1	
	3.75×10^{10} J	A1	**2**
(b)	$Q = mc\Delta\theta$	C1	
	1785 seen	C1	
	2.36×10^{9} J	A1	**3**
(c)(i)	$W = Fs$ or correctly substituted values	C1	
	2.48×10^{6} N	A1	**2**
	condone effect of change of g.p.e.		
(ii)	force = rate of change of momentum or use of an equation of motion	C1	
	0.33 s	A1	**2**
(iii)	$P = W/t$ or $P = Fv$ or substitution ignoring powers of 10	C1	
	1.88 (or 1.86) $\times 10^{8}$ W e.c.f. from (c)(ii)	A1	**2**
		Total for Question 4	**11**

Question 5

(a)	$v = \omega r$ or $v = \frac{2\pi r}{T}$ or $v = 2\pi rf$	C1	
	$\omega = 2\pi \times 45/60$ or correct substitutions for v	C1	
	0.59 ms^{-1}	A1	**3**
(b)(i)	radial arrow from **D** towards centre of disc	B1	**1**
(ii)	$a = \frac{v^2}{r}$ or $a = \omega^2 r$ condone $a = \omega^2 x$ **but not** $a = -(2\pi f)^2 x$	C1	
	2.78 ms^{-2} **but not if shm equation clearly used**	A1	**2**
(c)	recognition that closer toward centre particles need smaller centripetal force	B1	
	support for this: $v \propto r$ or ω = constant along disc	B1	
	idea that friction/electrostatic forces are sufficient to meet the requirements of particles close to centre but not for those further away	B1	**3**
		Total for Question 5	**9**

Question 6

(a)	$Q = CV$ or correctly substituted values ignoring powers	C1	
	0.30 mC	A1	**2**
(b)(i)	$V\uparrow$ vs $Q\rightarrow$ (only)	B1	**1**
(ii)	½ CV^2 or ½ QV or ½ Q^2/C or correctly substituted values ignoring powers	C1	
	2.25×10^{-2} J (e.c.f. from (a))	A1	**2**
(c)(i)	0.68(2) mA (c.a.o.)	B1	**1**
(ii)	either $I = I_0 e^{\frac{-t}{RC}}$ or equivalent	M1	
	substitution of values (including $I/I_0 = 0.1$ which is ok here)	A1	
	logs taken	A1	
	1.01 s	A1	
	or $I = I_0 e^{\frac{-t}{RC}}$ or equivalent	M1	
	correct value for I at 1s (≈ 0.07 mA) e.c.f. I_0	A1	
	ratio of $\frac{I}{I_0}$ shown	A1	
	comment that this is approximately 10%	A1	**4**
(d)	parallel combination stores more energy	B1	
	correct comparison of capacitances in series and parallel*	B1	
	statement of constant voltage and reference to ½ CV^2*	B1	**3**
	The use of Physics terms is accurate; the answer is fluent/well argued with few errors in spelling, punctuation and grammar and 2 or 3 marks for Physics.	2	
	The use of Physics terms is accurate but the answer lacks coherence or the spelling, punctuation and grammar are poor and a minimum of 1 mark for Physics.	1	
	The use of Physics terms is inaccurate; the answer is disjointed with significant errors in spelling, punctuation and grammar.	0	
			2 max
	Total for Question 6		**15**

***max 1 if these are answered qualitatively**

Question 7

(a)(i) no electrons will be released / no current / no effect B1
work function energy not being exceeded / insufficient photon energy to exceed work function / photon frequency below threshold frequency B1 **2**

(ii) more electrons released per second/current increases B1
more photons (of sufficient energy) striking metal surface per second B1 **2**

(iii)

answers must be in corresponding pairs below

cause - B1	**consequence - B1**
electrons collide with air molecules	less electrons reach anode (s^{-1})
photons absorbed by air	less photons reach plate so fewer electrons emitted (s^{-1})
air contaminates plate	(work function ↑) so fewer photons sufficiently energetic to release electrons
cause must be **everything in one pair** of boxes above	ammeter reading or current falls

2

(b)(i) $\lambda = \frac{h}{mv}$ or correctly substituted values irrespective of powers of 10 B1
1.61×10^{-11} m **N.B. "show that"** B1 **2**

(ii) crystal (or named crystalline material) / graphite B1
atomic spacing (condone atomic diameter or distance between nuclei) ≈ λ electrons B1 **2**

Total for Question 7 **10**