ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme
January 2004

GCE

Physics B

Unit PHB5

Marking Scheme

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 Awards meeting 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. Use the following criteria to award marks:

2 marks: Candidates write legibly with accurate spelling, grammar and punctuation; the answer containing information that bears some relevance to the question and being organised clearly and coherently. The vocabulary should be appropriate to the topic being examined.

1 mark: Candidates write with reasonably accurate spelling, grammar and punctuation; the answer containing some information that bears some relevance to the question and being reasonably well organised. Some of the vocabulary should be appropriate to the topic being examined.

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 AE 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 CE (consequential error).

4 With regard to incorrect use of significant figures, normally two, three or four significant figures will be acceptable. Exceptions to this rule occur if the data in the question is given to, for example, five significant figures as in values of wavelength or frequency in questions dealing with the Doppler effect, or in atomic data. In these cases up to two further significant figures will be acceptable. The maximum penalty for an error in significant figures is **one mark per paper**. When the penalty is imposed, indicate the error in the script by SF and, in addition, write SF 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.

PHB5

Question 1

(a)		product of flux and number of turns	B1	
		Wb or equivalent	B1	**2**
(b)		changing primary magnetic field due to alternating voltage (applied to primary)	B1	
		varying flux links with secondary	B1	
		induced emf ∝ rate of change of flux linkage	B1	
		$N_s < N_p$ so less voltage on secondary	B1	**4**
(c)	(i)	equation or correct substitution	C1	
		15.3 V	A1	**2**
	(ii)	<100% flux linkage/flux leakage/copper losses/iron losses/hysterysis losses **not** just "heating" or "heat loss"	B2	**2**

10

Question 2

(a)	(i)	mark at peak of graph	B1	**1**
	(ii)	B =8.8 MeV; allow A in range 53 o 57 (B and A both must be correct)	B1	**1**
	(iii)	B value x A value in MeV	B1	**1**
(b)	(i)	${}^{0}_{1}e$ positron	B1	
		ν neutrino	B1	**2**
	(ii)	**Q: 1 + 1 → 1 + 1 (+ 0 + 0)**	B1	
		B: 1 + 1 → 2 + 0 (+ 0 + 0)	B1	
		L: 0 + 0 → 0 + –1 + 1 + 0	B1	**3**
	(iii)	protons need high (kinetic) energy/k.e. determined by temperature	B1	

		proton energy must be sufficient to overcome the electrostatic repulsion between (similarly charged) protons	B1	**2**
	(iv)	conversion to joules (8.16×10^{-14} J)	B1	
		equation(s) or substitution	C1	
		2.43×10^{-12} m	A1	**3**
(c)		fission involves splitting into two or more less massive nuclei	B5 max	
		fusion involves two lighter nuclei combining to form a slightly heavier nucleus		
		both processes result in net decrease in binding energy which is released as k.e. of reaction products		
		both processes lead to increased b.e.p.n.		
		increase in b.e.p.n. is greater for lighter nuclei undergoing fusion		
		the binding energy of a massive nucleus is greater than that of lighter nucleus because it has more nucleons		
		net reduction in binding energy during the fission of a heavier nucleus is much greater than that occurring during the fusion of two light nuclei		
		the use of physics is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar (**must gain at least 2 for Physics**)	Q2	
		the use of physics is accurate but the answer lacks coherence or the spelling, punctuation and grammar are poor (**must gain at least 1 for Physics**)	Q1	
		the use of the physics is inaccurate, the answer is disjointed with significant errors in spelling punctuation and grammar.	Q0	
				7
				20

Question 3

(a)	(i)	g.p.e. = $G\frac{Mm}{R}$ **must be equation** *(condone "V=")*	B1	**1**
	(ii)	equate with k.e. **must be seen**	M1	
		cancelling **correct *m*** must be seen	A1	**2**
(b)		correct ratios taken ($\frac{v^2}{v_E^2} = 2$)	C1	
		v = 15.8(4) km s^{-1}	A1	**2**
(c)		mention of air resistance	M1	
		k.e. of rocket ➔ internal energy of rocket and atmosphere/ work is done against air resistance	A1	**2**

7

Question 4

(a)		no electric field / no p.d. within electrode	B1	
		hollow cylinder/ conductor at constant potential	B1	**2**
(b)	(i)	equation ($E_k = eV$) or substituted values seen	M1	
		1.14 x 10^{-14} no u.p.	A1	**2**
	(ii)	attempt to apply conservation of energy	C1	
		k.e. of injected ions + gain in k.e. = new k.e.	C1	
		new k.e. = 1.84 x 10^{-14} (J)	C1	
		3.31 x 10^5 ms^{-1} (3.35 x 10^5 ms^{-1})	A1	**4**
	(iii)	Δv = 1.2 x 10^5 (ms^{-1})	C1	
		$T = 1/f$ = 2.5 x 10^{-7} (s)	C1	
		t = 0.05 x 2.5 x 10^{-7} (s)	C1	
		F = 3.22 x 10^{-12} N (3.35 x 10^{-13} N) or $F = ma$ correctly used with candidate's values	A1	**4**
	(iv)	$E = F/Q$ or correctly substituted values	C1	
		2.01 x 10^7 NC^{-1} e.c.f. (2.09 x 10^7 NC^{-1})	A1	**2**

(v)	$E = \frac{\Delta V}{\Delta x}$ or $s = ut + \frac{1}{2} at^2$ etc or substituted values	C1	
	3.5 mm e.c.f. (3.4 mm)	A1	**2**
(vi)	product of 3.3×10^5 ms^{-1} and **any** t	C1	
	$t = 1.12 \times 10^{-7}$ s	C1	
	0.037 m	A1	**3**

19

Question 5

(a)	detects internal or external defects	B1	
	defects weaken system when under stress	B1	
	do not wish to harm system which may already be in use	B1	
	ensures every item produced can be screened for flaws/defects (no defective item supplied)	B1	
	when in use developing defects can be monitored	B1	
	any other relevant idea	B1	**Max 3**
(b)	fatigue occurs when structures undergo variable stress	B1	
	causes cracks to grow/weakens/other relevant comment	B1	
	failure means break/becomes unusable/dangerous	B1	**3**
(c)	**not medical uses – inappropriate with article** radiography – specific example (eg quality control: monitoring thickness of sheet material/testing in use of aircraft)	B1	
	radiography – X or γ radiation penetrates thin sheets easily / can be used with metals or non-metals / rapid feedback to rollers from detector / detects internal defects	B1	
	flux leakage – production quality control / testing in use of steel pipes or tubes	B1	
	flux leakage – ferromagnetic materials strongly magnetised	B1	
	ultrasound – detection of flaws / air bubbles in large casting	B1	

		ultrasound – suitable for metals or non-metals / attenuation with X or γ radiation too great	B1	
		examples should relate to non destructive testing and not other applications e.g. foetal scanning etc.		
		the use of physics is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar (**must gain at least 2 for Physics**)	Q2	
		the use of physics is accurate but the answer lacks coherence or the spelling, punctuation and grammar are poor (**must gain at least 1 for Physics**)	Q1	
		the use of the physics is inaccurate, the answer is disjointed with significant errors in spelling punctuation and grammar.	Q0	**8**
				14

Question 6

(a)	(i)	m and m^{-1} (or equivalent)	B1	**1**
	(ii)	reasonable exponential decay curve (*I* intercept , asymptotic on *x*)	B1	
		constant half-thickness by eye	B1	**2**
	(iii)	attempt to use natural logs or sensible comparison with other exponential decays – half-life/time constant etc.	C1	
		$\ln(½) = -\alpha(0.20)$ or $I = I_0/2$	C1	
		$\alpha = 3.45\ m^{-1}$ (no u.p.)	A1	**3**
(b)	(i)	$T_{\frac{1}{2}} = \frac{0.69}{\lambda}$ or correctly substituted values	M1	
		6.27×10^6 (s)	A1	
		72.6 day	A1	**3**
	(ii)	iridium decaying	B1	
		intensity of radiation from iridium is falling/ 73 days is a relatively short half-life	B1	**2**
				11

Question 7

(a)		flux density within tube cannot be increased further by applying a stronger magnetizing field (owtte)	B1	**1**	
(b)	(i)	current is rate of flow (movement) of charge	B1		
		magnetic field creates a force on moving charge	B1		
		direction of force given by Fleming's left hand rule	B1		
		any other relevant points	**Max 3**		
	(ii)	higher concentration of electrons produces Hall p.d. and hence electric field	B1		
		forces on electrons due to magnetic and electric field are equal and opposite (or balanced)	B1		
		Increasing B increases magnetic force – electric force must increase to balance so Hall p.d. increases	B1	**3**	
(c)		line(s) of flux would be parallel to crack and not project outside it	B1	**1**	
					8

Question 8

(a)		substitution into equation with k ➔10^3 and G ➔10^9 condone answers where the candidate substitutes approximate value of v and produces either E or ρ value	M1		
		8.4×10^3 no u.p. here or appropriate E/ρ	A1	**2**	
(b)	(i)	1.67 mm c.a.o.	B1	**1**	
	(ii)	needs large flaw to reflect	B1		
		if flaw ≈ wavelength diffraction occurs do not allow *defraction* (sic)	B1	**2**	
(c)	(i)	X and Y flaws/holes	B1		
		Z far surface of sample	B1	**2**	

(ii)	(4.3 or 4.4 squares x 2 x 10^{-5} s =) (8.6➔8.7) x 10^{-5} s	C1	
	recognition that time is half that for whole journey	C1	
	depth = (0.21/0.22) m	A1	**3**
(iii)	the surface is not smooth / region between Y and Z far less uniform than other regions	B1	
	so reflections occur at different times/different parts of wavefront travel with different velocities	B1	**2**
	suggestion and explanation must agree to gain both marks		
			12