AQA

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme January 2003

GCE

Physics B

Unit PHB5

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Unit 5: Fields and their Applications

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. 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. 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 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)	the flux density when a conductor carrying a current of 1 A experiences a force of 1 N per metre (condone $NA^{-1}\ m^{-1}$ and $Wb\ m^{-2}$)	B1
		1
(b)	apparatus that would work: coil, pivot, balancing weight	B1
	current direction consistent with arrangement	B1
	direction of force on conductor consistent	B1
		3
(c)(i)	use of $F = BIl$ or $F = BIlN$ or substituted values	C1
	6.6×10^{-2} N	A1
		2
(ii)	induced back emf	B1
	as conductor cuts the magnetic field	B1
		2
(iii)	difference in current = 0.41 A or two correct voltages	C1
	back emf = 0.205 V or $V = IR$ used appropriately	C1
	attempted use of $E = \Delta(N\Phi)/\Delta t$	C1
	$1.02(5) \times 10^{-2}$ Wbs^{-1}	A1
		4
		Total 12

Question 2

(a)	direction changing, velocity vector	B1
		1
(b)	Newton's law equation	M1
	centripetal force equation	M1
	cancel mass of Triton	A1
		3
(c)	$\omega = 2\pi f$ or $\omega = 2\pi/T$	M1
	$\omega^2 r^3$ = constant or $\omega^2 = \frac{GM}{r^3}$	M1
	$\frac{T_T^2}{T_P^2} = \frac{r_T^3}{r_P^3}$ **or** statement of Kepler III for B3	M1
	$\frac{T_T}{T_P} = \sqrt{\frac{(3.55\times10^8)^3}{(1.18\times10^8)^3}} = 5.2(2)$	A1
		4
		Total 8

Question 3

(a)(i)	vertical field line(s)	B1
	directed downwards	B1
		2
(ii)	mv^2/r and Bev seen	M1
	equated and correctly rearranged	A1
		2
(iii)	$v = \frac{2\pi r}{T}$ or equivalent	M1
	$T = \frac{2\pi m}{Be}$	A1
		2
(iv)	no v in the equation for T (m, B and e all independent of v)	B1
		1
(b)(i)	proton spirals outwards/suitable diagram	B1
	as $v \uparrow r \uparrow$	B1
		2
(ii)	$f = 1/T$	B1
		1
(c)(i)	conversion of keV to J (1.92×10^{-17})	C1
	use of ½ mv^2	C1
	1.50×10^5 ms^{-1}	A1
		3
(ii)	$\lambda = \frac{h}{p}$	C1
	$p = mv$ or substituted values	C1
	2.6×10^{-12} m	A1
		3
(iii)	γ-rays or X-rays or answer consistent with candidate's λ	B1
		1
		Total 17

Question 4

(a)(i)	4α's emitted	B1
	A→ A – 16 and Z→Z – 8	B1
	1β emitted	B1
	A→ A and Z→ Z + 1	
	or other appropriate route	B1
		Max 3
	$^{208}_{81}$T1	B1
	accept any equivalent argument leading to this nuclide	
		4
(ii)	each e^- must have $\bar{\nu}$	B1
	the emission of an anti neutrino (L = – 1) cancels electron (L = +1) or any equivalent correct argument	B1
(b)	gas mixes with air and can be breathed in (ingested)	B1
	radon is an α-emitter and α-particles are highly ionizing	B1
	ingested radiosotopes can cause cancers etc.	B1
	half-life of radon is very short compared with rate at which it is produced therefore build up unlikely	B1
		Max 3
	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
		Max 2
(c)(i)	$\lambda = 0.69/T_{½}$	B1
	substituted values	B1
		2
(ii)	$N = N_0e^{-\lambda t}$ or substituted values	C1
	either $\lambda t = 2.73$ or $e^{-\lambda t} = 0.065$	C1
	$m = 5.2 \times 10^{-4}$ kg	A1
	use of 4 $^1/_2$ lives – compensation of 1	
		3
(iii)	lead is still decaying	M1
	leading to increase in bismuth	A1
		2
		Total 18

Question 5

(a)	each droplet must have the same radius/mass/size in order:	B1
	to gain the same charge (when passing through ring electrode)	B1
	to ensure that all charged droplets are reflected equally (when passing through the deflecting plates)	B1
	that the print image is not blurred	B1
		4
	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 physics is inaccurate, the answer is disjointed with significant errors in spelling, punctuation and grammar	Q0
		Max 2
(b)(i)	$\Delta U = Q + W$	B1
	correct description of symbols	B1
	correct sign convention	B1
		3
(ii)	as bubble is heated it expands and does work on surroundings	B1
	either $\Delta U = 0$ or +ve, Q +ve and W –ve	B1
	as bubble collapses either $Q = 0$ or Q –ve, ΔU –ve and W +ve	B1
		3
	or ink returns to the same temperature $\Delta U = 0$	B1
	energy released on cooling<energy gained on heating so Q +ve	B1
	work done by vapour expanding>work done on vapour when contracting W –ve	B1
		Total 12

Question 6

(a)	4000 dots per line	B1
	2×10^5 dots per page	B1
	total number of dots × 20μs per dot (= 4s)	B1
		3
(b)	use of $s = r\theta$	B1
	$\theta = 2.8 \times 10^{-4}$ rad	B1
	statement of this being the smallest angle which two points can subtend and still be distinguished	B1
		Max 2
		Total 5

Question 7

(a)(i)	use of 80 μm and 1.1 $\times 10^3$ kg m^{-3}	C1
	$\rho = m/V$ and $V = 4/3\ \pi r^3$	C1
	$m = 1.1 \times 10^3 \times 4/3\ \pi \times (40 \times 10^{-6})^3$	A1
		3
(ii)	use of $F = mv/t$	C1
	number of drops s^{-1} (= 1/20μs) = 5×10^4	
	2.9×10^{-4} N	A1
		2
(b)(i)	½ mv^2 or substituted values	C1
	5.8×10^{-8} J	A1
		2
(ii)	Vlt or substituted values	C1
	2.2×10^{-5} J	A1
		2
(iii)	0.27 %	B1
		1
(iv)	ink quite good thermal conductor / energy losses will occur at each transition before droplet is formed	B1
	electrical energy → internal energy of (liquid) ink	B1
		2
		Total 13

Question 8

(a)(i)	correct dimensions on diagram	M1
	arrows in correct directions	M1
	scale diagram of sensible dimension with scale marked on it OR $v_v = 20.0 \times \tan 35°$	M1
	14.0 ms^{-1} (± 0.2 ms^{-1} for scale diagram)	A1
		4
(ii)	t = 5.0×10^{-4} / 20.0 or 2.5×10^{-5} s	C1
	a = 5.6×10^5 ms^{-2} (ecf from (i))	A1
		2
(iii)	$F = ma$ or substituted values	C1
	$1.6(2) \times 10^{-4}$N	A1
		2
(iv)	$F = Eq$ or substituted values	C1
	$8.1(2) \times 10^5$ Vm^{-1}	A1
		2
(v)	$E = V/d$ or substituted values	C1
	812 V	A1
		2
(b)	travels 1.0 mm @ 20 ms^{-1} /clear use of horizontal component of velocity and distance	C1
	time = 5×10^{-5} s	A1
	s = ½ gt^2 or 1.2×10^{-8} m	B1
	insignificant distance compared with size of droplet	B1
	attempted comparison of electric force with weigh can score a compensation of 2	**4**
		Total 16