AQA

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme January 2003

GCE

Physics B

Unit PHB6

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Unit 6: Practical Exercises

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.

Exercise 1

(a)(i)	record of L to nearest mm (approximately 0.2 m)	B1
		1
(ii)	Period determined from timing of a suitable number of oscillations (at least 20)	B1
	Repeat and average (must have used at least 10 oscillations)	B1
		2
(iii)	when the strip bends one face is in tension	B1
	when the strip bends the other face is in compression	B1
		2
(b)(i)	Range from maximum to sensible lower limit with justification based on difficulty of measuring small periods or counting fast oscillations	B1
	Sensible interval (dependent on range) chosen with justification	B1
		2
(ii)	Use a named sensor connected to a storage oscilloscope or computer	B1
	Increase the mass used to increase the period for short lengths	B1
	Use veriner callipers to measure short lengths	B1
		Max 2
(iii)	At least 4 measurements for L 8 0.1 m and T_n in addition to that in (a)	
	−1 for each omission; all T_n no less than 10 oscillations	B2
	At least 20 oscillations for all measurements	B2
	repeats and averages for T_n	B2
	repeats and averages for L	B1
	periods correctly calculated (check one) and given to 2 dp	B1
	Consistent sf's in columns	B1
	all units in table correct including log units	B1
	logs in table determined correctly	M1
	logs given to appropriate significant figures (2 or 3 dp)	A1
	Tabulation of data clear (must have repeats; if two tables must include L, T and log values in final table)	B1
		13
(iv)	labels shown log (T/s) and log (L/m) or other correct alternative (Condone ecf from table)	B1
	suitable scale points occupying at least ½ the paper in each direction	
	scale not multiples of three	
	plot in correct quadrant	B1
	plotting accurate	B2
	best line through the points and care in presentation	B1
		5
(v)	equation $\log T = n \log L + \log k$ stated clearly	B1
		1
(vi)	identifies n as the slope of the graph	B1
	large triangle and coordinates correct	M1
	slope consistent with their graph given to 2 or 3 sf (guide value 1.3)	A1
		3
(vii)	reads correct intercept or substitutes data in equation to obtain log k	M1
	allow data from a point in the table in equation in (b) for this mark	A1
	antilog to give k (must be from a point on the line)	**2**

(c)	value for *b* about 11 - 14 mm	M1
	repeat and average	A1
	correct substitution of data	M1
	value for thickness (about 1 mm) consistent with their data	A1
		4
(d)	value of *b* measurement accurate to 5 - 10%	M1
	use a micrometer or vernier callipers to measure b	
	or (if graph data is widely spread)	A1
		2
	the value for *k* since slope of graph has large uncertainty	
	(candidate may make an estimate of this uncertainty)	M1
	make further measurements for different lengths and/or make more repeats of observations	A1
		2

Total 39

Exercise 2

Question 1

(a)(i)	number of oscillations without foil (± 20% of supervisor's value)	B1
	repeat and average	B1
		2
(ii)	± 2-5 oscillations	B1
	Diffiult to judge when amplitude reaches 30 mm so use centre of possible number of oscillations for 30 mm or repeat readings and average (if done) or parallax problems – ensure that observation is perpendicular to the scale at 30 mm	B1
		2
(iii)	energy is proportional to (amplitude)^2	C1
	36% of original energy	A1
		2
(iv)	work done against air resistance	B1
	becomes internal energy in the air	B1
		2
(b)(i)	number of oscillations less than (a)(i)	B1
		1
(ii)	moving magnet causes a change in flux through the foil	B1
	there is an induced emf in the foil	B1
	induced currents (eddy currents) exist in the foil	B1
	Direction gives force opposing the motion of the magnet or mention of Lenz's law	
	the foil has resistance	B1
	there is I^2R heating on the foil or heating due to current in resistance	B1
		Max 4
	the energy becomes internal energy in the foil and air	B1
		1
		Max 5
	at least 3 marks for Physics + the use of Physics is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar	2
	at least 2 marks for Physics + the use of Physics is accurate, but the answer lacks coherence or spelling, punctuation and grammar are poor	1
	the use of Physics is inaccurate, the answer is disjointed, with significant errors in spelling, punctuation and grammar	0
		Max 2
(c)(i)	**ANY 2 from**	
(ii)	distance between the magnet and foil	M1
	less distance increases rate of energy loss since it increases rate of change of flux (or increases induced current)	A1
		2
(i)	strength of the magnet	M1
(ii)	increased strength increases the rate of energy loss since it increases change of flux (or increases induced current)	A1
		2
(i)	thickness of foil or number of layers of foil	M1
(ii)	increased thickness reduces resistance so power loss (ind emf/R) is greater	A1
(i)	resistivity of the metal used in the foil	M1
(ii)	very high and very low resistivity will cause very low energy loss, there will be an optimum resistivity for maximum energy loss	A1
		Total 20

Question 2

(a)(i)	reading of voltage and current at room temperature and in melting ice	B1
	use of $V = IR$ to determine at least one of the resistances correctly	B1
		2
(ii)	resistance depends on the number of charge carriers that are available (per unit volume)	B1
	as temperature falls fewer charge carriers are available to conduct electricity	B1
	less opposition to charge flow due to decrease in amplitude of lattice vibrations	B1
	decrease in charge carrier concentration has greater effect than the decrease in collision rate	B1
		Max 3
	Substitution of correct resistance and temperature value in the equation	C1
	Value for E_g (about 5 x 10^{-20} J) (unit penalty)	A1
		2
(b)(i)	uncertainty in V 0.1, 0.05 or 0.01 V and uncertainty in I = supervisor's value	B1
	calculates percentage uncertainty in R (adding % uncertainties or max/min approach)	B1
(ii)	correct determination of uncertainty in ln R	B1
		3
(c)(i)	sketch showing correct curvature for exponential decay; axes labelled; intercept on 1/R axis; no intercept on 1/T axis	B1
		1
(ii)	thermometer needed	B1
	clear description or diagram of means of changing water temperature	B1
	a safety precaution: e.g. wear protective clothing/ goggles to protect against splashing hot water; do experiment standing to enable quick getaway if accidental spillage	B1
	determine the resistance at >5 different temperatures in the range	B1
	stir and wait to ensure stable temperature or use thermostatic control	B1
	repeat with temperatures increasing and decreasing	B1
	plot graph of ln (1/R) against 1/T	M1
	this should be a straight line of negative gradient if equation holds	A1
		Max 6
	at least 4 marks for Physics + use of Physics is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar	2
	at least 3 marks for Physics + the use of Physics is accurate, but the answer lacks coherence or spelling, punctuation and grammar are poor	1
	the use of Physics is inaccurate, the answer is disjointed, with significant errors in spelling, punctuation and grammar	0
		Max 2
		Total 19