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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 5456
Specification B

PHB3 Practical Examination

Mark Scheme

2006 examination – June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Notes for Examiners

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.

e.c.f. is used to indicate that marks can be awarded if an error has been carried forward (e.c.f. must be written on the script). This is also referred to as a 'transferred error' or 'consequential marking'.

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

c.n.a.o. is used to indicate that the answer must be numerically correct but the unit is only penalised if it is the first error or omission in the section (see below).

Only **one** unit penalty **(u.p.)** in this paper unless there is a mark allocated specifically for giving a correct unit in the marking. Note that the unit is only penalised in the final answer to the question.

Only **one** significant figure penalty **(s.f.)** in this paper.
Allow 2 or 3 s.f. unless otherwise stated. s.f. penalties include recurring figures and fractions for answers.

Marks should be awarded for **correct** alternative approaches to numerical questions that are not covered by the mark scheme. A correct answer from working that contains a physics error (PE) should not be given credit. Examiners should contact the Team Leader or Principal Examiner for confirmation of the validity of the method, if in doubt.

Quality of Written Communication

Before accessing marks for the Quality of Written Communication (QWC) a candidate must first score a minimum of one mark for the physics that is being communicated – this will allow access to 1 mark for QWC. If the candidate scores more marks for physics (a minimum of two or three – depending upon the total mark for that part of the question) then this will allow access to 2 marks for QWC.

Good QWC: the answer is fluent/well argued with few errors in spelling, punctuation and grammar	**2**	
Poor QWC: the answer lacks coherence or spelling, punctuation and grammar are poor	**1**	**Max 2**
Very Poor QWC: the answer is disjointed, with significant errors in spelling, punctuation and grammar	**0**	

PHB3 Practical Examination

Question 1				
(a)	(i)	value for d	**B1**	**6**
		repeat and average	**B1**	
	(ii)	correct for their value of d (typically d/0.42)	**B1**	
	(iii)	$E_K = ½\ mv^2$ seen or used	**C1**	
		correct substitution	**C1**	
		correct for their values (typically 4×10^{-4} J to 10×10^{-4} J)	**A1**	
(b)	(i)	d_2 between twice and four times the value of d_1	**B1**	**3**
	(ii)	correct for their values	**B1**	
	(iii)	correct for their values (typically 3 to 7×10^{-3} J)	**B1**	
(c)		uses or quotes E/x^2 = constant or words to that effect	**M1**	**3**
		finds a constant or calculates E_1/E_2 and x_1^2/x_2^2 or the equivalent	**M1**	
		states an appropriate conclusion for their data	**A1**	
(d)	(i)	0.5 cm to 2 cm	**B1**	**4**
	(ii)	percentage uncertainty calculated correctly	**B1**	
	(iii)	adds 2% to their (d) (ii)	**B1**	
	(iv)	2 × (their (iii)) + 5%	**B1**	
(e)		attempts to use their (d) (iv) and (c) or kinetic energy to assess whether data supports theory within uncertainty limits	**M1**	**3**
		succeeds in using their (d) (iv) and (c) or kinetic energy to assess whether data supports theory within uncertainty limits	**M1**	
		states the appropriate judgement	**A1**	
		1 unit penalty in this question		
		1 sig fig penalty in this question – 2 or 3 s.f. in (a) and (b) 1 or 2 s.f. in (d) (i) 1 to 3 s.f. in (d) (ii) (iii) & (iv)		
				Total 19

Question 2				
(a)	(i)	l measured in metres to 2 or 3 decimal places	**B1**	**7**
	(ii)	2 × their (i) (allow s.f. if consistent with their answer to (i))	**B1**	
	(iii)	two correct overtones drawn	**B1**	
		one overtone – correct frequency stated	**B1**	
		another overtone – correct frequency stated	**B1**	
	(iv)	correct difficulty stated e.g. oscillations fade or difficult to judge resonant length	**B1**	
		2nd practical difficulty or further (physics) explanation of the first	**B1**	
(b)	(i)	correct substitution with their l, $T = 4.0$, $f = 50\,\text{Hz}$	**C1**	**4**
		correct calculation, 2 or 3 s.f., correct unit (kg m^{-1}) (typically about 5 x $10^{-4}\,\text{kg m}^{-1}$)	**A1**	
	(ii)	curvature of the correct type	**C1**	
		evidence showing deliberate drawing of a curve showing inverse proportion	**A1**	
(c)		uses variety of thicknesses or masses (per unit length)	**B1**	**max 6**
		measures mass on a balance	**B1**	
		means of varying f	**B1**	
		means of measuring f	**B1**	
		l and T kept constant	**B1**	
		any means of improving accuracy or safety	**B1**	
		sensible range of m or number of values of m (at least 5)	**B1**	
		plot graph of f against $1/\sqrt{m}$ or f^2 against $1/m$	**M1**	
		should be straight line through origin	**A1**	
		(allow **B1** for candidate that plots f^2 against m **and** explains how to check proportionality)		
		At least 3 marks for physics + **Good QWC** At least 3 marks for physics + **Poor QWC** At least 3 marks for physics + **Very Poor QWC** 1 or 2 marks for physics + sufficient attempt + **Good or Poor QWC** 1 or 2 marks for physics + insufficient attempt or **Very Poor QWC** No marks for physics or **Very Poor QWC**	**2** **1** **0** **1** **0** **0**	**max 2**
				Total 19

Question 3				
(a)		very sharp rise at between 0.5 V and 2 V	**B1**	**2**
		current zero for negative *V* and for some of the positive V values	**B1**	
(b)		expresses idea of using the resistors in series	**B1**	**4**
		expresses idea of using the resistors in parallel	**B1**	
		correct formula given for series or numerical example	**B1**	
		correct formula given for parallel or numerical example	**B1**	
		At least 2 marks for physics + **Good QWC** At least 2 marks for physics + **Poor QWC** At least 2 marks for physics + **Very Poor QWC** 1 or 2 marks for physics + sufficient attempt + **Good or Poor QWC** 1 or 2 marks for physics + insufficient attempt or **Very Poor QWC** No marks for physics or **Very Poor QWC**	**2** **1** **0** **1** **0** **0**	**max 2**
(c)	(i)	101 Ω used	**B1**	**17**
		I and *R* recorded	**M1**	
		repeat and average	**A1**	
		1/*I* recorded to 2 or 3 s.f. with correct unit (A^{-1})	**A1**	
	(ii)	well planned, neatly drawn table with provision for repeats and averages, data entered neatly, with no crossing out or overwriting etc.	**B1**	
		all quantities included, and units (allow e.c.f. from (i) for incorrect but not for missing unit)	**B1**	
	(iii)	original measurements from (c) (i) plus 5 further sets (minus one for each missing set)	**B4**	
		5 further sets of repeats and averages (minus one for each missing set down to zero)	**B2**	
		range from 10 Ω to 101 Ω	**B1**	
		no gaps of more than 25 Ω	**B1**	
		data to consistent, sensible precision within each column allow up to 3 s.f. for 0.01 A precision or up to 4 s.f. for 0.001 A precision	**B1**	
		sensible rounding of average values	**B1**	
		correct calculations of 1/*I*	**B1**	

(d)	(i)	quantities correctly labelled on axes the right way round	**B1**	**11**
		units correct on both axes (e.c.f. for incorrect but not for missing units)	**B1**	
		scales non awkward and covering half of the space in each direction & including origin and extend far enough for the plotting of all points	**M1**	
		6 points correctly plotted (minus one for each error or omission down to zero)	**A2**	
		overall quality of graphical work	**B1**	
	(ii)	reasonable choice of best fit straight line through the points	**M1**	
		good choice of best fit line	**A1**	
	(iii)	good sized triangle shown on graph	**B1**	
		data extracted correctly	**M1**	
		correct calculation of gradient – condone unit and sig figs	**A1**	
(e)	(i)	attempt to use their gradient = k/*E*	**M1**	**4**
		correct determination of k from their value of gradient 2 or 3 s.f. (condone unit)	**A1**	
	(ii)	Intercept recorded or correct substitution method	**B1**	
		r correctly calculated, 2 or 3 s.f. unit given (Ω)		
		(for zero intercept, some reasoning must be shown – minimum 'intercept is zero so internal resistance is zero')	**B1**	
				Total 40