Version 1.0: 0808

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 6456

Specification B

PHB6 Practical Examination

Mark Scheme

2008 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.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

Set and published by the Assessment and Qualifications Alliance.

NOTES
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 Marking 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 question that are not covered by the marking 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**	

GCE Physics, Specification B, PHB6, Practical Examination

Exercise 1			
(a) (i)	both axes clearly labelled with quantity and unit and time scale 0 to 100 s	**B1**	**4**
	eleven points plotted **and** t = 10 s and t = 70 s points plotted accurately	**B1**	
	smooth curve (*no big kinks*)	**M1**	
	good best-fit (*equal scatter of the points*)	**A1**	
(ii)	one value of $T_{1/2}$ in the range 25 to 40 s **or** clear attempt to read $T_{1/2}$ from the graph	**M1**	**5**
	two or more values for $T_{1/2}$ averaged	**A1**	
	$28 < T_{1/2} < 36$ s	**B1**	
	use of $\tau = T_{1/2}/0.693$ **and** $C = \tau/R$	**C1**	
	C with unit, consistent with candidates $T_{1/2}$ (*$T_{1/2} \div 0.069$ in μF*)	**A1**	
(iii)	the charge stored increases	**B1**	**3**
	V_C increases	**M1**	
	$V_S = V_R + V_C$ **OR** $V_R = IR$ with smaller current	**A1**	
(b) (i)	*if help given with circuit deduct 1 or 2 marks at end of question*		**2**
	V_0 = 6.0 V (approx) *2 or 3 s.f. with unit*	**B1**	
(ii)	$V = 0.9 \times V_0 \pm 10\%$ and $< V_0$ *2 or 3 s.f. with unit*	**B1**	
(c) (i)	1/C = 1/100 + 1/100	**C1**	**11**
	C = 50 μF *ignore s.f. but u.p. applies*	**A1**	
(ii) + (iii)	table of results with columns labelled n, V/V and $\ln(V/\text{V})$	**B1**	
	at least four rows fully completed	**C1**	
	all six rows fully completed	**A1**	
	repeat readings for V given (*check (b) (iii)*)	**B1**	
	repeat readings for V for all six rows included **in table**	**B1**	
	correct average for V found for n=1 (*check (b) (iii)*)	**B1**	
	$\ln(V/\text{V})$ found correctly for one value of V	**B1**	
	consistent d.p.s (2 or 3) column by column	**B1**	
	well presented table (*ruled lines and clear figures with no scribbling/overwriting/tipex*)	**B1**	

(d)	$\ln V$ on y-axis with no units or $\ln(V/\mathrm{V})$ or e.c.f. from table	B1	5
	non-awkward scales with points covering at least half-grid on both axes (*count whole squares*)	M1	
	at least five points plotted **and** n = 3 and n = 4 points correct	A1	
	best straight line (*if a minimum 4 points plotted*)	B1	
	overall graph quality (*neat points, axes drawn, sharp pencil, etc*)	B1	
(e) (i)	gradient triangle hypotenuse over half length of the best straight line **and** values taken from the line (*can be implied*)	M1	8
	correct calculation of gradient **including minus sign** (*expected answer approximately -0.1*)	A1	
	clear understanding that gradient $\mathrm{m} = -\mathrm{T/RC}$	M1	
	consistent answer for R (= 100/m in kΩ) *must have opposite sign to gradient and unit*	A1	
(ii)	anti-log of y-axis intercept correctly found to give V_0 **or** other valid method using point(s) from the graph	M1	
	(b) (i) recalled with sensible comment referring to experimental uncertainties	A1	
(iii)	**max 2 from**:		
	difficulties reading stopclock and voltmeter at the same time	B1	
	the capacitors may not all be identical because of tolerances	B1	
	voltmeter resistance may affect the time constant	B1	
	the voltage of the battery may decrease during the experiment	B1	
	poor electrical **contacts** (e.g. crocodile clips)	B1	
		Total	**38**

Exercise 2			
Question 1			
(a)	*if help given with mode of oscillation deduct 1 mark at the end of question*		3
	at least 10 oscillations taken and recorded and sensible T_N found (*see centre sample results*)	**B1**	
	f = 1/T used	**C1**	
	f_N correctly calculated, 2 or 3 s.f. and correct unit (Hz or s^{-1})	**A1**	
(b)	measurements show that $T_S > T_N$ (*check centre sample if not*)	**M1**	2
	f_S calculated correctly *with u.p. and s.f.* if not applied in part (a)	**A1**	
(c) (i)	f_N^2 correctly found *no s.f. or u.p.*	**B1**	5
	sensible estimate for the absolute uncertainty (± 2 to 5% of candidate's value)	**B1**	
(ii)	answer twice uncertainty stated in part (i)	**B1**	
(iii)	$f_N^2 - f_S^2$ correctly calculated **with unit** (Hz^2 or s^{-2})	**B1**	
	correct calculation of % uncertainty, 1 or 2 s.f.	**B1**	
(d)	$H = 1.7 \times 10^{-4} \cos 66°$	**C1**	2
	$= 6.9 \times 10^{-5}$ T *c.a.o. but ignore unit*		
	award one mark for an accurate answer from a scale drawing	**A1**	
(e)	period of oscillation depends on:		max 6
	the length of the magnet/distance between its poles	**B1**	
	the mass of the magnet (***moment of inertia*** *gains one of the above*)	**B1**	
	the strength of the magnet	**B1**	
	the length/other relevant property of the suspension	**B1**	
	to improve sensitivity:		
	a longer magnet should be used	**B1**	
	a lighter/thinner magnet should be used	**B1**	
	a stronger magnet should be used	**B1**	
	lengthen/(make other relevant change to) the suspension	**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 mark for physics + sufficient attempt + **Good or Poor QWC** 1 mark 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	**20**

Question 2			
(a)	values for x and y with unit *check sample values from centre* (x = *60.0 cm* y = *8.0 cm approximately*) both quoted to nearest mm	**B1** **B1**	**2**
(b)	new value for y ($y^{/}$) probably between 2 and 5 cm **less than** value in 2 (a) *check with data supplied by centre if out of this range*	**B1**	**1**
(c) (i)	repeat readings taken and recorded d = 0.20 ± 0.05 mm *u.p. applies* *check with data supplied by centre if out of this range*	**B1** **B1**	**7**
(ii)	use of stress = F/A answer consistent with candidate's readings *e.g.* $= 0.50 \times 9.81/(\pi(0.10 \times 10^{-3})^2) = 1.6 \times 10^8$ unit given as Pa or Nm^{-2} increase in strain (= $(y - y^{/})/x$) calculated correctly *(0.075 a typical value but* ***watch out for*** x **+** y ***used as denominator****)*	**C1** **A1** **B1** **C1**	
(iii)	both unchanged	**B1**	
(d)	Young modulus = stress/strain $= \Delta F/A \div \Delta l/l$ *must be explicit*	**B1** **B1**	**2**

(e)	(i)	longer sample thinner sample } credit if given in part (ii)	**B1** **B1**	max 6
	(ii)	up to 4 marks from:		
		use a pulley instead of a metal rod to reduce friction	**B1**	
		use a travelling microscope/Vernier scale to measure changes in y or x	**B1**	
		use a heavier load to increase the extension	**B1**	
		take readings for a range of loads	**M1**	
		repeat the readings by increasing then decreasing the load step by step	**A1**	
		plot a graph of F against Δl and draw a best fit straight line	**M1**	
		measure the gradient $m = F/\Delta l$	**A1**	
		measure l, calculate A and use these values, together with m, to find E	**A1**	
		for alternative graphs:		
		what is plotted, what the gradient represents, what measurements are needed		
		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 mark for physics + sufficient attempt + **Good or Poor QWC** 1 mark 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	**20**