Version 1.0: 0808

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 5456

Specification B

PHB3 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.

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales (company number 3644723) and a registered charity (registered charity number 1073334).
Registered address: AQA, Devas Street, Manchester M15 6EX
Dr Michael Cresswell Director General

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, PHB3, Practical Examination

Exercise 1				
(a)	(i)	**max 3 from:**		
		white image in centre	**B1**	
		coloured spectrum/images **on either side of lamp**	**B1**	
		1/2/3/several **orders** observable	**B1**	
		orders/spectra of increasing width further from straight through	**B1**	
		blue closest to straight through/red furthest from…	**B1**	
		decreasing intensity further from straight through	**B1**	
	(v)	record value for $h \geq 15$ cm (if tan used, adj ≥14 cm)	**B1**	**9**
		record of x_r – sensible value (in line with h)	**B1**	
		sinθ correctly calculated from values 2/3 s.f.		
		tan$\theta \approx$ sinθ not allowed	**B1**	
		(calculation of θ is neutral provided sin$\theta = \theta$ not stated)		
	(vi)	1/N either as term or value seen (e.g. 3.3×10^{-6} m/ 3.3×10^{-3} mm etc, if 300 lines per mm)	**B1**	
		equation seen or correct substitution of values allow (1/300 etc as being a correct sub)	**C1**	
		correct calculation in range 570-670 nm (any correct prefix allowed or power of 10) u.p.	**A1**	
(b)	(i)	uncertainty in x_r between 2 mm and 5 mm (± not needed)	**B1**	
		uncertainty in h of 1 mm or 2 mm only (± not needed)	**B1**	
		a single 1 mm scores zero/a single 2 mm scores 1 only – unless two values of 2 mm used in calculation in (b) (ii) u.p. once		**5**
	(ii)	method for a single percentage uncertainty (any values)	**C1**	
		both % uncertainties correct (with e.c.f. from abs values)	**A1**	
	(iii)	% uncertainties in (ii) added e.c.f.	**B1**	

(c)	confine beam using a (narrow) slit	**M1**	**max 4**
	light is coming from different angles therefore straight through position inaccurate	**A1**	
	draw a larger triangle	**M1**	
	reduces % uncertainty in x_r and h	**A!**	
	use protractor/set square to obtain right angle	**M1**	
	reduces (absolute) uncertainty in x_r and h	**A1**	
	use brighter (raised voltage/more powerful) lamp/bring lamp closer to grating/perform experiment in dark(er) room	**M1**	
	increases reliability of seeing image/'clearer' image	**A1**	
	use grating of more lines per mm to spread	**M1**	
	smaller d means larger sinθ and θ	**A1**	
	measure 'adjacent' side of triangle and cosθ	**A1**	
	reduces % uncertainty compared with x_r	**M1**	
	repeat and average readings needed for angle	**M1**	
	reduces random uncertainty in (sinθ and) θ	**A1**	
	take readings for higher order images/image on both sides of the straight through position	**M1**	
	allows a mean value for wavelength to be obtained/larger value for angle	**A1**	
	use spectrometer	**M1**	
	means position of beam and angle of light can be known **or** angles measured to a greater precision/uses Vernier scale	**A1**	
	do not allow use camera/simply repeat and average experiment/change the source or use laser or use a filter/move source further away/use 'larger' grating/use more pins/project onto screen/thinner pins/un-named or inappropriate measuring instruments		
	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)		resistance ~ 1 Ω; 1 or 2 d.p.s u.p.	**B1**	**1**
(b)	(i)	measurement of diameter of rod + repeat and average ~ 10 mm	**B1**	**5**
	(ii)	use of number of turns × circumference or πd etc, seen or clearly used	**B1**	
		length consistent with diameter (allow addition of unwound wire a leads) – approx 2.0 m seen (u.p.)	**B1**	
	(iii)	calculated value will be small**er** than actual length	**M0**	
		length of connecting leads ignored		
		wire in centre of insulation so not against dowel (owtte)	**A1**	
		turns helical traverse dowel so extra length	**A1**	
		incomplete turns (either counted or not)	**A1**	
(c)	(i)	min of 'resistance', 'length' '**cross-sectional** area'	**B1**	**3**
	(ii)	correct $\rho \sim 10^{-7}$ using candidate's values	**B1**	
		Ωm	**B1**	
(d)	(i)	sensible room temperature to nearest whole or half degree Celsius u.p.	**B1**	**8**
	(ii)	value of R higher than in (a) + second temperature (ignore s.f. and unit)	**B1**	
	(iii)	graph labelled with ρ against T units consistent with those used previously (axes either way round scores)	**B1**	
		two points marked + consistent (straight or curved) line **passing through points**	**B1**	
	(iv)	two points would allow any graph to be drawn/minimum of 3 points needed	**B1**	
		charge carriers in wire electrons	**B1**	
		increased temperature increases (amplitude of) vibration of lattice ions (condone 'atoms'/'molecules' but **not** 'particles')	**B1**	
		increase in resistance/resistivity caused by increased **rate** (**or frequency or change or probability**) of collision of charge carriers and lattice ions	**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	**19**

Question 3			
(a)	values of L recorded (any appropriate unit) 0.28 m ≤ L ≤ 0.32 m repeat and average (any appropriate unit) correct average 2 or 3 s.f. and in metres	**B1** **B1** **B1**	**3**
(b)	θ value = 140° ± 10° no d.p. (may be in table)	**B1**	**1**
(c) (i)	minimum **5** oscillations repeated and averaged period ~ 1 s (2 or 3 s.f.) u.p.	**B1** **B1** **B1**	**4**
(ii)	several oscillations/repeated and averaged/small oscillations	**B1**	
(d)	all quantities included T_n, T, T^2, θ, $\cos\frac{\theta}{2}$ and $\frac{1}{\cos\frac{\theta}{2}}$ consistent units for T_n, T and T^2 columns/spaces for repeats and averages of T rows for 6 sets of readings and general organisation of the table	**B1** **B1** **B1** **B1**	**4**

(e)	5 **additional** sets of readings (min 10 oscillations, -1 of each missing until 0) **2-9 oscillations → max 2**	**B5**	
	repeats and averages (-1 of each missing until 0)	**B3**	
	correct calculation of $\cos\frac{\theta}{2}$ (check first)	**B1**	
	consistent calculation of $\frac{1}{\cos\frac{\theta}{2}}$ (check first)	**B1**	**13**
	T^2 correct (check first)	**B1**	
	all derived data to 2 or 3 d.p.s **and** all data in columns consistent d.p.s	**B1**	
	overall neatness (no overwriting/crossings out/general untidiness/illegibility)	**B1**	
(f)	T^2 (y-axis) against $\frac{1}{\cos\frac{\theta}{2}}$ with axes labelled	**B1**	
	correct units (s^2) (or units consistent with table)	**B1**	
	scales non-awkward covering at least half plotting area in each direction	**M1**	**7**
	six points correctly plotted (-1 for each omission until 0)	**A2**	
	overall quality of graphical work	**B1**	
	line of good quality in a position that examiner could not improve significantly	**B1**	
(g) (i)	gradient triangle at least half length of line in each direction	**B1**	
	correct coordinates for line	**M1**	
	correct calculation of gradient **no s.f. penalty**	**A1**	**6**
(ii)	recognition that $4\pi^2 k$ = gradient/use of point on line	**M1**	
	consistent value for k (= grad/40) **2/3 s.f.**	**A1**	
(iii)	unit for k = s^2	**B1**	
(h)	equally spaced points would bunch up (owtte) (because of the trigonometric function)	**B1**	**1**
		Total	**39**