Version 1.0: 03/06

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 5456
Specification B

PHB3 Practical Examination

Mark Scheme

2006 examination – January 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.

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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)	reasonable temperature recorded to nearest degree or ½ degree or 0.1 for an average of more than 2 readings	**B1**	
	(ii)	final temperature recorded temperature difference correctly calculated and recorded – allow temperature rise in (iii)	**M1** **A1**	
	(iii)	substitution correct	**C1**	
		energy correctly calculated	**A1**	**7**
	(iv)	calculates the energy input by multiplying power by 240	**C1**	
		subtracts (iii) from this value	**A1**	
		credit calculations performed the other way round – via 'light' power **1 sig fig and/or 1 unit pen anywhere in (a)**		
(b)		larger voltages will produce larger power	**C1**	
		power is proportional to voltage^2 or $P = VI$ quoted	**A1**	**3**
		$P = V^2/R$ or $P = VI$ plus $I = V/R$	**A1**	
(c)	(i)	voltage and current (not amperage or 'amps & volts') accept readings from ammeter and voltmeter	**B1**	
	(ii)	either voltmeter or ammeter correctly connected (ignoring any incorrect positioning of the other meter)	**B1**	**4**
		circuit completely correct	**B1**	
	(iii)	energy = $Pt - E_h$ or any more detailed formula in symbols	**B1**	

(d)	all measurements mentioned: *I, V, t,* plus starting and final temperature at least 5 measurements in the ranges between 0 to 5 V and 0 to 20 with reasonable intervals – accept sensible variations such as 2 – 6 in 1V intervals mass, volume or amount of water and time to be kept constant graph of light energy output against voltage or V^2 or appropriate log graph	**B1** **B1** **B1** **B1**	**4**
	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 + **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	**20**

Question 2			
(a)	transmitted ray parallel to incident ray transmitted ray disappears (from that face) for large *I* total internal reflection starts for large values of *i* increasing angle of incidence leads to greater horizontal separation of incident and transmitted rays greater angle of incidence gives fainter transmitted ray or sensible alternatives	**B1** **B1** **B1** **B1** **B1**	**Max 2**

(b)	(i)	h = 46 mm; k = 59 mm; d = 33 or 34 mm; x = 31 mm +or- 1 mm (minus one for any omission or error down to zero)	**B2**	**9**
	(ii)	1.23 to 1.51 according to their data c.a.o.	**B1**	
	(iii)	all uncertainties + or – 1 mm or ½ mm (minus one for every omission or error to zero)	**B2**	
		single statement of + or – 1 mm gets B1 but 'all uncertainties are + or – 1 mm' gets B2		
	(iv)	correct method for calculating percentage error	**C1**	
		any one uncertainty correctly calculated	**A1**	
		all 4 uncertainties correctly calculated	**A1**	
	(v)	percentage uncertainty for refractive index calculated correctly **s.f. pen**	**B1**	
(c)	(i)	i = 46º or 47º and r = 31º or 32º	**B1**	**2**
	(ii)	1.36 to 1.42 according to their data c.a.o.	**B1**	
		1 unit pen in (b) or (c) but s.f. pen only in (b) (v)		
(d)		comment about dimness of rays	**B1**	**Max 3**
		comment about width of rays (spreading)	**B1**	
		comment about difficulty in marking rays or measuring with apparatus in place	**B1**	
		comment about (lack of) precision in making measurements	**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 + **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	**18**

Question 3				
(a)		records sensible *l* in m	**B1**	
		records *d* in mm (condone additional conversion to m)	**B1**	
		repeats and averages both measurements	**B1**	**4**
		gives *l* and *d* to the nearest mm	**B1**	
		1 unit pen in (a)		
(b)	(i)	marks and labels, with any reasonable labels, the tension in all three strings. must be along or very close to the lines on the diagram	**C1**	
		indicates that the two above the point P have the same tension (could be on diagram)	**A1**	**4**
	(ii)	clear attempt to resolve forces vertically	**C1**	
		$2T\cos\theta = mg$ (any m will do) allow $2T\sin\theta = mg$ if the appropriate angle is shown	**A1**	
(c)	(i)	well planned, neatly drawn table with columns for repeats and averages	**B1**	
		all quantities included, and units	**B1**	
		neat data presentation without crossings out etc (tolerate one or two neat changes)	**B1**	
	(ii)	original measurements from (a) plus 5 further sets (minus one for each missing set) candidates who have clearly measured the wrong *d* get max B2	**B5**	**12**
		5 further sets of repeats and averages (minus one for each missing set down to zero)	**B3**	
		data to consistent, sensible, precision within each column (allow 2 or 3 dp for mass in kg)	**B1**	
(d)		table includes *M, e* and *ed*	**B1**	
		units correct for each quantity – accept *d* in m (*M*/kg; *ed*/ m mm or m^2)	**B1**	**4**
		correctly calculated values of *e*	**B1**	
		correctly calculated values *ed* condone sig figs	**B1**	

(e)	(i)	quantities correctly labelled	**B1**	
		units correct on each axis e.c.f. from (d) – consistent with table	**B1**	
		scales non awkward and covering half of the available space in each direction	**M1**	
		6 points correctly plotted + or – ½ square		**9**
		(minus one for each error or omission down to zero)	**A3**	
		overall quality of graphical work	**B1**	
	(ii)	reasonable choice of best fit straight line through the points	**C1**	
		good choice of best fit straight line through the points – well drawn	**A1**	
(f)	(i)	good sized triangle shown on graph	**B1**	
		data extracted correctly + or – ½ square at each end	**M1**	
		correct calculation of gradient – condone unit	**A1**	
	(ii)	intercept correct + or – ½ square – condone unit	**B1**	**7**
	(iii)	sensible attempt using their value for intercept and gradient	**M1**	
		intercept/grad	**A1**	
		correct answer for their data including unit and sensible sig figs	**A1**	
			Total	**40**