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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 6456
Specification B

PHB6 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**	

PHB6 Practical Examination

Exercise 1				
(a)	(i) &	measurement of L and l_0 to nearest mm with correct unit (about 70 mm for l_0)	**B1**	**4**
	(ii)	repeat and average for L and/or l_0	**B1**	
	(iii)	stretching force = 0.070 × 9.8 = 0.69 N or $\frac{0.070}{(l-l_0)}$	**C1**	
		force per mm = 0.69/{candidate's $(l - l_0)$} (about 0.02 N)	**A1**	
(b)	(i)	S = circumference/2 given to 2 or 3 s.f. + unit (about 35 mm)	**B1**	**6**
	(ii)	e.g. description of difficulty of spotting movement and measuring l at the same time/slipping occurs suddenly large difference in length of spring when slipping occurs	**B1**	
	(iii)	measurement of l to nearest mm	**B1**	
		at least one repeat and average	**B1**	
	(iv)	$F = (l - l_0)$ × their (a) (iii) process correct	**C1**	
		F *correctly calculated to 2 or 3 d.p. with unit (usually about 1.3 N)*	**A1**	
(c)		6 tabulated sets of values of l and S including that from (b) (−1 for each missing or set out of trend)	**B3**	**12**
		3 (or more) measurements repeat and average for l (could be for F) (−1 if repeats of data looks contrived; i.e. spread of 4 mm)	**B3**	
		S to nearest mm or 0.1 mm consistently	**B1**	
		values of F correct to 2 or 3 d.p. consistently (check highest)	**B1**	
		values of ln F process correct (n.b. not $\log_{10}$)	**B1**	
		values of ln F to 2 or 3 d.p. consistently	**B1**	
		all columns have appropriate units (n.b. ln (F/N) as in QP)	**B1**	
		good tabulation (allow one slip and allow separate table for plotting data if link to measured data clear)	**B1**	

(d)	graph axes labelled quantity and unit (consistent with table) S must be in mm	**B1**	**6**
	suitable scale (allow e.c.f. for logs)	**M1**	
	correct plotting check highest and lowest *S*: if accurate 2 marks if either out by ½ square check rest if both out by ½ square –1 and check the rest if either out by more than ½ square –1 and check the rest	**A2**	
	best line	**B1**	
	good presentation	**B1**	
(e) (i)	$\ln F = \ln K + \mu S/R$	**M1**	**11**
	graph should be a straight line/compare $y = mx + c$	**A1**	
	reference to **spread of points** about (best-fit) line supporting or disproving the equation	**B1**	
(ii)	suitable triangle or separation of coordinates	**B1**	
	correct sides and calculation correct	**B1**	
	correct calculation of radius with unit	**B1**	
	gradient = μ/R − stated or implied by working	**M1**	
	value for μ to 2 or 3 s.f. and no unit (about 0.1 – 0.3 if all correct) (lose for a $\log_{10}$ graph) allow if they work consistently in m throughout	**A1**	
(iii)	correct **approach**: • read coordinates of point on line and calculate $\ln K$ using equation in either form • states $\ln K$ = intercept	**M1**	
	correct calculation of *K* to 2 or 3 s.f. (should be about 0.7 N) allow if they work consistently in m throughout (lose for a $\log_{10}$ graph * or intercept not on graph grid or false origin) • penalise s.f.s for **either** μ **or** *K*	**A1**	
	unit for *K* (N)	**B1**	
			Total 39

Exercise 2			
Question 1			
(a) (i)	mentions vibration/oscillation/repeated cycle/reference to frequency **not** bouncing/flickering	**B1**	
	reference that motion applies to the free end **or** movement in a vertical plane/up and down	**B1**	
(ii)	the magnetic field strength/flux density/distance from magnet	**B1**	**5**
	the magnitude of the current	**B1**	
	the length of the foil **that is in the magnetic field/cutting the field/affected by the field**	**B1**	
	(if more than 3 factors, −1 for any not related to BIL)		
(b)	the current and field are at right angles/mention of LHR	**B1**	
	there is an **upward force/moment** on the foil	**B1**	
	the contact breaks/current stops flowing	**B1**	**max 5**
	downward motion/falls due to gravitational force/weight or clockwise moment due to weight or due to elasticity/torque due to bending of the foil	**B1**	
	the foil makes contact with **F** again and the process repeats	**B1**	
	At least 3 marks for physics + **Good QWC**	**2**	
	At least 3 marks for physics + **Poor QWC**	**1**	
	At least 3 marks for physics + **Very Poor QWC**	**0**	
	1 or 2 marks for physics + sufficient attempt + **Good or Poor QWC**	**1**	**max 2**
	1 or 2 marks for physics + insufficient attempt or **Very Poor QWC**	**0**	
	No marks for physics or **Very Poor QWC**	**0**	
(c) (i)	amplitude falls/decreases	**B1**	
(ii)	**for each factor** relevant factor + effect	**M1**	
	simple reasoning	**A1**	**7**
	further detail e.g. links the force acting to energy/momentum/velocity change during an impulse	**A1**	
	(examples on next page)		
			Total 19

	magnetic field strength (strength of magnet) or distance between foil and magnet	**M1**	
	stronger field more amplitude	**A1**	
	greater force when charge flows (*F = BIL)* **extra detail**: foil gains more kinetic energy/velocity/ momentum	**A1**	
	length of foil in the field/length of magnet shorter length less amplitude	**M1**	
	lower force on foil (*F = BIL)*	**A1**	
	extra detail: foil gains more kinetic energy velocity/momentum	**A1**	
	length/width/thickness/mass/density/weight of strip increase gives lower amplitude	**M1**	
	less acceleration when force applied or $a \propto 1/m$	**A1**	
	extra detail: foil loses ke/velocity/momentum over shorter distance	**A1**	
	resistance **of the foil strip** increase lowers amplitude	**M1**	
	greater resistance leads to lower current so lower deflecting force	**A1**	
	foil gains more kinetic energy/upward velocity/momentum	**A1**	
	Young modulus/stiffness of the strip	**M1**	
	higher *E/*stiffer leads to lower amplitude foil decelerates at greater rate	**A1**	
	energy converted to elastic energy for smaller amplitude	**A1**	
	surface area of strip large area lower amplitude	**M1**	
	damping caused by air resistance	**A1**	
	energy gained is lost more quickly	**A1**	
	contact time of foil with 'nail' longer leads to higher amplitude	**M1**	
	force applied for a longer time	**A1**	
	greater change in momentum/more energy	**A1**	
	not gravitational field strength/current in strip unless linked to resistance of the strip		

Question 2				
(a)	(i)	appropriate values of I and V recorded	**M1**	**6**
		repeat and average of both to suitable s.f. (compare their uncertainties for consistency)	**A1**	
	(ii)	V/I calculated with unit (ignore s.f.)	**B1**	
	(iii)	room temperature recorded (allow if seen as e.g. 21 + 273 = 294 K)	**B1**	
		correct conversion to K (temperature between 285 and 300 K)	**M1**	
		calculation of T_r correct to 2 or 3 s.f. with unit	**A1**	
(b)	(i)	difficulty of identifying the instant at which glow starts allow for this mark only: difficult to control the rheostat to make fine adjustments meter readings fluctuate/reference to sensitivity quoted by manufacturer	**B1**	**6**
		sensible suggestion for greater reliability: e.g. start with lamp lit and determine when it stops glowing/do experiment in a dark room allow repeat and average of **readings if done in (a)**	**B1**	
	(ii)	percentage uncertainty in V, I and R correctly calculated or correct equation seen with all components (check % error in R.; R value from (a) (iii) is ±0.1)	**M1**	
		three percentage uncertainties added and answer to 2 s.f. only (penalise any unreasonable absolute uncertainties here)	**A1**	
	(iii)	uncertainty in temperature = ±1 K or ± 0.5 K (°C)	**B1**	
		273 added to the room temperature reduces the % uncertainty in T or room temperature is (e.g. 300 K ± 1 K) i.e. about 0.3 %	**B1**	

(c)	plot graph of *T* against *f* which should be a straight line **through the origin** or show that $T/f = constant$ (allow reference to a diagram if axes and origin clearly labelled)	**B1**	**2**
	calculate frequency using $c = f\lambda$ or look up frequency in manufacturer's data etc	**B1**	
	use a range of different coloured filters (may be implied by 'each')	**M1**	**max 4**
	measure *V* and *I* or *R* for each filter when lamp just glows	**A1**	
	determine the temperature at which lamp glows using each filter	**A1**	
	(allow A1 for repeat procedure in (a) (i) & (ii))		
	maximum 3 points of detail of how wavelength is found: use a diffraction grating or double slit or look up in data book	**B1**	
	known number of lines per mm or spacing known	**B1**	
	measure angle for 'a maximum' or fringe spacing and *D*	**B1**	
	calculate wavelength using $n\lambda = d \sin\theta$ or $\Delta y = \frac{\lambda D}{d}$	**B1**	
	At least 3 marks for physics + **Good QWC**	**2**	**max 2**
	At least 3 marks for physics + **Poor QWC**	**1**	
	At least 3 marks for physics + **Very Poor QWC**	**0**	
	1 or 2 marks for physics + sufficient attempt + **Good or Poor QWC**	**1**	
	1 or 2 marks for physics + insufficient attempt or **Very Poor QWC**	**0**	
	No marks for physics or **Very Poor QWC**	**0**	
			Total 20