Version 1.0: 0905

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 6456
Specification B

PHB4 Further Physics

Mark Scheme

2005 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 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.

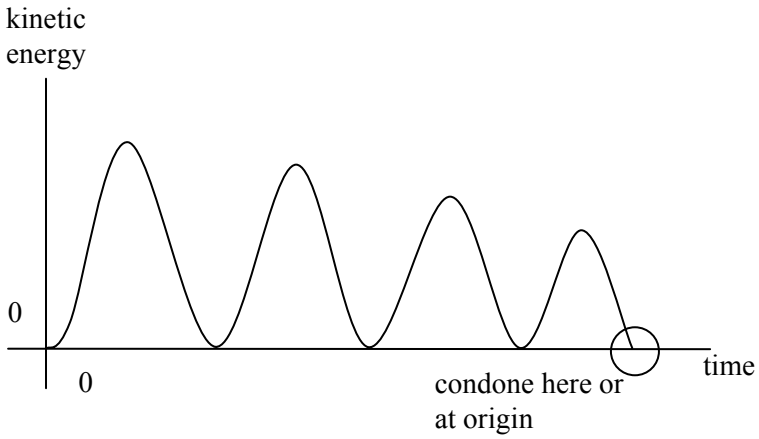
Marks should be awarded for **correct** alternative approaches to numerical questions that are not covered by the marking scheme. A correct answer from working that contains a physics error (PE) should not be given credit. Examiners should contact the Team Leader or Principal Examiner for confirmation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

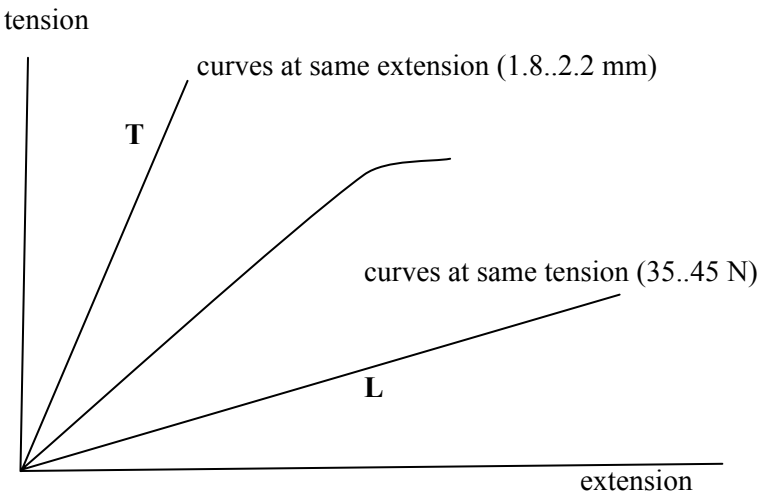
PHB4 Further Physics

Question 1 (a) (i)	$\Delta E = mg\Delta h$ = (16.8+1.2)9.8 x 0.5 *or a mass x 9.8 x 0.5* = **88.2** (J)	**B1** **B1** **B1**	**3**
(ii)	108 J *or answer to (a) (i) + 20 J*	**B1**	**1**
(iii)	108/0.40 *allow ecf from (ii) (i.e. their (ii)/0.40)* 270 N *{68/.4 = 170}*	**C1** **A1**	**2**
(b)	gain in KE = loss in PE – work done = 88-20 = 68 KE = ½mv^2 v = 2.7(5) m s^{-1} *no ecf*	**C1** **C1** **C1** **A1**	**4**
(c)	 graph starts at origin and forms a full rounded peak **exactly** two cycles (4 peaks) shown but not arches height of peaks decreases **and** peaks approximately equally spaced	 **B1** **B1** **B1**	**3**

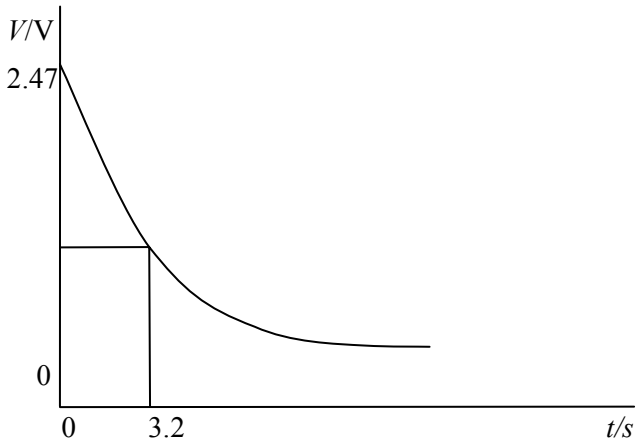
Question 2 (a)	$a = v^2/r$	**C1**	
	$= (7.68 \times 10^3)^2/(6.760 \times 10^6)$ **or** $r = 6380+380$	**C1**	**3**
	$= 8.73\ m\ s^{-2}$	**A1**	
(b)	(the scientist is in) free-fall (owtte)	**B1**	
	his/her **weight provides the centripetal force**	**B1**	
	(to maintain) the same orbit/same radius **and** velocity/same acceleration (as the ISS)	**B1**	**Max 2**
	his/her body experiences no motion/force relative to the ISS	**B1**	
(c) (i)	$k = 4\pi^2 m/T^2$ **or** $T = 2\pi(m/k)^{1/2}$ *and inferred transposition*	**B1**	
	$= 4 \times (3.142)^2 \times 2.0/ (1.2)^2$	**B1**	**2**
	(= 54.8)		
(ii)	*use of* $T = 2\pi(m/k)^{1/2}$ *and* $f = 1/T$	**C1**	**2**
	$f = 5.4 \times 10^{12}$ Hz	**A1**	
(d)	the molecular model proposes that all matter is made up of **molecules** *1*	**B1**	
	kinetic theory assumes that these **molecules** are always moving *2*	**B1**	
	(Brownian motion is) the **microscopic observation** of pollen *3*	**B1**	
	grains/smoke particles *4*	**B1**	
	and their **irregular** movement *5*	**B1**	**Max 5**
	appropriate medium stated *6*	**B1**	
	the fluid comprises **randomly moving (invisible) molecules** *7*	**B1**	
	the **molecules** are colliding with the (much larger) particles *8*	**B1**	
	the collisions result in a (varying) imbalance of forces (on the particles) *9*	**B1**	
	award points as above to a maximum of 5		
	At least 3 marks for physics + well argued, logical description + **Good QWC**	**2**	
	At least 1 mark for physics + **Good QWC**	**1**	**Max 2**
	At least 3 marks for physics + **Poor QWC**	**1**	
	No marks for physics or **Very Poor QWC +** muddled description	**0**	

Question 3 (a)	m = gradient = 0.035 $\pm$ 0.001 ($cm^2\,°C^{-1}$)	**B1**	**4**
	c = intercept = 10.5 $\pm$ 0.1 (cm^2)	**B1**	
	absolute zero = -c/m	**C1**	
	= -300 $\pm$ 10 °C *some relevant working must be seen*	**A1**	
or	a meaningful attempt to use similar triangles	**M1**	**4**
	an accurate value for the base found	**C1**	
	adjustment to the base (if appropriate)	**C1**	
	answer = -300 $\pm$ 10 °C	**A1**	
or	*relevant use of* $V_1/T_1 = V_2/T_2$	**M1**	**4**
	valid introduction of **unknown** temperature	**A1**	
	consistent solution of the equation	**C1**	
	answer = -300 $\pm$ 10 °C	**C1**	
(b)	statement of *or use of* pV = nRT	**C1**	**5**
	accurate reading from the line	**C1**	
	Celsius converted to Kelvin *(+273 or + answer to part (a))*	**C1**	
	n = 4.52 x 10^{-4} **or** 4.11 x 10^{-4} *or 4.2 x 10^{-4} ($\Delta V/\Delta T$)* (mol)	**A1**	
	m = n x 0.044 (m = 4.52 x 0.044 = 2.0 x 10^{-5} kg)	**B1**	

Question 4 (a)	area under graph = work done *stated or clearly applied* *allow use of 1/2FΔl*	**M1**	**4**
	area = 86 $\pm$ 3 *or* 21 $\pm$ 1 (squares)	**A1**	
	scale factor = 0.001/0.004 Jsquare^{-1} **or** correct reading of scales implied	**C1**	
	work done = 0.086 $\pm$ 0.002 J	**A1**	
(b)	A = Fl/(ΔlE) /statement or use of E = F/A/(Δl/l)	**C1**	**3**
	correct substitution ignoring powers of 10	**C1**	
	(A = ((24.5 $\pm$ 0.5) x 3.0)/(1.2 x 10^{11} x 1.2 x 10^{-3}))		
	= (5.1 $\pm$ 0.1) x 10^{-7} m^2	**A1**	

(c)			**2**
	L and T correctly labelled, initially linear and starting at origin	**B1**	
	both lines well drawn	**B1**	

Question 5 (a) (i)	Q = CV	**C1**	**2**
	= 2.47 x 470 x 10^{-6} = 1.16 x 10^{-3} C or 1.2 x 10^{-3} C	**A1**	
(ii)	1.2 x 10^{-3} C *allow ecf from (i)*	**B1**	**1**
(iii)	3.00-2.47 = 0.53 V	**B1**	**1**
(iv)	C = Q/V = 1.16 x 10^{-3}/0.53 = 2200 μF *allow ecf from (ii) and (iii)*	**B1**	**1**
(b) (i)	τ = RC = 10^4 x 470 x 10^{-6} = 4.7 s	**B1**	**1**

(ii)	 graph curves down from (0, 2.47) good shape (does not cut time axis) time to halve *approx* 3.2 s / curve *approx* passes through ((b) (i) answer, ~1 V)	**B1** **M1** **A1**	**3**
(c)	C = 470 + 2200 = 2670 (μF) *allow ecf from (a) (iv)* $E = ½ CV^2$ $= ½ (2670 \times 10^{-6}) (3.00)^2 = 0.012$ J *allow ecf again (0.119 .. 0.013)*	**C1** **C1** **A1**	**3**

Question 6 (a)	$f = c/\lambda = 3.00 \times 10^8/(486 \times 10^{-9})$, $E = hf = 6.63 \times 10^{-34} \times 6.17 \times 10^{14}$ both formulae quoted **or** $E = hc/\lambda$ correct substitution seen $= 4.09 \times 10^{-19}$ (J) *cao with at least 2 sf*	 **B1** **B1** **B1**	**3**
(b)	the electron occupies one of a *limited* number of energy levels *1* when the electron drops from one level to a lower level/ state a photon/energy/light/ is emitted *2* wavelength/frequency/photon energy depends on energy level **difference** *3* each spectral line corresponds to a photon energy/wavelength/frequency *4* *award points as above to a maximum of 3*	**B1** **B1** **B1** **B1**	**Max 3**

(c)	vertical line connecting –1.36 and –5.45 levels downward arrow between any two levels	**B1** **B1**	**2**

Question 7	a clear statement of the First Law: e.g. the increase/change in internal energy of a body is equal to the sum of the heat/energy it receives and the work done on it. *accept $\Delta U = Q + W$ if all terms (and signs) are clearly and correctly stated* *1* **plus** any **five** of the following 8 answers when a hot lump of metal is dropped into cold water its internal energy decreases *2* heat/energy flows from the metal to the water *3* heat/energy flow stops when thermal equilibrium is reached/ temperatures are the same *4* work is done on the metal as it contracts by cooling *5* work done is (average) pressure x change in volume *6* credit **one** other source of work/energy transfer: e.g. work done on the metal by gravity as it falls /on the water/bucket by the lump as it comes to rest /on the water as it is displaced by the lump the hiss of steam as the lump enters the water *7* (total) work done (on and by the metal) is negligible *8* internal energy lost by metal equals internal energy gained by the water *9*	**B1** **B1** **B1** **B1** **B1** **B1** **B1** **B1**	**6**
	At least 3 marks for physics + well argued, logical description + **Good QWC** At least 1 mark for physics + **Good QWC** At least 3 marks for physics + **Poor QWC** No marks for physics or **Very Poor QWC +** muddled description	**2** **1** **1** **0**	**Max 2**