Version 1.0: 03/06

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 6456
Specification B

PHB4 Further Physics

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.

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.

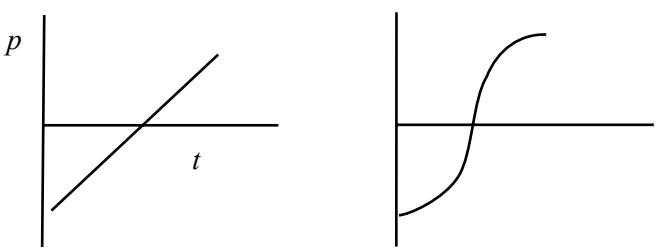
Quality of Written Communication

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**	

PHB4 Further Physics

Question 1				
(a)	(i)	period = 1.8 or 1.9 s or $f = 1/T$	**C1**	**5**
		0.56 (0.556)Hz or 0.53 (0.526) s if T = 1.9 s	**A1**	
	(ii)	0.074 – 0.078 m	**B1**	
	(iii)	frequency remains constant	**B1**	
		amplitude reduces	**B1**	
(b)		attempt shows understanding of $\pi/2$ phase difference (lag or lead)	**M1**	**2**
		constant phase difference and amplitude (acceptable quality)	**A1**	
(c)	(i)	maximum acceleration = $\omega^2 A$ or $\omega = 2\pi f$	**C1**	**5**
		0.91(3) m s^{-2} or 0.83 if T = 1.9 s (e.c.f. from (a) (i)) and (a) (ii)) (not allowed if period given as answer in (i))	**A1**	
	(ii)	(maximum) speed = ωA (0.267 m s^{-1})	**C1**	
		use of KE = ½ mv^2 with at least m (= 8 x 10^{-3}) substituted	**C1**	
		(2.5 to 3.0) × 10^{-4} J	**A1**	
		or		
		maximum restoring force = 8.0 × 10^{-3} × 0.91	**C1**	
		oscillator energy = ½ × F × A or 0.5 × 8.0 × 10^{-3} × 0.91 × 0.075	**C1**	
		(2.5 to 3.0) × 10^{-4} J	**A1**	
			Total	**12**

Question 2				
(a)	(i)	impulse or **change in** momentum	**B1**	**6**
	(ii)	clearly attempts to calculate area or half area under the graph 1.7×0.8, seen gets 1	**C1**	
		total change in momentum = 1.36×10^{-3} (N s) or initial momentum = 0.68 N s $1.7 \times 0.8 \times 10^{-3}$ seen gets 2	**C1**	
		initial momentum = 6.8×10^{-4} Ns (kg m s^{-1})	**A1**	
		or		
		counts squares 5.4 ± 0.3 136 ± 4	**C1**	
		Δmv per square 0.25 ($\times 10^{-3}$) (Ns) 0.01 ($\times 10^{-3}$) Ns	**C1**	
		initial momentum $0.64 - 0.72 \times 10^{-4}$ Ns	**A1**	
	(iii)	 condone positive starts		
		first diagram	**C1**	
		second diagram with time roughly correct	**A1**	

(b)	force experienced **by the television set** lower in Y/greater in X time to come to rest in Y is longer or shorter in X any 2 from impulse = force x time (allow $I = Ft$ if rest of answer implies definition of terms) change in momentum is the same in each case impulse received is the same **or** any 1 from velocity change same in each case deceleration in Y is lower	**B1** **B1** **B1** **B1** **B1** **B1** **B1**	**Max 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	**16**

Question 3				
(a)		$1/C = 1/500 + 1/1000$ or $C = \frac{500 \times 1000}{500 + 1000}$ 330 (333) µF	**C1** **A1**	**2**
(b)	(i)	Q = VC *or* Q = *0.25 × 9* 2.3 or 2.25 C (c.a.o. unit essential)	**C1** **A1**	**7**
	(ii)	*energy* = ½ CV^2 or $0.5 \times 0.25 \times 9^2$ or ½ QV **used** 10(.1) J (allow e.c.f. for Q)	**C1** **A1**	
	(iii)	$V = V_o e^{-t/RC}$ $0.1 = 9\ e^{-t/(8.5 \times 0.25)}$ 9.6 (9.56) s	**C1** **C1** **A1**	

(c) (i)	$Q = mc\Delta\theta$ or mass = volume × density	**C1**	
	correct substitution $10.1 = (2.2 \times 10^{-7} \times 8900 \times 400 \times \Delta\theta)$	**C1**	
	12 (12.3) K or ºC e.c.f. for energy from (b) (ii)	**A1**	**5**
(ii)	some energy raises temperature of the thermometer	**B1**	
	energy/heat lost to (raise temperature of) surroundings	**B1**	
		Total	**15**

Question 4			
(a)	stress = force/area (definition in words or terms in formula defined) or force per unit area	**M1**	
	force and area correctly shown on diagram force arrow producing tension, aligned with wire; allow only one arrow	**A1**	**4**
	strain = extension/**original** length or extension per unit (original) length	**M1**	
	extension and original length correctly shown on diagram diagram must relate to definition: i.e. if definition given as extension per unit length, original length must be 1 m)	**A1**	
(b) (i)	force = $(2 \times 1.5 \times 10^{-2} \times 9.8)$	**C1**	
	$1.2 \times 10^{8} = (2 \times 1.5 \times 10^{-2} \times 9.8)$ /A (condone loss of '2' **or** 9.8)	**C1**	
	area = 2.45 or 2.5×10^{-9} m^2	**A1**	
(ii)	area = πr^2 or $\pi d^2/4$ or 3.14×10^{-8} (m^2)	**C1**	
	$E = \frac{FL}{A\Delta L}$ *or* $\Delta L = \frac{FL}{EA}$ *or strain = Stress/*E *(allow* x *or* e *for* Δl*)*		**6**
	or stress = $\frac{1.5\times10^{-2}\times2\times9.8}{\text{their area}}$ (9.36×10^{6} Pa seen) (e.c.f. for factor of 2 missed)	**C1**	
	$3.2(0) \times 10^{-6}$ m c.n.a.o. number and unit but allow $3.2(0) \times 10^{-7}$ for loss of *g* if e.c.f. from (i)	**A1**	
		Total	**10**

Question 5			
(a)	answer clearly shows understanding that pressure is caused by collision of molecules with the container	**B1**	
	or		
	pressure is in change in momentum of molecules per second per unit area	**B1**	
	any 4 from		
	at constant temperature: when volume increases molecules have further to travel between collisions or molecule collisions spread over larger area	**B1**	**Max 5**
	frequency of collisions (with the container walls) is reduced	**B1**	
	at constant volume: when temperature is lowered (mean) speed/momentum/KE of molecules falls	**B1**	
	change in momentum/impulse (per collision) is lower	**B1**	
	fewer collisions (with the walls) (each second)	**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**

(b)	(i)	cooling or energy transferred from gas due to temperature difference (between gas and surroundings) or gas heats the surroundings	**B1**	
	(ii)	gas must be heated or energy supplied by heating	**B1**	
		otherwise the pressure would fall because temperature/internal energy would fall or use of gas laws leading to need for rise in temperature/internal energy	**B1**	
	(iii)	recognisable attempt to determine area of cycle (condone loss of powers of 10; 13.68 seen) allow statement that net work done is area enclosed	**C1**	**7**
		(1.4) 1.37×10^4 J	**A1**	
	(iv)	efficiency = useful work out/energy input or 0.35 = their (iii)/energy input	**C1**	
		39(.1) kJ (allow 40 kJ if rounded to 1.4 in (iii)) e.c.f. $\frac{\textit{their (iii)}}{0.35}$	**A1**	
			Total	**14**

Question 6				
(a)		lowest energy state/level that the electron can occupy or state in which electron needs most energy to be released or the level of an unexcited electron (not lowest orbit)	**B1**	**1**
(b)	(i)	force = mv^2/r or $mr\omega^2$ and $v = r\omega$	**B1**	**7**
		$8.1 \times 10^{-8} = 9.1 \times 10^{-31} \times v^2/5.3 \times 10^{-11}$ or (v^2 =) 4.72×10^{12} seen	**B1**	
		2.17×10^6 (m s^{-1})	**B1**	
	(ii)	$\lambda = h/mv$ or $6.6 \times 10^{-34}/9.1 \times 10^{-31} \times 2.2 \times 10^6$	**C1**	
		3.3×10^{-10} m	**A1**	
	(iii)	circumference = $2\pi 5.3 \times 10^{-11} = 3.3 \times 10^{-10}$ m	**M1**	
		1 (allow e.c.f. from (ii))	**A1**	
(c)	(i)	$1.9(4) \times 10^{-18}$ J	**B1**	**5**
	(ii)	5.6×10^{-19} J (e.c.f. 2.5×10^{-18} − their (i))	**B1**	
	(iii)	energy difference $E = 3 \times 10^{-19}$ J (condone any difference)	**C1**	
		$E = hc/\lambda$ *or* $E = hf$ *and* $c=f\lambda$ *or their* $E = 6.6 \times 10^{-34} \times 3.0 \times 10^8/\lambda$	**C1**	
		6.6 or 6.7×10^{-7} m	**A1**	
			Total	**13**