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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 6456

Specification B

PHB4 Further Physics

Mark Scheme

2007 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.

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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**	

PHB4 Further Physics

Question 1			
(a) (i)	$T = mv^2/r$ **or** $T = m\omega^2 r$ and $\omega = v/r$ **or** correctly rearranged equation **or** correct substituted values irrespective of powers	**C1**	**4**
	2.29 m s^{-1}	**A1**	
(ii)	$T = 2\pi r/v$ or $T = 2\pi/\omega$ and $\omega = v/r$ **or** calculation of ω from tension (5.09 rad s^{-1}) **or** (a) (i) ÷ 0.45	**C1**	
	1.23 s **or** ecf from v value **or** 2.83 ÷ (a) (i)	**A1**	
(b) (i)	**max 2**		**5**
	weight **or** *mg* **or** *gravitational force* with vertical arrow from centre of the mass (allow up to ~ 20° from vertical) **not** 'gravity'	**B1**	
	tension with arrow towards centre along thread (**do not allow** parallel arrow or **centripetal force** as label)	**B1**	
	air resistance or drag (**not** 'friction') arrow tangential opposite direction to that of rotation	**B1**	
	-1 for each additional incorrect force shown		
(ii)	tension at top lower (lowest) **or** at bottom tension greater (greatest)	**B1**	
	top: weight + tension provide centripetal force **or** $\frac{mv^2}{r} = mg + T$	**B1**	
	bottom: weight opposes tension **or** $\frac{mv^2}{r} = T - mg$	**B1**	
	must include reference to centripetal force or equation to gain 3		
			Total 9

Question 2			
(a) (i)	(heat =) energy supplied or removed by (any of) conduction, convection or radiation/energy transferred because of temperature difference/energy transferred when not in thermal equilibrium	**B1**	**6**
	(internal energy =) total (kinetic) energy of (gas) particles	**B1**	
(ii)	$\Delta U = Q + W$	**B1**	
	condone other consistent versions of equation with consistent definitions of quantities		
	ΔU –ve when internal energy (of system) decreases	**B1**	
	Q –ve when heat removed (from the system)	**B1**	
	W –ve when work done by the system/on surroundings	**B1**	
(b) (i)	**C**	**B1**	**7**
	increase in volume/expansion (as gas does work on surroundings)	**B1**	
(ii)	attempt to use of pV = const	**B1**	
	two points leading to const = 60±1	**B1**	
	three points leading to = 60±1	**B1**	
(iii)	attempted use pV/T or p/T or V/T = const	**C1**	
	(1200-1250) K	**A1**	
			Total 13

Question 3			
(a)	1.0 µF condone 1 µF (cao)	**B1**	**1**
(b)	use of $T = 1/f$ 2.5 ms	**C1** **A1**	**2**
(c) (i)	decay equation in any form V, Q, or I correctly substituted values 0.041 V (cnao)	**C1** **C1** **A1**	**4**
(ii)	reasonable assumption because 0.34% V left or >11 time constants (ecf for reasoned wrong outcome) *do not allow if physics error in (c) (i)*	**B1**	
(d)	1 V held constant 2 f held constant 3 d held constant 4 use of spacers or insulating sheet 5 use of rectangular plates to facilitate calculation of areas of overlap 6 for different areas of overlap (min 5) 7 measure lengths with ruler to calculate areas 8 measure I on ammeter **or** series of ammeter readings **(in context of sensible experiment)** 9 graph of I against area of overlap I series of I/A values 10 should be linear origin graph/ I/A values const (approx)	**B1** **B1** **B1** **B1** **B1** **B1** **B1** **B1** **B1** **B1**	**max 6**
	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 15

Question 4				
(a)		– cosine graph drawn cosine get 1 sine or – sine gets 0 two cycles (only) of constant period and any reasonable sinusoid (no straight lines) allow up to 50% damping	**B2** **B1**	**3**
(b)	(i)	correct period or frequency equation 3.98 Hz or 4 Hz with 0.251 s seen	**B1** **B1**	**6**
	(ii)	$v_0 = \omega A$ or $2\pi fA$ seen or used 2.13 m s^{-1} or 2.14 m s^{-1} or ecf	**B1** **A1**	
	(iii)	attempted use of ½ mv^2 or ½ kx^2 0.903 J **or** 0.907 J **or** 0.916 J **or** 0.882 J **or** 0.899 J	**C1** **A1**	
				Total 9

Question 5			
(a)	longest wavelength of (incident e-m) radiation/light/uv that can liberate electrons	**B1** **B1**	**2**
(b)	Einstein's photoelectric equation correctly quoted in any part of the question	**B1**	**5**
(i)	gradient of the graph	**B1**	
(ii)	(max) k.e. ('y') intercept **or** $h \times$ frequency intercept (ignore sign) or use values at point on line and h, subtract E_k from hf or $h \times$ intercept on frequency ('x') axis	**B1**	
(iii)	c/f_0 or v/f_o with v defined	**B1**	
	reference to frequency (or 'x') intercept **or** hc ÷ (b) (ii) value	**B1**	
(c)	1 increase in intensity increases rate of (electron) emission	**B1**	**max 3**
	2 higher intensity corresponds to more electrons s^{-1}	**B1**	
	3 increase in intensity has no effect on (maximum) ke of (emitted) photoelectrons	**B1**	
	4 no change in energy per incident photon just more photons per second	**B1**	
	5 condone comment that below threshold frequency change of intensity has no effect on rate of electron emission	**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 12

Question 6				
(a)		having discrete/well defined/particular/definite/specific …values or energies	**B1**	**1**
(b)	(i)	so that electrons can remain in an excited state (much) longer **than normal** (or e.g., 10^{-3} s c.f. 10^{-9} s)	**B1**	**4**
		in order to build up a population inversion	**B1**	
	(ii)	the photon energy must match the difference between the energy levels	**M1**	
		one level being the metastable level	**A1**	
(c)		attempted conversion eV → J (may be in calculation)	**C1**	**4**
		use of ½ mv^2	**C1**	
		correct substitution irrespective of powers of 10	**C1**	
		1.56×10^3 m s^{-1} cnao	**A1**	
				Total 9

Question 7				
(a)		clear evidence of idea that impulse or change in momentum is relevant here	**B1**	**2**
		(for fixed change in momentum or impulse) time increasing decreases force (**do not** allow absorption of kinetic energy argument – candidates told in (b) (ii))	**B1**	
		full credit for $F = m\alpha$ argument i.e. increase in time means decrease in acceleration (B1) which means decrease in force (B1)		
(b)	(i)	$a = \Delta v/t$ or $F = \Delta(mv)/t$ equivalent	**C1**	**6**
		$\Delta v = 9.5$ m s^{-1}	**C1**	
		2380 (*825 gains total of 2 marks of these three marks*) condone correct force here (11900 N)	**A1**	
		acceleration below 2940 or 242 g below 300 g		
		if force used 11900 is below 14700 N	**B1**	
		so passes or ecf provided no physics error		
	(ii)	attempt to calculate 2 kinetic energies using ½ mv^2 or ratios with masses cancelled	**C1**	
		76.5 or 76.6 (%)	**A1**	
				Total 8