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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 6456

Specification B

PHB4 Further Physics

Mark Scheme

2008 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**	

GCE Physics, Specification B, PHB4, Further Physics

Question 1				
(a)	(i)	use of $\omega = \sqrt{(8.5/18)}$ = (= 0.687 (rad s^{-1}))	**B1**	**4**
	(ii)	'gravity' appears to act outwards from centre/towards the wall/centrifugal	**B1**	
		mention of inwards/centripetal force acting on astronaut (unless talked about)	**B1**	
		astronaut feels/experiences a reaction at feet/correct statement involving N3	**B1**	
(b)	(i)	[2π/0.69] = 8.98/9.0/9.1/9.15 s *not 9* 1 s.f.	**B1**	**2**
	(ii)	orientation of aerial varies relative to Earth with change in position of station/Doppler shift causes frequency change	**B1**	
			Total	**6**

Question 2				
(a)	(i)	68000	**B1**	**4**
		s [unit] allow $F\Omega$ $k\Omega F$	**B1**	
	(ii)	use of $V = V_0 e^{-t/RC}$	**C1**	
		V = 2.5 e^{-2} = 0.34/0.338 V		
		[alt: $(0.347)^2 V_0$ 0.342 V]	**A1**	
(b)		uses $I = V/R$ condone power of 10 error	**C1**	**5**
		to give 0.147 mA	**C1**	
		attempt to incorporate 0.02 mA	**C1**	
		total initial current = 0.147 + 0.02 = 0.167 mA	**A1**	
		vertical separation of curves decreasing with time starting at candidate initial value (b) (i)	**B1**	
			Total	**9**

Question 3				
(a)	(i)	48 ÷ 1800 seen	**C1**	
		48/(1800 × 0.76 × 0.11) = 0.319 m s^{-1}	**A1**	
	(ii)	use of $Ft = m(v)$	**M1**	
		15.3 N [14.4 from 0.3 m/s; also 15.5 possible from 0.32]	**A1**	**6**
	(iii)	use of power = force × speed	**C1**	
		(15.3 × 0.318 =) in range 4.32 – 5.01 e.c.f. possible	**A1**	
(b)	(i)	use of ½ mv^2	**C1**	
		2.16 – 2.65 [2.16 from ½ × 48 × 0.3^2] 3+ s.f. required	**A1**	
	(ii)	difference is due to need to accelerate the gravel/work done on gravel **by belt/increase in** k.e. **of gravel**	**B1**	**4**
		mention of internal energy change/heat generated in gravel/belt	**B1**	
(c)	(i)	rubber shape correct	**B1**	
		steel shape correct	**B1**	
	(ii)	stress calculated as 2.6 × 10^4/(0.14 × 0.76) = (2.4 × 10^5 N m^2) *condone power of ten error in this mark*	**C1**	**6**
		recognition that strain = change in length/original length, must see l = 78 [m] somewhere	**C1**	
		($\Delta l = \sigma l/E$ =) 12.5 cm [0.125 m]	**A1**	
		appreciation that answer must be to 2/3 s.f. *condone power of ten error in this mark*	**A1**	
			Total	**16**

Question 4				
(a)		max 4 from: matter can behave as particle or wave (depending on the situation) example showing particle behaviour (e.g. photons photoelectric behaviour) example showing wave behaviour (e.g. electron diffraction through graphite) describes reconciliation *e.g. particle has wavelength given by* $\lambda = h/mv$ *good detail about Schrodinger: meaning of wave function/intensity – wave relationship* *where energy goes = wave; how it manifests on arrival* *= particle*	**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 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**
(b)	(i)	$0.023 \times 4 \times 10^{-19}$ seen (9.2×10^{-21}) *condone power of ten error in this mark*	**C1**	**4**
		$5.9 \times 10^{-19} \div 9.2 \times 10^{-21}$ [e.c.f.] *condone power of ten error in this mark*	**C1**	
		64 s	**A1**	
	(ii)	minimum together with sensible reason, e.g. mechanism by which not all energy given to single electron	**B1**	
(c)	(i)	use of $f = c/\lambda$	**C1**	**6**
		$E = hf = 6.2 \times 10^{-19}$ (J) [must show 2+ s.f.]	**A1**	
	(ii)	calculates energy per second = $(0.023 \times 1.2 \times 10^{-4})$	**C1**	
		number of photons = *previous expression*/6.2×10^{-19} = $4.46/4.5 \times 10^{12}$ photons per s [use of $6 \rightarrow 4.6 \times 10^{12}$]	**A1**	
	(iii)	(charge per second = ne) 0.714 → 0.736 μA	**B1**	
	(iv)	not all photons will release electrons/not all electrons will reach detector or other stated mechanism	**B1**	
			Total	**16**

Question 5				
(a)		α and x defined correctly [acceleration; displacement]	**B1**	**3**
		ω defined correctly [angular speed/angular frequency/ angular velocity/2π (*frequency of shm* OWTTE) – not f etc]	**B1**	
		qualifies either α or x in terms of minus sign e.g. acceleration described as towards centre of oscillation **or** displacement described a measured away from centre (of oscillation)/origin/equilibrium position/midpoint/accelerate in opposite direction to displacement etc [*mark as top line + 2nd line, third tick against correct item*]	**B1**	
(b)	(i)	correct time period read off [9.0 s]	**C1**	**4**
		frequency = 1/T = 0.11 s^{-1}/Hz	**A1**	
	(ii)	uses $T = 2\pi\sqrt{(l/g)}$ [$l = gT^2/4\pi^2$]	**C1**	
		length calculated as 20 m/20.1 m	**A1**	
(c)	(i)	correct read off of amplitude [7.5 m] allow 7.2 – 7.5	**C1**	**5**
		$v_{max} = \omega A = 2\pi fA = 2\pi \times 0.11 \times 7.5$ (= 5.18 m s^{-1})	**C1**	
		68.1 – 75.4 kJ [*mgh solutions from 20 m do not score*]	**A1**	
	(ii)	**max 2 of** heating up the sphere/deforming the sphere/ke of wall fragments/ke of sphere as it continues to swing/air resistance/sound with origin specified 'whistling air'/ induced emf in sphere *do not allow 'heat' or 'sound' or 'friction' bald*	**B2**	
				12

Question 6			
(a)	**max 2 of** (small fast-moving) (air) atoms or molecules strike/collide with dust particle OWTTE **atoms/molecules** moving randomly *not dust particle* energy/momentum transferred and dust particle 'jolted' to one side number of collisions differ on different sides of dust particle at one time	 **M1** **A1** **A1** **A1**	**max 2**
(b) (i)	substitute into $n = pV/RT$ [*allow 61 for 334 here*] *but it must be clear; condone power of ten error in this mark* number of molecules [= their $n \times 6.0 \times 10^{23}$] $= 1.6 \times 10^{22}$ *missing T conversion loses one mark ans 8.9 × 10²²*	**C1** **C1** **A1**	**5**
(ii)	straight line through data point going through/directed at -270 → -275 K *must use ruler; ignore labelling*	**B1**	
(iii)	line goes through same temperature axis point as A; half previous gradient	**B1**	
(c)	recognition that pressure is caused by **change of momentum** when atom strikes **wall** of container temperature is the (average kinetic) energy of (all) molecule**s** larger temperature means higher **average** speed/momentum/kinetic energy higher (average) speed means greater momentum exchange at wall/more frequent collisions with wall [*not more collisions*]	**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 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**
(d)	constant volume so W (= $p\Delta V$) = 0 (Q is the) heat/energy **removed** from gas (ΔU is the) **change in**/decrease in/fall in internal energy due to change in temperature *not 'negative'*	**B1** **B1** **B1**	**3**
		Total	**16**