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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 6456

Specification B

PHB4 Further Physics

Mark Scheme

2007 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.

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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)	$p = mv$ or equivalent	C1	5
	2.17 x 10^4 Ns **or** kg m s^{-1} (allow 22 000 **or** 21 700 without s.f.p.)	A1	
(ii)	(use of) conservation of momentum	C1	
	equation with value irrespective of powers	C1	
	0.213 (**or** 0.21 **or** 0.22) m s^{-1}	A1	
(b)	½ mv^2 seen or used	C1	4
	½ kx^2 seen or used	C1	
	substitution irrespective of powers	C1	
	8.47 cm	A1	
			Total 9

Question 2			
(a)	use of $\omega = 2\pi f$ **or** v = 118 m s^{-1} **and** $v = \omega r$	B1	2
	942 (**no u.p.**)	B1	
(b) (i)	tension	B1	4
(ii)	(F =) $m\omega^2 r$ (**or** $F = \frac{mv^2}{r}$) seen or used	C1	
	substitution irrespective of powers (or v = 118)	C1	
	88.4 N **or** 88.7 N **or** 88 N **or** 89 N **c.a.o.**	A1	
(c)	force = rate of change of momentum (words/equation) **or** $F = ma$	C1	3
	substitution irrespective of powers **or** a = 2.2 x 10^4 **c.a.o.**	C1	
	26.5 N **or** 26 N	A1	
			Total 9

Question 3			
(a)	1 sensible comment on work including 'negligible'	**M1**	**max 5**
	2 W +ve or –ve or zero consistent with M mark	**A1**	
	3 ice absorbs heat/energy from system (water) water transfers heat to ice	**M1**	
	4 Q -ve	**A1**	
	5 $Q>W$ **or** $U \propto T$ **or** U falls **or** W and Q both –ve **or** $\Delta U=Q$ consistent with earlier points	**B1**	
	6 ΔU -ve	**B1**	
(b)	ml used or $2.4(75) \times 10^4$ seen	**C1**	**4**
	$mc\Delta\theta$ used or seen	**C1**	
	heat lost by cooling water = heat gained in melting ice + heat gained by melted ice	**C1**	
	final temp = 3.35 °C – 3.38 °C	**A1**	
	4.1(4) °C gains 3 marks		
			Total 9

Question 4			
(a)	1 Brownian motion **or** diffusion named	**M1**	**4**
	2 clear experimental detail of experiment and observation	**M1**	
	3 link observation to a relevant conclusion e.g. movement of smoke **particles** due to collision with air **molecules**	**A1**	
	4 second link to a relevant conclusion e.g. kinetic energy transferred from air **molecules** to smoke **particles**	**A1**	
	At least 2 marks for physics + **Good QWC**	**2**	**max 2**
	At least 2 marks for physics + **Poor QWC**	**1**	
	At least 2 marks for physics + **Very Poor QWC**	**0**	
	1 mark for physics + sufficient attempt + **Good or Poor QWC**	**1**	
	1 mark for physics + insufficient attempt or **Very Poor QWC**	**0**	
	No marks for physics or **Very Poor QWC**	**0**	
(b) (i)	attempt at using $E_K = 3/2kT$	**C1**	**5**
	410 K	**A1**	
(ii)	use of $m = M_m/N_A$ or 4.67×10^{-26} seen	**C1**	
	use of $E_K = \frac{1}{2} m\langle c^2\rangle$ **do not allow** $\frac{1}{2} mv^2$	**C1**	
	$3.6 \times 10^5\ m^2s^{-2}$ **or** $3.7 \times 10^5\ m^2s^{-2}$	**A1**	
			Total 11

Question 5				
(a)	(i)	twice amplitude **or** amplitude = $d/2$	**B1**	**4**
	(ii)	any reasonable sinusoid - minimum single cycle (condone slight attenuation)	**B1**	
		amplitude correctly marked (0.85 mm)	**B1**	
		period correctly marked (1.95/2.0 **ms**) **not** 1/512 etc	**B1**	
(b)	(i)	$(v_{max}) = A\omega$ or $2\pi fA$	**C1**	**4**
		2.73 m s^{1} cao	**A1**	
	(ii)	$(a_{max}) = A\omega^2$ or $(2\pi f)^2 A$	**C1**	
		8.8×10^3 m s^{-2} c.a.o.	**A1**	
				Total 8

Question 6			
(a)	any region between **C** and **F**	**B1**	**1**
(b)	region **AB** (condone **DG**)	**B1**	**1**
(c)	beyond the elastic limit/behaving plastically/past yield pt	**B1**	**max 2**
	masses are removed and stress/strain reduced	**B1**	
	permanent set (owtte) **AG**	**B1**	
(d)	stress/strain	**C1**	**2**
	gradient of **AB** (or **GD**) **or** stress/corresponding strain in region **AB**	**A1**	
			Total 6

Question 7			
(a) (i)	single correct measurement leading to 4.4 - 4.6 s	**B1**	**8**
	second value in range 4.4-4.8 s + average value **(no u.p.)**	**B1**	
(ii)	use of $T_{½} = 0.69RC$	**C1**	
	652/650 μF ecf from (i) if use RC = 6.4 s accept 640 μF	**A1**	
(iii)	recognition that capacitances in same ratio as half-lives **or** statement of time to half for **B** = 2 s	**C1**	
	$C_B = 4/9C_A$ **or** $= 2.9 \times 10^{-4}$ F	**C1**	
	consistent substitution into or rearrangement of series formula	**C1**	
	200 μF **c.a.o.**	**A1**	
(b)	energy of capacitor = $½QV$ or $½CV^2$ or $½Q^2/C$	**B1**	**3**
	correct comparison of Q or V	**M1**	
	consistent correct comparison of V or Q leading to conclusion that energy stored on **B** is greater	**A1**	
	allow E_B = 0.11 J and E_A = 0.05 J for all 3 marks		
			Total 11

Question 8			
(a)	1 bright and dark rings/circles or circular fringes	**B1**	**max 3**
	2 max + min/constructive + destructive	**B1**	
	3 interference or superposition	**B1**	
	4 link to being characteristic of waves	**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**
(b) (i)	$\lambda = h/(mv)$ or correctly substituted values	**C1**	**5**
	1.99×10^{-11} m	**A1**	
(ii)	$\frac{1}{2} mv^2$ or correctly substituted values	**C1**	
	5.96×10^{-16} J **or** 6.0×10^{-16} J	**A1**	
(iii)	wavelength of electrons **much** shorter/similar magnitude to crystal spacing/electron microscope (much) better resolving power	**B1**	
(c)	probability mentioned or loose wording	**C1**	**2**
	probability of finding electron $\propto$ square of amplitude	**A1**	
			Total 12