GCE 2005
January Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Physics Specification B

PHB4 Further Physics

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.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

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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**	
Very Poor QWC: the answer is disjointed, with significant errors in spelling, punctuation and grammar	**0**	**Max 2**

PHB4 Further Physics

Question 1

(a)		$2\pi/T$ or $2\pi f$ **or** angular speed/velocity/frequency/$\Delta\theta \div \Delta t$ *with symbols defined*	**B1**		
		displacement direction opposite to acceleration vector/ acceleration towards central point/equilibrium point	**B1**	**2**	
(b)	(i)	$\omega = 2\pi/T = 2.86$ rad/s *can appear as* $(2\pi/2.2)$ in subst	**C1**		
		F = 0.053(1) N	**A1**	**2**	
	(ii)	to centre of turntable/rotation/circle *not* 'towards centre'	**B1**	**1**	
(c)	(i)	$l = [T^2g/4\pi^2] = 1.20$ m	**A1**	**1**	
	(ii)	correct use of $a = \omega^2 A$	**M1**		
		or accel = v^2/r or F/m approach			
		a = 1.0 / 1.1 / 1.04 / 1.06 m s^{-2} [cao]	**A1**	**2**	
(d)		a origin at zero	**C1**		
		a in antiphase	**A1**		
		k.e always positive and start at maximum	**C1**		
		k.e. twice f and good shape	**A1**	**4**	
				Total 12 Marks	

Question 2

(a)		**total** momentum of system constant/**total** momentum before = **total** momentum after	**B1**		
		isolated system/no external force	**B1**	**2**	
(b)	(i)	clear explanation of method	**B1**		
		correct numerical working leading to 4.25 m s^{-1}	**B1**	**2**	
	(ii)	$F = 0.31 \times$ a speed	**C1**		
		use of speed difference [4.25 – 0.68]	**C1**		
		= 1.11 N [ecf]	**A1**	**3**	
	(iii)	states that two momenta/forces related to hose and wall are equal in size/appreciates reaction force transmitted by hose to Earth	**B1**		
		and in opposite direction	**B1**	**2**	
				Total 9 Marks	

Question 3

(a)	use of $C = A\varepsilon/d$ ignore power of ten error		**B1**	
	$= 38.8 \times 10^{-12}$ F		**B1**	**2**
(b)	**route 1**			
	capacitance changes		**B1**	
	p.d./voltage constant		**B1**	
	so charge [on plates] changes		**B1**	
	flow of charge is current		**B1**	**4**
	route 2			
	capacitance changes			
	voltage/p.d. across capacitor changes			
	therefore p.d./voltage appears across resistor			
	so current			
	Use of physics terms is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar **And gains at least 3 marks for physics**		**B2**	**2**
	Use of physics terms is accurate but the answer lacks coherence or the spelling, punctuation and grammar are poor **and gains at least 1 mark for physics**		**B1**	
	Use of physics terms is inaccurate, the answer is disjointed with significant errors in spelling, punctuation and grammar		**B0**	
(c)	*correct subst in* $T = RC$		**C1**	
	$R =$ 0.39 MΩ [0.375 if 40pF used]		**A1**	**2**
(d)	(i)	*quotes* $C = Q/V$	**C1**	
		calculates $0.2 \times 10^{-12} \times 6 = 1.2 \times 10^{-12}$ C	**A1**	**2**
	(ii)	*quotes* ½ QV **or** ½ CV^2	**C1**	
		calculates $0.5 \times 1.2 \times 10^{-12} \times 6 = 3.6 \times 10^{-12}$ J [e.c.f]	**A1**	**2**
	(iii)	to supply	**M0**	
		capacitance falls/charge falls /less energy stored	**B1**	**1**
				Total 15 Marks

Question 4

(a) **3 from**

He gas excited/later falls to ground state	**B1**	
He excites Ne atoms to metastable state	**B1**	
Ne atoms drop to lower state…	**B1**	
… stimulated by **either** photon **or** descent of e from metastable to level B	**B1**	
coherent light/all photons in phase/all Ne atoms de-excite together	**B1**	
plus	**B1**	
metastable – lasts for [comparatively] long time population inversion – more atoms in higher state than lower	**B1**	**5** **Max 5**
Use of physics terms is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar	**B2**	
And gains at least 3 marks for physics Use of physics terms is accurate but the answer lacks coherence or the spelling, punctuation and grammar are poor	**B1**	
and gains at least 1 mark for physics Use of physics terms is inaccurate, the answer is disjointed with significant errors in spelling, punctuation and grammar	**B0**	**2**

(b)

correct energy difference seen (3.306 – 2.992)/ 0.314	**B1**	
correct use of $E = hf$ with any recognisable energy; calc correct $[4.74 \times 10^{14}$ Hz]	**B1**	**2**

(c) (i)

$E_k = hf - \Phi$ or substitution seen	**C1**	
$E_k = \frac{1}{2} mv^2$ seen	**C1**	
$v = 2.30 \times 10^5$ m s^{-1} [cnao] [5×10^{14} yields 3.05×10^5]	**A1**	**3**

(ii)

$\lambda = h/m_e v = 6.63 \times 10^{-34}/9.11 \times 10^{-31} \times 2.30 \times 10^5)$	**C1**	
[ecf] $= 3.2 \times 10^{-9}$ m	**A1**	**2**

(iii)

diameter of carbon < wavelength [ecf]	**M1**	
diffraction effects not observed OWTTE	**A1**	**2**
		Total 16 Marks

Question 5

(a)		energy required to heat the ice up	**C1**	
		2100 J needed to **raise** / extracted to lower temperature of 1 kg by 1 deg (K or °C)	**A1**	**2**
(b)	(i)	**either** water @ 18 to water @ 0 = 75600 J **or** ice @ 0 to ice at –5 = 10500 J	**M1**	
		water @ 0 to ice @ 0 = 330000 J	**M1**	
		total = 416100 J	**A1**	**3**
	(ii)	cand. bi × 1.5 **or** cand. bi/300	**C1**	
		power = 2080 W	**A1**	**2**
		[0.4 MJ yields 2 kW condone 1 sf; J s^{-1}]		
				Total 7 Marks

Question 6

(a)	pV = *constant* seen	**C1**	
	p = 88 kPa	**A1**	**2**
(b)	completes correct shape curve to (0.85,88 000 **or** 90000),	**B1**	
	then horizontal to 0.35 m^3	**B1**	**2**
(c)	attempts to measure area [graph evidence or words]	**C1**	
	correct use of graph scale	**C1**	
	answer in range (80 – 91) kJ	**A1**	**3**
(d)	done **on** gas because it is compressed	**B1**	**1**
			Total 8 Marks

Question 7

(a)	assumption 1	**B1**	
	assumption 2	**B1**	**2**
(b)	uses k.e. = 3/2 kT **and** T = 294 K	**C1**	
	= 6.17×10^{-21} J	**A1**	**2**
(c)	gases mixed so thermal equilibrium / same temp	**B1**	
	temperature related to **mean** k.e.	**B1**	**2**
(d)	½ $m\langle c^2\rangle$ = 6.17×10^{-21} J [ecf]	C1	
	$\langle c^2\rangle$ = 250000 m^2 s^{-2} [condone unit error] *allow working to go through to* v = 500 m s^{-1} *without penalty*	A1	2
			Total 8 Marks

Paper Total 75 Marks