GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Physics B
Unit PHB4

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 from:

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Marking Scheme

NOTES FOR GUIDANCE

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.

Note: 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.

Where an error carried forward (e.c.f.) is allowed by the Marking Scheme for an incorrect answer, e.c.f. must be written on the script if an error has been carried forward.

Instructions to Examiners

1 Give due credit to alternative treatments which are correct. Give marks for what is correct; do not deduct marks because the attempt falls short of some ideal answer. Where marks are to be deducted for particular errors specific instructions are given in the marking scheme.

2 Do not deduct marks for poor written communication. Refer the script to the Awards meeting if poor presentation forbids a proper assessment. In each paper candidates may be awarded up to two marks for the Quality of Written Communication in cases of required explanation or description. Use the following criteria to award marks:

2 marks: Candidates write legibly with accurate spelling, grammar and punctuation; the answer containing information that bears some relevance to the question and being organised clearly and coherently. The vocabulary should be appropriate to the topic being examined.

1 mark: Candidates write with reasonably accurate spelling, grammar and punctuation; the answer containing some information that bears some relevance to the question and being reasonably well organised. Some of the vocabulary should be appropriate to the topic being examined.

0 marks: Candidates who fail to reach the threshold for the award of one mark.

3 An arithmetical error in an answer should be marked AE thus causing the candidate to lose one mark. The candidate's incorrect value should be carried through all subsequent calculations for the question and, if there are no subsequent errors, the candidate can score all remaining marks (indicated by ticks). These subsequent ticks should be marked CE (consequential error).

4 With regard to incorrect use of significant figures, normally two, three or four significant figures will be acceptable. Exceptions to this rule occur if the data in the question is given to, for example, five significant figures as in values of wavelength or frequency in questions dealing with the Doppler effect, or in atomic data. In these cases up to two further significant figures will be acceptable. The maximum penalty for an error in significant figures is **one mark per paper**. When the penalty is imposed, indicate the error in the script by SF and, in addition, write SF opposite the mark for that question on the front cover of the paper to obviate imposing the penalty more than once per paper.

5 No penalties should be imposed for incorrect or omitted units at intermediate stages in a calculation or which are contained in brackets in the marking scheme. Penalties for unit errors (incorrect or omitted units) are imposed only at the stage when the final answer to a calculation is considered. The maximum penalty is **one mark per question**.

6 All other procedures, including the entering of marks, transferring marks to the front cover and referrals of scripts (other than those mentioned above) will be clarified at the standardising meeting of examiners.

PHB4 Further Physics

Question 1

(a)	(i)	collisions with/bombardment by air molecules (condone particles)	B1	**1**
	(ii)	motion of air molecules ("they are") random (in all directions)	B1	
		fast moving	B1	**Max**
		air molecules small or much smaller than smoke particles	B1	**2**
(b)	(i)	3/2kT or substituted values (independent of powers) do not allow all equations written	C1	
		6.21×10^{-21} J	A1	**2**
	(ii)	$pV = 1/3\ Nm\langle c^2 \rangle$	C1	
		relates Nm/V to ρ	C1	
		$2.4 \times 10^5\ m^2s^{-2}$	A1	
		(allow compensation of ½ $m\langle c^2 \rangle$ for 1)		**3**
	(iii)	there will be a range of speeds	B1	
		there will be molecules with lower speeds than mean /average		
		means higher and lower values	B1	**2**
			Total	**10**

Question 2

(a)	(i)	velocity changes because direction changes or wtte	B1	
		acceleration is the rate of change of velocity/velocity is a vector		
		(allow equation of $a = \Delta v/\Delta t$ as part of answer)	B1	**2**
	(ii)	arrow marked towards centre of circle on Figure 2	B1	**1**
(b)		$(F =) \frac{mv^2}{r}$ or substituted values	C1	
		5.06×10^{-3} N	A1	**2**
(c)	(i)	outer wheel	C1	
		rail pushes on flange or wtte (arrow on diagram ok)	A1	**2**
	(ii)	stress = force/area	B1	
		statement of what affects F (mass/radius/speed)	B1	
		statement that A = area of contact	B1	
		any detail of how the change in the physical quantity is affects stress (e.g. mass increases => force or stress increases; radius of wheel or depth of flange increases => stress decreases)	B1	
		allow access to first three marks for arguments based on vertical force and weight		**4**
		The use of Physics terms is accurate; the answer is fluent/well argued with few errors in spelling, punctuation and grammar and **a minimum of 2 marks** for Physics.		**2**
		The use of Physics terms is accurate but the answer lacks coherence or		

		the spelling, punctuation and grammar are poor and a **minimum of 1 mark** for Physics.		**1**
		The use of Physics terms is inaccurate; the answer is disjointed with significant errors in spelling, punctuation and grammar.		**0**
				Max 2
				Total 13

Question 3

(a)	(i)	acceleration (not a) and displacement (not x) are in opposite directions OR restoring force/acceleration always acts toward rest position	B1	**1**
	(ii)	(+) sine curve consistent with a graph	B1	**1**
(b)	(i)	statement that $E_K = E_P$	B1	
		statement of max values considered	B1	
		$E_P = ½ k(\Delta l)^2$ or $E_{Pmax} = ½ kA^2$	B1	
		correctly substituted values	B1	
		$E_K = 3.7 \times 10^{-2}$ J	B1	
		OR		
		$f = 1/T$ or $T = 3.97$ s or period equation	B1	
		leading to $f = 0.252$ Hz	B1	
		$\omega_{max} = 1.58$ rad s^{-1} or $v_{max} = 0.055$ms^{-1} (seen or used)	B1	
		substituted values into $E_K = ½ mA^2\omega^2$ or $E_K = ½mv^2$	B1	
		$E_K = 3.7 \times 10^{-2}$ J	B1	**5**
	(ii)	any attenuation from t=0 seen	M1	
		10 mJ or $E_0/4$ at either 4s or third hump	M1	
		consistent period values minima at 1 and 3s maxima at 0 and 4s	A1	**3**
				Total 10

Question 4

(a)	$F = \frac{\Delta(mv)}{t}$ or $Ft = mv - mu$ etc.	M1	
	substitute units	A1	**2**
(b)	conservation of momentum mentioned	B1	
	ejected gas has momentum or velocity in one direction	B1	
	rocket must have equal momentum in the opposite direction	B1	**3**
	or		
	force = rate of change of momentum	(B1)	
	ejected gas has momentum or velocity in one direction	(B1)	
	rocket must have equal and opposite force	(B1)	
(c)	equation seen ($F = m/t$ x v but not $F = ma$)	B1	

		substitution into any sensible equation leading to 3.6×10^7 (N)	B1	**2**
			Total	**7**

Question 5

(a)	(i)	$f = c/\lambda$ or correct substitution irrespective of powers 5.26×10^{14} **(**Hz**) not** 5.2×10^{14}	C1 A1	**2**
	(ii)	$\Phi = hf$ or substitution irrespective of powers $3.3–3.5 \times 10^{-19}$ J	C1 A1	**2**
(b)	(i)	statement or clear use of photoelectric equation max ke $=1.2–1.4 \times 10^{-19}$ (J) $\frac{1}{2}$ mv^2 or substituted values ecf for max ke $5.1–5.6 \times 10^5$ ms^{-1} **(cao)**	C1 C1 C1 A1	**4**
	(ii)	same intensity and shorter wavelength =>less photons incident per second fewer electrons emitted per second condone *argument* for unchanged numbers of electrons (based on 1 to 1 correspondence between photons and electrons)	B1 B1	**2**
			Total	**10**

Question 6

(a)		$C = \varepsilon_0\varepsilon_r A/d$ 15.6 nF or 16 nF	C1 A1	**2**
(b)	(i)	2.4×10^9 **(**V**)**	B1	**1**
	(ii)	$\frac{1}{2}$ CV^2 (or $\frac{1}{2}QV$ if attempt to calculate Q made) $4.3–5.0 \times 10^{10}$ J	C1 A1	**2**
	(iii)	36–40 C	B1	**1**
(c)		recognition that 1% of charge or voltage remains any appropriate form of decay equation (either exponential or logarithmic) 3.48×10^6 **Ω cao** (but do not allow if physics error)	C1 C1 A1	**3**
			Total	**9**

Question 7

optical pumping (e.g. flash tube) provides energy to excite electrons (or atoms)	B1
to 3.6 x 10^{-19} J state	B1
spontaneously (after short time) decay to metastable level	B1
metastable level provides long-lived time in excited state	B1
population inversion occurs (or description of pop. inv.)	B1
photon of correct energy (682 nm or 2.9 x 10^{-19} J photon)	B1
causes (stimulates) all electrons to decay in phase/same direction/coherent beam of photons	B1
max 2 any appropriate calculations (e.g. 0.7 x 10^{-19} J and 2.8 x 10^{-6} m photons)	B2
	Max 5

The use of Physics terms is accurate; the answer is fluent/well argued with few errors in spelling, punctuation and grammar and a **minimum of 2** marks for Physics.	**2**
The use of Physics terms is accurate but the answer lacks coherence or the spelling, punctuation and grammar are poor and a **minimum of 1** mark for Physics.	**1**
The use of Physics terms is inaccurate; the answer is disjointed with significant errors in spelling, punctuation and grammar.	**0**
	Max 2
	Total 7

Question 8

(a)	(i)	(temperature pressure and volume) ice, water and steam are in equilibrium or simultaneously or are together	B1	**1**
	(ii)	molecules have minimum (zero) energy/molecules stationary/zero internal energy	B1	**1**
(b)	(i)	thermodynamic temperature scale or ideal gas equation	C1	
		correct substitution into equation	C1	
		1060 K or 1100 K	A1	**3**
	(ii)	for each point name effect that detracts from use explanation of that effect		
		can't get good thermal contact with many systems or wtte	B1	
		size of bulb makes immersion difficult	B1	
		slow to respond to temperature changes	B1	
		glass bad conductor	B1	
		can be inaccurate (must be linked to reason to allow this)	B1	
		dead-space means gas not all at same temperature	B1	
		volume not constant	B1	
		bulb expands on heating	B1	

thermal capacity of bulb large	B1
energy (or heat) extracted from the system (thus altering its temp)	B1
	Max 4
	Total 9