GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Physics B
Unit PHB6

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.

PHB6 Experimental Work

Exercise 1

(a)	(i)	correct magnitude to 2 or 3 sf and unit (about 6 V)	B1	**1**	
	(ii)	p.d. after 10 s > 0.5 (i); sf consistent with (i) u.p if not penalised in (i)	B1		
		repeat and average (allow 2 or 3 sf in average)	B1	**2**	
	(iii)	p.d across the capacitor increases **or** charge on plate repels other electrons	B1		
		p.d. across the resistor decreases	B1		
		current (through the resistor) decreases	B1	**3**	
	(iv)	power = V^2/R or $I = V/R$ **and** $P = VI$	C1		
		(their E)^2/22 000 correctly calculated to 2 or 3 sf with unit (about 1.6 mW)	A1	**2**	
	(v)	immediately the switch is closed (at $t = 0$) OWTTE when the capacitor starts to charge	B1	**1**	**9**
(b)	(i)	5 further possible sets of values of R and V (−1 for each missing or impossible set; -1 for any one out of trend) (possible R values/kΩ: 11; 13.2;16.5; 33; 44; 55; 66; (77; 88; 110)	B2		
		repeats and average for each set (−1 for each missing) allow if repeats taken and they say ln (E–V)value is the average	B2		
		units for raw data correct ((kΩ or Ω for R)	B1		
		consistent d.p. for V (must have repeats)	B1		
		values of ln (E–V) correct to 2 or 3 dp (check one) e.g. R = 22 kΩ might give ln (6.5 – 3.5) = 1.10	B1		
		values of $1/R$ in Ω^{-1} correct to 2 or 3 sf only (check one) $1/R$ /$10^{-5}\Omega^{-1}$ 9.1; 6.3; 4.5; 3.0; 2.3; 1.8; 1.5; 1.3; 1.1; 0.91	B1		
		unit for $1/R$ correct (allow kΩ^{-1})	B1		
		correct unit for ln (E–V); ln {(E–V)/V} **condone ln (E–V)/V** **or** ln (E–V) where (E–V) is in V	B1		
		good tabulation of data (condone split tables if clearly presented) no overwriting, untidy crossing out etc.	B1	**11**	

	(ii)	graph axes labelled (lose if wrong way round)	B1		
		units consistent with table (–1 for no unit on $1/R$ axis)	B1		
		suitable scale (lose for wrong plot e.g. $\log_{10}(E$–V) or ln V)	M1		
		correct plotting of 6 points (-1 for only 5 points)	A2		
		best line (must have at least 4 plotted points)	B1		
		good presentation	B1	**7**	
	(iii)	suitable triangle or separation of coordinates	B1		
		correct sides (allow ±1 square; ½ square in coordinates)	M1		
		correct calculation to 2 or 3 sf and **negative** (about –20 000)	A1	**3**	
	(iv)	gradient = $-10/C$ or $-t/C$ where t = 10 s or correct substitution of point that is on the line not allowed if gradient is positive and the negative sign is lost in later working or if wrong graph is plotted	B1		
		unit correct (F or μF)	C1		
		value for C about 500 μF (ignore sfs) (using candidates gradient; NB no ecf for R left in kΩ condone carrying through negative sign if consistent)	A1	**3**	**24**
(c)	(i)	time to reach voltage in (a) (about 30 s)	M1		
		repeat and average	A1	**2**	
	(ii)	correct use of ratio or determines constant etc or substitution in equation (a) (ii) = (a) (i) $e^{-(c)(i)/22000\ C}$ or gradient = their (c) (i)/C	M1		
		value for total capacitance about 3 x their (b)(iv) (about 1500 μF allow ecf for R in kΩ)	A1	**2**	
	(iii)	quotes or clearly uses $C = C_1 + C_2$	C1		
		value for X correct from candidate's data + unit (ignore sfs) (c) (ii) – (b) (iv)	A1	**2**	**6**
					39

Exercise 2

Question 1

(a)	(i)	Record of initial temperatures of sand and water and final temperature with unit	M1		
		All given to one dp and to nearest 0.5°C lose for incorrect conversion to K	A1	**2**	**2**
	(ii)	Substitution of data correct	M1		
		Value for *c* correct for candidates data (e.g. 1000 to 2500 J kg^{-1} K^{-1})	A1		
		value given to 2/3 sf only + unit	B1	**3**	**3**
(b)	(i)	(absolute uncertainty) 1 K or 1°C unit essential (accept in form as above or ± 1K) (if all (a) (i) to nearest degree then allow ±2 K	B1	**1**	**1**
	(ii)	correct calculation of percentage uncertainty in a temperature difference	C1		
		adds at least two percentage uncertainties or adds two fractional uncertainties including one temperature	C1		
		adds all 5 percentage uncertainties that are correctly calculated	A1	**3**	**3**
(c)		Δ*U* increases (is positive) since temperature rises since or water gets warmer or there is (net) energy transfer into the water or there is heat/thermal energy supplied to the water or molecules have more KE or Q increases and W increases or Q increases and W is unchanged (if consistent with other statements)	B1		
		W increases (is positive) since work is done to bring the water to rest when it is added or work done on the water when it is stirred or work done against atmosphere as water expands	B1		
		Q increases (is positive) since water is heated by energy transfer from the warmer sand or heat (energy) flows from sand to water or there is heating of water by the sand or water is in contact with a hotter body (OWWTE) **Allow B1 if 'increase; increase; increase' without explanation**	B1	**3**	**3**

(d)	energy gained from/exchanged with (condone lost to) surroundings/hands/measuring cylinder	B1			
	use lagging and/or a lid for the sand container or use a vacuum flask	B1			
	take temperature of the water immediately before adding to the sand	B1			
	not all water leaves measuring cylinder	B1			
	determine **masses** by weighing/using scales	B1			
	add sand to water rather than water to sand (in any context)	B1			
	temperature differences are small	B1			
	use more sensitive (condone accurate) thermometer (allow use of temperature sensor/probe)	B1			
	mix sand with water that is at a stated temperature $>2\theta_S$ **or** increase the temperature of the sand	B1			
	allow other sensible modifications				
	measure water volume more accurately using pipette/burette/tall narrow measuring cylinder	B1 B1			
	repeat readings and take average				
	use thermometer with lower thermal capacity				
	Not use mechanical mixer or mix more thoroughly use of computer monitoring over time				
	Any 6			**6** **Max 6**	
	At least 3 marks for Physics + use of Physics is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar			**2**	**2**
	At least 1 mark for Physics the use of Physics is accurate, but the answer lacks coherence or spelling, punctuation and grammar are poor			**1**	
	the use of Physics is inaccurate, the answer is disjointed, with significant errors in spelling, punctuation and grammar			**0**	
				Max 2	
					20

Question 2

(a)	(i)	separation of pole faces with unit given to nearest mm (35 to 70 mm)	B1	**1**	**1**
	(ii)	as separation decreases the displacement of Q increases or displacement of Q varies inversely with separation (condone $1/r^2$)	B1		
		the closer the pole faces are the greater the force experienced by Q (must refer to force not just stronger field strength)	B1	**2**	**2**

(b)	(i)	Arrow down (along dotted line) labelled weight or *mg* or *W* gravitational force (not gravity)	B1		
		Arrow on thread toward pivot and labelled tension -1 for any additional forces	B1	**2**	**2**
	(ii)	Any correct moments equation: weight x *d* = horizontal force x vertical distance of force below the pivot or e.g. $W\,d = F\cos\theta$ (x 1); θ must be labelled correctly on diagram or $W\sin\theta$ (x 1) = $F\cos\theta$ (x 1)	B1		
		(weight is constant and) for small displacements vertical distance is constant ≈ length of nylon thread or for small angles cos θ ≈ 1	B1	**2**	**2**
		or for second equation above: sin $\theta = d/(1)$ and for small angles cos $\theta \approx 1$			
(c)		statement that if $F \propto 1/r^2$ $d \propto 1/r^2$ (i.e. reasoning behind the test)	B1		
		suitable test calculate dr^2 (stated or implied) or calculates *k* for one set and uses this to predict *d* or *r* for other sets substitute values in $\ln F = \ln k - 2\ln r$	M1		
		Correct calculations using at least 3 sets of data e.g. of dr^2, to at least 2 sf 14625; 14283; 14415; 14400 (-1 for each incorrect) or ln *k* or *k* calculated correctly	M1		
		calculations for all 4 sets of data correct to more than 2 sf	A1		
		Conclusion that within limits of uncertainty in measurements the data verifies the law or values are similar or approximately constant or about the same **so relationship is proved**	A1	**5**	**5**
		NB must gain at least 1 mark for remote sensing for full Physics marks in (d)			
(d)		**Reason For Remote Sensing**			
		experimenter might affect charge on the spheres or experimenter may carry a charge	B1		

experimenter might disturb spheres due to air movement	B1	
Light Spheres Or Light Suspension Needed		
electric force between charged spheres is small or is smaller than magnetic force between the two magnets	B1	
the spheres/suspension have to be light: so that the spheres will move more easily/move more or otherwise they would not move	B1	
Long Thread Suspension Needed		
long length of suspension increases the displacement	B1	
light thread increases displacement or enables the spheres to move more easily	B1	
Charge Leakage Problem		
use insulator/nylon for suspension	B1	
use glass rod insulator rather than metal mass	B1	
large distance between the spheres and the bench	B1	
Effect Of Ruler	B1	
discusses effect of using a metal or plastic ruler **or** why a wooden ruler is preferable		
Use Of Camera		
stores data for later analysis	B1	**Max 5**
allows enlargement of image for greater accuracy	B1	
Not camera increases accuracy of readings reduces parallax error		
At least 3 marks for Physics + use of Physics is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar		**2**
At least 1 marks for Physics the use of Physics is accurate, but the answer lacks coherence or spelling, punctuation and grammar are poor		**1**
the use of Physics is inaccurate, the answer is disjointed, with significant errors in spelling, punctuation and grammar		**0**
		Max 2 **19**