GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Physics B
Unit PHB1

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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or

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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.

PHB1 Foundation Physics

Section A

Question 1

(a)		$7.5 = 15 \sin \theta$ **(or** $15 \cos \theta$) (i.e. attempt to resolve and equate)	C1	
		$\theta = 30°$ (cao) (**n.b. unit** accept deg or degree)	A1	**2**
(b)		$F = 15 \cos 30$ or $15 \sin 60$ (if wrong way round) = 13 N or $F = (15^2 - 7.5^2)^{1/2}$	B1	**1**

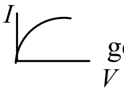
Question 2

(a)	(i)	2.4 m s^{-2}	B1	**1**
	(ii)	$F = ma$	C1	
		132 000 N (ecf from (i))	A1	**2**
(b)		final speed = $(890^2 + 60^2)^{1/2}$	C1	
		892 m s^{-1} (cao) (allow 890 m s^{-1} as final answer but 892 must be seen in working)	A1	**2**
(c)		$\tan^{-1}$ 60/890 or $\sin^{-1}$ 60/892 = 3.9° (3.86)° or $\cos^{-1}$(890/892) = 3.8 (4)° or $\sin^{-1}$ 60/890 =3.9° (3.86)° if ecf from (b)	B1	**1**

Question 3

(a)		Force arrow shown downwards at the edge slab starting within the bar and within contact region of slab with bar	B1	
		Force shown upwards at **C and** weight acting downwards starting within the bar (no labelling required) –1 for each extra forces but no negative marks	B1	**2**
(b)	(i)	350 x a distance = 'F' x a distance e.g. 350 x 1.8 = F x 0.55	C1	
		350 x (1.80 – 0.55) = F x 0.55 (this gets 2 C marks)	C1	
		F = 795 (800) N	A1	**3**
	(ii)	1590 (1600) N (2 x their (i))	B1	**1**

Question 4

(a)	voltmeter, ammeter and lamp connected correctly to measure V and I must include a cell	B1	
	cell and potentiometer correctly connected with other components across the output terminals	B1	**2**
(b)	0.24 A	B1	**1**
(c)	 general shape Line through origin and correct curvature clear (condone levelling off)	B1	**1**

Question 5

(a)	$R = \rho L/A$	C1		
	$A = 2.0 \times 10^{-6}$ (m^2) or $\pi(0.8 \times 10^{-3})^2$ seen in equation (condone $\pi(1.6 \times 10^{-3})^2$ or 8.04×10^{-6} seen)	C1		
	L = 2900 m, 2940 m, 2960 or 3000 m	A1	**3**	
(b)	resistance leads to loss of heat/energy/power or I^2R loss or voltage drop (across cable)	B1		
	lower current lowers loss of heat/energy/power or reduces voltage drop	B1		
	ac can be transformed (to lower transmission current)	B1	**3**	**25**

Section B

Question 6

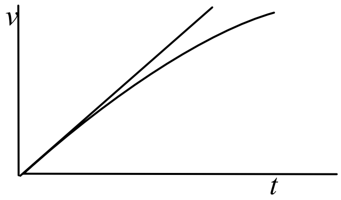
(a)	(i)	PE = $mg\Delta h$ or mgh or correct numerical substitution (condone g = 10 m s^{-2})	B1	
		$3.6(3) \times 10^{13}$ J (accept 3.6 or 3.7)(NB not only 4.0×10^{13} J) **no up**	B1	**2**
	(ii)	$mg\Delta h = ½ mv^2$ or $E = ½ mv^2$ or numerical substitution **n.b. not** $v^2 = u^2 + 2as$	M1	
		85 (84.9) m s^{-1} or use of 4×10^{13} J giving 89 m s^{-1}	A1	**2**
	(iii)	$E = Pt$ or $t = ½ mv^2/P$ or numerical substitution i.e. time = their (i)/400 x 10^6 or 4 x 10^{13}/400 x 10^6 or time = their (i)/100 x 10^6 or 4 x 10^{13}/100 x 10^6 (allow attempt using incorrect v from (ii) for this mark only) **(note no further ecf for incorrect v)**	C1	
		90 000 s or 1 x 10^5 s	C1	

		or 3.6×10^5 s or 4×10^5 s 100 – 112 hours (i.e. forgetting to include factor of 4)		
		25 hours or 27.8 (28 h) (using 4×10^{13})	A1	**3**
	(b)	inefficiency of the pump or generator/turbines with no further detail **(This is a compensation mark and is not awarded if any of the next three marks are given)**	B1	
		work done/power/energy/heat lost due to friction in pumps or generators/turbines	B1	
		energy/power/heat lost in transmission/generator/pump due to current/resistance in wires I^2R heating collisions of electrons with lattice etc **not just** energy lost in the wires	B1	
		KE of water not reduced to zero in the generator/not all KE converted to electrical energy	B1	
		energy lost due to friction between water and ground/pipes or moving stones as water falls or due to turbulence in water or viscosity of water	B1	
		distance from reservoir to generator < lake to reservoir	B1	**Max 3** **10**
		not water evaporation/sound/resistance in pipes		

Question 7

(a)	$s = \frac{1}{2} at^2$	C1	
	9.6 m s^{-2}	A1	**2**
(b)	lower value obtained	M1	
	air resistance has a greater effect on the ball	A1	
	resistive force is same/higher (for given speed) and downward force/weight/gravitational force lower **or** **resultant** downward force will be lower for the lower mass/ball **or** ball reaches terminal velocity quicker/sooner	A1	**3**
	Allow B1 for no change since acceleration is independent of mass		
(c)	curve drawn with correct shape always below the given line	C1	

	(line may or may not be shown reaching terminal velocity)				
	curve showing a time greater than given line; initial slope as given line		A1	**2**	**7**



Allow B1 only as ecf for same line drawn or statement that there is no change for those who say acceleration is independent of mass

Question 8

(a)	(i)	**X**	B1	**1**	
	(ii)	thermistor (not semiconductor)	B1	**1**	
(b)	for X increased temperature increases **amplitude** of lattice vibrations		B1		
	increases rate of collision of electrons/charge carriers with lattice (condone atoms/ions/particles/molecules or more frequent (or more chance of collisions) of electrons/charge carriers with lattice ions etc or lowers drift velocity of electrons through the wire or makes it more difficult for electrons to move through the wire		B1		
	allow B1 for the vague answer vibrate more so more electron/charge carrier collisions				
	for Y more electrons available for conduction at higher temperature		B1	**3**	
	At least 2 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 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**	
(c)	(i)	26°C	B1	**1**	
	(ii)	550 Ω to 555 Ω or attempt to add R_X to R_y at 70°C (i.e. condoning misread graph)	C1		
		8.1 to 8.2 (8.11 to 8.18) mA (Not 8 mA i.e. do not allow sfa)	A1	**2**	**10**

Question 9

(a)	(i)	resistance inside the battery **or** resistance of component/chemicals in the battery **or** resistance of the cell/battery	B1		
		some pd is used (lost) to pass current/charge through the internal resistance or **internal** resistance gives rise to lost volts or terminal pd = emf – current x internal resistance (lost volts) (no symbolic equations unless terms defined)	M1		
		in X there is no current /open circuit (so no pd is lost) or in Y there is a current (so pd is lost)	A1	**3**	
	(ii)	$V = E - Ir$ or 3.1 = 4.5 – 0.39 r (n.b. 4.5 = 3.1 – 0.39 r gets 0)	C1		
		r =3.6 (3.59) Ω	A1		
		their r/3 (1.2 Ω if correct)	B1	**3**	
(b)	(i)	Reading on voltmeter in **X =** 1.5 V	B1	**1**	
	(ii)	Resistance in circuit **Y =** 8.0 + 3.6 = 11.6Ω	C1		
		their (i) / (8 + their total internal r) (1.5/11.6 = 0.13 A if correct) **or** lost volts = 3.6/11.6 x 1.5 = 0.47 V (allow ecf for r)	A1	**2**	**9**
		terminal pd = 1.5 – 0.47 = 1.03 V (must see working for this mark)	C1		
		1.03/8 = 0.13 A if correct	A1		

Question 10

(a)	(i)	quotes potential divider formula or $R \propto V$ or $R_1/R_2 = V_1/V_2$ or 150/(150 +75) x 6 = V or 150/(150 + x) x 6 = 4	M1		
		correct manipulation to arrive at 75Ω or arrives at 4 V and relates this to given maximum output **or**	A1	**2**	
		current = 4/150 = 0.0267 A	M1		
		R = 2/0.00267 or 2/(4/150)=75 Ω	A1		
	(ii)	$P = V^2/R$ or I^2R or VI or total R = 225Ω	C1		
		0.16 W (0.162 to 0.164 W)	A1	**2**	
(b)	(i)	0.4 V or 0.40 V	B1	**1**	

	(ii)	3.5 mm	B1	**1**
	(iii)	Use more bits when representing data digitally or use a higher binary number to represent 4 V	B1	
		increase the supply voltage	B1	
		decrease value of **R**	B1	
		use a shorter variable resistor of same resistance **or** use variable resistor of higher resistance but same length	B1	**Max 2**
(c)		May give one example of each or two examples of fast event or two of capture over a long time but must be **significantly different** Must be sensible physical quantity in a sensible situation over a short/long time Sensible situation where fast capture is needed	B1	
		Not possible to take readings quickly enough because event happens quickly	B1	
		Sensible situation where data capture is needed over long time Must be sensible physical quantity in a sensible situation over a short time	B1	
		Readings over long time so inconvenient returning to take readings frequently/humans need a break or other sensible reason	B1	**4**
		Note: Not timing a single event/triggered timing (e.g. frequency/count rate/time for a ball to fall). Not for safety reasons or control situations		
		At least 2 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 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 **13**

Acceptable situations for use of:

Fast capture	**Slow capture**
position- time variation for an oscillator	Monitoring (radio) activity in a sensible place (e.g. laboratory background) over a long time Measuring variation of temperature **with time** e.g. in a greenhouse/nuclear reactor/ laboratory
monitoring temperature produced by a chemical reaction	Voltage variation of a discharging cell
damping of oscillator (a pendulum)	
current change when switching on a lamp	medical examples: monitoring heart beat/blood pressure/ temperature of a patient over time
voltage-time variations for charging a capacitor (short time constant)	Rate of photosynthesis over a long time
Measuring a short half life r/a decay	checking changes in sea levels over day/week etc.
	recording sensible named weather data over a period of time
	monitoring changes in operation of an engine
	Monitoring vibrations in Earth
	Stress/strain sensors on a bridge
	Measuring stress/strain in a wire over a long time

Unacceptable situations seen:

Fast capture	**Slow capture**
Time for a ball to hit the floor	Using LDR to control light intensity in a 24 hour photosynthesis experiment
measuring frequency of oscillations	Measuring a long half life
use of digital photography	measuring iron rust over time
measuring the speed of light/sound	