Published Mark Schemes for GCE A2 Physics

Summer 2010

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NORTHERN IRELAND GENERAL CERTIFICATE OF SECONDARY EDUCATION (GCSE) AND NORTHERN IRELAND GENERAL CERTIFICATE OF EDUCATION (GCE)

MARK SCHEMES (2010)

Foreword

Introduction

Mark Schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of 16- and 18-year-old students in schools and colleges. The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes therefore are regarded as a part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

The Council hopes that the mark schemes will be viewed and used in a constructive way as a further support to the teaching and learning processes.

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ADVANCED
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Physics

Assessment Unit A2 1

assessing

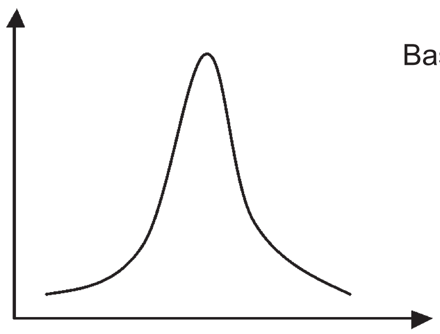
Momentum, Thermal Physics, Circular Motion, Oscillations and Atomic and Nuclear Physics

[AY211]

THURSDAY 27 MAY, AFTERNOON

MARK SCHEME

				AVAILABLE MARKS
1	**(a)** Displaced to one side then to the other Returns to starting position or about a fixed point	[2]		
	(b) Tangent where displacement = 0 Large triangle Max velocity = $(0.15 - (-0.15) \times 10^{-3}) / 100 \times 10^{-6}$	[3]		
	OR $v = \Omega x$ $v = 2\pi (0.3 \times 10^{-3}) / 600 \times 10^{-6}$ $\Omega = 1.05 \times 10^{4}$ rad s^{-1} (sub info from graph)	[3]		
	(c) **(i)** The product of mass and velocity	[1]		
	(ii) $p = 1.4 \times 10^{-25}$ (ecf candidate's max velocity) kg m s^{-1} or Ns	[2]		8
2	**(a)** **(i)** Sketch of working apparatus to show: fixed mass of air method to vary pressure	[2]		
	(ii) Adjustment to pressure consistent with their diagram Measuring pressure (Bourdon gauge etc) Volume proportional to length of tube (consistent with their diagram)	[3]		
	Quality of written communication **2 marks** The candidate expresses ideas clearly and fluently, through well-linked sentences and paragraphs. Arguments are generally relevant and well structured. There are few errors of grammar, punctuation and spelling. **1 mark** The candidate expresses ideas clearly, if not always fluently. Arguments may sometimes stray from the point. There are some errors in grammar, punctuation and spelling, but not such as to suggest a weakness in these areas. **0 marks** The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage.	[2]		
	(b) **(i)** Gradient = nRT $12200 = 5.30 \times 8.31 \times T$ T = 277 (K) $\theta = 277 - 273$	[3]		
	(ii) Steeper gradient through origin	[1]		11

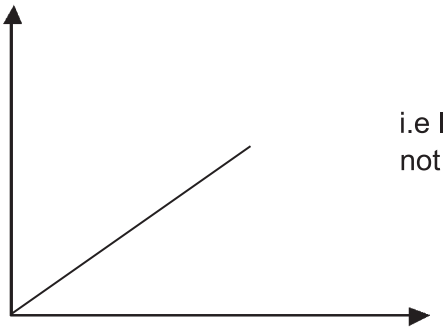
					AVAILABLE MARKS
3	(a)	(i)	$\omega = \theta / t = 2\pi/T$ $\omega = 2\pi / (172 \times 3600)$ (ω = is 1.01×10^{-5} rad s^{-1})	[2]	
		(ii)	$v = \omega r$ t = $2\pi r/t$ $v = 1.01 \times 10^{-5} \times 1.07 \times 10^{9}$ $v = 1.09 \times 10^{4}$ (m s^{-1}) Wrong ω used, max 1 mark	[3]	
	(b)	(i)	$F = mv^2/r$ $F = 1.64 \times 10^{22}$ (N)	[2]	
		(ii)	Towards Jupiter/the centre of its orbit or centripetal	[1]	8
4	(a)	(i)	**Mass-spring** system	[1]	
		(ii)	(Rotating) cam	[1]	
	(b)	(i)	Label (Amplitude on y-axis), x_0, A  Basic shape	[2]	
		(ii)	Immerse masses in water or similar or attach a (light weight) lamina of large surface area to the masses	[1]	
		(iii)	Curve showing: reduced amplitude flatter peak displaced to lower frequency –1 no label	[3]	
	(c)		32 (Hz)	[1]	9

AVAILABLE MARKS

5 (a) (i) radius of a nucleon [1]

(ii) mass number or number of nucleons [1]

(b) (i)



i.e linear graph
not necessarily through origin [1]

(ii) r_o = gradient [1]

(c) (i) r = 1.20 $(109)^{0.333}$ [1]

(ii) mass = 109 × (1.66 × 10^{-27}) = 1.81 × 10^{-25} (kg)
volume = 7.88 × 10^{-43} (m^3)
density = 2.30 × 10^{17} (kg m^{-3})
SE 2.5 × 10^{19} → 1/3 [3]

(iii) Similar densities
Nuclear packing is consistently tight or density independent of A [2] 10

6 (a)

	Mass /u	Charge / C
Alpha particle	4	+ 3.20 × 10^{-19}
Beta particle	(1 / 1840)	-1.60 × 10^{-19}
Gamma radiation	0	0

Each correct row [1] mark [3]
Penalty; –1 once only for using 'e'

(b) (i) Collisions with molecules/atoms/ions (of the medium)
Cause energy to be transferred (from the decay particle) [2]
(Ionisation 1/2)

(ii) ^{1} Larger charge or ^{2} Travelling slower / A More interactions per second
^{3} Larger mass, B greater momentum loss per collision
(1 – 3) Property → 1
(A, B) Consequence → 1 [2]

				AVAILABLE MARKS
(c)	r = Beta since atomic number increases by 1 s and t = Alpha since atomic number decreases by 2 or mass number decreases by 4 (must both be correct and unambiguous for the mark) (don't accept no change in mass on its own for r!) stating t and s are the same decay		[3]	10
7 (a) (i)	Basic curve Detail: 8.8 MeV at ~ 60 & ~ 7.5 MeV at A = 240		[2]	
(ii)	Average energy required to (completely) remove a single nucleon from its nucleus or converse or BE/no nucleus + BE explained		[1]	
(b) (i)	Fission is splitting of heavy nuclei Fusion is joining of light nuclei		[2]	
(ii)	Energy liberated when BE/nucleon increases, increased stability/ increased mass defect Both fission & fusion result in nuclei with larger BE/nucleon		[2]	
(iii)	Greater increase in BE/nucleon		[1]	8
8 (a) (i)	Uranium-235		[1]	
(ii)	Deuterium & tritium		[1]	
(b) (i)	1. Neutron 2. • to allow capture by the target nucleus or enhance likelihood of fission • Introduce a moderator (heavy water/graphite) to the pile • Neutrons collide with moderator atoms and lose energy		[4]	
(ii)	1. (D and T) ions or protons 2. • KE is increased • to overcome mutual electrostatic repulsion		[3]	9

		AVAILABLE MARKS
9 **(a)** $(\lg(f)) = \lg k + n \lg y$	[2]	

(b)

f / Hz	**y / m**	**lg (f/Hz (or s^{-1})**	**lg (y / m)**
256	3.32	2.41 (2.408)	0.521
317	2.68	2.50 (2.501)	0.428
422	2.01	2.63 (2.625)	0.303
513	1.66	2.71 (2.710)	0.220
627	1.36	2.80 (2.797)	0.134

Titles/headings
Values for lg f accept 2 or 3 decimal places
Values for lg y accept 2 or 3 decimal places
More than 1 value incorrect penalty 1 mark [3]

(c) **(i)** Axes: scales using at least half available grid
Plot : ± 2 mm tolerance (< 2 wrong)
BFL: an appropriate trend line [3]

(ii) Gradient process
$n = -1 \pm 0.2$

Intercept/anti-log process or by calculation
k in range 750 – 1250 [4]

(iii) Obtaining $\lambda = 0.4y$
Use of $v = f\lambda$
$v \sim 340$ (m s^{-1}) but consistent with their values [3]

(d) Subs $dB = 10 \log (1.32 \times 10^{-3} / 1.0 \times 10^{-12})$
$= 91$ (dB)
(S.E. 88dB scores ½)
121.2 dB → 10^n error → ½ [2] 17

Total **90**

New Specification

Rewarding Learning

ADVANCED
General Certificate of Education
June 2010

Physics

Assessment Unit A2 2

assessing

Fields and their Applications

[AY221]

WEDNESDAY 9 JUNE, MORNING

MARK SCHEME

Section A

AVAILABLE MARKS

1 (a)
- **Attractive** force (between 2 point masses) [1]
- (directly) proportional product mass
  inversely proportional to square of separation [1]

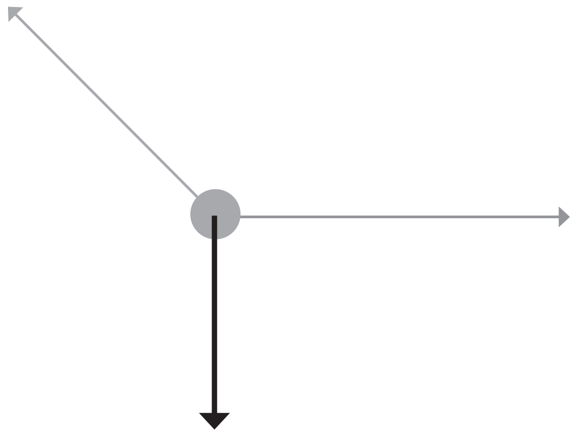
(b) (i) $F = \frac{Gm_s m_e}{(r_e + h)^2}$ symbols as stem [1]

(ii)
- $g = \frac{Gm_e}{(r_e + h)^2}$ or $\frac{Gm}{r^2}$ Eqn
- $= \frac{6.67 \times 10^{-11} \times 6 \times 10^{24}}{(6.4 \times 10^6 + 3.5 \times 10^5)^2}$ Subs
- $= 8.78 m\ s^{-2}$ ($8.8 m\ s^{-2}$) Ans [3]

(iii)
- Both astronaut and station experience centripetal **force**
- Both accelerate towards centre at **same rate** or falling at the same rate
- No interaction [3] 9

				AVAILABLE MARKS
	Equation or statement			
2 **(a)**	• $F = \left(\frac{1}{4\pi\varepsilon_o}\frac{q_1q_2}{x^2}\right)$ or k	• or force proportional to product of charges • force inversely proportional to square of separation		
	• All Symbols explained		[2]	

(b) (i)



[1]

(ii) • PC = $(0.60^2 - 0.30^2)^{0.5}$ = 0.52 m

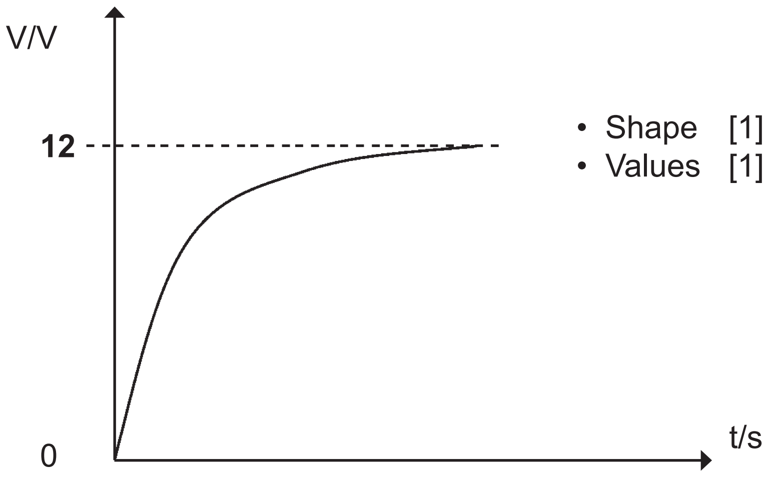
• × = 0.60 – PC = 0.08 m [2]

(iii) • $F = 9 \times 10^9 \times (5 \times 10^{-6} \times 3 \times 10^{-6}) / (0.08)^2$
• = 21 (N) [2]

(iv) • 1. sinθ = 0.3/0.6 = 0.5
• = 30^o [1]
• 2. T cosθ = 21
• T = 24.4 (N) allow ECF (iii) [2] 10

			AVAILABLE MARKS

3 **(a)**



• Shape [1]
• Values [1] [2]

(b)
- Initially, rapid flow of charge carriers/electrons
- Voltage rises quickly
- As charge builds up, flow of charges decreases

Accept "current" only if defined in terms of charge carriers [3]

(c)

• 2t identified	or $V = V_oe^{-t/cr}$		[1]
• t = 24 s	$1.64 = 12.0_e\,[^{-48}/(6 \times 10^{-6}R)]$	Subs	[2]
• CR = 24	R = 4 (MΩ)		[1]
• R = 4 (MΩ)			[4]

9

4 **(a)** **(i)** Induced emf
equals rate of change of flux linkage
or proportional [2]

(ii) Sketch showing: magnetic field
conductor
voltmeter or CRO or ammeter } 2 marks (–1 each omission to zero)

Prose to:
- explain how the change in flux linkage is achieved
- relate the change to the detector variation

i.e.
- what is done to apparatus
- what effect this has on flux lineage
- relate change to detector variation

} 3 marks [5]

(b) EMF = $(600 \times 10^{-6} \times 4.0 \times 10^{-3} \times 1) / 0.8$
$= 3 \times 10^{-6}$ (V)
$i = (3 \times 10^{-6} / 2.6 =)\ 1.2 \times 10^{-6}$ (A) [3]

10

AVAILABLE MARKS

5 **(a)**
- A.c.voltage at primary generates alternating B field
- Magnetic field links with secondary coil through the core
- Changing magnetic field induces emf in secondary [3]

Quality of written communication

2 marks
The candidate expresses ideas clearly and fluently, through well-linked sentences and paragraphs. Arguments are generally relevant and well structured. There are few errors of grammar, punctuation and spelling.

1 mark
The candidate expresses ideas clearly, if not always fluently. Arguments may sometimes stray from the point. There are some errors in grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.

0 marks
The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage. [2]

(b)
- $V_s I_s = V_p I_p$ [1]
  $19 \times 3.3 = 240 \times I_p$
- $I_p = 0.26A$ [1]

(c)
- Current drawn in primary would be larger [1]

(d)
- one source, e.g. heat in windings [1]
- method of reduction, e.g. low resistance wire [1] 10

					AVAILABLE MARKS
6	**(a)**	**(i)**	• Charge moving in magnetic field experiences force • Force always at right angles to path	[2]	
		(ii)	• F = Bqv • Equating Bqv and mv^2/r	[2]	
		(iii)	• $r = (6.6 \times 10^{-27} \times 1.55 \times 10^{6})/(0.80 \times 3.2 \times 10^{-19})$ subs = 0.0399 = 4.0 cm	[2]	
		(iv)	• Curved path to right consistent with (iii)	[1]	
			• then straight No label penalty –1	[1]	
	(b)	**(i)**	• Curved path of smaller radius No label penalty –1 (don't apply if penalty applied in (a) (iv)	[1]	
		(ii)	• Double B r becomes ½ or inversely proportional	[1]	10
7	**(a)**		• same mass • Opposite charge (or spin) • Composed of anti-particles	[2]	
	(b)	**(i)**	Diagram to show: • circular path and deflecting **electro**magnets • accelerating electrodes (minimum detail)	[2]	
		(ii)	• Accelerated between electrodes • Electrode ac freq linked to particle speed	[2]	
	(c)	**(i)**	to conserve momentum	[1]	
		(ii)	$E = mc^2$ • 1 x eqn or subs $= 9.11 \times 10^{-31} x(3x10^{8})^2$ • 1 x ans $= 8.2 \times 10^{-14}\ J$	[2]	9

					AVAILABLE MARKS
8	(a)	(i)	cannot be subdivided into smaller particles	[1]	
		(ii)	electron / neutrino / quark / lepton / muon	[1]	
	(b)	(i)	• Force between electrons is experienced / result of / mediated • by the **exchange** of this particle	[2]	

(ii)

Force	Gauge Boson
Strong	gluon
Electromagnetic	photon
Weak	$W^- W^+ Z^0$ (W or Z)
Gravitational	graviton

4 x ½ round down [2]

(c) (i) Mesons and baryons [1]

(ii) Mesons have a two quark structure, baryons a three quark structure [1] 8

9 (a) (i) $\frac{1}{2} m_c v_c^2 = \frac{1}{2} m_b v_b^2$

$190 \times (44.7)^2 = 46 \times (v_b)^2$

$v_b = 90.9 m\ s^{-1}$ $(91 m\ s^{-1})$ eqn [1] subs [1] ans [1] [3]

(ii) Club does not come to a complete stop
Some kinetic energy changed to sound and/or heat [2]

(b) (i) $CoR = \left(\frac{63.5}{44.7}\right) = 1.42$ [1]

(ii) ball has greater velocity or the ball will travel further [1]

(c) frequency at which club will vibrate without any outside driving force. [1]

(d) (i) Material C [1]

(ii) Need low Young Mod and high hardness [1]

(e)
- v = u + at
- 0 = 63.5 sin 30 – 9.81t
- t = 3.235 s
- Time of flight = 6.47s – Independent double marking
- Horizontal range (63.5 cos 30 × 6.475) = 356m

Alternative
- $R = \frac{u^2 \sin 20}{9}$ [1]
- subs [3]
- ans [1] [5] 15

Total **90**

New Specification

Rewarding Learning

ADVANCED
General Certificate of Education
2010

Physics

Assessment Unit A2 3

Practical Techniques (Internal Assessment)

Session 1

[AY231]

WEDNESDAY 12 MAY, MORNING

MARK SCHEME

Instructions for Internal Assessment

1 **Mark strictly according to this mark scheme.** Do not agonise over awarding "charity" or "benefit of doubt" marks. Give credit for numerical answers only if they are within the ranges indicated in this mark scheme. Remember, every script will be checked later to ensure that candidates are not disadvantaged.

2 Mark in **red** ball-point pen. For each correct point in the scheme you are rewarding, place a tick in the text of the script; for each incorrect point, place a cross. Then add up the ticks for each part of a question for which there is a sub-total in square brackets, and write this total in the "Teacher Mark" column to the right of the text. When you have finished marking a question, write the total for the question as a ringed mark at the beginning of the question and in the appropriate box on the front of the script.

3 In marking graphs you will have to exercise some professional judgment, but other features must be marked strictly according to the scheme. In labeling the axis, candidates should give the label/unit. The mark for "Scales" is normally awarded only if the plotted points occupy at least half of the printed graph grid along each axis. In addition, the scale must be to an easily manageable factor, such as 1:2, 1:4, 1:5, 1:10, 1:20. A factor of, for example, 10 mm to represent 30 cm does not score because of the difficulty of accurately plotting or reading off values.
The credit for plotting the points is, following the normal tariff, 2 marks for plotting 5 points correctly and 1 mark for plotting 4. "Correctly" means to within ± one small square (± 2 mm) on the printed grid in either *x*- or *y*-direction. The marker's professional judgment comes in here. One tick is to be awarded for drawing the best straight line through the points. Do not agonise over scoring (or not) this mark; your professional judgment will allow you to come to a decision very quickly.
In measuring the gradient, one mark is reserved for a "large triangle". This means that either rise or run (or both) must be at least 5 cm on the printed graph grid. Some candidates do not draw their triangle, but use points read off from the line. Provided the rise and/or run in this virtual triangle meet the 5 cm criterion, the mark is scored. Beware of candidates who read off their gradient points directly from **Table 2.1**. The marker must check that the points used actually **lie on the line** and meet the 5 cm test.

4 When you have finished marking the paper, add up the marks for the three questions in the "Teacher Mark" column in the box on the front page of the booklet and enter the total. Check this total by adding up all the sub-total marks for parts of questions throughout the script (**not** the ringed total question marks). The totals arrived at in these two different ways should agree. If you cannot get agreement after a re-count, go back to counting the individual ticks throughout the text of the script.

				AVAILABLE MARKS
1	(a)	(i)	Measure from desk to metre rule or between metre rules at either end (in 2 places), <u>distances equal</u> or length of springs equal [1]	
		(ii)	5 Complete sets of readings Penalty of –1 if d not in cm apply once only Penalty of –1 if d not measured from RIGHT HAND end. [5]	
	(b)		Graph: Scale (Maximum d value must be at least halfway along axis) [1] 5 points plotted correctly (4 points correct, [1]) –1 each error, max 2 [2] Best straight line [1]	
	(c)	(i)	Gradient [1]	
		(ii)	Intercept (± 1 small square) [1] *Equating $\left(\frac{600 + B}{2}\right)$ with the intercept *FIRST marking point [1] B calculated correctly (from correct intercept) [1]	
	(d)	(i)	Thickness 2.0 mm – 8.0 mm or 0.20 cm – 0.80 cm [1] Width 20.0 mm – 40.0 mm or 2.00 cm – 4.00 cm [1] Error stated as (±) 0.1 mm or (±) 0.01 cm [1]	
		(ii)	(Number) + it is the <u>smallest</u> value (or equivalent) [1]	
		(iii)	Volume correctly calculated (any unit) ecf **(c)(ii)** [1] Density correct in g cm^{-3} [1]	20

				AVAILABLE MARKS
2	**(a)**	5 sets of h (last value between 0.35 m and 0.40 m)	[1]	
		Timing for at least 10 oscillations	[1]	
		Repeat readings (& average)	[1]	
		T calculated correctly (check 1)	[1]	
	(b)	**(i)** T^2	[1]	
		h	[1]	
		or correct alternatives		
		(ii) Heading & unit: T^2 / s^2	[1]	
		Values correctly calculated	[1]	
		(iii) Graph: Axes labelled correct format with quantity and unit *	[1]	
		Scales * If T^2 starts from 0, no mark	[1]	
		5 points plotted correctly * (4 points correct, [1])	[2]	
		Best straight line *	[1]	
		(iv) 1 Gradient: used large triangle *	[1]	
		Value for gradient correct * } Ignore signs	[1]	
		P calculated correctly } Ignore signs	[1]	
		Unit: $m\,s^{-2}$	[1]	
		2 Subs into Equation 2.1 or 2.2 or use intercept	[1]	
		Allow use of any h – T value from Table 2.1 or h – T^2 value from graph		
		Quality mark R = 0.85 m ± 0.05 m	[1]	
		Units of R (m)	[1]	20

Plotting the wrong graph in question 2

Scenario A Transposed axes
- can score a maximum of 15 marks for part (b)
- must NOT be credited with the mark for axes labels in (b)(iii)
- can score all processing marks (denoted *) for consistent results
- can only score for P and R if value is correct
- can only score for units if they are correct (as scheme)

Scenario B All other incorrect graphs
- can score a maximum of 12 marks for part (b)
- **(b)(i)** may score max [1]
- **(ii)** may score max [2]
- **(iii)** do not credit the best-fit line max [4]
- **(iv)1** do not credit for P max [3]
- **2** do not credit for R max [2]
- can only score for units if they are correct (as scheme)

		AVAILABLE MARKS

3 (a) (i)
- Voltmeter across thermistor, ammeter in series using correct symbols for meters
- (Heat & thermometer) changing and measuring temp, either described or in diagram
- Range of temp (20 ºC – 100 ºC) or multiple readings
- Current, voltage & temperature measured
- calculating $R = V/I$
- T in K = T in °C + 273

[1] each [6]

(ii)

	Description [1]	Explanation [1]
either	Stir or heat slowly	Thermistor temp = water bath temp
or	T, V and I measured at the same instant	Resistance is calculated at that temperature

(b) (i) Decrease in R with temperature, correct curve [1]

(ii) $\ln R = \ln A - BT$ [1]

(c) (i) y axis – $\ln R$ [1]
x axis – T [1]

(ii) Read intercept [1]
Inverse log or $e^{\text{intercept}} = A$ [1]

(d) Measure Gradient [1]
Gradient × 2k = E_g [1]
(Ignoring negative value of gradient)

(Penalise $\log_{10}$ once only — applies to (b)(ii) to (d))

(e) Calculate percentage uncertainty in ammeter = $\frac{0.01}{reading} \times 100$ [1]

Calculate percentage uncertainty in voltmeter = $\frac{0.1}{reading} \times 100$ [1]

Add percentage uncertainty to get percentage in R [1]
Calculate absolute uncertainty in R [1] 20

Total **60**

New Specification

Rewarding Learning

ADVANCED
General Certificate of Education
2010

Physics

Assessment Unit A2 3

Practical Techniques (Internal Assessment)

Session 2

[AY232]

THURSDAY 13 MAY, MORNING

MARK SCHEME

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3 In marking graphs you will have to exercise some professional judgment, but other features must be marked strictly according to the scheme. In labeling the axis, candidates should give the label/unit. The mark for "Scales" is normally awarded only if the plotted points occupy at least half of the printed graph grid along each axis. In addition, the scale must be to an easily manageable factor, such as 1:2, 1:4, 1:5, 1:10, 1:20. A factor of, for example, 10 mm to represent 30 cm does not score because of the difficulty of accurately plotting or reading off values.
The credit for plotting the points is, following the normal tariff, 2 marks for plotting 5 points correctly and 1 mark for plotting 4. "Correctly" means to within ± one small square (± 2 mm) on the printed grid in either *x*- or *y*-direction. The marker's professional judgment comes in here. One tick is to be awarded for drawing the best straight line through the points. Do not agonise over scoring (or not) this mark; your professional judgment will allow you to come to a decision very quickly.
In measuring the gradient, one mark is reserved for a "large triangle". This means that either rise or run (or both) must be at least 5 cm on the printed graph grid. Some candidates do not draw their triangle, but use points read off from the line. Provided the rise and/or run in this virtual triangle meet the 5 cm criterion, the mark is scored. Beware of candidates who read off their gradient points directly from **Table 2.1**. The marker must check that the points used actually **lie on the line** and meet the 5 cm test.

4 When you have finished marking the paper, add up the marks for the three questions in the "Teacher Mark" column in the box on the front page of the booklet and enter the total. Check this total by adding up all the sub-total marks for parts of questions throughout the script (**not** the ringed total question marks). The totals arrived at in these two different ways should agree. If you cannot get agreement after a re-count, go back to counting the individual ticks throughout the text of the script.

				AVAILABLE MARKS
1 **(a)** **(i)**	Measure from desk to metre rule or between metre rules at either end (in 2 places), distances equal or length of springs equal	[1]		
(ii)	5 Complete sets of readings Penalty of –1 if s not in m apply once only Penalty of –1 if s not measured from RIGHT HAND end	[5]		
(b)	Graph: Scale	[1]		
	5 points plotted correctly (4 points correct, [1]) –1 each error, max 2	[2]		
	Best straight line	[1]		
(c) **(i)**	Gradient	[1]		
(ii)	Intercept (± 1 small square)	[1]		
	*Equating $\left(\frac{A + 2.2}{5}\right)$ with the intercept *FIRST marking point	[1]		
	A calculated correctly (from correct intercept)	[1]		
(d) **(i)**	Thickness 2.0 mm – 8.0 mm or 0.20 cm – 0.80 cm	[1]		
	Width 20.0 mm – 40.0 mm or 2.00 cm – 4.00 cm	[1]		
	Error stated as ± 0.1 mm or ± 0.01 cm	[1]		
(ii)	(Number) + it is the smallest value (or equivalent)	[1]		
(iii)	Volume correctly calculated (any unit) ecf **(c)(ii)**	[1]		
	Density correct in kg m^{-3}	[1]		20

				AVAILABLE MARKS
2	**(a)**	5 sets of h (last value between 0.45m and 0.5m) Timing for at least 10 oscillations Repeat readings (& average) T calculated correctly (check 1)	[1] [1] [1] [1]	
	(b)	**(i)** T^2 h or correct alternatives	[1] [1]	
		(ii) Heading & unit: T^2 / s^2 Values correctly calculated	[1] [1]	
		(iii) Graph: Axes labelled correct format with quantity and unit * Scales * If T^2 starts from 0, no mark 5 points plotted correctly * (4 points correct, [1]) Best straight line *	[1] [1] [2] [1]	
		(iv) 1 Gradient: used large triangle * Value for gradient correct * } Ignore signs P calculated correctly } Unit: m s^{-2}	[1] [1] [1] [1]	
		2 Subs into Equation 2.1 or 2.2 or use intercept Allow use of any h–T value from Table 2.1 or h–T^2 values from graph Quality M = 0.80 m ± 0.05 m Units of M (m)	[1] [1] [1]	20

Plotting the wrong graph in question 2

Scenario A   Transposed axes
- can score a maximum of 15 marks for part (b)
- must NOT be credited with the mark for axes labels in (b)(iii)
- can score all processing marks (denoted *) for consistent results
- can only score for *K* and *M* if value is correct
- can only score for units if they are correct (as scheme)

Scenario B   All other incorrect graphs
- can score a maximum of 12 marks for part (b)
- **(b)(i)** may score — max [1]
- **(ii)** may score — max [2]
- **(iii)** do not credit the best-fit line — max [4]
- **(iv)1** do not credit for K — max [3]
- **2** do not credit for M — max [2]
- can only score for units if they are correct (as scheme)

				AVAILABLE MARKS
3	**(a)**	**(i)**	• Voltmeter across LDR, ammeter in series using correct symbols for meters only • metre rule changing and measuring *d*, either described or in diagram • Good range of *d* at least 5 • Current, voltage and distance measured • Calculating $R = V/I$ • Repeat & average [1] each [6]	
		(ii)	Describe: no ambient light Explain: ambient light influences LDR <u>resistance</u> [2]	
	(b)		$\log R = \log B + \gamma \log d$ [1]	
	(c)	**(i)**	y-axis – log *R* [1] x-axis – log *d* [1]	
		(ii)	Read intercept [1] Inverse log or $10^{\text{intercept}} = B$ [1]	
		(iii)	Gradient [1]	
	(d)	**(i)**	$\Omega\ m^{-2}$ or $V\ A^{-1}\ m^{-2}$ [1]	
		(ii)	Increase in *R* with *d*, correct curve [1]	
	(e)		Calculate percentage error in ammeter $= \frac{0.001}{reading} \times 100$ [1] Calculate percentage error in voltmeter $= \frac{0.01}{reading} \times 100$ [1] Add percentage errors to get percentage in *R* [1] Calculate error in *R* [1]	20
			Total	**60**