Published Mark Schemes for GCE AS Physics

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

MARK SCHEMES (2009)

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 SUBSIDIARY (AS)
General Certificate of Education
2009

Physics

Assessment Unit AS 1

Module 1: Forces, Energy and Electricity

[AY111]

TUESDAY 16 JUNE, AFTERNOON

MARK SCHEME

AVAILABLE MARKS

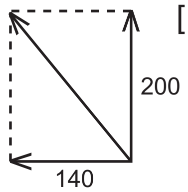
1 **(a)** **(i)** Scalar quantity has magnitude/size **only** [1]

(ii) **Displacement** and **force** ONLY
[1] each, [–1] per mistake [2] [3]

(b) Addition: $\sqrt{200^2 + 140^2}$ [1]
Force = **244 kN** [1]

$\tan\theta = \frac{200}{140}$ [1]

Direction **55° N of W (or indicated on sketch)** [1]
or graphically:
rectangle or triangle with arrows [1]
sensible scale [1]
values [1], [1] to 5% tolerance [4] 7



2 **(a)** **(i)** Moment of a force about a point is the product of the force and the perpendicular [1] distance from (the line of action of) the force to the point [1] [2]
(i.e. Force × distance [1], detail of perpendicular [1])

(ii) Newton metre (**or** N m **or** kg m^2 s^{-2}) [1]

(iii) When a system is in equilibrium [1] the sum of the clockwise moments (about any point) is equal to the sum of the anti-clockwise moments (about the same point) [1] [2] [5]

(b) **(i)** Magnitude = 175 – 50 = **125 N** [1]
(vertically) upwards **or** arrow to top of page [1]

(ii) $50 \times 1.4 = 175 \times Z$ [1]
$Z = 0.4$ m [1]
Distance = 1.0 m [1] [5] 10

3 **(a)** **(i)** H component = $\frac{25}{1.4}$ [1] = **18 (17.9)** m s^{-1} [1] [2]

(ii) V component: $u = v - at$
$u = 0 - (-9.8) \times 1.4$ [1]
= **13.7 m s^{-1}** [1] [2] [4]

(b) **(i)** Velocity = $\sqrt{(17.9^2 + 13.7^2)}$
= **23 (22.5) m s^{-1}** **or** e.c.f. from **(a)** [2]

(ii) Tan $\theta = \frac{13.7}{17.9}$

θ = **37°** (38° or 37.4°) **or** e.c.f. from **(a)** [2]

(iii) $v^2 = u^2 + 2as$ [1] **or** $s = ut + \frac{1}{2}at^2$
$0 = 14^2 - 2 \times 9.8H$ [1]
H = **9.6 m** [1] [3] [7] 11

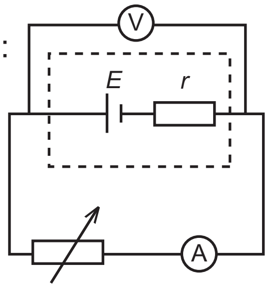
AVAILABLE MARKS

4	(a)	(i)	Labelled diagram showing pulley or two vertical wires, wire, marker or vernier scale, weights, clamp, ruler (or travelling microscope or vernier scale) **Five** items [$-\frac{1}{2}$] per omission, round down		[2]	
		(ii)	Initial length, extension, wire diameter	[2]		
			Initial length by metre rule [$\frac{1}{2}$] [$\frac{1}{2}$], Extension by ruler or travelling microscope [$\frac{1}{2}$] [$\frac{1}{2}$] diameter by micrometer [$\frac{1}{2}$] [$\frac{1}{2}$] round down	[3]		
		(iii)	$Y = \frac{\text{applied force} \times \text{initial length}}{\text{c s area} \times \text{extension}}$	eqn [1]		
			$A = \frac{\pi d^2}{4}$	[1]		
			Graph and axes	[1]		
			Result from gradient	[1]	[4]	
			or			
			l, *x*, *F*, *D*	[1]		
			$Y = \frac{Fl}{Ae}$	[1] [1]		
			$A = \pi d^2/4$			
			Take average of *Y* values	[1]	[4]	
	(b)	(i)	Force on each spring $= 1.8 \times \frac{9.8}{3} = 5.88\text{N}$	[1]		
			Extension $h = \frac{5.88}{300} = 0.0196\text{m}$	[1]		
			$= \mathbf{19.6mm}$	[1]	[3]	
			(Fails to divide by 3 (59mm), max. [2]/[3]) **or** use stiffness			
			$k = 900\,\text{N m}^{-1}$	[1]		
			$x = 1.8 \times 9.81 \div 900$ subs	[1]		
			answer = 19.6 mm	[1]	[3]	
		(ii)	Force on each spring = $1.8 \times 9.8 = 17.6\,\text{N}$	[1]		
			Extension H = **176 mm (177, 180)**	[1]	[2]	
			or			
			use $k = 100\,\text{N m}^{-1}$	[1]		
			Hence 9 × **(b)(i)**			
			= 9 × 19.6 = 176.4 mm	[1]	[2]	14
5	(a)		EMF is the potential difference across the output terminals of the source when no current is being drawn from it **or** define in terms of energy conversion	[1]		
			Terminal potential difference is the voltage across the terminals when a current is being drawn from the source. (**or** equivalent)	[1]	[2]	

AVAILABLE MARKS

(b) (i) Opposition to current flow through the electrical power source
or resistance of chemicals in battery
or resistance of components in source [1] [1]

(ii) Circuit diagram:

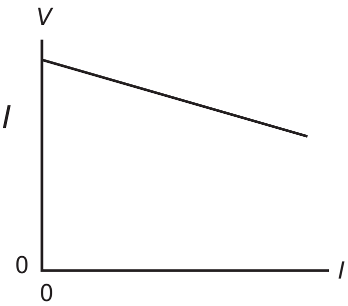


Cell, variable load resistor
(internal resistance) [1]
Ammeter, voltmeter [1] [2]

(confuse ammeter, voltmeter
or connect ammeter across
cell in no-load circuit, [0])

Experiment:
Vary load [1]
Read V, A [1] [2]

Analysis: Graph of V against I [1]
Sketch [1]



$r = -$ gradient
(r from one set of values, [1] only) [1] [3]

E.m.f. = value of V for I = 0 or intercept
or reading of voltmeter across battery with no load [1] [1] 13

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]

					AVAILABLE MARKS
6	**(a)**	**(i)** Resistance = $\frac{V}{I} = \frac{14.2}{8.4} = \mathbf{1.69}\,\Omega$ eqn or subs [1] ans [1]	[2]		
		(ii) Power = $V \times I$ = 14.2 × 8.4 = **119 W (120)** eqn or subs [1] ans [1]	[2]	[4]	
	(b)	**(i)** Resistance = 1.69 × 6 = **10.1 Ω (10)** allow e.c.f. from **(a)(i)**	[1]		
		(ii) $\rho = R \times \frac{A}{L}$	[1]		
		$\frac{10.1 \times 2.0 \times 0.15 \times 10^{-6}}{1.05}$	[1]		
		$= \mathbf{2.88 \times 10^{-6}\ (2.9 \times 10^{-6})}$	[1]		
		Unit: **Ω m**	[1]		
		allow e.c.f. from **(b)**		[5]	
	(c)	1. If one strip open circuited the whole heating element would fail, hence no heat	[1]		
		2. Deliver smaller current i.e. less energy (as heat $\propto I^2$)	[1]		
		less heat to defrost or need higher voltage source	[1]	[3]	12
7	**(a)**	Shows left pair have combined resistance **15 Ω**	[1]		
		and right pair, **16 Ω**	[1]		
		adding to 31 Ω	[1]	[3]	
	(b)	Total resistance = $\frac{12}{0.3}$	[1]		
		= **40 Ω**	[1]	[2]	
	(c)	R = 40 – 31 = **9 Ω** **or** e.c.f. from **(b)**	[1]	[1]	
	(d)	Ratio 48 : 24			
		Current ratio = 2 : 1	[1]		
		Current = **100 mA**	[1]	[2]	8
		or from voltage across combination			
				Total	**75**

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Physics

Assessment Unit AS 2

Module 2: Waves, Photons and Medical Physics

[AY121]

FRIDAY 19 JUNE, MORNING

MARK SCHEME

AVAILABLE MARKS

1 **(a)** L to R: TV/Radio, micro, IR, Visible, UV, X, gamma [3]
(Reverse order [2]/[3])
(7 names present, wrong order [1]/[3])

(b) Any value between **400 and 700 nm** (unit must be present) [1]

(c) $c = f\lambda$ [1]
$3 \times 10^8 = 620 \times 10^9\ \lambda$ [1]
$\lambda =$ $\mathbf{4.84 \times 10^{-4}}$ m [1] [3] — 7

2 **(a)** Diagram to show (i) glass block (any shape) [1]
(ii) ray box [1]

(b) Direct ray onto glass block at different angles [1]
Join the entering and emerging rays [1]
Measure the incident and refracted angles [1]

(c) **(i)** sin *i* v sin *r* [1] Straight line through origin (labelled 1) [1] [2]

(ii) Slope change consistent with their axes (labelled 2) [1] — 8
(Neither line labelled, max [2]/[3])

3 **(a)** **(i)** Short sight/myopia [1]

(ii) Diverging (concave) (No e.c.f. from **(i)**) [1]

(b) **(i)** Use of $1/u + 1/v = 1/f$ [1]
$1/0.25 + 1/{-1.30} = 1/f$ [1]
$f =$ **0.31** (m) [1]

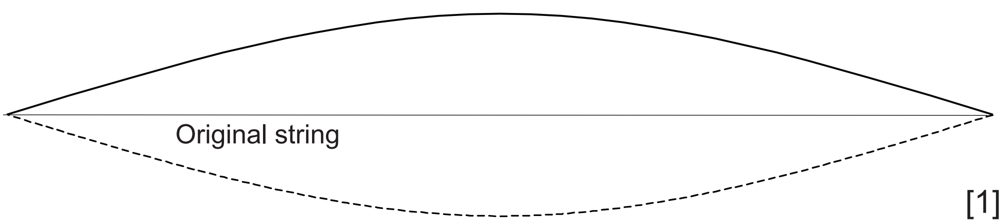
(ii) $P =$ **3.2 (D)** (or e.c.f from **(b)(i)**) [1] — 6

4 **(a)** **3rd** mode/ 3rd harmonic/ 2nd overtone [1]

(b) correctly labelled antinode [1]

(c) Wavelength = **0.16** (m) [1]

(d)



[1]

(e) **(i)** $F = \frac{1}{3}$ [1]

(ii) $W = \frac{1}{3}$ [1] [2] — 6

[Any unit, [–1] each time]

				AVAILABLE MARKS
5	(a)	Spreading of waves (**not** bending) Passing through an aperture or passing by an obstacle/into geometric shadow	[1] [1]	
	(b)	Linear wave fronts with slight spreading at edges Constant wavelength Lengthening wave fronts	[1] [1] [1]	
	(c)	Wavelength of sound > wavelength of light Diffraction spreading or related to proportional to wavelength **or** wavelength of sound ≈ door opening Greater diffraction of sound than light	[1] [1] [1]	
		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]	10
6	(a)	Points: 3.21 3.61 3.88 5.29 6.02 (4 or 5 to 2,3 or 4 s.f.)	[1]	
	(b)	Points (4 or 5) Best-fit line from their points	[1] [1]	
	(c)	Large triangle (i.e. one vertical or horizontal side >5cm) Consistent value **m s^{-1} or** Hz m	[1] [1] [1]	
	(d)	Gradient = $v/4$ Quality **325 – 375** m s^{-1}	[1] [1]	8

					AVAILABLE MARKS
7	(a)	(i)	**Computed Tomography**	[1]	
		(ii)	**Magnetic Resonance Imaging**	[1]	
	(b)		CT = **X-rays** MRI = **radio waves**	[1] [1]	
	(c)		Detector or X-ray tube **or** detector and X-ray tube	[1]	
	(d)		Magnet (coils of magnet) Very strong B-field needed Coils **superconducting** at low temperatures or below transition temperature	[1] [1] [1]	8
8	(a)		A packet of electromagnetic energy **or** a particle of light **or** light quantum	[1]	
	(b)		$E = hf$ $E = 6.63 \times 10^{-34} \times 6.00 \times 10^{16}$ $E = \mathbf{3.98 \times 10^{-17}}$ (J)	[1] [1] [1]	
	(c)		Emission of an electron (from metal) due to absorption of em radiation Occurs when photon energy > metal work function	[1] [1] [1]	7
9	(a)	(i)	Most electrons in excited state (Some in excited state but fewer than half [1]) (any electrons in between, [0]/[2])	[2]	
		(ii)	**Population inversion**	[1]	
	(b)		A (passing) photon of the correct/same frequency/energy	[1]	
	(c)		193 nm converted to 193×10^{-9} m or equivalent Photon energy = 1.03×10^{-18} J Photon energy = 6.44 eV Energy level = **–2.74** eV (must have minus sign) ((–)15.6eV, [3]/[4])	[1] [1] [1] [1]	8
10	(a)		Wavelength, Planck constant, momentum or mass/velocity	[1]	
	(b)		$\mathbf{1.51 \times 10^{33}}$ (Stating $1/h$ [1]) $\mathbf{J^{-1}\ s^{-1}}$ or $\mathbf{N^{-1}\ s^{-1}\ m^{-1}}$	[2] [1]	
	(c)		$\lambda = 6.63 \times 10^{-34}/(0.9 \times 3.00 \times 10^{8} \times 9.11 \times 10^{-31})$ correct use of 0.9 other subs $\lambda = \mathbf{2.70 \times 10^{-12}}$ (m)	[1] [1] [1]	7
				Total	**75**

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Physics

Assessment Unit AS 3

Practical Techniques (Internal Assessment)

Session 1

[AY131]

WEDNESDAY 13 MAY

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.

   Taking **Question 1** as an example, if you see two markworthy points in part **(a)** on p 4, you will mark two ticks at the points you are rewarding and a cross at the point where an error has been made or where there is an omission. Then you will put a "2" in the "Teacher Mark" column near the [3] in the text. Moving on to part **(b)** on p 6, if the candidate scores both possible marks, you will put two ticks in the text and a "2" in the "Teacher Mark" column near the [2] in the text at the end of the question. These sub-totals are not to be ringed, but when you come to add up the total for the question (2 + 2 = 4 in our example) you will put a "4" with a ring round it at the top of the "Teacher Mark" column at the beginning of this question on p 4. You will also transcribe this total of 4 to the "Teacher Mark" column of the mark box for **Question 1** on the front of the question/answer booklet.

   In **Question 5 (a)(i)** there is a possibility that a candidate may have asked to be told what graph to plot. If this is the case, you will already have marked the "YES" box in the "For Teacher's use only" area on the front of the booklet. When marking, you will apply the 2-mark deduction by noting two crosses in the text and putting a "0" in the "Teacher Mark" column, opposite the [2] in the text. (In the majority of cases, you will have marked "NO" on the front of the booklet, and will then give two ticks in the text and a "2" in the "Teacher Mark" column.)

3. In marking graphs (as in **Question 5**) you will have to exercise some professional judgment, but other features must be marked strictly according to the scheme.

   In **5(b)(iii)** candidates are told to label the axes in the boxes provided. The box contains an answer line with a solidus (or "slash"), so the candidate is prompted to answer in the form h/cm and t^2/s^2. **Only** these forms are to be credited; either or both of "h in cm" or "t^2 in s^{-2}" scores a cross for the "Axes labelled" mark.

   The mark for "Scales" in **5(b)(iii)** is awarded only if the plotted points occupy at least half of the printed graph grid along each axis. Thus, if a candidate were to choose a scale of 10 mm on the h-axis as representing a value of h = 10 cm, the plotted points would cover a range of only 50 mm (from 30 cm to 80 cm) or 80 mm (from the origin to 80 cm). Because the printed graph grid extends to 180 mm, this scores a cross. 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 in **5(b)(iii)** 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 in **5(c)(i)**, 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 5.1**. 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 five 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.

Section A

					AVAILABLE MARKS
1	**(a)**	Perimeter of block and normal drawn up to or through boundary	[1]		
		Two complete rays drawn correctly, with incident and emergent rays parallel by eye	[2]	[3]	
		(One complete ray correct [1])			
	(b)	Ranges for angles of refraction r:			
		For i = 20°, r in range 12° to 14°			
		For i = 40°, r in range 24° to 27°			
		One r within these ranges	[1]		
		Refractive index **as a result of correct averaging sin i/sin r results** from both angles	[1]	[2]	5
		(Single value of refractive index, even in range, [0])			
2	**(a)**	Times t for at least 10 oscillations at each length (no units needed)	[1]		
		One or more repeats at each length	[1]		
		Ranges for periods T:			
		For x = 15 cm, T in range 0.7 s to 0.9 s			
		For x = 30 cm, T in range 1.0 s to 1.2 s			
		For x = 45 cm, T in range 1.3 s to 1.4 s			
		At least one T within these ranges	[1]	[3]	
	(b)	$n = \frac{1}{2}$	[1]		
		Because increase in x leads to increase in T but x not proportional to T or show k to be constant	[1]	[2]	
		(**Both** factors mentioned)			5
3	**(a)**	E value **in range 14.5 mm to 16.0 mm**	[1]		
		I value **in range 12.0 mm to 14.5 mm**	[1]		
		t value calculated from $t = (E - I)/2$, **consistent with candidate's E, I values**	[1]		
		Both measured E, I values to 0.1 mm	[1]	[4]	
	(b)	**±0.1mm or ±0.2mm**		[1]	5

					AVAILABLE MARKS
4	**(a)**	*R* values in range:			
		AD, 370 Ω to 570 Ω	[1]		
		BD, 190 Ω to 290 Ω	[1]		
		CD, 720 Ω to 1120 Ω	[1]	[3]	
		(Power of 10 error, [–1] once only)			
	(b)	**Arrangement 3**	[1]		
		Explanation: ● CD must be highest/twice **because in series** ● BD must be lowest/half **because in parallel**			
		Both bullet point statements	[1]	[2]	5
				Section A	**20**

Section B

					AVAILABLE MARKS
5	**(a)**	**(i)**	If **YES** ticked, score	[0]	
			Otherwise Horizontal: $\boldsymbol{t^2}$	[1]	
			Vertical: ***h (or s)***	[1] [2]	
			Acceptable alternatives: h versus $\frac{1}{2}t^2$; $2h$ versus t^2; accept any possible alternative transposed axis acceptable		
		(ii)	**Gradient = 0.5 *g*** (*or* consistent with their correct axes) ***or* 0.5 a**	[1]	
	(b)	**(i)**	Quantity: $\boldsymbol{t^2}$ (or $\frac{1}{2}t^2$)	[1]	
			Unit: $\boldsymbol{s^2}$	[1] [2]	
		(ii)	**0.0620, 0.0858, 0.102, 0.123, 0.143, 0.160** all to 3 sig fig	[2]	
			(Any value not to 3 sig fig, [–1] once only) (2 d.p. [–1] once only)		
			(Allow consistent correct alternative values for $\frac{1}{2}t^2$)		
		(iii)	Graph: Axes, labelled h/cm, t^2/s^2 consistent with Table 5.1.	[1]	
			(allow consistent correct alternatives)		
			Scales	[1]	
			5 points plotted correctly (± 2 mm)	[2]	
			(4 points correct, [1])		
			Best straight line	[1] [5]	
			wrong graph plotted, 0/1		
	(c)	**(i)**	Gradient: Correct large triangle	[1]	
			Gradient **in range 450 to 525**	[1]	
			(*or* correct alternatives, scaled)		
			Unit **cm s^{-2}**	[1] [3]	
			(*or* appropriate consistent value for transposed axes)		
		(ii)	*g* **in range 9 m s^{-2} to 10.5 m s^{-2}**	[1]	
			(Power of 10 error, i.e. not in m s^{-2}, [0])		
			(wrong graph, no credit for **(c)**)		
	(d)	**(i)**	Percentage difference expression:		
			$\{\lvert g_{\mathbf{(c)(ii)}} - 9.81\rvert/9.81\} \times 100\%$	[1]	
			Calculates numerical answer (ignore sign in answer)	[1] [2]	
			(use of $g_{\mathbf{(c)(ii)}} - 9.81/g_{\mathbf{(c)(ii)}}$, [1] only)		
		(ii)	Plot extreme upper line of best fit, find $g_{\text{upper limit}}$ from maximum gradient	[1]	
			Evidence of attempt, with plausible value (don't check arithmetic closely)	[1] [2]	20
				Section B	**20**
				Total	**40**

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Physics

Assessment Unit AS 3

Practical Techniques (Internal Assessment)

Session 2

[AY132]

THURSDAY 14 MAY

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.

   Taking **Question 1** as an example, if you see two markworthy points in part **(a)** on p 4, you will mark two ticks at the points you are rewarding and a cross at the point where an error has been made or where there is an omission. Then you will put a "2" in the "Teacher Mark" column near the [3] in the text. Moving on to part **(b)** on p 6, if the candidate scores both possible marks, you will put two ticks in the text and a "2" in the "Teacher Mark" column near the [2] in the text at the end of the question. These sub-totals are not to be ringed, but when you come to add up the total for the question (2 + 2 = 4 in our example) you will put a "4" with a ring round it at the top of the "Teacher Mark" column at the beginning of this question on p 4. You will also transcribe this total of 4 to the "Teacher Mark" column of the mark box for **Question 1** on the front of the question/answer booklet.

   In **Question 5 (a)(i)** there is a possibility that a candidate may have asked to be told what graph to plot. If this is the case, you will already have marked the "YES" box in the "For Teacher's use only" area on the front of the booklet. When marking, you will apply the 2-mark deduction by noting two crosses in the text and putting a "0" in the "Teacher Mark" column, opposite the [2] in the text. (In the majority of cases, you will have marked "NO" on the front of the booklet, and will then give two ticks in the text and a "2" in the "Teacher Mark" column.)

3. In marking graphs (as in **Question 5**) you will have to exercise some professional judgment, but other features must be marked strictly according to the scheme.

   In **5(b)(iii)** candidates are told to label the axes in the boxes provided. The box contains an answer line with a solidus (or "slash"), so the candidate is prompted to answer in the form h/cm and t^2/s^2. **Only** these forms are to be credited; either or both of "h in cm" or "t^2 in s^2" scores a cross for the "Axes labelled" mark.

   The mark for "Scales" in **5(b)(iii)** is awarded only if the plotted points occupy at least half of the printed graph grid along each axis. Thus, if a candidate were to choose a scale of 10 mm on the h-axis as representing a value of h = 10 cm, the plotted points would cover a range of only 50 mm (from 30 cm to 80 cm) or 80 mm (from the origin to 80 cm). Because the printed graph grid extends to 180 mm, this scores a cross. 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 in **5(b)(iii)** 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 in **5(c)(i)**, 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 5.1**. 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 five 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.

Section A

					AVAILABLE MARKS
1	(a)	Perimeter of block and normal drawn up to or through boundary	[1]		
		Two complete rays drawn correctly, with incident and emergent rays parallel by eye	[2]	[3]	
		(One complete ray correct, [1])			
	(b)	Ranges for angles of refraction *r*:			
		For *i* = 30°, *r* in range 18.5° to 20.5°			
		For *i* = 40°, *r* in range 24° to 27°			
		One *r* within these ranges	[1]		
		Refractive index **as a result of correct averaging sin *i*/sin *r* results** from both angles	[1]	[2]	
		(Single value of refractive index, even in range, [0])			5
2	(a)	Times *t* for at least 10 oscillations at each length (no units needed)	[1]		
		One or more repeats at each length	[1]		
		Ranges for periods *T*:			
		For *x* = 20 cm, *T* in range 0.8 s to 1.0 s			
		For *x* = 30 cm, *T* in range 1.0 s to 1.2 s			
		For *x* = 40 cm, *T* in range 1.2 s to 1.3 s			
		At least one *T* within these ranges	[1]	[3]	
	(b)	$n = \frac{1}{2}$	[1]		
		Because increase in *x* leads to increase in *T* but *x* not proportional to *T* or show *k* to be constant	[1]	[2]	5
		(**Both** factors mentioned)			
3	(a)	*E* value **in range 21.0 mm to 23.0 mm**	[1]		
		I value **in range 19.0 mm to 21.5 mm**	[1]		
		t value calculated from $t = (E - I)/2$, **consistent with candidate's *E*, *I* values**	[1]		
		Both *E, I* values to 0.1 mm	[1]	[4]	
	(b)	**±0.1 mm** or **±0.2 mm**		[1]	5
4	(a)	R values in range:			
		AD, 370 Ω to 570 Ω	[1]		
		BD, 190 Ω to 290 Ω	[1]		
		CD, 720 Ω to 1120 Ω	[1]	[3]	
		(Power of 10 error, [–1] once only)			
	(b)	**Arrangement 2**		[1]	
		Explanation:			
		● CD must be highest/twice **because in series**			
		● BD must be lowest/half **because in parallel**			
		Both bullet point statements		[1]	5
				Section A	**20**

Section B

						AVAILABLE MARKS
5	(a)	(i)	If **YES** ticked, score	[0]		
			Otherwise Horizontal: t^2	[1]		
			Vertical: **h** *(or s)*	[1]	[2]	
			Acceptable alternatives: h versus $\frac{1}{2}t^2$, $2h$ versus t^2; accept any possible alternative transposed axes acceptable			
		(ii)	**Gradient = 0.5 *g* or 0.5 *a*** (*or* consistent with their correct axes)		[1]	
	(b)	(i)	Quantity: t^2 (or $\frac{1}{2}t^2$)	[1]		
			Unit: s^2	[1]	[2]	
		(ii)	**0.0620, 0.0858, 0.102, 0.123, 0.143, 0.160** all to 3 sig fig		[2]	
			(Any value not to 3 sig fig, [–1] once only)(2 d.p, [–1] once only)			
			(Allow consistent correct alternative values for $\frac{1}{2}t^2$)			
		(iii)	Graph: Axes, labelled h/cm, t^2/s^2 Consistent with Table 5.1			
			(allow consistent correct alternatives)	[1]		
			Scales	[1]		
			5 points plotted correctly (±2 mm)	[2]		
			(4 points correct, [1])			
			Best straight line wrong graph plotted, [0]/[1]	[1]	[5]	
	(c)	(i)	Gradient: Correct large triangle	[1]		
			Gradient **in range 450 to 525**	[1]		
			(or correct alternatives, scaled)			
			Unit **cm s^{-2}**	[1]	[3]	
			(or appropriate consistent value for transposed axes)			
		(ii)	***g* in range 9 m s^{-2} to 10.5 m s^{-2}**		[1]	
			(Power of 10 error, i.e. not m s^{-2}, [0])			
			(Wrong graph, no credit for **(c)**)			
	(d)	(i)	Percentage difference expression:			
			$\{\lvert g_{(c)(ii)} - 9.81\rvert/9.81\} \times 100\%$	[1]		
			Calculates numerical answer (ignore sign in answer)	[1]	[2]	
			(Use of $(g_{(c)(ii)} - 9.81)/g_{(c)(ii)}$, [1]/[2])			
		(ii)	Plot extreme lower line of best fit, find $g_{lower\ limit}$ from minimum gradient	[1]		
			Evidence of attempt, with plausible value (don't check arithmetic closely)	[1]	[2]	20
					Section B	**20**
					Total	**40**