Cambridge Assessment

A Level

Physics

Session: 2000 June
Type: Mark scheme
Code: 9244

Oxford Cambridge and RSA Examinations

OCR

RECOGNISING ACHIEVEMENT

A LEVEL

(former Cambridge linear syllabus)

A 9244

PHYSICS

MARK SCHEME FOR COMPONENTS

TAKEN IN JUNE 2000

CAMBRIDGE LINEAR A LEVEL PHYSICS 9244
JUNE 2000 ASSESSMENT SESSION

Component Threshold Marks

Component	Maximum Mark	A	B	C	D	E	N	U
1	30	25	22	19	17	15	13	0
2	90	73	67	59	51	44	37	0
3	110	73	62	52	43	34	25	0
4	50	39	36	31	27	23	19	0
5	50	39	36	32	28	24	20	0
7	36	32	29	26	23	20	17	0
9	36	34	31	28	25	22	19	0

Overall Threshold marks

Option (components)	Maximum Mark	A	B	C	D	E	N	U
A (1, 2, 3, 4)	310	226	206	180	155	130	105	0
B (1, 2, 3, 5)	310	229	207	182	157	132	107	0
C (1, 2, 3, 7)	310	236	212	186	160	134	108	0
D (1, 2, 3, 9)	310	239	215	189	163	137	111	0
H (1, 2, 3, 89)	310	239	215	189	163	137	111	0

The cumulative percentage and number of candidates achieving each grade was as follows:

Grade	**A**	**B**	**C**	**D**	**E**	**N**	**U**
Cumulative percentage	24.2	41.7	56.9	72.0	83.1	91.4	100
Number of candidates	220	380	518	656	757	833	884

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Markscheme 9244/1
June 2000

Multiple Choice

Question No.	Correct Answer
1	B
2	D
3	B
4	C
5	A
6	D
7	A
8	C
9	D
10	B
11	D
12	C
13	D
14	C
15	B
16	C
17	D
18	C
19	B
20	B
21	C
22	C
23	C
24	D
25	C
26	A
27	C
28	C
29	C
30	A

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Markscheme 9244/2
June 2000

Physics Theory

1 (a) mass per unit volumes *equation in words gets full credit. Not in units* **B1**
force per unit area *Not in symbol equation unless symbols are defined* **B1** [2]

(b) consider a column of liquid height h and area A **B1**
weight of column = mg = V x ρ x g = Ahρg **B1**
pressure = weight / area = hρg **A1** [3]

(c) upthrust caused by low pressure on top and higher pressure on bottom **B1**
pressure force on bottom acts upwards **B1**
comparison between air and liquid densities **B1** [3]

Total marks [8]

2

circuit component	A	B	C	whole circuit
potential difference / V	12 **B1** *Order 1*	2 x 5 = 10 **B1** *6*	12 -10 = 2 **B1** *7*	12
current / A	12 / 4 = 3 **B1** *2*	5 – 3= 2 *4*	2 **B1** *5*	5.0
power / W	12 x 3 = 36 **B1** *3*	10 x 2 = 20 *8*	2 x 2 = 4 *9*	12 x 5 = 60 **or** 36+20+4=60 **B1** *10*
resistance / Ω	4.0	5.0	2 / 2 =1 **B1** *11*	12 / 5 = 2.4 or using series / parallel **B1** *12*

Total marks [9]

3 (a) Vertical component of $P = 3.92 \times 10^5$ (N) **B1**
At least 2 sig figs throughout this question and all the rest [1]

(b) $P \cos 35 = 3.92 \times 10^5$ **C1**
$P = 3.92 \times 10^5 / \cos 35 = 4.79 \times 10^5$ (N) **A1** [2]

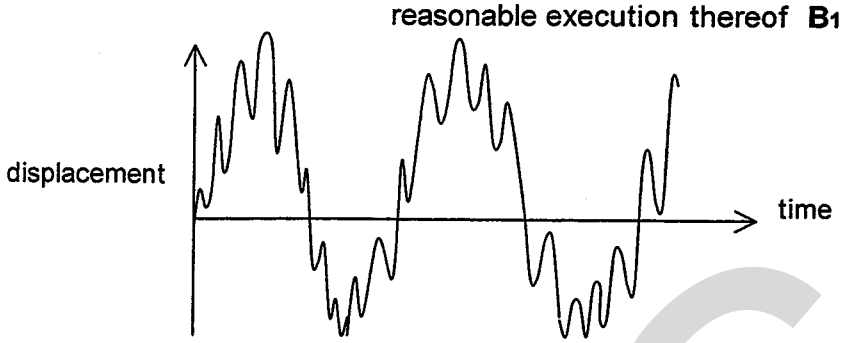
(c) $P \cos 55 = 4.79 \times 10^5 \times \cos 5 = 2.74 \times 10^5$ (N) **A1** [1]

(d) $a = F / m$ **C1**
$= (2.74 \times 10^5) / (4.0 \times 10^4) = 6.86$ (ms^{-2}) **A1** [2]

(e) $a = v^2 / r$ $\quad 6.86 = 250^2 / r$ **C1**
$r = 250^2 / 6.86 = 9110$ (m) **A1** [2]

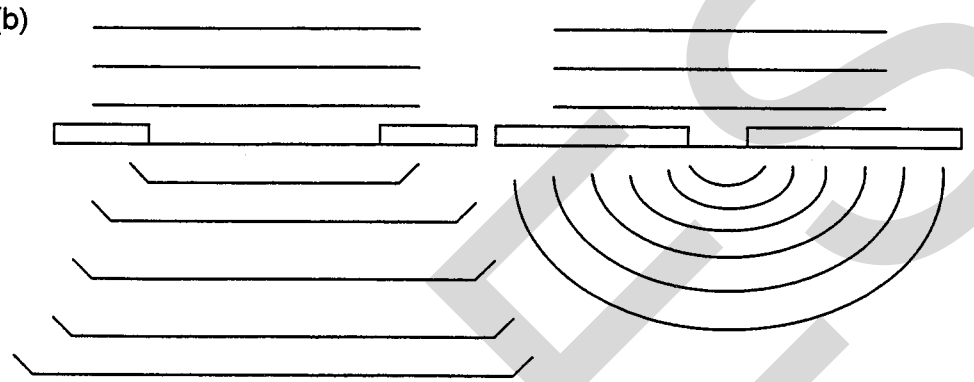
Total marks [8]

4 (a) Idea of adding **B1**
reasonable execution thereof **B1**



[2]

(b)



Large gap: not much diffraction shown **M1** Small gap: waves become circular **M1**
wavelength not changed in both sketches **A1**

[3]

(c) (i) number of wavelengths = 923.7 / 30 = 30.8 **B1**
Or 30.79 to 4 sig figs
[1]

(ii) $584^2 + 810^2 = BP^2$ **C1**
BP = 998.6mm
Number of wavelengths = 998.0 /30 = 33.3 **A1**
Or 33.29 to 4 sig figs
[2]

(iii) 1. zero OR minimum OR low **B1** [1]
2. 2 maxima and 2 minima before maximum at O.
Can be shown on a sketch.
1st mark for pattern of light dark light, 2nd mark for 2 maxima and 2 minima **B2**
[2]

Total marks [11]

5 (a) (i) turns ratio = 40 / 1000 = 1/25 **C1**
p.d. = 230 / 25 = 9.2(V)(r.m.s) **A1** [2]

(ii) 9.2V x √2 **C1**
= 13.0 (V) **A1** [2]

(b) (i) to allow current to flow into the battery **B1**
to prevent current in the opposite direction **B1**
OR good statement concerning a.c. or rectification
[2]

(ii) to reduce the current(from the high value) **M1**
when 13V forward and only 9 V reverse (i.e. 4 V and zero resistance gives a large current **A1** [2]

Total marks [8]

6 (a) Electromagnetic radiation OR UV OR light **B1**
Falling on (clean) metal (surface) **B1**
Causing electrons to be emitted (from surface) * **M1**
* *Treat as **second** point* [3]

(b) (i) a packet (quantum) of electromagnetic energy **M1**
$E = hf$ **A1** [2]

(ii) the energy (Φ) required to release an electron from the metal's surface **B1** [1]

(iii) the minimum frequency (f_0) required to cause photoelectric emission **B1** [1]

(c) $E = hf = hc / \lambda$ **C1**
$= (6.63 \times 10^{-34} \times 3.00 \times 10^{8}) / (5.89 \times 10^{-7})$ **C1**
$= 3.38 \times 10^{-19}$ (J) **A1** [3]
Total marks [10]

7 (a) (i) glass **B1** [1]

(ii) (long plastic region for copper) and no plastic region for glass **B1** [1]

(b) (i) area $= \pi \times (0.00018\text{m})^2 = 1.018 \times 10^{-7}$ **B1** [1]

(ii) EITHER
stress $= 8.0 / 1.018 \times 10^{-7} = 7.86 \times 10^{7}$ (Pa) **C1**
strain $= 2\text{mm} / 1600\text{mm} = 1.25 \times 10^{-3}$ **C1**
Y = stress / strain **C1**
$= 6.3 \times 10^{10}$(Pa) **A1** [4]
OR
$Y = F\ell / xA$ **C1**
$= (\ell/A) \times$ gradient **C1**
$= (1600 / 1.018 \times 10^{-7}) \times (7.6/2)$ **C1**
$= 6.0 \times 10^{10}$ (Pa) **A1** [4]

(iii) ultimate tensile stress $= 14.3 / 1.018 \times 10^{-7}$ **C1**
$= 1.405 \times 10^{8}$ Pa **UNIT PENALTY** **A1** [2]

(iv) area under line $= \frac{1}{2} \times 2/1000 \times 12$
$= 0.012$ (J) *for idea of areas* **C1**
area under curve $\approx (23 / 1000) \times 13.5$
$= 0.31$ (J) *for values given* **C1**
Total work done ≈ 0.32 (J) $\pm$ 0.03 J *1 sig fig enough* **A1** [3]
Total marks [12]

8 (a) (i) to ensure that the beam is strong enough **B1**
to ensure that too much sag does not occur **B1** [2]

(ii) it minimises the amount of steel for a given load **B1** [1]

(iii) the top is where maximum compression occurs; the bottom is where maximum extension occurs - either statement will suffice **B1**
these parts are made thicker to withstand these forces **B1** [2]

(b) $x = WL^3/kab^3$ $\therefore W = kab^3x / L^3$ **C1**
$= (3.6 \times 10^{10} \times 0.050 \times (0.10)^3 \times 0.010) / 3.0^3$ **C1**
$= 667$(N) **A1** [3]

(c) (i) $1/360 \times 4.20\text{m} = 0.0117$(m) **A1** [1]

(ii) $B = WL / 8 = 33000 \times 4.20 / 8$
$= 17300$ **A1** Nm UNIT PENALTY **B1** [2]

(iii) $x = BL^3/(3.35 \times 10^{8}) = (17300 \times 4.203) / (3.35 \times 10^{8})$ **C1**
$= 3.83 \times 10^{-3}$m **A1** [2]

(d)	10 kN x 0.50 m = 5.0 kN m	**C1**	
	6.0 kN x 1.3 m = 7.8 kN m	**C1**	
	22 kN x 2.3 m = 50.6 kN m		
	7.0 kN x 3.1 m = 21.7 kN m	**C1**	
	Total = 85.1 kN m	**A1**	
	1 off for each mistake to minimum zero		
	2 (or more) sig figs required		
	Units, same as above, required throughout		[4]
(e)	(i) 91 (MPa) interpolation required	**B1**	[1]
	(ii) 17300 Nm / 91 x 106 Pa = 1.90 x $10^{-4}m^3$	**M1**	
	Yes, it is safe	**A1**	[2]
		Total marks [20]	
		Quality of language	**[4]**
		Total Marks	**90**

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RECOGNISING ACHIEVEMENT

Markscheme 9244/3
June 2000

General instructions

Mark all scripts in red. Team leaders comment in green.

Put a mark of some sort of *every* page to show that is has been seen.

Tick the point in the candidate's work where you finally decided that the candidate had dome enough to earn the mark. One tick should be made for each and every mark. Show the mark awarded for each section of question in the right-hand margin. There should be a mark shown in the margin corresponding to each square bracket on the question paper. Note: the total number of ticks on the script must agree with the final overall total for the script, as shown on the front page.

Comments, including underlining and ringing of crucial parts of answers, are required so that the marking and/ or checking of scripts can be completed efficiently (please see below).

Categorisation of marks

The marking scheme categories marks of the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a B- mark to be scored, the point to which it refers must be seen specifically in the candidate's answer.

M marks: These are method marks upon which A – marks (accuracy marks) later depend. For an M- mark to be scored, the point to which it refers must be seen in the candidate's answer. If a candidate fails to score a particular M- mark, then none of the dependent A- marks can be scored.

C marks These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a C mark and the candidate does not write down the actual equation but does correct working which shows he/ she knew the equation, then the C mark is awarded.

A marks These are accuracy or answer marks which either depend on an M mark, or allow a C mark to be scored.

Conventions to be used when marking questions

EXPLANATION

The rubric on the question paper specifies that all working should be shown. However, some candidates may miss steps in their arguments. Where explanation is considered essential for full credit, this will be indicated by M or B marks.

INCORRECT PHYSICS
No credit is given for correct substitution, or subsequent arithmetic, in a physical incorrect equation. This is indicated by M marks and subsequent A marks.

TRANSFERRED ERROR (indicated by writing **ECF** on the script)
Answers to later sections of *numerical* questions which are consistent with earlier incorrect answers, no matter how obtained, may be awarded up to the full credit for the section. The transferred error is applied in *non-numerical* questions only where a specific instruction to do so is given in the marking scheme.

ARITHMATIC ERROR (Indicated by writing **AE** on the script)
Follow through the figures and give full subsequent credit if there are no further errors. This ruling also includes 10^n errors.

UNITS (indicate by writing **U** on the script)
Omitted or wrongly stated in the final answer, do not award the mark for the final answer. Where this unit penalty (-1 mark) is to be applied, it will be discussed at the standardisation meeting.

TRANSCRIPTION ERROR (indicated by putting a ring around the figures)
For example, incorrect transcription of data from question or data sheet. Deduct the relevant ABC mark, then follow through the working, giving full subsequent credit.

ANSWER NOT WORKED OUT
Deduct the relevant mark – but use discretion e.g. no mark should be deducted for quoting an angle as 2π radians. Exceptions will be discussed at the standardisation meeting.

SIGNIFICANT FIGURES
Where more significant figures are given than is justified by the question, do not penalise. Fewer significant figures than are necessary will be considered within the detailed marking scheme.

BENEFIT OF DOUBT
Where a candidate provides an answer which is not totally satisfactory but the examiner feels that sufficient work has been done to award than mark, then this mark should be indicated with the letters **BOD**.

Conventions within the marking scheme

BRACKETS
Where brackets are shown in the marking scheme, the candidate is not required to give the bracketed formation in order to earn the available marks.

UNDERLINING
The marking scheme, underlining indicates information which is essential for marks to be awarded.

Question Number		Mark Scheme Details	Part Mark
1 (a)	(i)	allow 1.6 cm, allow 1.65 cm (do not allow 1.7 cm)	B1
		at constant speed, acceleration is zero	B1
	(ii)	extension for a = 0.6 ms^{-2} 12.8 cm	C1
		change in extension = (12.8 – 1.6)	A1
		= 11.2 cm /allow 11.15 cm	A0
(b)	(i)	$F = ma$	C1
		= 0.8x 0.6 = 0.48N (missing unit -1)	A1
	(ii)	spring constant = force /extension	C1
		= 0.48/11.2	
		= 4.3x 10^{-2} Ncm^{-1} (note ecf from (i))	A1
	(iii)	frictional force = 4.3 x 10^{-2} x 1.6	
		= 6.9 x 10^{-2} N	
		allow use of 1.65 cm from (a) (i) and ecf from (b) (ii)	A1
(c)	(i)	$v^2 = u^2 + 2as$ and a = 0.1 ms^{-2}	C1
		= 0 + 2 x 0.1 x 1.2	
		v = 0.49 ms^{-1}	A1
	(ii)	$s = ut + \frac{1}{2} at^2$	C1
		$t_{1.2}$ = 4.90s	C1
		$t_{1.5}$ = 5.48s	C1
		time taken = 0.58s	A1
		N.B. Apply –1 for only 1 s f ONCE in the question.	
(d)	(i)	does not go through origin	M1
		∴ not proportional	A1
	(ii)	because acceleration is proportional to *elastic force –friction force*	M1
		and from graph, acceleration is (constant x x) – constant *friction force* constant so *elastic force proportional to extension.*	M1
		The gradient is constant / straight line graph scores 1. If friction is removed line would go through the origin scores 2	A1

Question Number	Mark Scheme Details	Part Mark
2 (a)	(i) product of force and distance moved / displacement	M1
	distance moved in direction of the force	A1
	(ii) energy / work (done) / time (taken) OR rate of doing work	B1
	do not allow work done in unit time i.e. ratio must be clear	
(b)	Use of $v^2 = u^2 + 2as$ and $F = ma$	B1
	Substitution leading to $Fs = ½ mv^2 - ½ mu^2$ if $½ mu^2$ disappears need to see $u = 0$	B1
	Fs is work done (i.e. idea of balanced equation) (link between work and gain in energy)	B1
	So, $½ mv^2$ and $½ mu^2$ is kinetic energy	B1
	Wrong algebra leading to a quote that k.e. = $½ mv^2$ does not get the last mark	
(c)	(i) base unit of v^3: $m^3 s^{-3}$ / $(ms^{-1})^3$	B1
	base units of P: (kg m s^{-2} m) / s	C1
	kg m^2 s^{-3}	A1
	base units of k: kg m^{-1}	B1
	(ii) power = (240 x 31) + (0.98 x 31^3)	C1
	= 36.6kW (allow 2 sf)	A1
(d)	(i) $E_k = ½ mv^2 = ½ \times 720 \times 31^2$	
	$= 3.46 \times 10^5$J	A1
	(ii) power = Fv	C1
	$F = (36.6 \times 10^3) / 31$	
	= 1180 N	A1
	N.B. ecf from (c)(ii)	
	(iii) work done = Pt or distance = 5 x 60 x 31	C1
	= 36.6 x 10^3 x 5 x 60 $W = Fs = 1180 \times 5 \times 60 \times 31$	
	= 11 MJ = 11 MJ	A1
	N.B. ecf from (c)(ii)	
(e)	No because E_k << work done	B1
	Comment re cost of device relative to fuel costs	
	Or extra mass / extra friction etc	B1

Question Number		Mark Scheme Details	Part Mark
3 (a)	(i)	progressive: energy transferred	B1
		stationary: no energy transfer	B1
	(ii)	progressive: the same / constant	B1
		stationary : depends on position in the internodal loop/ amplitude varies/ not constant	B1
	(iii)	progressive: out of phase with neighbours	B1
		stationary: all in phase in any intermodal loop	B1
		and further detail in (ii) or (iii) e.g. reference to internodal loop, labelled diagram showing phase or amplitude	B1
(b)	(i)	1. Current in (wire normal) B-field so force on wire direction of force Clear OR reference to FLHR (allow vertical force)	M1 A1
		as *I* changes direction, *F* changes also, giving rise to vibrations	A1
		2. wire has (natural) frequency of vibration dependent on tension	B1
		when natural frequency = forced frequency / frequency of current	B1
		resonance occurs	B1
	(ii)	reasonable sketch showing one or three <u>loops</u> etc. single line allowed but not in the rest position	B1
		2. wavelength = 152 cm for one loop or 51 cm for three loops etc.	
		answers must agree with answer in (b) (ii) 1. But no error carried forward for 2 loops	
(c)	(i)	wire/ conductor cuts magnetic field / flux	M1
		so by Faraday's law, e.m.f. is induced **or** $E\alpha = \Delta\Phi/\Delta t$	A1
	(ii)	induced e.m.f. / current must produce force oppose motion of wire	B1
		so, when wire changes direction of motion, e.m.f. changes direction	B1
		any extra good physics e.g. phase discussion in (i) or (ii)	B1

Question Number	Mark Scheme Details		Part Mark
4 (a)	(i)	graph: straight line through origin.. axes need not be labelled V or Q	B1
	(ii)	1. (ratio Q/V) is gradient OR (gradient)$^{-1}$ of graph	B1
		2. (change in) energy = $V\Delta Q$ or Vq	B1
		correct area identified on graph	B1
		(hence) energy = ½ QV	M1
		= ½ CV^2	A1
(b)	(i)	1. Two capacitors in series gives 25 μF	C1
		total capacitance = 50 μF	A1
		2. advantage: e.g. smaller p.d. across each capacitor	B1
	(ii)	e.g. larger force on nucleus	B1
		forces in opposite directions **(or different directions)**	B1
	(iii)	forces due to electric field strip electrons off atoms / **ionisation occurs**	B1
		(charges/ electrons and / or ions) move giving rise to a current	B1
	(iv)	1.Total energy = ½ CV^2 = ½ x50x10^{-6}x540^2 = 7.29 J	C1
		energy dissipated = 4.6J	A1
		2. final energy = ½ CV^2	
		7.29 x 0.37 = ½ x50 x10^{-6}xV^2	C1
		V = 328 V N.B. ecf from (iv)	
		p.d. across each capacitor = 164V... allow ecf from (iv) 2	A1
(c)	(i)	$I_1 = I + I_2$	B1
	(ii)	$E_1 = I_1R_1 + IR_2$	B1
	(iii)	$E_2 = -IR_2$	B1

Question Number		Mark Scheme Details	Part Mark
5 (a)	(i)	Evaporation boiling occurs at surface of liquid / in body of liquid (both required)	B1
		at all temperatures/ at boiling point/ at one temperature (both required)	B1
	(ii)	molecules separate so increase in potential/ internal energy	B1
		vapour (pushed back atmosphere so) external work done	B1
		statement of first law $U = Q + W$ with symbols defined	M1
		directions explained to show Q must be supplied	A1
(b)	(i)	any three assumptions – beware of repetition *1 each* comparisons must be clearly stated	B3
	(ii)	$pV = nRT$. If N given then it must be defined as no. of moles	B1
	(iii)	$\rho = Nm/V$ so $p = 1/3\ (Nm/V) \langle c^2 \rangle$	B1
		and $k = R/N_A$ so $pV = NkT$	B1
		correct algebra leading to $1/3\ m\langle c^2 \rangle = kT$	C1
		so $\langle E_k \rangle = \frac{1}{2}\ m\langle c^2 \rangle = 3/2\ Kt$	A1
(c)	(i)	**1.** $\langle E_k \rangle = 3/2 \times 1.38\times10^{-23} \times (273 + 35)$ using T in °C scores 0/2	C1
		$= 6.38 \times 10^{-21}$ J	A1
		2. $6.38 \times 10^{-21} = \frac{1}{2} \times 1.67\times10^{-27}\times\langle c^2 \rangle$	C1
		$\langle c^2 \rangle = 7.64 \times10^{-6}$ N.B. ecf. From (c)(i) 1	
		$c_{r.m.s.} = 2760\ ms^{-1}$	A1
	(ii)	either $3/2 \times 1.38 \times 10^{-23} \times T = \frac{1}{2} \times 4\times 1.66\times 10^{-27} \times 7.64 \times10^{6}$	C1
		$T = 1200K$ N.B. ecf. From (c)(i) 2.	A1
		Or $\frac{1}{2}\ m \langle c^2 \rangle = 3/2\ kT$, $\langle c^2 \rangle$constant) so $m \propto T$ $T = 1200K$	

Question Number	Mark Scheme Details	Part Mark
6 (a)	Nucleon: proton or neutron	M1
	Found in nucleus	A1
	Nucleus: small massive	B1
	Positively charged core of atom	B1
	Nuclide: particular type of atom / nucleus	B1
(b)	(i) $^{220}_{86}Rn \rightarrow {}^{216}_{84}Po + {}^{4}_{2}\alpha + \gamma$ + energy	B2
	any error or omission, -1 each allow He for α and Q for energy	
	(ii) time for activity / number of atoms (or nuclei)/ mass / amount of substance to half	M1
	reference to particular isotope/ substance	A1
	(iii) **1**. Energy released $=6.84MeV=1.09\times10^{-12}$ J	C1
	$E=(\Delta)mc^2$	C1
	$\Delta m = (1.09 \times 10^{-12}) / (9.0 \times 10^{16})$	
	$= 1.2 \times 10^{-29}$kg if no conversion of MeV to J then maximum 1/3 (second mark)	A1
	2. $\Delta E = hc/\lambda$ allow $\Delta E = hf$ and $c = f\lambda$	
	$0.55 \times 1.6 \times10^{-13} = (6.63 \times10^{-34} \times 3.0 \times 10^{8})/ \lambda$	C1
	$\lambda = 2.26 \times 10^{-12}$m	A1
	do not penalise non conversion of Mev to J twice If the failure to convert is only in part 2, then both marks are lost in 2.	
(c)	(i) $A = \lambda N$	C1
	$200 = (\ln2/56) \times N$	
	$N = 1.6 \times 10^4$	A1
	No unit required (if m^{-3} given then allow)	
	(ii) number of air molecules per cubic metre $= (6.02 \times 10^{23}) / 0.024$	C1
	ratio is 6.44×10^{-22}	A1
(d)	e.g. can cause (lung) cancer	B1
	when breathed in	B1
	do not allow 'dangerous to health'	

Question Number		Mark Scheme Details	Part Mark
7 (a)	(i)	group / cluster of (many) stars	M1
		further detail e.g.: shape, diameter	A1
	(ii)	distance (travelled)	M1
		by light in one year	A1
(b)		At this distance, galaxy is very faint	B1
		Further comments, e.g. atmosphere absorbs radiation, causes distortion, discovered by gamma-ray burst *1 each to max 2* Light pollution	B2
(c)	(i)	Hubble constant given by $v = H_0 d$	B1
		And v and d not known with certainty / mean density of universe not known	B1
	(ii)	$\rho = 3 \times (2.6 \times 10^{-18})2 / (8 \times \pi \times 6.67 \times 10^{-11})$	C1
		$= 1.2 \times 10^{-26}$kg m^{-3}	A1
	(iii)	nucleon mass is about 1.67×10^{-27}kg allow 1.66×10^{-27}kg	C1
		number density $= (1.2 \times 10^{-26}) / (1.67 \times 10^{-27})$ $= 7$ m^{-3}	A1
	(iv)	speed of recession (of galaxies) will decrease to zero / expansion stops	B1
		then (galaxies) will have increasing speed of approach / collapses / big crunch	B1

Question Number	Mark Scheme Details		Part Mark
8 (a)	(i)	incomplete plane of atoms / complete plane	M1
		between complete planes (*allow words or diagram with some explanation*) / moving one atom	A1
	(ii)	atoms in complete plane move in direction of applied force	M1
		to complete the half-plane	A1
		so dislocation moves by successive movement of planes	B1
	(iii)	large number prevents movement of dislocations	M1
		so more difficult to deform / any other relevant comment	A1
(b)	(i)	large stress required to make it yield / break/ fail	B1
		e.g. steel, aluminium	B1
	(ii)	**1.** Tough to absorb large quantity of energy before breaking	M1
		not stiff so that it does not resist deformation	M1
		so that energy of collusion is absorbed	A1
		2. Strong cage does not yield / no crumple zones	B1
		so that energy of collusion is shorter	M1
		so large force are experienced	A1

Question Number	Mark Scheme Details	Part Mark
9 (a)	(i) **1.** Op-amp has very large gain	M1
	and $V_+ = 0$, $V_x = V_+$ unless amplifier saturated	A1
	2. $I_{IN} = V_{IN} / R_{IN}$	B1
	$I_{OUT} = (0\text{-}V_{OUT}) / R_F$... **or** $I_o = V_o / R_F$	B1
	$I_{IN} = I_{OUT}$ explained and $I_{OUT} = -I_{IN}$ no current in amplifier / input impedance is large, ∞	B1
	(So) $V_{OUT} / V_{IN} = -R_F / R_{IN}$ = gain	B1
	(ii) **1.** -1.0 V	B1
	2. (+) 9.0 V	B1
(b)	(i)	

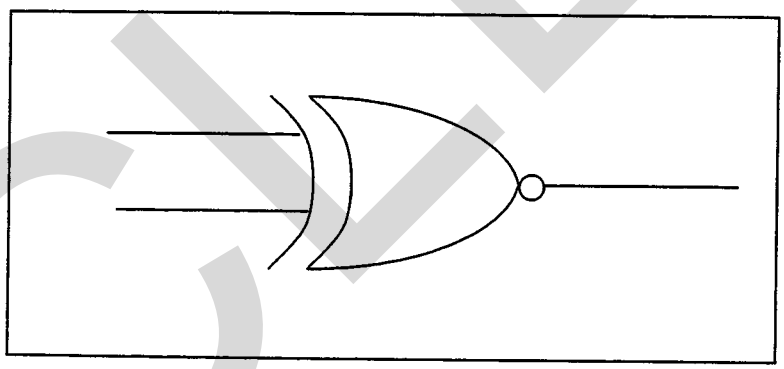
X	Y	A	B	C		
0	0	0	1	0	Column A correct	B1
0	1	0	0	1	Column C correct	B1
1	0	1	0	0	Column B following A and C (i.e. ecf)	B1
1	1	0	1	0		

(ii) **1.** Yellow — N.B. ecf from (b) (I) — B1

2. green — If identified with the letters A, B or C allow max 2/3 — B1

3. red — B1

(iii) symbol — Possible ecf from B — B1



Question Number	Mark Scheme Details	Part Mark
10 (a)	(i) weight = upthrust / weight of displaced water	B1
	(iii) metacentre is above centre of gravity / mass	B1
	(iv) further detail e.g. metacentre defined	B1
	allow ship returns to rest position when displaced from vertical axis 1/2	
(b)	(i) **1.** Mass per unit of time = density x volume per unit time	M1
	$= \rho Av$	A0
	2. Either energy transfer per unit of time = force x v	M1
	And force = pA	M1
	So, energy transfer per unit of time = pAv	A0
	Or $W = Fx$	
	$W = pAx$	
	$W/t = pA\ x/t = pAv$	
	(ii) *1.* Energy transfer per unit of time = change in E_k per unit of time	B1
	$p_1A_1v_1 - p_2A_2v_2 = \frac{1}{2}\ \rho A_2v_2^3 - \frac{1}{2}\ \rho A_1v_1^3$	B1
	but $A_1v_1 = A_2\ v_2$	M1
	hence $p_1 - p_2 = \frac{1}{2}\ \rho v_2^2 - 1.2\ \rho v_1^2$ i.e. this line follows some algebra	A1
	2. e.g. incompressible or horizontal tube of flow or streamline	B1
(c)	(i) against head –wind, speed is effectively 100 km h^{-1}	M1
	so power is $(110 / 100)^3$ greater or 1.33 times greater or 67 kW	A1
	(ii) e.g. at any one better speed, lower fuel consumption lower power requirement at higher speed ....*1 each, max 2..*	B2
	or higher speeds for same power	
	less pollution	
	less noise	
	for two marks some reference must be made to speed in one of the statements.	

Question Number		Mark Scheme Details	
11 (a)	(i)	e.g. diagnose broken bone X – rays absorbed to different extent by bone and soft tissue 'shadow' image produced	
	(ii)	e.g. pulse oximetry intensity of light absorbed / reflected depends on concentration of blood gases intensity reflected measured to give O_2 concentration / blood flow rate e.g. endoscopy laser light sent down optical fibre illumination of site	
(b)	(i)	Most refraction at air / cornea boundary (ciliary) muscles change lens shape to (fine) –focus on retina / back of eye	
	(ii)	eyeball about 17 mm long (allow 15-20 mm) focussing at 30 cm, power = $0.3^{-1} + 0.017^{-1}$ = 62.2 D focussing at infinity, power = 0.017^{-1} = 58.8 D Change is 3.4 D (ignore sign)	Or $P_1 = (1/0.3) + 1/v$ $P_2 = (1/\infty) + (1/v)$ $P_2 - P_1 = (1/0.3) = 3.3$ D
(c)	(i)	$I.L. = 10 \lg (I/I_0)$ *Where* $I_0 = 10^{-12}$ W m^{-2} or is threshold intensity	
	(ii)	Approximate measure at any one frequency But loudness is also frequency dependent (subjective response to intensity level scores 1/ 2)	

Question Number	Mark Scheme Details	Part Mark
11 (a)	(i) e.g. diagnose broken bone	M1
	X – rays absorbed to different extent by bone and soft tissue	A1
	'shadow' image produced	A1
	(ii) e.g. pulse oximetry	M1
	intensity of light absorbed / reflected depends on concentration of blood gases	A1
	intensity reflected measured to give O_2 concentration / blood flow rate	A1
	e.g. endoscopy	
	laser light sent down optical fibre	M1
	illumination of site	A1
		A1
(b)	(i) Most refraction at air / cornea boundary	B1
	(ciliary) muscles change lens shape to (fine) –focus on retina / back of eye	B1
	(ii) eyeball about 17 mm long (allow 15-20 mm) Or $P_1 = (1/0.3) + 1/v$	B1
	focussing at 30 cm, power = $0.3^{-1} + 0.017^{-1}$	
	= 62.2 D $P_2 = (1/\infty) + (1/v)$	A1
	focussing at infinity, power = 0.017^{-1} = 58.8 D	
	Change is 3.4 D (ignore sign) $P_2 - P_1 = (1/0.3) = 3.3$ D	A1
(c)	(i) *I.L.* = 10 lg (I/I_0)	M1
	Where $I_0 = 10^{-12}$ W m^{-2} or is threshold intensity	A1
	(ii) Approximate measure at any one frequency	B1
	But loudness is also frequency dependent	B1
	(subjective response to intensity level scores 1/ 2)	

Question Number	Mark Scheme Details		Part Mark
12 (a)	(i)	nucleus of large mass / of uranium	B1
		'splits' when bombarded by a neutron	M1
		into two large fragments plus neutrons plus energy	A1
	(ii)	e.g. gamma ray photons	
		k.e. of fission fragments or ke of neutrons. Two forms needed max 2 marks	B2
	(iii)	slows down neutrons	M1
		so that neutrons may then cause further fissions.	A1
(b)	(i)	A to B /AB	B1
	(ii)	**1.** 200J	B1
		2. efficiency = (useful output) / (input)	C1
		= 200/380	
		=53%	A1
(c)	e.g. visual pollution		M1
	produced by roads, car parks etc		A1
	e.g. destruction of the landscape		M1
	during building of roads, fuel production etc.		A1
	e.g. heat/ thermal pollution		M1
	emitted in the exhaust gases		A1
	e.g. rubber from tyre		M1
	disposal of the tyre		A1
		Max marks: 4	

Question Number	Mark Scheme Details		Part Mark
13 (a)	(i)	signal has discrete energy levels	B1
	(ii)	time between starts of samples = 1/18000 = 55.6 μs	C1
		length of 5-bit number = 2.5μs	C1
		time interval = 53.1μs	A1
	(iii)	e.g. for sending other messages (allow time division mutliplexing)	B1
	(iv)	frequencies greater than 9 kHz not recovered	B1
	(v)	further comment e.g. loss of quality of signal	B1
(b)	(i)	loss = 2.3 x 140 = 322 dB allow 320 dB	B1
	(ii)	ratio is 60 μW /60mW = 10^{-4}	C1
		ratio is (-) 40 dB	A1
	(iii)	total gain of repeaters must be 282dB (to be seen somewhere in (iii))	B1
		number required = 282/75 = 4	A1
		322/75 giving scores 1 /2 362 giving 5 scores 1/ 2	
(c)	Satellite in orbit above Equator		B1
	Period of rotation about Earth = 24 hours		B1
	ONE of any further detail e.g. height/ direction of rotation (W to E)/ appears in fixed position / speed 3100m/s		B1
	Allow (3 to 4) x 10^4 km above surface (4 to 4.5) x 10^4 km radius		

OCR

RECOGNISING ACHIEVEMENT

Markscheme 9244/4
June 2000

Physics Practical

Question 1.

Measurements and Observations.

M1 Readings 3

Write the number of readings by the results table
6+ sets of readings scores 3/3
5 sets of readings scores 2/3
4 sets of readings scores 1/3
Less than four sets scores zero
Most t's must be > 10 seconds; if not then -1
Check a value for T^4. Tick if correct.
Begin checking from t average. Ignore rounding errors.
If incorrect write in correct value and -1.
If help is given by the Supervisor then -1. Excessive help then -2.
Please indicate when help has been given to a candidate by writing SR at the top of the front page of the candidates' script. Also indicate the type of help which has been given by writing a brief comment by the table of results.

M2 Repeated readings 1

Expect to see at least two values for t for each value of d.
Do not award this mark if all the repeats are the same.

Presentation of results.

R1 Column headings 1

Every column must be headed with a quantity and a unit.
There must be some distinguishing mark between the quantity and unit.
See guide for further details.

R2 Consistency of raw readings 1

Apply to t and d.
Readings of a particular quantity must all be given to the same number of d.p.
Do not allow t to be given to the nearest second or 0.001 s.
Expect d to be given to the nearest millimetre.

R3 SF in T^4, where $T > 1$ s 1

If t given to 2 sf then accept T^4 to 2 or 3 sf.
If t given to 3 sf then accept T^4 to 3 or 4 sf.
If t given to 4 sf then accept T^4 to 3 or 4 sf.

Graphical work.

G1 Axes 1

Each axis must be labelled with a quantity. Ignore units.
Scales must be such that the plotted points occupy at least 6 large squares in the *y*-direction and 5 large squares in the *x*-direction.
Ignore plots which are not on the grid.
Do not allow more than 3 large squares between scale markings.
Do not allow awkward scales (e.g. 3:10, 6:10, 7:10, 8:10 etc.)

G2 Plotting of points 1

Count the number of plots on the grid and write this value by the line and ring it. Do not allow plots which are in the margin area.
The number of plots must correspond to the number of observations.
Do not award this mark if the number of plots is less than the number of observations.
Check one suspect plot. Circle this plot. Tick if correct.
If incorrect then mark the correct position with a small cross and use a small arrow to indicate where the plot should have been.
Allow errors up to and including half a small square.

G3 Line of best fit. 1

Only a drawn straight line through a linear trend is allowable.
This mark can only be awarded for 5 or more trend plots on the graph grid.
There must be a reasonable balance of points about the line which has been drawn.
If one of the plots is a long way from the linear trend of the other plots then allow this plot to be ignored when the line of best fit is drawn.

G4 Measurement of gradient. 1

The hypotenuse of the triangle must be greater than half the length of the line which has been drawn.
The gradient must be negative. Circle and tick the negative sign.
Please indicate the vertices of the triangle used by labels.
Check that the substitution has been done correctly.
If any read-offs are inaccurate by more than half a small square, then -1.
If a tangent to a curve is drawn then this mark is lost.

G5 *y*-intercept 1

Must be accurate to half a small square. Check for false origin.
Allow calculation from a point on the line. Working must be seen.
A drawn curve loses this mark.

Analysis.

A1 Gradient equated with $-8\pi^4 L/g^2$ 1

A2 Intercept equated with $4\pi^4 Lk/g^2$ 1

A3 Correct method of working for g, with consistent unit (cm s^{-2} or m s^{-2}) 1
Allow one small slip with the sign, or a factor of 2 error.
If a small slip is made and not penalised write 'slip' by the workings.
Allow $L/2$ to be used instead of L (no penalty).

A4 Correct method of working for k with consistent unit (cm or m) 1
Allow one small slip (e.g. factor of 2 error or other AE).
Allow $L/2$ to be used instead of L (no penalty).

A5 Valid reason for failure of model 1
e.g. appreciable air resistance effects (accept 'wind')
model may not be valid for large amplitude oscillations
steel cable is not a continuous loop
weight of steel cable needs to be taken into account
Underline and tick correct response.
Do not allow answers relating to the mass or the weight of the riders.
Do not allow stretching of cable.
Do not allow a selection of right and wrong answers to be given together.
If a selection of right and wrong answers are given write SIF.

17 marks in total.

Special cases.

S1 Calculates f^4 instead of T^4;
M1, -1; G3 = 0.

S2 Substitution method to find g and k;
A1 = A2 = A3 = A4 = 0.

S3 Graph of log T against log d;
A1 = A2 = A3 = A4 = 0.

S4 Calculates t^4 instead of T^4;
M1, -1.

S5 Graph of d against T^4 or graph of T against d;
A1 = A2 = 0 (transfer error into **A3** and **A4**).

S6 No record of the number of oscillations, or one oscillation done (and T recorded);
M1, -1.

S7 Measures number of oscillations in a given time (poor procedure);
M1, -1; R3 = 0.

S8 Something seriously wrong (e.g. no trend/wrong trend);
M1, -2.

S9 No raw times;
M1, -1.

S10 Misread stopwatch;
M1, -1.

Question 2.

Measurements and Observations.

M1 Readings 3
Write the number of readings by the results table
6+ sets of readings scores 3/3
5 sets of readings scores 2/3; 4 sets of readings scores 1/3
Less than four sets scores zero
Check a value for 1/*I* and 1/*R*. Tick if correct.
Begin checking from raw values. Ignore rounding errors.
If incorrect write in correct value and -1.
If help is given by the Supervisor then -1. Excessive help then -2.
Please indicate when help has been given to a candidate by writing SR at the top of the front page of the script. Indicate the type of help by writing a brief comment by the table of results.

M2 Justification for SF in values of 1/*I*. 1
Answer must relate SF in *I* (or 'raw data') to SF in 1/*I*.
Do not accept answers given in terms of decimal places.

M3 Quality of results 1
Judge by scatter of points about line of best fit.
There must be 5 trend plots for this mark to be awarded.
N.B. Serious rounding errors may lead to this mark not being awarded.

Presentation of results.

R1 Column headings 1
Every column must be headed with a quantity and a unit
(ignore table values)
There must be some distinguishing mark between the quantity and unit.

R2 Consistency of raw readings 1
Apply to current values only.
Expect all values of current to be given to the same number of d.p..
Accept whole mA or 0.1 mA. Do not allow 0.01 mA.

R3 SF in *s* 1
Allow 2 or 3 SF only.

Graphical work.

G1 Axes 1
Each axis must be labelled with a quantity. Ignore units.
Scales must be such that the plotted points occupy at least 6 large squares in the *y*-direction and 5 large squares in the *x*-direction.
Ignore plots which are not on the grid.
Do not allow more than 3 large squares between scale markings.
Do not allow awkward scales (e.g. 3:10, 6:10, 7:10, 8:10 etc.)

G2 Plotting of points 1
Count the number of plots on the grid and write this value by the line and ring it. Do not allow plots which are in the margin area.
The number of plots must correspond to the number of observations.
Do not award this mark if the number of plots is less than the number of observations.
Check one suspect plot. Circle this plot. Tick if correct.
If incorrect then mark the correct position with a small cross and use a small arrow to indicate where the plot should have been.
Allow errors up to and including half a small square.
See guide for further details.

G3 Line of best fit. 1
Only a drawn straight line through a linear trend is allowable.
This mark can only be awarded for 5 or more trend plots on the graph grid.
There must be a reasonable balance of points about the line which has been drawn.
If one of the plots is a long way from the linear trend of the other plots then allow this plot to be ignored when the line of best fit is drawn.

G4 Measurement of gradient. 1
The hypotenuse of the triangle must be greater than half the length of the line which has been drawn.
Please indicate the vertices of the triangle used by labels.
Check that the substitution has been done correctly.
If any read-offs are inaccurate by more than half a small square, then -1.
See guide for further details.

G5 *y*-intercept 1
Must be accurate to half a small square. Check for false origin.
Allow calculation from a point on the line. Working must be seen.

Analysis.

A1 c = candidate's value for y-intercept, with correct unit (mA^{-1} or A^{-1}) 1

A2 E.M.F. of power supply (8.5 V $\leq E <$ 9.5 V), with unit. 1
If SV is different then $\pm$ 0.5 V of SV is allowable.
Please write SV next to the candidate's value if a different range is used.

A3 Gradient equated with rs/E 1
Can be implied from the working

A4 Value of s (42 Ω to 54 Ω), with unit 1

17 marks in total.

Special cases.

S1 Substitution method used to find s;
A3 = A4 = 0.

S2 Graph of $1/R$ vs $1/I$;
A4 = 0.
Allow TE for A1 and A3.

S3 Miscalculates $1/I$ (or $1/R$);
M1, -1; M3 = 0 (probably); G3 = 0 (probably); A4 = 0.

S4 Raw current values are not tens of milliamperes;
A4 = 0.

S5 Something seriously wrong (i.e. wrong trend/no trend of plots);
M1, -2.

3.

A1	Basic idea (heat water and measure rise in capillary tube)	1
A2	Method of finding original volume of water: Measuring cylinder method or weighing.	1
A3	Weigh flask empty + full using top-pan balance & calculate volume of water using density $V = m/$. Detail needed.	1
B1	Use of microscope (+ scale) to measure diameter of capillary tube. Do not allow calipers/micrometer screw gauge/rule. Allow Hg method.	1
B2	Method of finding volume increase (i.e. measure rise of water level & multiply by cross-sectional area of capillary tube).	1
C1	Method of maintaining constant temperature of the whole flask (e.g. use water bath; remove heat and add insulation). Could be shown on diagram. Do not allow Bunsen burner on a low flame method.	1
C2	Method of measuring temperature rise of water in flask with suitable use of thermometer. Do not allow vague 'use the thermometer to measure the temperature of the water in the flask'. Allow wires of thermocouple to enter flask through bung or mercury-in-glass thermometer to be shown in bung. Could be shown on diagram. Allow thermometer in water bath. Do not allow wires/thermometer down the capillary tube.	1
D1/2	Any further details. e.g. Measure diameter of capillary tube in several places (& average); Measure rise of water level using microscope or calipers (but not if S1); Flask shown to be fully submerged; Swirling of flask to improve mixing; Water is poor conductor of heat; Use small bore capillary tube or large flask; Measure a range of temperatures and volumes; Don't heat the water to temp. close to 100 ^{O}C (due to steam problems); Leave appreciable time for apparatus to come to thermal equilibrium; Use coloured water so the levels can be seen more easily. Allow any valid/relevant further details. Any two; one mark each.	2

9 marks possible, but only 8 marks maximum can be scored.

S1 Partially filled flask (usually shown on diagram) loses **A1** and **B2**.

4

A1	Correct kit (S.G. + speaker, microphone + CRO (or noise meter)) Extraneous equipment loses this mark. Do not allow tuning forks.	1
A2	Workable reflecting arrangement (source → board → receiver) Ignore extraneous equipment.	1
A3	Method of ensuring incident sound does not reach the microphone directly (e.g. use tubes, partition etc.)	1
B1	Measure amplitude of reflected wave using the amplitude (height) of the wave on CRO screen (could be shown on a diagram). Do not allow vague answers - must be explicitly stated. Allow reading on noise meter.	1
B2	Obtain frequency from signal generator or use (timebase on) CRO. Do not allow tuning fork methods for this mark.	1
B3	Change frequency and measure new amplitude of reflected wave (could be shown as table or graph).	1
C	Maintain constant distances	1
D1/2	Any further good design/experimental features. Some of these might be: Surround apparatus with absorbent material to avoid reflections from other surfaces (or perform experiment in a quiet room); Method of measuring frequency using CRO; Problem with frequency response of microphone or loudspeaker; Calibrate signal generator using CRO; Use incident waves of same amplitude (or power/volume/loudness/intensity) for each different frequency; Method of ensuring waves of varying frequency have same amplitude: Use same absorbing material each time (*explicitly stated*).	2

9 marks available, but 8 only marks maximum can be scored.

S1 Wrong experiment (e.g. concert hall with many microphones; fixed frequency and varying reflecting surfaces; reverberation time experiment. N.B. if correct experiment is repeated for different surfaces, no penalty); **A2 = A3 = 0.**

S2 Transmission experiment; **A2 = A3 = B1 = 0.**

OCR

RECOGNISING ACHIEVEMENT

Markscheme 9244/5
June 2000

Practical Examination (Physics A) (Alt B)

Question 1.

Measurements and Observations.

M1 Readings **3**
Write the number of readings by the results table
6+ sets of readings scores 3/3
5 sets of readings scores 2/3
4 sets of readings scores 1/3
Less than four sets scores zero
Most t's must be > 10 seconds; if not then -1
Check a value for T^2h and h^2. Tick if correct.
Begin checking from t average and h. Ignore rounding errors.
If incorrect write in correct value and -1.
If help is given by the Supervisor then -1. Excessive help then -2.
Please indicate when help has been given to a candidate by writing SR at the top of the front page of the candidates' script. Also indicate the type of help which has been given by writing a brief comment by the table of results.

M2 Repeated readings **1**
Expect to see at least two values for t for each value of d.
Do not award this mark if all the repeats are the same.

Presentation of results.

R1 Column headings **1**
Every column must be headed with a quantity and a unit.
There must be some distinguishing mark between the quantity and unit.
See guide for further details.

R2 Consistency of raw readings **1**
Apply to t and h.
Readings of a particular quantity must all be given to the same number of d.p.
Do not allow t to be given to the nearest second or 0.001 s.
Expect h to be given to the nearest millimetre.

R3 SF in h^2, where $h^2 > 0.1$ m^2 **1**
If h given to 1 sf then accept h^2 to 1 or 2 sf.
If h given to 2 sf then accept h^2 to 2 or 3 sf.
If h given to 3 sf then accept h^2 to 3 or 4 sf.

Graphical work.

G1 Axes **1**

Each axis must be labelled with a quantity. Ignore units.
Scales must be such that the plotted points occupy at least 6 large squares in the y-direction and 5 large squares in the x-direction.
Ignore plots which are not on the grid.
Do not allow more than 3 large squares between scale markings.
Do not allow awkward scales (e.g. 3:10, 6:10, 7:10, 8:10 etc.)

G2 Plotting of points **1**

Count the number of plots on the grid and write this value by the line and ring it. Do not allow plots which are in the margin area.
The number of plots must correspond to the number of observations.
Do not award this mark if the number of plots is less than the number of observations.
Check one suspect plot. Circle this plot. Tick if correct.
If incorrect then mark the correct position with a small cross and use a small arrow to indicate where the plot should have been.
Allow errors up to and including half a small square.

G3 Line of best fit. **1**

Only a drawn straight line through a linear trend is allowable.
This mark can only be awarded for 5 or more trend plots on the graph grid.
There must be a reasonable balance of points about the line which has been drawn.
If one of the plots is a long way from the linear trend of the other plots then allow this plot to be ignored when the line of best fit is drawn.

G4 Measurement of gradient. **1**

The hypotenuse of the triangle must be greater than half the length of the line which has been drawn.
Please indicate the vertices of the triangle used by Δ labels.
Check that the substitution has been done correctly.
If any read-offs are inaccurate by more than half a small square, then -1.
If a tangent to a curve is drawn then this mark is lost.

G5 y-intercept **1**

Must be accurate to half a small square. Check for false origin.
Allow calculation from a point on the line. Working must be seen.
A drawn curve loses this mark.

Analysis.

A1 Gradient equated with $4\pi^2/g$ **1**

A2 Intercept equated with $4\pi^2k^2/g$ **1**

A3 Correct method of working for g, with consistent unit (cm s^{-2} or m s^{-2}) **1**

A4 Correct method of working for k with consistent unit (cm or m) **1**

A5 Valid reason for failure of model **1**
e.g. appreciable air resistance effects (accept 'wind')/friction
model may not be valid for large amplitude oscillations
model may not be valid for large values of h
weight of metal rods needs to be taken into account
rule is uniform, ship is not, ∴ model is invalid
oscillations are driven not free
Underline and tick correct response.
Do not allow answers relating to the mass or the weight of the riders.
Do not allow stretching of rods.
Do not allow a selection of right and wrong answers to be given together.
If a selection of right and wrong answers are given write SIF.

17 marks in total.

Special cases.

S1 Calculates f^2h instead of T^2h;
M1, -1; G3 = 0.

S2 Substitution method to find g and k;
A1 = A2 = A3 = A4 = 0.

S3 Graph of log T against log h;
A1 = A2 = A3 = A4 = 0.

S4 Calculates t^2h instead of T^2h;
M1, -1.

S5 Incorrect graph (e.g. T vs h; h^2 vs T^2h);
A1 = A2 = 0 (transfer error into **A3** and **A4**).

S6 No record of the number of oscillations, or one oscillation done (and T recorded);
M1, -1.

S7 Measures number of oscillations in a given time (poor procedure), unless $t > 60$ s
M1, -2;

S8 Something seriously wrong (e.g. no trend/wrong trend);
M1, -2.

S9 No raw times;
M1, -1 (and probably R2 = 0 also).

S10 Misread stopwatch;
M1, -1.

Question 2.

Measurements and Observations.

M1 Readings **3**
Write the number of readings by the results table
6+ sets of readings scores 3/3
5 sets of readings scores 2/3; 4 sets of readings scores 1/3
Less than four sets scores zero
Check a value for $1/V$ and $1/R$. Tick if correct.
Begin checking from raw values. Ignore rounding errors.
If incorrect write in correct value and -1. Both wrong, then -2.
If help is given by the Supervisor then -1. Excessive help then -2.
Please indicate when help has been given to a candidate by writing SR at the top of the front page of the script. Indicate the type of help by writing a brief comment by the table of results.

M2 Justification for SF in values of $1/V$. **1**
Answer must relate SF in V (or 'raw data') to SF in $1/V$.
Do not accept answers given in terms of decimal places.

M3 Quality of results **1**
Judge by scatter of points about line of best fit.
There must be 5 trend plots for this mark to be awarded.
N.B. Serious rounding errors may lead to this mark not being awarded.

Presentation of results.

R1 Column headings **1**
Every column must be headed with a quantity and a unit (ignore table values)
There must be some distinguishing mark between the quantity and unit.

R2 Consistency of raw readings **1**
Apply to values of potential difference only.
Expect all values of potential difference to be given to the same number of d.p..
Accept 0.1 V or 0.01 V. Do not allow 0.001 V or whole numbers.

R3 SF in E **1**
Allow 2 or 3 SF only.

Graphical work.

G1 Axes **1**

Each axis must be labelled with a quantity. Ignore units.
Scales must be such that the plotted points occupy at least 6 large squares in the y-direction and 5 large squares in the x-direction.
Ignore plots which are not on the grid.
Do not allow more than 3 large squares between scale markings.
Do not allow awkward scales (e.g. 3:10, 6:10, 7:10, 8:10 etc.)

G2 Plotting of points **1**

Count the number of plots on the grid and write this value by the line and ring it. Do not allow plots which are in the margin area.
The number of plots must correspond to the number of observations.
Do not award this mark if the number of plots is less than the number of observations.
Check one suspect plot. Circle this plot. Tick if correct.
If incorrect then mark the correct position with a small cross and use a small arrow to indicate where the plot should have been.
Allow errors up to and including half a small square.
See guide for further details.

G3 Line of best fit. **1**

Only a drawn straight line through a linear trend is allowable.
This mark can only be awarded for 5 or more trend plots on the graph grid.
There must be a reasonable balance of points about the line which has been drawn.
If one of the plots is a long way from the linear trend of the other plots then allow this plot to be ignored when the line of best fit is drawn.

G4 Measurement of gradient. **1**

The hypotenuse of the triangle must be greater than half the length of the line which has been drawn.
Please indicate the vertices of the triangle used by Δ labels.
Check that the substitution has been done correctly.
If any read-offs are inaccurate by more than half a small square, then -1.
See guide for further details.

G5 y-intercept **1**

Must be accurate to half a small square. Check for false origin.
Allow calculation from a point on the line. Working must be seen.

Analysis.

A1 c = candidate's value for y-intercept, with correct unit (V^{-1}) **1**

A2 Gradient equated with r/E **1**
Can be implied from the working

A3 E.M.F. in range 8.5 V $\leq E <$ 11.0 V, with unit. **1**
Working must be correct.
If SV is different then $\pm$ 1.0 V of SV is allowable.
Please write SV next to the candidate's value if a different range is used.

A4 New value of c from V (i.e. $1/V$) **1**
Acceptable range from 0.18 V^{-1} to 0.22 V^{-1}. Unit required.

17 marks in total.

Special cases.

S1 Substitution method used to find c and E;
A1 = A3 = 0.

S2 Graph of $1/R$ vs $1/V$;
A1 = 0.
Allow TE for A2 and A3.

S3 Miscalculates $1/V$ (or $1/R$);
M1, -1; M3 = 0 (probably); G3 = 0 (probably).

S4 Raw potential difference values are not of the order of a few volts;
M1, -1.

S5 Something seriously wrong (i.e. wrong trend/no trend of plots);
M1, -2.

3

A1	Closed chamber used (e.g. glass tank with lid)	**1**
A2	Diagram of workable arrangement (electrodes with some method of achieving high humidity; hygrometer shown). Ignore circuit at this stage (although circuit must be outside the chamber).	**1**
A3	Circuit diagram correct (p.s.u. in series with electrodes and current measuring meter; voltmeter across supply or electrodes). Accept a.c. or d.c. power supply.	**1**
B1	Vary p.d. across electrodes and measure current and p.d. (table or graph)	**1**
B2	Take readings at constant humidity	**1**
C1/2	Safety precautions (e.g. wear (heatproof) gloves; protective goggles; aspects relating to the use of H.T. supplies, use 'rubber' coated wires etc.). Allow other valid points. Any two, one mark each.	**1**
D1/2	Any further details. e.g. H.T. supply shown on diagram Method of attempting to achieve constant humidity (e.g. low heat to water); Use small separation of electrodes, with reason; Keep air temperature constant/suitable temperature (40^{o} - 90^{o}) given; Maintain constant separation of electrodes; Support electrodes on insulating stand; Drainhole shown Any comment relating to conduction through surface water. Allow any valid/relevant further details. Any two; one mark each.	**2**

9 marks possible, but only 8 marks maximum can be scored.

S1 Experiment conducted in sauna; **A1 = 0 (and probably A2 = 0 also)**

S2 Wrong experiment (e.g. change humidity and measure current);
B1 = 0; B2 = 0.

S3 Evacuated chamber/vacuum pump used;
A2 = 0; B2 = 0.

4

A1	Correct kit (S.G. + speaker, microphone + CRO (or noise meter)) Extraneous equipment loses this mark. Do not allow tuning forks. Workable arrangement must be shown (source → board → receiver).	**1**
A2	Method of ensuring incident sound does not reach the microphone by other means (e.g. relection from walls of room) - use of sound absorbing materials.	**1**
B1	Measure amplitude of transmitted wave using the amplitude (height) of the wave on CRO screen (could be shown on a diagram). Do not allow vague answers - must be explicitly stated. Allow reading on 'noise' meter. Allow intensity to be used.	**1**
B2	Measure mass and volume of material; use $\rho = m/V$ to find density of material. Do not allow weight to be used instead of mass.	**1**
B3	Change material/density and measure new amplitude of transmitted wave (could be shown as table or graph).	**1**
C1/2	Control of variables; Maintain constant distance between speaker and microphone; Use material of constant thickness; Use sample of constant surface area; Use waves of same amplitude/power/volume/loudness/intensity/freq. Any two; one mark each.	**1**
D1/2	Any further good design/experimental features. Some of these might be: Perform experiment in a quiet room; Method of ensuring waves have same amplitude for each material; Use audible signal with range of frequencies (20 - 20000 Hz) Sensible comment relating to low frequencies; Any two; one mark each. Allow other valid points.	**2**

9 marks available, but 8 only marks maximum can be scored.

S1 Wrong experiment description can only get 4/8 max.