CAMBRIDGE
INTERNATIONAL EXAMINATIONS

NOVEMBER 2002

GCE Advanced Level

MARK SCHEME

MAXIMUM MARK : 30

SYLLABUS/COMPONENT :9702 /5

PHYSICS
(PRACTICAL)

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

Marking scheme for question 1

M1 Readings **6**
6 sets then 6/6; 5 sets then 5/6; 4 sets then 4/6 etc.
Allow more than 6 sets without penalty.
Write the number of readings as a ringed total by the table.
Misread ammeter (i.e. impossibly large currents), then –1
Wrong trend of plots (i.e. probable misreading of rule), then –1
Minor help from the Supervisor, -1. Major help, then -2.
If help has been given then write SR at the top of the front page of the script, and give a brief explanation of the type of help that has been given by the table of results.

M2 Repeated readings **1**
For each value of d expect to see at least two values of I.
An average value must be calculated.
Do not award this mark if all the repeats are the same

M3 Quality of results **1**
Judge by scatter of points about the line of best fit
There must be at least five trend plots
This mark can be scored even if the trend of plots is incorrect

R1 Column headings **1**
Each column heading must contain a quantity and a unit.
There must be some distinguishing feature between the quantity and the unit.
Do not allow (I) A. Insist on I(A)

R2 Consistency of results **1**
All the raw readings of d should be given to the same number of d.p.
The values of d must be given to the nearest millimetre
All the raw readings of I should be given to the same number of d.p.
Do not accept the second decimal place to be zero for every reading of current

R3 SF in m **1**
Allow 2 or 3 sf only
If m not equated with gradient, then apply to gradient value

G1 Axes **1**
The axes must be labelled with the quantities plotted.
Ignore units on the axes.
The plotted points must occupy at least half the graph grid in both the x and y directions. Do not allow more than 3 large squares between the labels on an axis.
Do not allow awkward scales (e.g. 3:10, 6:10, 8:10 etc.).

G2 Plotting of points **1**
All the observations must be plotted.
Count the number of plots and ring this total on the grid.
Do not allow plots in the margin area.
Check one suspect plot. Circle this plot. Tick if correct. If incorrect, mark the correct position with a small cross and use an arrow to indicate where the plot should have been, and -1. 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 for this mark.
This mark can only be awarded for 5 or more plots on the grid.
There must be a reasonable balance of points about the drawn line.
Do not allow a line of thickness greater than half a small square.

G4 Determination of gradient **1**
Ignore any units given with the value.
Hypotenuse of Δ must be > half the length of line drawn.
Check the read-offs. Work to half a small square. $\Delta x/\Delta y$ gets zero.
Values taken from the table that lie on the line to within half a small square are acceptable.

G5 y-intercept **1**
The value may be read from the y-axis or calculated from a point on the line using $y = mx + c$.

A1 m = gradient **1**
Allow if not explicitly stated, but the substitution into $y = mx + c$ is correct.

A2 c = y-intercept **1**

A3 Units of m and c (A m^{-1}, A) **1**
Do not allow this mark if the axes are reversed.
If the candidate has realised the error and made allowances for it, then allow full credit to be given.
Power of ten error in calculations, or unit muddle, will not score this mark

A4 Sensible comments relating to measurement of current **1**
Measure d, use graph or equation to find I.

20 marks in total for this question.

Question 2.

A1 Workable arrangement and correct kit **1**
Do not allow this mark if the method of investigation is invalid.
E.g. Do not allow d.c. with magnet or d.c. with vibration generator.
Do not allow stopwatch methods
Do not allow if no method given for changing frequency
Do not allow if no method of finding tension (e.g. turning pegs on a guitar)
Allow microphone + CRO for frequency measurement
Allow tuning fork placed on sonometer + paper rider on wire

A2 Procedure (determine T and f, change T and measure new f) **1**
This mark may be scored even if the arrangement is unworkable
Could be given for table headings. If l varies then this mark cannot be scored.

B1 Method of measuring tension (e.g. weight of mass on wire/Newton meter) **1**
Do not accept methods involving measurement of extension

B2 Method of measuring frequency (e.g. read scale from SG or strobe) **1**
Allow microphone connected to CRO to be placed near to the wire and
'find the frequency from the CRO'. Allow frequency from the fork to be given.
Allow use of 'high speed photography' if sensible
Do not accept 'frequency sensor'. Do not accept 'camera' or 'video'

C1 Method of achieving resonance of wire **1**
(e.g. adjust output freq. of SG until large amplitude oscillations are seen)
Allow 'pluck the wire'

C2 Any one safety precaution **1**
(e.g. wear safety goggles (in case the wire snaps); safety screens; keep feet away from the load in case the wire snaps; use a bucket of sand below load;
do not look directly into strobe). Do not allow 'gloves'.

C3 Use constant length of wire or same mass per unit length of wire **1**

D1/2/3 Any further good design features. Some of these might be: **3**
Place white card behind vibrating wire so it can be seen easily.
Check frequency scale of SG/calibration ideas
Good description for finding resonance position
Use top pan balance/electronic scales to find mass
Do preliminary experimentation to determine suitable loads
Detail relating to how the frequency would be found from the CRO trace
Check uniformity of wire (1 mark) Use screw gauge to check the uniformity (1 mark)
Sensible ideas relating to the elastic limit
Perform the experiment in a quiet place if using microphone and CRO
Check the wire to ensure that it is free from kinks
Accept 'smooth pulley' or 'smooth rod' ideas
Do not accept 'repeat readings' ideas

10 marks in total.

Theory and sample results for question 1.

Taking moments about the centre of the rule:

$$(F_{coil} \text{x} d_1) + (m_m g \text{x} d_1) = (W \text{x} d_2)$$

Where d_1 and d_2 are the distances from the magnet and weight to the fulcrum respectively.

Assuming that the force on the magnet is directly proportional to the current in the coil ($F = kI$) and $d_2 + 0.5 = d$ then

$$I = \left(\frac{W}{kd_1}\right)d - \left(\frac{0.5W}{kd_1} + \frac{m_m g}{k}\right)$$

Hence the graph of I vs d should be a straight line with a negative y-intercept.

d/cm	I_1/A	I_2A	I_{av}/A
98.0	2.59	2.61	2.60
95.0	2.22	2.25	2.24
93.0	2.03	2.05	2.04
88.0	1.47	1.48	1.48
85.0	1.11	1.11	1.11
83.0	0.89	0.89	0.89
80.0	0.54	0.55	0.55

Gradient of graph = 0.114, so m = 0.114 A cm^{-1}.

Intercept = -8.56 , so c = -8.56 A