MARK SCHEME for the May/June 2007 question paper

9702 PHYSICS

9702/32 Paper 32 (Advanced Practical Skills 2),
maximum raw mark 40

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners’ meeting before marking began.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates’ scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

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1 Manipulation, measurement and observation

Successful collection of data

(a) (i) Measurement of e.m.f. of power supply [1]

(b) Measurements
Five marks for six sets of readings for $I$ and $R_3$, four for five sets, etc. [5]

(b) Circuit set up without help from Supervisor [1]

Range and distribution of values

(b) $R_3 = 33$ or $47\Omega$ and $R_3 = 560$ or $680\Omega$ must be included [1]

Quality of data

(Graph) Judge by scatter of points about the best fit line. Trend must be correct. At least 5 plots are needed for this mark to be scored. [1]

Presentation of data and observations

Table: layout

(b) Column headings
Each column heading must contain a quantity and a unit where appropriate. Ignore units in the body of the table. There must be some distinguishing mark between the quantity and the unit (i.e. solidus is expected, but accept, for example, $I$ (A)). [1]

Table: raw data

(b) Consistency of presentation of raw readings
All values of $I$ must be given to the same number of decimal places. [1]

Table: calculated quantities

(b) Significant figures
Apply to $1/I$ only.
If $I$ is given to 2 sf, then accept $1/I$ to 2 or 3 sf.
If $I$ is given to 3 sf, then accept $1/I$ to 3 or 4 sf.
If $I$ is given to 4 sf, then accept $1/I$ to 4 or 5 sf. [1]

(b) Values of $1/I$ correct.
Check a value. If incorrect, write in the correct value. [1]
Graph: layout

(Graph) Axes [1]
Sensible scales must be used. Awkward scales (e.g. 3:10) are not allowed.
There should not be more than three large squares between axis labels.
Scales must be chosen so that the plotted points must occupy at least half
the graph grid in both x and y directions.
Scales must be labelled with the quantity which is being plotted. Ignore units.

Do not penalise reversed axes or if the wrong graph has been plotted.

Graph: plotting of points

(Graph) All observations must be plotted. [1]
Ring and check a suspect plot. Tick if correct. Re-plot if incorrect (and re-check quality mark).
Work to an accuracy of half a small square.

Graph: trend line

(Graph) Line of best fit (must be 5 or more plots) [1]
Judge by scatter of points about the candidate's line.
There must be a fair scatter of points either side of the line.
Indicate best line if candidate's line is not the best line.

Analysis, conclusions and evaluation

Interpretation of graph

(c) (iii) Gradient [1]
The hypotenuse must be greater than half the length of the drawn line.
Read-offs must be accurate to half a small square.
Check for \( \Delta y / \Delta x \) (i.e. do not allow \( \Delta x / \Delta y \)).

(c) (iii) \( y \)-intercept [1]
The value must be read to the nearest half square.
The value can be calculated using ratios or \( y = mx + c \).
If a false origin has been used then label FO.

Drawing conclusions

(d) Must be in range 40.0 to 55.0 Ω. [1]
Value for \( R_1 \) obtained from \( y \)-intercept \( \times E \).
2 or 3 sf. Unit required

(d) Value for \( R_2 \) [1]
Should be 220 Ω ± 50 Ω unless Supervisor has used different resistors to those specified.
Method of working must be correct.
2 or 3 sf. Unit required.

[Total for Question 1: 20]
2 Manipulation, measurement and observation

Successful collection of data

(a) (ii) First value of \(d\) (less than 40 cm) no more precise than 1 mm. [1]

(a) (ii) First value of \(h\) (less than \(d\)) [1]

(a) (iii) Method of measuring \(h\) accurately
  e.g. Use of set squares to indicate height / repeat to refine position.
  Do not accept repeated readings for this mark
  Do not accept just ‘use a set square’ [1]

(b) Second value of \(d\) (less than 40 cm) [1]

(b) Second value of \(h\) (less than \(d\)) [1]

(b) Evidence of repeated measurements for \(h\) (first or second reading) [1]

Quality of data

(b) Values of \(e\) within 10% of each other [1]

Presentation of data and observations

Display of calculation and reasoning

(b) Values of \(e\) calculated correctly
  One mark each
  Calculations must be checked [2]

(c) Consideration of the percentage uncertainty in \(h\) from (a)(iv) is expected.
  Knowledge of error propagation methods is not required. [1]
Analysis, conclusions and evaluation

Drawing conclusions

(c) Conclusion
Sensible comments relating to values of e. Incorrect ideas score zero. [1]

Estimating uncertainties

(a) (iv) Percentage uncertainty in h
If repeated readings have been done then the uncertainty must be half the range. Absolute uncertainty must be 2 to 10 mm. Correct ratio idea required. [1]

Identifying limitations

(d) (i) Relevant points must be underlined and ticked. Some of these might be:
A Two sets of readings not enough (to draw valid conclusion)
B Hard to judge rebound height, with reason
C Parallax (error in measuring h)
D Difficult to release without applying a force
E Rule may not be vertical / perpendicular
F Only cm divisions on rule (if borne out by readings)
G Inconsistent bounce [4]

Suggesting improvements

(d) (ii) Relevant points must be underlined and ticked. Some of these might be:
A Take several d values and plot graph/compare e values
B Use video and play back slowly/position sensor
C Method of reducing parallax problem (adjustable marker/drop many times to refine value of h/assistant to drop ball/ensure measurement taken at eye level)
D Mechanical method of release/hold ball against stop
E Method of making rule vertical
G Use flat surface/turn off fans

Do not allow ‘repeated readings’ (unless qualified by ‘plot a graph’) Do not allow ‘use a computer to improve the experiment’ Do not allow ‘increase d’

[Total for Question 2: 20]