

**Specimen Paper**

**GCE A AND AS LEVEL**

**MARK SCHEME**

**MAXIMUM MARK: 40**

**SYLLABUS/COMPONENT: 9702/31**

**PHYSICS**  
**Paper 31 (Advanced Practical Skills)**

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## Question 1

### Manipulation, measurement and observation (9 marks)

#### Successful collection of data (7 marks)

- (c) Measurements 6  
One mark for each set of readings for  $I$  and  $R$ .

- (c) Repeats 1

#### Range and distribution of values (1 mark)

- (c) Range of resistance values 1  
Should cover the whole range from  $2.5\ \Omega$  to  $40\ \Omega$ .

#### Quality of data (1 mark)

- Graph Quality of results 1  
Judge by scatter of points about the best fit line.  
At least 5 plots are needed for this mark to be scored.

### Presentation of data and observations (7 marks)

#### Table of results: layout (1 mark)

- (c) Layout: Column headings 1  
Each column heading must contain a quantity and a unit.  
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)).

#### Table of results: raw data (1 mark)

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

#### Table of results: calculated quantities (2 marks)

- (c) Significant figures in calculated quantities 1  
Apply to  $1/I$ . Accept two or three significant figures only.
- (c) Correct values of total resistance and  $1/I$  calculated 1  
All values should be correct for this mark.

#### Graph: layout (1 mark)

- Graph Axes 1  
Sensible scales must be used. Awkward scales (e.g. 3:10) are not allowed.  
Scales must be chosen so that the plotted points occupy at least half the graph grid in both  $x$  and  $y$  directions.  
Scales must be labelled with the quantity which is being plotted.

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**Graph: plotting of points (1 mark)**

Graph	Plotting of points	1
	All observations must be plotted. Ring and check a suspect plot. Tick if correct. Re-plot if incorrect. Work to an accuracy of half a small square.	

**Graph: trend line (1 mark)**

Graph	Line of best fit	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 (4 marks)**

**Interpretation of graph (2 marks)**

(d)(iii)	Gradient	1
	The hypotenuse of the $\Delta$ 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 $\Delta x/\Delta y$ ).	

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

**Drawing conclusions (2 marks)**

(e)	Value for $E$	1
	Unit required.	
(e)	Value for $r$	1
	Unit required.	

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## Question 2

### Manipulation, measurement and observation (7 marks)

#### Successful collection of data (6 marks)

- (a) Measurements of  $m_A$  and  $m_B$  with mass of beaker included 2  
One mark each.
- (a) Measurement of mass of empty beaker measured 1
- (c)(ii) Measurement of  $t_A$  1
- (c)(iii) Measurement of  $t_B$  1
- (c)(iii) Repeated measurements for both  $t_A$  and  $t_B$  1

#### Quality of data (1 mark)

- (c)(iii) Quality of results ( $t_B = 2t_A \pm 10\%$ ) 1  
Do not allow this mark if the stopwatch has been misread.

### Presentation of data and observations (3 marks)

#### Display of calculation and reasoning (3 marks)

- (a) Correct calculation of  $m_A$  and  $m_B$  (i.e. subtraction of mass of beaker) 1
- (e)(i) Calculation of mass flow rates 2  
One mark each.  
Correct unit ( $\text{g s}^{-1}$  or  $\text{kg s}^{-1}$ ), consistent with candidate's working, required for both marks to be awarded.

### Analysis, conclusions and evaluation (10 marks)

#### Drawing conclusions (1 mark)

- (e)(ii) Sensible comment relating to constant mass flow rate 1  
e.g. rate not affected by mass.

#### Estimating uncertainties (1 mark)

- (d) Percentage uncertainty in  $t$  1  
If repeated readings have been done, then the uncertainty must be half the range.  
Accept  $\Delta t = 0.1 \text{ s}$  to  $0.4 \text{ s}$ . Correct ratio idea required.

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**Identifying limitations (4 marks)**

- (f)(i) Sources of error or limitations of procedure 4
- Relevant points might include:
- Two readings are not enough to draw a valid conclusion
  - Difficulty with removing finger and starting the stopwatch at the same time
  - Length of pipe at bottom of funnel may affect results
  - Salt may contain 'lumps' which affect the flow rate
  - Moisture content of salt may affect flow rate
  - Hard to see the point at which all the salt has passed out of the container
  - Human error in starting/stopping the stopwatch
  - Salt sticks to the sides of the funnel
- (f)(i) Improvements 4
- Relevant points might include:
- Take many readings and plot a graph of the results
  - Use greater masses of salt to increase  $t$
  - Greater masses reduce uncertainty in  $t$
  - Use mechanical method (joined to timer) to start the flow
  - Use light gates to determine when salt ceases to pass out of the hole
  - Use of a second person
  - Do not allow 'repeated readings'.
  - Do not allow 'use a computer to improve the experiment'.