

MARK SCHEME for the October/November 2013 series

9702 PHYSICS

9702/31

Paper 3 (Advanced Practical Skills 1),
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, which would have considered the acceptability of alternative answers.

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Page 2	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2013	9702	31

- 1 (a) (i) Value for d in the range $0.15 \text{ mm} \leq d \leq 0.25 \text{ mm}$, with unit. [1]
- (c) (ii) Values of V_1 and V_2 , and $V_1 > V_2$. [1]
- (d) Six sets of readings of l , V_1 and V_2 scores 5 marks, five sets scores 4 marks etc. [5]
Major help from Supervisor –2. Minor help from Supervisor –1.
- Range: $\Delta l \geq 30 \text{ cm}$. [1]
- Column headings: [1]
Each column heading must contain a quantity and a unit where appropriate.
The unit must conform to accepted scientific convention, e.g. l / m or $l (\text{m})$
- Consistency: [1]
All values of raw l must be given to the nearest mm.
- Significant figures: [1]
Significant figures for every row of V_1/V_2 must be the same as, or one more than the least number of significant figures used in V_1 and V_2 .
- Calculation: [1]
Values of V_1/V_2 calculated correctly.
- (e) (i) Axes: [1]
Sensible scales must be used, no awkward scales (e.g. 3:10).
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 that is being plotted.
Scale markings should be no more than three large squares apart.
- Plotting of points: [1]
All observations in the table must be plotted.
Diameter of plotted point must be $\leq$ half a small square (no “blobs”).
Work to an accuracy of half a small square.
- Quality: [1]
All points in the table must be plotted on the grid for this mark to be awarded.
All points must be within 0.05 (to scale) on the y -axis V_1/V_2 from a straight line.
- (ii) Line of best fit : [1]
Judge by balance of all points on the grid about the candidate’s line (at least 5 points)
There must be an even distribution of points either side of the line along the full length.
Allow one anomalous point only if clearly indicated by the candidate.
Line must not be kinked or thicker than half a small square.

Page 3	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2013	9702	31

- (iii) Gradient: [1]
 The hypotenuse of the triangle must be at least half the length of the drawn line.
 Both read-offs must be accurate to half a small square in both the x and y directions.
 The method of calculation must be correct.

- y-intercept: [1]
 Either:
 Check correct read off from a point on the line and substituted into $y = mx + c$.
 Read-off must be accurate to half a small square in both x and y directions.
 Or:
 Check read-off of the intercept directly from the graph.

- (f) (i) Value of P = candidate's gradient. Value of Q = candidate's intercept. [1]
 (ii) Value of ρ in range $1.0 - 20.0 \times 10^{-7} \Omega \text{ m}$ [1]

[Total: 20]

- 2 (b) Value of m to the nearest 1 g or better with consistent unit. [1]
- (c) (ii) Measurement of raw θ to nearest degree with unit. [1]
 Evidence of repeat readings for θ . [1]
- (iii) Percentage uncertainty in θ based on absolute uncertainty of 2 to 5° (or half the range provided this is not zero), and correct method of calculation. [1]
- (iv) Correct calculation of $\tan(\theta/2)$. [1]
- (d) (i) Second value of $m >$ first value of m . [1]
 (ii) Second value of θ . [1]
 Quality: second value of $\theta <$ first value of θ . [1]
- (e) Value of θ . [1]
- (f) (i) Two values of k calculated correctly. [1]
 (ii) Justification of s.f. in k linked to significant figures in m and θ . [1]
 (iii) Sensible comment relating to the calculated values of k , testing against a criterion specified by the candidate. [1]

Page 4	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2013	9702	31

(g)	(i) Limitations (4 max)	(ii) Improvements (4 max)	Do not credit
A	Two readings not enough (to draw a conclusion)	Take more readings <u>and</u> plot a graph / take more readings and calculate more k values and compare	repeat readings / 'few readings' / 'take more readings and calculate average' / 'only one reading' / 'repeat readings' on its own
B	Difficult to measure θ because hook of mass (hanger) in the way / thick band	Tie thread to centre of bottom of rubber band and hang mass from it	
C	Difficult to hold the protractor steady / parallax error reading angle / protractor	Improved method to measure θ e.g. project image of stretched rubber band onto a screen / mark on board / measure lengths and calculate θ / clamp protractor / take picture or video <u>and</u> <u>measure angle</u>	
D	Rubber band stretches over time	Take readings quickly / remove mass from rubber band between readings	
E	Stands moved / rods twist when loads attached to rubber band	Method of preventing movement of stands / clamp stands to bench / use nails in board	
F	Difficult to locate centre of band	Method of locating <u>and mark</u> centre e.g. measure and mark centre	
G	Change in θ small	Larger range of masses	

[Total: 20]

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maximum raw mark 40

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- 1 (a) (i) Value for d in the range $0.15 \text{ mm} \leq d \leq 0.25 \text{ mm}$, with unit. [1]
- (c) (ii) Values of V_1 and V_2 , and $V_1 > V_2$. [1]
- (d) Six sets of readings of l , V_1 and V_2 scores 5 marks, five sets scores 4 marks etc. [5]
Major help from Supervisor –2. Minor help from Supervisor –1.
- Range: $\Delta l \geq 30 \text{ cm}$. [1]
- Column headings: [1]
Each column heading must contain a quantity and a unit where appropriate.
The unit must conform to accepted scientific convention, e.g. l / m or $l (\text{m})$
- Consistency: [1]
All values of raw l must be given to the nearest mm.
- Significant figures: [1]
Significant figures for every row of V_1/V_2 must be the same as, or one more than the least number of significant figures used in V_1 and V_2 .
- Calculation: [1]
Values of V_1/V_2 calculated correctly.
- (e) (i) Axes: [1]
Sensible scales must be used, no awkward scales (e.g. 3:10).
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 that is being plotted.
Scale markings should be no more than three large squares apart.
- Plotting of points: [1]
All observations in the table must be plotted.
Diameter of plotted point must be $\leq$ half a small square (no “blobs”).
Work to an accuracy of half a small square.
- Quality: [1]
All points in the table must be plotted on the grid for this mark to be awarded.
All points must be within 0.05 (to scale) on the y -axis V_1/V_2 from a straight line.
- (ii) Line of best fit : [1]
Judge by balance of all points on the grid about the candidate’s line (at least 5 points)
There must be an even distribution of points either side of the line along the full length.
Allow one anomalous point only if clearly indicated by the candidate.
Line must not be kinked or thicker than half a small square.

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- (iii) Gradient: [1]
 The hypotenuse of the triangle must be at least half the length of the drawn line.
 Both read-offs must be accurate to half a small square in both the x and y directions.
 The method of calculation must be correct.

y-intercept: [1]
 Either:
 Check correct read off from a point on the line and substituted into $y = mx + c$.
 Read-off must be accurate to half a small square in both x and y directions.
 Or:
 Check read-off of the intercept directly from the graph.

- (f) (i) Value of P = candidate's gradient. Value of Q = candidate's intercept. [1]
 (ii) Value of ρ in range $1.0 - 20.0 \times 10^{-7} \Omega \text{ m}$ [1]

[Total: 20]

- 2 (b) Value of m to the nearest 1 g or better with consistent unit. [1]
- (c) (ii) Measurement of raw θ to nearest degree with unit. [1]
 Evidence of repeat readings for θ . [1]
- (iii) Percentage uncertainty in θ based on absolute uncertainty of 2 to 5° (or half the range provided this is not zero), and correct method of calculation. [1]
- (iv) Correct calculation of $\tan(\theta/2)$. [1]
- (d) (i) Second value of $m >$ first value of m . [1]
 (ii) Second value of θ . [1]
 Quality: second value of $\theta <$ first value of θ . [1]
- (e) Value of θ . [1]
- (f) (i) Two values of k calculated correctly. [1]
 (ii) Justification of s.f. in k linked to significant figures in m and θ . [1]
 (iii) Sensible comment relating to the calculated values of k , testing against a criterion specified by the candidate. [1]

Page 4	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2013	9702	33

(g)	(i) Limitations (4 max)	(ii) Improvements (4 max)	Do not credit
A	Two readings not enough (to draw a conclusion)	Take more readings <u>and</u> plot a graph / take more readings and calculate more k values and compare	repeat readings / 'few readings' / 'take more readings and calculate average' / 'only one reading' / 'repeat readings' on its own
B	Difficult to measure θ because hook of mass (hanger) in the way / thick band	Tie thread to centre of bottom of rubber band and hang mass from it	
C	Difficult to hold the protractor steady / parallax error reading angle / protractor	Improved method to measure θ e.g. project image of stretched rubber band onto a screen / mark on board / measure lengths and calculate θ / clamp protractor / take picture or video <u>and</u> <u>measure angle</u>	
D	Rubber band stretches over time	Take readings quickly / remove mass from rubber band between readings	
E	Stands moved / rods twist when loads attached to rubber band	Method of preventing movement of stands / clamp stands to bench / use nails in board	
F	Difficult to locate centre of band	Method of locating <u>and mark</u> centre e.g. measure and mark centre	
G	Change in θ small	Larger range of masses	

[Total: 20]

MARK SCHEME for the October/November 2013 series

9702 PHYSICS

9702/34

Paper 3 (Advanced Practical Skills 2),
maximum raw mark 40

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Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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	GCE AS/A LEVEL – October/November 2013	9702	34

- 1 (a) (ii) Value of $h_2 < h_1$, with consistent unit. [1]
- (b) (iv) First values of L_A and L_B , with unit, and value of $L_A - L_B$ in range 1.0 to 6.0 cm. [1]
- (c) Six sets of values for x , L_A and L_B scores 5 marks, five sets scores 4 marks etc. [5]
 Incorrect trend –1.
 Help from Supervisor –1.
- Range: x values must include 20.0 cm or less and 80.0 cm or more. [1]
- Column headings: [1]
 Each column heading must contain a quantity and a unit where appropriate.
 The unit must conform to accepted scientific convention, e.g. x/cm or x (cm).
- Consistency of presentation of raw readings: [1]
 All values of x must be given to the nearest mm.
- Significant figures: [1]
 Every value of $(L_A - L_B)/C$ must be given to the same s.f. as (or one more than) the least s.f. in C or in $(L_A - L_B)$.
- Calculation: $(L_A - L_B)/C$ calculated correctly. [1]
- (d) (i) Axes: [1]
 Sensible scales must be used, no awkward scales (e.g. 3:10).
 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 that is being plotted.
 Scale markings should be no more than three large squares apart.
- Plotting of points: [1]
 All observations must be plotted.
 Diameter of plotted points must be $\leq$ half a small square (no “blobs”).
 Plots must be accurate to half a small square.
- Quality: [1]
 All points in the table must be plotted for this mark to be scored.
 All points must be within ± 4 scale cm, on the x -axis, of a straight line.
- (ii) Line of best fit: [1]
 Judge by balance of all points on the grid about the candidate's line (at least 5 points). There must be an even distribution of points either side of the line along the full length. Allow one anomalous point only if clearly indicated by the candidate.
 Line must not be kinked or thicker than half a small square.

Page 3	Mark Scheme	Syllabus	Paper
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- (iii) Gradient: [1]
 The hypotenuse must be at least half the length of the drawn line.
 Both read-offs must be accurate to half a small square in both x and y directions.
 The method of calculation must be correct.

- y -intercept: [1]
 Either:
 Correct read-off from a point on the line and substituted into $y = mx + c$.
 Read-off must be accurate to half a small square in both x and y directions.
 Or:
 Correct read-off of the intercept directly from the graph.

- (e) Value of a = candidate's gradient and value of b = candidate's intercept. [1]
 A value presented as a fraction is not allowed.

Correct units for a (e.g. cm^{-1}) and b (no unit), and gradient in range
 -0.050 to -0.150 cm^{-1} (-5.0 to -15.0 m^{-1}). [1]

[Total: 20]

- 2 (a) (i) Raw value(s) for d to nearest 0.1 mm or nearest 0.01 mm. [1]
 d in range 10.0 to 15.0 mm. [1]

- (ii) Correct calculation of R . [1]

- (b) Valid justification for s.f. in R based on s.f. in d and D . [1]

- (d) (iv) θ in range 10° to 50° , with unit. Raw reading(s) must be integer value(s). [1]
 Evidence of repeated readings of θ . [1]

- (e) Estimate of percentage uncertainty based on an absolute uncertainty of 2° to 10°
 (or half the range provided this is not zero), and correct method of calculation. [1]

- (f) Second values for d and D . [1]
 Second value of θ . [1]
 Quality: Second θ less than first θ . [1]

- (g) (i) Correct calculation of two values of k . [1]

- (ii) Sensible comment relating to the calculated values of k , testing against a
 criterion specified by the candidate. [1]

Page 4	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2013	9702	34

(h)

	(i) Limitations (4 max)	(ii) Improvements (4 max)	Do not credit
A	Two readings are not enough (to draw a valid conclusion)	Take many R values and plot a graph/ calculate more k values and compare	'few readings'/ 'take more readings and calculate average'/'only one reading'
B	Spool does not roll straight/ spool topples over/ jerky motion	Roll spool between guides/ use wider spool	Lubricate bench or spool
C	Difficult to judge θ as it varies, equilibrium position not maintained		
D	Difficult to measure θ due to parallax	Method to reduce parallax (e.g. shadow method)	
E	Difficult to pull thread when measuring θ / difficult to watch spool and protractor at same time	Specified thread guiding method (e.g. pulley or rod)	
F	Difficult to align thread with centre of protractor	Take photo or video and measure θ on image (e.g. photo or screen)	
G	Difficult to make protractor vertical	Use plumb-line/detail of another sensible method (e.g. use set square on bench)	

Do not allow 'repeated readings'

Do not allow 'use a computer to improve the experiment'

[Total: 20]

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level

MARK SCHEME for the October/November 2013 series

9702 PHYSICS

9702/35

Paper 3 (Advanced Practical Skills 1),
maximum raw mark 40

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	GCE AS LEVEL – October/November 2013	9702	35

- 1 (a) Value for L in the range 0.500–0.600 m. [1]
- (c) (iv) Value for n in the range 3–8. [1]
- (d) Six sets of readings of D and n scores 5 marks, five sets scores 4 marks etc. Help from Supervisor –1. [5]
- Range of D : $D_{\min} < 45$ cm and $D_{\max} > 50$ cm. [1]
- Column headings: [1]
Each column heading must contain a quantity and a unit where appropriate.
The unit must conform to accepted scientific convention e.g. D/m .
- Consistency: [1]
All values of D must be given to the nearest mm.
- Significant figures: [1]
Every value of $((n + 1)/n)^2$ should be given to 2 or 3 s.f.
- Calculation: [1]
Values of $((n + 1)/n)^2$ calculated correctly.
- (e) (i) Axes: [1]
Sensible scales must be used, no awkward scales (e.g. 3:10).
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 that is being plotted.
Scale markings should be no more than three large squares apart.
- Plotting of points: [1]
All observations in the table must be plotted.
Diameter of plotted point must be $\leq$ half a small square (no “blobs”).
Work to an accuracy of half a small square.
- Quality: [1]
All points in the table must be plotted on the grid for this mark to be awarded.
All points must be no more than 0.04 of $((n + 1)/n)^2$ from a straight line.
- (e) (ii) Line of best fit: [1]
Judge by balance of all points on the grid about the candidate’s line (at least 5 points)
There must be an even distribution of points either side of the line along the full length.
Allow one anomalous point only if clearly indicated by the candidate. Line must not be kinked or thicker than half a small square.

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	GCE AS LEVEL – October/November 2013	9702	35

- (iii) Gradient: [1]
 The hypotenuse of the triangle must be at least half the length of the drawn line.
 Both read-offs must be accurate to half a small square in both the x and y directions.
 The method of calculation must be correct.

y-intercept: [1]
 Either:
 Check correct read-off from a point on the line and substituted into $y = mx + c$.
 Read-off must be accurate to half a small square in both x and y directions.
 Or:
 Check read-off of the intercept directly from the graph.

- (f) Value of $P = -(\text{candidate's gradient})$. Value of $Q = \text{candidate's intercept}$. [1]
 Unit for P (e.g. m^{-1}) consistent with value and no unit for Q . [1]

[Total: 20]

- 2 (b) (i) Value for V_0 in range $25.0 - 35.0 \text{ cm}^3$. [1]
 (ii) Evidence of two volumes added together. [1]
 (v) Correct calculation of V . [1]
 (vi) Absolute uncertainty in V in range $1 \text{ cm}^3 - 3 \text{ cm}^3$.
 If repeated readings have been taken, then the uncertainty can be half the range
 (but not zero if values are equal).
 Correct method of calculation to find percentage uncertainty. [1]
- (c) (iii) Value(s) of x . [1]
 Evidence of repeat readings of x (either here or in (d)(ii)). [1]
- (d) (ii) Second value of V . [1]
 Second value of x . [1]
 Quality: second value of x less than first value of x . [1]
- (e) (i) Two values of k calculated correctly. [1]
 (ii) Justification of s.f. in k linked to significant figures in x and V . [1]
 (iii) Sensible comment relating to the calculated values of k , testing against a
 criterion specified by the candidate. [1]

Page 4	Mark Scheme	Syllabus	Paper
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(f)

	(i) Limitations (4 max)	(ii) Improvements (4 max)	Do not credit
A	Two readings not enough (to draw a conclusion)	Take more readings and plot a graph/take more readings, calculate more k values and compare	'few readings'/'take more readings and calculate average'/'only one reading'/'repeat readings' on its own
B	Difficult to remove correct amount of water because air drawn into syringe	Use syringe with longer nozzle/needle Tilt/invert ball	'nozzle too short' on its own
C	Blu-tack not sticky enough/water leaks from ball/syringe	Use e.g. sellotape/small cork to seal hole	
D	Difficult to judge lowest depth with reason e.g. parallax error/difficult to move head	Line up both sides of rubber band with ball Use mirror behind ball	Parallax measuring x Take measurements at eye level
E	Difficult to judge lowest depth because ball at <u>maximum depth</u> for a short time	Video experiment with <u>scale</u>	Moves too fast/too quickly Use motion sensor/high-speed cameras/slow-motion cameras Use light sensors
F	Large uncertainty in value of V /scale <u>divisions</u> on syringe too large	Use a smaller syringe/measure mass/weight of ball and water	
G	Difficult to release ball without applying force/difficult to hold the ball on the surface of the water	Method of releasing ball e.g. cut string attached to ball	Clamp ball Use card/plastic gate

Do not allow 'use a computer to improve the experiment'.

[Total: 20]

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- 1 (b) (i) Value for E in range 2.00 to 3.50 V, with unit. [1]
- (c) (iii) Value of x (for $V = 0$) with consistent unit, in range 0.250 to 0.400 m. [1]
- (d) Six sets of readings of x and V scores 5 marks, five sets scores 4 marks etc. [5]
 Incorrect trend –1.
 Help from Supervisor –1.
- Range: [1]
 Range of values to include $x_{\min} \leq 20.0$ cm and $x_{\max} \geq 80.0$ cm.
- Column headings: [1]
 Each column heading must contain a quantity and a unit where appropriate.
 The unit must conform to accepted scientific convention, e.g. V / V or $V (V)$.
- Consistency: [1]
 All values of x must be given to the nearest mm.
- Significant figures: [1]
 Every value of V/E must be given to the same number of s.f. (or one more than) the least s.f. in the corresponding values of V and E .
- Calculated values: [1]
 V/E calculated correctly, including sign.
- (e) (i) Axes: [1]
 Sensible scales must be used, no awkward scales (e.g. 3:10).
 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 that is being plotted.
 Scale markings should be no more than three large squares apart.
- Plotting of points: [1]
 All observations must be plotted.
 Diameter of plotted points must be $\leq$ half a small square (“no blobs”).
 Plots must be accurate to half a small square.
- Quality: [1]
 All points in the table must be plotted on the grid for this mark to be awarded.
 All points must be within 2 cm (to scale) on the x -axis of a straight line.
- (ii) Line of best fit: [1]
 Judge by balance of all points on the grid about the candidate’s line (at least 5 points). There must be an even distribution of points either side of the line along the full length. Allow one anomalous point only if clearly indicated by the candidate.
 Line must not be kinked or thicker than half a small square.

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- (iii) Gradient: [1]
 The hypotenuse of the triangle must be at least half the length of the drawn line.
 Both read-offs must be accurate to half a small square in both the x and y directions.
 The method of calculation must be correct.

y -intercept: [1]
 Either:
 Correct read-off from a point on the line is substituted into $y = mx + c$.
 Read-off must be accurate to half a small square in both x and y directions.
 Or:
 Correct read-off of the intercept directly from the graph.

- (f) Value of a = candidate's gradient and value of b = candidate's intercept. [1]
 $|b|$ in range 0.25 to 0.75.
 A value presented as a fraction is not allowed.

Unit for a correct (e.g. cm^{-1}) and consistent with value, and no unit given for b . [1]

[Total: 20]

- 2 (a) (i) Value for m_A in range 5.0 to 30.0 g. [1]

(iii) Correct calculation of R . [1]

(iv) Justification for s.f. in R linked to s.f. in m_A and $(m_A + m_B)$. [1]

(b) Value for h_0 , with unit, to nearest mm. [1]

(c) Value for $h_B > h_0$. [1]
 Evidence of repeat readings for h_B . [1]

(d) Percentage uncertainty in h_B based on absolute uncertainty of 2 to 5 mm (or half the range provided this is not zero), and correct method of calculation. [1]

(e) Second value of m_B . [1]
 Second value of h_B . [1]
 Quality: h_B smaller for larger m_B . [1]

(f) (i) Two values of k calculated correctly. [1]

(ii) Sensible comment relating to the calculated values of k , testing against a criterion specified by the candidate. [1]

Page 4	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2013	9702	36

(g)

	(i) Limitations (4 max)	(ii) Improvements (4 max)	Do not credit
A	Two readings are not enough (to draw a conclusion)	Take more readings and plot a graph/take more readings and calculate more k values and compare	'few readings'/'take more readings and calculate average'/'only one reading'/'repeat readings' on its own
B	Difficult to judge highest <u>point</u> / h_B with reason (e.g. short time at highest point/doesn't stay still for long at highest point)	Method of improved measurement of h_B (e.g. video <u>with scale</u> /multiflash photography with scale/use marker/use pointer/trial and error method/mark track with scale/put scale on board behind/ink or chalk on ball/motion sensors at top of track)	'too fast'/'ball travelling too quick/high speed camera/ slow motion camera/light gates
C	Error when measuring height(s) because of: parallax/ruler not vertical/ruler not perpendicular to bench	Detailed explanation of reducing error	'set squares' on own/'view perpendicular'/'parallax error' on own
D	Bottom of ball not visible	Method of improved measurement of height(s) (e.g. measure to top of ball)	
E	<u>Energy lost</u> (e.g. as friction with track or air/sound/hitting sides/not hitting square on)		Lubricate track
F	Difficult to release marble without applying a force/difficult not to apply (sideways) velocity	Detail of a mechanical release method (e.g. card gate)	Friction on track

Do not allow 'repeated readings' or 'use a computer to improve the experiment'

[Total: 20]