

MARK SCHEME for the May/June 2011 question paper
for the guidance of teachers

9702 PHYSICS

9702/31

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

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- 1 (b) (iii) Value of I non-zero value and 10 mA with unit. [1]
Value of V 0.5 V 1.5 V with unit. [1]
- (c) Six sets of readings of I and V scores 5 marks, five sets scores 4 marks etc. [5]
Incorrect trend then –1. Minor help from supervisor –1; major help –2.
- Range: Range of I at least 0.3 mA. [1]
- Column headings: [1]
Each column heading must contain a quantity and a unit where appropriate. There must be some distinguishing mark between the quantity and the unit e.g. V/V .
- Consistency of presentation of raw readings: [1]
All values of I must be given to the same number of decimal places. All values of V must be given to the same number of decimal places.
- Significant figures: [1]
Significant figures for $1/V$ the same as, or one more than, that for V .
- Calculation: Check the values of $1/V$ and $1/I$. [1]
- (d) (i) 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 on the grid occupy at least half the graph grid in both x and y directions. Scales must be labelled with the quantity that is being plotted. Ignore units.
Scale markings should not be greater than three large squares apart.
- Plotting of points: [1]
All the observations in the table must be plotted. Check the points are plotted correctly. Work to an accuracy of half a small square.
Do not accept blobs (points with diameter greater than half a small square).
- Quality: [1]
All points in the table must be plotted (at least 5) for this mark to be scored. Judge by the scatter of all points about a straight line. All points must be within 0.01 V^{-1} on the $1/V$ axis from a straight line.
- (ii) Line of best fit: [1]
Judge by the balance of all the points (at least 5) about the candidate's line. There must be an even distribution of points either side of the line along the full length.
- (iii) Gradient: [1]
The hypotenuse of the triangle must be at least half the length of the drawn line. Read-offs must be accurate to half a small square.
- Intercept: [1]
Either:
Check correct read-off from a point on the line, and substitution into $y = mx + c$. Read-off must be accurate to half a small square. Allow ecf of gradient value.
Or:
Check the read-off of the intercept directly from the graph.

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(e) Correct method to find R . [1]

Answer in range $40 - 60\Omega$ with unit. [1]

[Total: 20]

2 (a) Measurement of t in the range $0.20\text{ cm} - 1.00\text{ cm}$ to 0.1 mm or 0.01 mm with unit. [1]

(b) (i) Measurement of d in the range $3\text{ cm} - 9\text{ cm}$ with unit. [1]

(ii) Correct calculation of w . [1]

(c) (ii) Value of T in the range $3\text{ s} - 5\text{ s}$. [1]

Evidence of repeat readings. [1]

(d) Absolute uncertainty in T in range $0.1\text{ s} - 0.6\text{ s}$. [1]

If repeated readings have been taken, then the uncertainty can be half the range.
Correct method of calculation of percentage uncertainty.

(e) Second value of d in the range $14\text{ cm} - 31\text{ cm}$. [1]

Correct calculation of second value of w . [1]

Second value of T . [1]

Second value of $T < \text{first value of } T$. [1]

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

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

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(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/ calculate more k values (and compare) Allow 'repeat readings and plot a graph'	Few readings Take more readings and calculate average k Only one reading
B	Rule hits bench	Method of preventing rule hitting bench e.g. project end of cylinder over bench or elevate apparatus	Ignore amplitude changes/difficult to start at the same amplitude each time
C	rule used for wider diameter/ couldn't use calipers	Method to improve measurement of larger diameter e.g. use set squares held against ruler/wrap string or paper around and measure circumference/use calipers and hold against ruler/travelling microscope	Use larger Vernier calipers
D	Difficult to judge <u>when</u> oscillation is complete	1.Use video (+ playback) + timer/use clock on video / use position or motion sensor placed above/below rule (not above centre) / use of light gate with detailed method. 2.Use (fiducial) marker/pointer at centre (of oscillation)	Difficult to measure the time/human error/ references to reaction times
E	Oscillations die away quickly/too few oscillations/ damped		
F		Use same surface/material (for cylinders)	

Ignore 'parallax problems', 'use assistant' or references to draughts, fans, air conditioning.

[Total: 20]

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

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- 1 (b) Raw reading for nail height H , to nearest mm. [1]
- (d) (i) Reading for string height h , less than H . [1]
- (e) No help from supervisor. [1]
- Six sets of readings scores 4 marks, five sets scores 3 marks etc. [4]
Incorrect trend then -1 .
- Range: m values must include 180 g or more. [1]
- Column headings: [1]
Each column heading must contain a quantity and a unit where appropriate.
There must be some distinguishing mark between the quantity and the unit.
- Consistency of presentation of raw readings: [1]
All values of h must be given to the nearest mm.
All values of m must be given to the nearest g.
- Significant figures: [1]
S.f. for $1/(H-h)^2$ must be the same as, or one more than, the s.f. given for $(H-h)$.
- Calculation: [1]
 $1/(H-h)^2$ calculated correctly.
- (f) (i) Axes: [1]
Sensible scales must be used, no awkward scales (e.g. 3:10).
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.
Scale markings must be no more than 3 large squares apart.
- Plotting of points: [1]
All observations in the table must be plotted.
Check that the points are correctly plotted. Work to an accuracy of half a small square.
Do not accept blobs (points with diameter greater than half a small square).
- Quality: [1]
All points in the table must be plotted (at least 5) for this mark to be scored.
Scatter of points must be less than $\pm 2000 \text{ g}^2$ on the m^2 axis from a straight line.
- (ii) Line of best fit: [1]
Judge by balance of all the points (at least 5) about the candidate's line. There must be an even distribution of points either side of the line along the full length.

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- (f) (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. If incorrect, write in the correct value(s). Do not allow use of points from the table unless they are on the line. Do not allow $\Delta x/\Delta y$.

Intercept: [1]
 Either:
 Check correct read-off from a point on the line, and substitution into $y = mx + c$.
 Read-off must be accurate to half a small square. Allow ecf of gradient value.
 Or:
 Check the read-off of the intercept directly from the graph.

- (g) Correct method used to find a and b . [1]
 Correct unit for a and correct unit for b . [1]

[Total: 20]

- 2 (a) (ii) y in range 65 to 75 cm. [1]
 (iii) Value for h to nearest mm and in range 1 to 20 cm, with unit. [1]
- (b) (ii) First value of x in range 8 to 11 cm. [1]
 (iii) First value of h_1 . [1]
- (c) (i) First value of d calculated correctly. [1]
 (ii) Percentage uncertainty in d calculated using correct method and using absolute uncertainty of 1 or 2 mm (or half the range if repeated readings have been taken). [1]
- (e) (ii) Second value of x . [1]
 Second value of h_1 . [1]
 Repeats: Any evidence of repeats for height values or x values. [1]
 Quality: Second value of d less than first value. [1]
- (f) (i) Two values of k calculated correctly. [1]
 (ii) Sensible comment relating to the calculated values of k , testing against a specified criterion. [1]

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(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/calculate more k values (and compare). Allow 'repeat readings and plot a graph'	Few readings/take more readings and calculate average k /only one reading
B	d is very small.	1. Use larger mass/use larger x value. 2. Use thinner rule.	Parallax error.
C	Difficult to measure h (with reason).	Use vernier caliper/travelling microscope/dial gauge/position sensor above rule.	
D	Difficult to measure x (with reason)/difficult to judge position of mass.	Method of improving measurement of x (e.g. hang masses below rule).	
X	Other specific relevant problem with apparatus.	Relevant solution.	Apparatus slips.

Do not accept 'repeated readings' or 'light gates'.

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- 1 (a) (i) Value of x in the range 1 cm – 3 cm. [1]
- (b) (ii) Value of T in range 1.8 s – 4.5 s with consistent unit. [1]
If outside this range allow $SV \pm 40\%$ (write in SV if used).
Evidence of repeat times. [1]
- (c) Six sets of readings of x and T scores 4 marks, five sets scores 3 marks etc. [4]
Incorrect trend then –1. Help from supervisor –1.
Range of x : To include 1 cm and 6 cm. [1]
Column headings: [1]
Each column heading must contain a quantity and a unit.
There must be some distinguishing mark between the quantity and the unit e.g. T / s .
Ignore POT errors. Ignore units in body of table.
Consistency of presentation of raw readings: [1]
All values of x must be given to the nearest mm.
Significant figures:
Significant figures for every row of $1/x$ same as, or one more than, raw x . [1]
Calculation: $1/x$ calculated correctly. [1]
- (d) (i) 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 on the grid occupy at least half the graph grid in both x and y directions. Indicate false origin with FOX.
Scales must be labelled with the quantity which is being plotted. Ignore units.
Scale markings should not be more than three large squares apart.
Plotting of points: [1]
All observations in table must be plotted.
Write a ringed total of plotted points ignoring any point off the grid.
Check points plotted correctly. Tick if correct. Re-plot if incorrect.
Work to an accuracy of half a small square.
Do not accept 'blobs' (points with diameter greater than half a small square).
Quality: [1]
All points in the table must be plotted (at least five) for this mark to be scored. Judge by scatter of all points about straight line. All points must be within 0.05 cm^{-1} of $1/x$ from a straight line.
- (ii) Line of best fit: [1]
Judge by the balance of all the points (at least five) about candidate's line. There must be an even distribution of points either side of the line along the whole length. If mark is not awarded indicate rotation or direction of best fit line. Lines must not be kinked.

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- (iii) Gradient: [1]
 The hypotenuse of the triangle must be at least 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 $\Delta x/\Delta y$). If incorrect, write in the correct value(s).

y-intercept: [1]
 Either:
 check correct read off from a point on the line and substitute into $y = mx + c$. Read off must be accurate to half a small square. Allow ecf of gradient value.
 Or:
 check read-off of intercept directly from graph.

- (e) a is the value of candidate's gradient with consistent unit (s(c)m or (c)ms). [1]
 b is the value of candidate's y-intercept with consistent unit (s).
 (f) Either: Strip too wide for clips. [1]
 Or: time too small (to measure).

[Total: 20]

- 2 (a) (ii) Measurement of raw l to nearest mm in the range 90 cm – 100 cm. [1]
 (iii) Value of h_0 with unit. [1]
 (b) (ii) Value of $h < h_0$. [1]
 (iii) Check correct calculation of d . [1]
 (c) Absolute uncertainty in d in the range 1 mm – 2 mm or half the range of repeated readings, unless zero. Correct method of calculation to get percentage uncertainty. [1]
 (d) Second value of l in range 55 cm l 65 cm. [1]
 Second value of h_0 . [1]
 Second value of $h < h_0$. [1]
 Quality : second value of $|d| < \text{first value of } |d|$. [1]
 (e) (i) Correct calculation of two values of k . [1]
 (ii) Sensible comment relating to the calculated values of k , testing against a specified criterion. [1]
 (iii) Justification of sf in k linked to l and d . [1]

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(f)

	(i) Limitations 4 max		(ii) Improvements 4 max	Do not credit
A_p	Two readings (of d and l) not enough/ only two readings/ too few readings	A_s	Take more readings <u>and plot a graph</u> / more values of k (and compare).	Take more readings and calculate average k / only one reading
B_p	Difficult to measure h with reason/ parallax error in h	B_s	Detailed use of set square or pointer to improve parallax/ method for easier access/ method of reducing parallax	Mass gets in the way.
C_p	d is small	C_{s1} C_{s2}	Larger mass Method to measure d directly e.g. using a travelling microscope or position sensor	
D_p	Rule may not be vertical (when measuring h)	D_s	Detailed use of set square (table level)	
X_p	Specific problem candidate encountered e.g. ruler slips on support/supports slip on block	X_s	e.g. glue support to block	Ignore reference to computers, using assistance, draughts

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- 1 (c) Angle x , with unit. [1]
- (d) (iii) Angle y , greater than x . [1]
- (e) Six sets of readings scores 4 marks, five sets scores 3 marks etc. [4]
 Incorrect trend then -1 . Help from supervisor then -1 .
- Range: m values must include 190 g or greater. [1]
- Column headings: [1]
 Each column heading must contain a quantity and a unit where appropriate.
 There must be some distinguishing mark between the quantity and the unit, e.g. m/g.
- Consistency of presentation of raw readings: [1]
 All values of y must be given to the nearest degree or half degree.
 All values of m must be given to the nearest gram (e.g. 190 g or 0.190 kg).
- Significant figures: [1]
 S.f. for $\sin \theta$ must be the same as, or one more than, the s.f. given for θ .
- Calculation: Values of $\sin \theta$ calculated correctly. [1]
- (f) (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. Ignore units.
 Scale markings must be no more than 3 large squares apart.
- Plotting of points: [1]
 All observations in the table must be plotted.
 Check that the points are correctly plotted. Work to an accuracy of half a small square.
 Do not accept blobs (points with diameter greater than half a small square).
- Quality: [1]
 All points in the table must be plotted (at least 5) for this mark to be scored.
 Scatter of points must be less than ± 0.02 on the $\sin \theta$ axis from a straight line.
- (ii) Line of best fit: [1]
 Judge by balance of all the points (at least 5) about the candidate's line. There must be an even distribution of points either side of the line along the full length.

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

Intercept: [1]
 Either:
 Check correct read-off from a point on the line, and substitution into $y = mx + c$.
 Read-off must be accurate to half a small square. Allow ecf of gradient value.
 Or:
 Check the read-off of the intercept directly from the graph.

- (g) (ii) Raw value(s) of r in range 30 to 50 mm (or SV diameter/2 $\pm$ 10 mm) and given to nearest mm, with unit. [1]

- (h) Method of calculation of a is correct and uses the gradient value. [1]
 Unit for a has dimensions mass $\times$ length (e.g. g cm). [1]

[Total: 20]

- 2 (a) (ii) Value for R , with unit, in range 10 to 50 mm. [1]
 Diameter is measured to determine R (either here or in (d)). [1]

- (iii) Percentage uncertainty in R calculated by correct method, with absolute uncertainty of 0.5 mm or 1 mm or half the range of any repeats. [1]

- (b) (ii) First measurement of T , with unit, in range 0.5 s to 10.0 s. [1]
 Evidence of repeat measurements of T . [1]

- (c) First value of C calculated correctly, with correct unit (e.g. kg mm²). [1]

- (d) (ii) Second value for R . [1]
 Second value for T . [1]

Quality: Second T < first T . [1]

Second value of C calculated correctly. [1]

- (e) (i) Both values of k calculated correctly. [1]

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

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(f)

	(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/calculate more k values (and compare). Allow 'repeat readings and plot a graph'	Few readings/take more readings and calculate average k /only one reading.
B	Difficult to judge the end of an oscillation.	1. Use video (+ playback) + <u>timer</u> /use <u>clock</u> on video 2. Use (fiducial) marker/pointer, with reference point on mass hanger	Difficult to measure the time/human error/references to reaction times/difficult to release from the same point each time. Data logging/light gates motion sensor/"release when marks line up".
C	Diameter/radius of a mass hanger not constant.		Comparison of diameters of 50 g and 100 g mass hangers.
D	Mass tends to swing as well as rotate.		Switch off fans.
E	T affected when rubber band extends.		
F		<u>Method</u> of measuring <u>diameter</u> . Use more precisely (e.g. vernier calipers).	
G		<u>Method</u> of <u>increasing</u> T (e.g. use larger mass/diameter or longer/thinner rubber band).	
H	Labelled values of mass may not be accurate.	<u>Method</u> of finding mass (e.g. top pan balance).	

Do not allow "parallax error".

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- 1 (a) Value of l_0 with unit in range 1.5 cm l_0 3.0 cm. [1]
- (b) (iv) Value of T with unit 20 s T 5 s. [1]
Evidence of repeat times.
- (c) Six sets of readings of l and T scores 4 marks, five sets scores 3 marks etc. [4]
Incorrect trend then –1 Help from supervisor –1.
- Range : $\Delta x \geq 7$ cm. [1]
- Column headings: [1]
Each column heading must contain a quantity and a unit where appropriate.
There must be some distinguishing mark between the quantity and the unit
e.g. T/s , x/cm .
- Precision of x from raw values of l and l_0 . [1]
- Check values of x the same as the least precision in l or l_0 . [1]
- (d) (i) 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 on the grid 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. Scale markings should not be more than three large squares apart.
- Plotting of points: [1]
All observations in table must be plotted.
Write a ringed total of plotted points ignoring any point off the grid. Check points plotted correctly. Tick if correct. Re-plot if incorrect. Work to an accuracy of half a small square. Do not accept 'blobs' (points with diameter greater than half a small square).
- Quality: [1]
All points in the table must be plotted (at least five) for this mark to be scored. Judge by scatter of all points about straight line. All points must be within 4 mm to scale from a straight line. Indicate tolerance on graph. Indicate reason if mark is not awarded.
- (ii) Line of best fit: [1]
Judge by the balance of all the points (at least five) about candidates' line. There must be an even distribution of points either side of the line along the whole length. If mark is not awarded indicate rotation or direction of best fit line. Lines must not be kinked.
- (iii) Gradient: [1]
The hypotenuse of the triangle must be at least 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 $\Delta x/\Delta y$).
If incorrect, write in the correct value(s).
- y -intercept: [1]
Either: check correct read off from a point on the line and substitute into $y = mx + c$.
Read off must be accurate to half a small square. Allow ecf of gradient value.

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Or: check read-off of intercept directly from graph.

(e) p is the value of the candidate's gradient in sm^{-1} , scm^{-1} , smm^{-1} , mm^{-1}s . [1]
 q is the value of the candidate's y -intercept in s.

(f) Value of x (10 – 100 cm) with consistent unit when $T = 75$ s. [1]
Correct method seen.

[Total: 20]

2 (a) Measurement of d to nearest 0.01 mm with consistent unit. [1]
Evidence of repeat readings.

(c) (ii) Value of h in the range 9 cm – 11 cm with unit. [1]

(d) (ii) Value of x in the range 1 cm – 5 cm to the nearest mm with unit. [1]

(iii) Value of $y = x - (10 \pm 2)$ mm. [1]

(e) Absolute uncertainty in y in range 2 – 5 mm (or half the range of repeated readings). [1]
Correct calculation to get percentage uncertainty.

(f) Second value of $d < \text{(a)}$. [1]

Second value of x . [1]

Quality : second value of $y > \text{first value of } y$. [1]

(g) (i) Values of k calculated correctly. [1]

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

(iii) Justification of s.f. in k linked to least s.f. in d and y or x . [1]

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(h)

	(i) Limitations 4 max		(ii) Improvements 4 max	Do not credit
A_p	Two readings (of d and l) not enough/ only two readings/too few readings.	A_s	Take more readings <u>and plot a graph</u> /more values of k (and compare).	Take more readings and calculate average k / only one reading.
B_p	Maintaining h constant.	B_s	Clamp mass hanger/specified release mechanism/hold against fixed pointer.	
C_p	Explain difficulty in getting measurement of x /depth accurately with finger/position of finger and line may not be in line.	C_s	Put mark <u>on rod</u> /use a clip/measure rod out of sand with scale or ruler/scale marked on ruler/draw mark all the way round.	
D_p	Rod falls sideways/not entering sand vertically.	D_s	Practical method to keep rod vertical e.g. guide for rod.	
E_p	Cannot see if mass is directly above rod.	E_s	Practical method to ensure centralisation of mass e.g. guide for mass.	Do not credit use of computers, assistants, dataloggers.
F_p	Depth/ x very small	F_s	Increase height/mass	
X_p	Specific problem candidate encountered e.g. uniformity of sand.	X_s	e.g. solution to specific problem candidate encountered.	Ignore uneven surface.

[Total: 20]