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# MARK SCHEME for the May/June 2015 series

## 9702 PHYSICS

**9702/34** Paper 3 (Advanced Practical Skills 2), maximum raw mark 40

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**1 (b) (i)** Value of $r$ in the range 28.0 cm to 32.0 cm, with unit. [1]

**(c) (ii)** Value of $T$ in range 2.0 s to 4.0 s. If out of range, allow Supervisor's value ±20%. [1]

Evidence of repeat measurements for $T$. [1]

**(d)** Six sets of readings of $r$ and $T$ scores 4 marks, five sets scores 3 marks etc. [4]
Incorrect trend –1. Help from Supervisor –1.

Range: [1]
$r_{max} - r_{min} \geq 30$ cm.

Column headings: [1]
Each column heading must contain a quantity and a unit. The presentation of quantity and unit must conform to accepted scientific convention e.g. $r^2 / m^2$.

Consistency: [1]
All values of $r$ must be given to the nearest mm.

Significant figures: [1]
The number of significant figures for every value of $T^3$ must be the same as, or one more than, the number of significant figures in the corresponding time.

Calculation: [1]
Values of $T^3$ calculated correctly to the number of significant figures given by the candidate.

**(e) (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 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: [1]
All observations in the table must be plotted on the grid.
Diameter of plotted points must be ≤ half a small square (no "blobs").
Plotted points must be accurate to within half a small square.

Quality: [1]
All points in the table must be plotted (at least 5) for this mark to be awarded.
All points must be within $\pm 2\,s^3$ of a straight line in the $T^3$ direction.

**(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 (i.e. circled or labelled) by the candidate.
Lines must not be kinked or thicker than half a square.

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

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

**(f)** Value of *a* = candidate's gradient and value of *b* = candidate's intercept. [1]

Units for *a* and *b* are correct (e.g. $s^3 m^{-2}$ for *a* and $s^3$ for *b*). [1]

**2 (a) (ii)** Value for *t* in range 0.10 cm to 0.90 cm and given to nearest 0.01 cm. [1]

Value for *D* in range 3.0 cm to 6.0 cm. [1]

Value for *h* less than *t*. [1]

**(b)** Correct calculation of *R*. [1]

Value of *R* given to 2 or 3 significant figures. [1]

**(c) (ii)** Value for *f* in range 13.0 cm to 17.0 cm or 28.0 to 32.0 cm. [1]

**(iii)** Absolute uncertainty in *f* in range 0.2 cm to 0.5 cm and correct method of calculation to obtain percentage uncertainty. If repeated readings have been taken, then the absolute uncertainty can be half the range (but not zero) if the working is clearly shown. [1]

**(d)** Second values for *t*, *D* and *h*. [1]

Second value for *f*. [1]

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

Quality: Both *k* values in range 0.50 to 1.50. [1]

**(ii)** Sensible comment relating to the calculated values of *k*, testing against a criterion specified by the candidate. [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 valid conclusion | Take more readings and plot a graph / obtain more *k* values and compare | "repeat readings"/ "few readings"/ only one reading/ take more readings and (calculate) average *k* |
| B | Reason for difficulty in measuring *t*, *h* or *D* e.g. jaws of calipers slip off ends of lens/jaws too short and cannot reach centre of lens | Use a travelling microscope | References to parallax |
| C | *h* is small/large uncertainty in *h* | Use micrometer/travelling microscope | |
| D | Difficult to obtain sharp image/hard to focus/blurred image | Use a dark(ened) room/ turn off lights/ use point/more compact source of light | |
| E | Difficult to measure *f*/take measurement with ruler/measure distance, with reason e.g. difficult to keep lens steady/screen not vertical/lens not vertical/ruler not perpendicular to lens or screen | Mount lens in holder/clamp/ fix lens to bench with e.g. Blu-Tack/ use optical bench | Flexible/bendy screens |

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