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.

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

Cambridge will not enter into discussions about these mark schemes.

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1 (a) $t$ in the range 0 (mm) to 4 (mm) B1

(b) (i) sensible value of $D$. Repeats shown and correctly averaged, measured to the nearest mm or better B1

(ii) clear description or clear diagram of how values of $D$ obtained accurately. B1

eye vertically above edge of lens on scale / set square used against edge of lens, resting on scale / measurements in two different orientations shown.

(c) (i) diagram showing set square on each side of the lens (like the jaws of vernier callipers)

(ii) and sensible $T$ in the range $t < T \leq 10$ mm B1

(d) correct calculation of $f$ giving an answer in the range 7.5 cm to 30.0 cm with consistent unit with elsewhere in (a), (b)(i) or (c)(ii). (Ignore s.f.) B1 [5]

2 (a) decreases own
e B1

(b)(i) $T_1 = \frac{t_1}{10}$ B1

$T_1$ given to $2/3$ s.f. Correct unit seen in (b) or (c) B1

(c) $t_2 > t_1$ B1

(d) $T_2 / T_1$ in the range 1.0 to 1.2 when rounded (ignore unit) B1 [5]

3 (a) $V_1$ in the range 1.8 V to 2.8 V to 0.1 V or better with unit seen here or in (b). and $I_1$ in the range 0.18 A to 0.28 A to 0.01 A or better with unit seen here or in (b) B1

(b) $V_2 > V_1$ and in the range 2.4 V to 4.0 V to 0.1 V or better with unit seen here or in (a) and $I_2 < I_1$ and in the range 0.10 A to 0.20 A to 0.01 A or better with unit seen here or in (a). B1

(c) (increasing the resistance) reduces the current which increases the voltmeter reading or vice versa B1

(d) correct calculation of $R$ from their (a) and (b) note – B0 if sign error in calculation $R$ in the range 6.0 $\Omega$ to 20.0 $\Omega$ to $2/3$ s.f. and unit B1 [5]
4 Preliminary results

(a) $y$ measured to the nearest mm or better and in the range 1.5 cm to 3.0 cm with consistent unit seen here or in (b) B1

(b) (i) $x$ in the range 39.6 cm to 40.4 cm to nearest mm or better and with consistent unit seen here or in (a) or (b)(ii) B1

(ii) correct determination of $e$ in the range 9 cm to 14 cm with unit seen here or in (a) or (b)(i) B1

(iii) diagram or explanation measured the height of the metre rule above the bench in at least 2 places (and found to be equal)/Horizontal alignment with window sill/top of door etc. B1 [4]

Table

(c) column headings with units for $x$, $L$ and $e$ and results from (b) included B1

correct calculation of $e$ B1

$\Delta x$ values $\geq 50$ cm B1

at least 5 results showing correct trend, $e$ increases as $x$ increases B1 [4]

Graph

(d) axes labelled with units and correct orientation B1

(allow e.c.f. from wrong unit in table but not no units)

suitable scale, not based on 3, 6, 7 etc. with plotted data occupying $\geq$ half the page in both directions B1

two points plotted correctly – check the two points furthest from the line. This mark can only be scored if the scale is easy to follow B1

(points must be within $\frac{1}{2}$ small square of the correct position)

best-fit fine straight line and fine points or crosses B1 [4]

(line thickness to be no greater than the thickest lines on the grid)
Calculations

(e) correct readings used for a pair of points on the line used for the gradient determination (triangle seen or implied) B1

more than half the drawn line used for points B1

correct calculation of gradient in the range 0.2 to 0.3 when rounded (ignore unit) B1 [3]