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.

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1 (a) (i) \( h, w \) and \( d \) recorded in cm and sensible, accept 2.0 – 5.0 cm [1]

(ii) \( V_A \) present and \( h, w, d \) all to nearest millimetre [1]

(iii)(iv) \( m \) recorded and density calculated correctly [1]
  
density between 2.0 and 3.5 (g/cm\(^3\)) [1]

(b) (i) sensible \( d \) value – not smaller than all of \( h, w, d \) [1]

(ii) diagram showing blocks and rule correctly used – blocks touching the sphere, and rule spanning gap and touching blocks [1]

(c) \( V_1 \), 90 – 110 cm\(^3\), \( V_2 \) larger [1]

\( V_B \) correctly calculated and sensible, with unit cm\(^3\) [1]

(d) any two from:
  measuring cylinder not sensitive owtte
  some clay left on fingers
  cube not perfectly shaped / difficult to measure owtte
  air bubbles clinging to modelling clay / within the modelling clay
  volume of string
difficult to judge the bottom of the meniscus / bubble on meniscus
  ignore parallax
  do not credit poor experimental practice e.g. spills or splashes [2]

[Total: 10]
2 (a) sensible cold water temperature (accept 15(°C) – 50(°C) )

(b) table:
   correct V values 10, 20, 30, 40, 50
   temperatures decreasing, evidence of temperatures to at least 1°C
   final interval less than initial interval

(c) $t_2$ more than $t_1$
   $R_1$ and $R_2$ correct
   cm$^3$/s

(d) rate / flow is not constant

(e) any two from:
   room temperature / air conditioning
   initial / hot water temperature
   volume / quantity / amount of hot water
   cold water temperature
   intervals / time between adding volumes of water
   ignore draughts / humidity / pressure

[Total: 10]

3 (a) $V$ to at least 1 d.p. and < 3 $V$ and increasing
   all column headings with correct unit cm, V, A, Ω

(b) graph:
   axes correctly labelled and correct orientation
   suitable scales, plots using more than half available axes
   $R$ values calculated and plotted correct to ½ small square
   good line judgement, thin, continuous,
   do not allow ‘blobs’ greater than half square diameter

(c) triangle method shown on graph
   $G$ calculation correct using large triangle

(d) $R_1$ value to 2 or 3 significant figures
   $R_1$ value about 2 × value at 0.5 m

[Total: 10]
4  first ray trace:
   normal at 90° in correct position (2.0 cm from A) [1]
   angle of incidence 30° ±1° [1]
   all lines present and neat [1]
   emergent ray parallel to EF [1]
   second trace:
   complete and neat [1]

(h)  \( r \) value correct to ±1° [1]

(j)  \( r \) value correct to ±1° and within 2° of first value [1]

(k)  idea of within (or beyond) limits of experimental accuracy [1]

(l)  any two from:
   viewing bases of pins/ensure that pins are vertical/not bent
   large pin separations
   use of repeats
   use of thin pencil lines (or equivalent comment)
   close one eye (when aligning pins)
   use thin/sharp pins
   ignore parallax error
   NOT dark room [2]

[Total: 10]