Fundamental Data Analysis

Q1 $V = JC^{-1}$ & $A = Cs^{-1}$ $\therefore VA^{-1} = JC^{-1}C^{-1}s = JsC^{-2}$

Q2 $\theta = {}^{arc}/_{radius} = {}^{1.5m}/_{4.5m} = 0.33$ rad

Q3 Should read $33\frac{1}{3}$ revolutions per minute.

$33\frac{1}{3}/60 \times 2\pi = 3.49$ rad s^{-1}

Q4 a) $2.33(\times 10^{0})$ b) 1.00×10^{5} c) 2.35×10^{-5} d) 5.52×10^{2}

Q5 a) 5.1×10^{-1} b) 1.2×10^{11} c) 1.0×10^{6} d) 2.0×10^{-10}

Q6 Scale on ruler can be read to ± 0.5 mm and two reading are required per measurement. (The zero needs to be lined up as well). This gives an uncertainty of ± 1 mm as absolute uncertainties add.

Thickness $= 10.5 \pm 1$ mm | Number of sheets $= \frac{252}{2} = 126$

One sheet $= 10.5 \times 10^{-3}/126 = 8.33 \times 10^{-5}$ m

Uncertainty $= {}^{1}/_{10.5} \times 100 = 10\% = 8.3 \times 10^{-6}$ m

$\therefore$ Thickness of one page = $\underline{\underline{83 \pm 8\ \mu m}}$

Q7 Width $= 195 \pm 1$ mm $= 195$ mm $\pm 0.5\%$
Height $= 264 \pm 1$ mm $= 264$ mm $\pm 0.4\%$

Area $= 195 \times 264 = 51480\ mm^2 = 5.148 \times 10^{-2}\ m^2$
Uncertainty $= 0.5\% + 0.4\% \approx 1\% = 5 \times 10^{-3}\ m^2$

Area = $\underline{\underline{(5.1 \pm 0.5) \times 10^{-2}\ m^2}}$

Q8 Volume = Area × Thickness

Thickness = 12.5 ± 1 mm = $12.5\,\text{mm} \pm 8\%$

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Volume = $12.5 \times 10^{-3} \times 5.15 \times 10^{-2}$ = $6.44 \times 10^{-4}\ m^3$

Uncertainty = $1\% + 8\%$ = 9%

Absolute uncert. = $0.09 \times 6.44 \times 10^{-4}\ m^3$

= $5.8 \times 10^{-5}\ m^3$

= $6 \times 10^{-5}\ m^3$ to 1 s.f.

$\therefore$ Volume = $\underline{\underline{(6.4 \pm 0.6) \times 10^{-4}\ m^3}}$

Q9 68 is a clear outlier so is removed from data set. (This is assuming the values are repeated measurements of the same quantity)

mean = 26 spread = $\pm 5.5 \approx$ absolute uncertainty

range = $32 - 21 = 11$

% uncertainty = $5.5/26 \times 100$ = $\pm 21\%$

= $\pm 20\%$ 1 s.f.

Q10

accuracy	the closeness of a measured value to a standard or known value
uncertainty	the margin of error of a measurement, when explicitly stated, is given by a range of values likely to enclose the true value. This may be denoted by error bars on a graph, or by measured value ± margin of error
resolution	the smallest detectable change in input, for example 1mm on a standard ruler
sensitivity	the ratio of output to input, for example, the change in p.d. across a thermistor with a temperature change of 1°C
zero error	the output for zero input, for example a newton meter that reads 0.1 N when there is no force acting
systematic error	a consistent, repeatable error associated with faulty equipment or a flawed experiment design. These errors are usually caused by measuring instruments that are incorrectly calibrated or are used incorrectly.
response time	the time interval between a change in input and a corresponding change in output, for example, how long it takes a thermometer to respond when you put it in hot water
stability	the extent to which repeated measurements give the same result, including gradual change with time (drift)
noise	variations, which may be random, superimposed on a signal, for example changes to a reading on a thermometer due to a draughts
calibration	determining the relation between output and true input value, including linearity of the relationship, for example the relationship between the resistance of a thermistor and the temperature.
range	the highest value – the lowest value (usually after outliers are disregarded)
spread	± half the range
dot-plot	Like bar chart but with dots rather than bars showing the spread of a set of results
intercept	where a line of best fit meets an axis
estimate	an educated guess at the size of a quantity
distribution	how the values of set of measurements are spread out over a range
precision	a measure of how close repeated measurements are to each other
line of best fit	a line or curve that averages out random errors in a set of measurements
gradient	= $\Delta y/\Delta x$
percentage uncertainty	= 100 x absolute uncertainty / (mean) value
absolute uncertainty	also called absolute error - is the size of the range of values in which the "true value" of the measurement probably lies.
outlier	a value that does not fit in with the majority of the data – this may be an error or it may be for a valid reason. They should be investigated to see if there is a reason for them.
median	the number that is halfway into a data set. To find it, the data should be arranged in order from least to greatest. If there is an even number of items in the data set, then it is found by taking the mean of the two middlemost numbers
magnitude	the size of a measurement rounded to the nearest integer power of 10
mean	the sum of a set of values divided by the number of values
validity	describes whether the results of an experiment really do measure the concept being tested. Does seeing how far a ruler can drop through someone's hand really measure reaction time? What other variables may be influencing the results?
inherent variation	e.g. a variation that occurs due to non-identical components e.g. resistors