

Solutions

Original-task marking: M1 method, A1 accuracy, B1 reasoning.

2.1 Height percentage: $\%U(h) = \frac{2}{115} \times 100\% = 1.7\%$. Volume rule: $\%U(V) = 2 \times \%U(r) + \%U(h)$. $\%U(V) = 2 \times 1\% + 1.7\% = 3.7\% \approx 4\%$.

2.2 $R = V/I = 5.2/0.64 = 8.125 \approx 8.1 \Omega$. $\%U(R) = \frac{0.1}{5.2} \times 100\% + \frac{0.02}{0.64} \times 100\% = 1.9\% + 3.1\% = 5.0\%$.

2.3 Thickness = $(26.2 - 24.8)/2 = 0.7$ mm. Diameters are subtracted then halved: absolute uncertainties add, $\pm(0.1 + 0.1) = \pm 0.2$ mm on the diameter difference, so the thickness is $0.7 \text{ mm} \pm 0.1 \text{ mm}$. (Halving halves the absolute uncertainty; the percentage is unchanged.)

3.1 (a) Rearranged: $a = 2s/t^2$. $a = 2 \times 0.900/1.40^2 = 1.80/1.96 = 0.918 \text{ m s}^{-2}$. (b) $\%U(s) = \frac{0.002}{0.900} \times 100\% = 0.22\%$ and $\%U(t) = \frac{0.05}{1.40} \times 100\% = 3.6\%$. a divides by t^2 , so $\%U(a) = 0.22\% + 2 \times 3.6\% = 7.4\%$, about 8%. (c) Interval: $0.918 \times (1 \pm 0.074) = 0.85$ to 0.99 m s^{-2} . The predicted 0.94 m s^{-2} lies inside the interval, so the measurement is accurate to the precision claimed.

3.2 Absolute uncertainty: $0.03 \times 1.75 \times 10^{-8} = 0.0525 \times 10^{-8} \Omega \text{ m}$. Interval: 1.70 to $1.80 \times 10^{-8} \Omega \text{ m}$. The copper value $1.72 \times 10^{-8} \Omega \text{ m}$ lies inside, so the wire could be copper; the data does not distinguish copper from any other material whose value also falls inside the interval.

3.3 (a) Corrected rate $R = 480 - 45 = 435 \text{ min}^{-1}$. Subtracted readings add absolute uncertainties: $\Delta R = 10 + 10 = 20 \text{ min}^{-1}$, so $R = 435 \pm 20 \text{ min}^{-1}$. (b) $\%U(R) = \frac{20}{435} \times 100\% = 4.6\%$. (c) The corrected rate's 4.6% is the dominant contribution to the stated 5%. Count for a longer time at each distance: more counts means a smaller statistical uncertainty in each rate, which shrinks the absolute uncertainty of both the gross and background readings.