On uncertainty

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Warm-up problems

1. Explain the difference between *absolute undertainty* and *percentage undertainty*.
2. Round the following numbers to (a) two significant figures and (b) four significant figures.

   (i) 602.20
   (a) 0.001 380 6
   (b) 0.022 413 83
   (c) 1.602 19
   (d) 91.095
   (e) 0.1660
   (f) 299 790 000
   (g) 66.2617
   (h) 0.000 000 667 2
   (i) 3.141 593
3. Rewrite the ten numbers from question 2 in scientific notation.

Regular problems

4. A car covers a distance of 250 m in 13 s; the average speed is calculated to the 10 decimal places of the calculator as $19.230\,769\,23\,\mathrm{m\,s^{-1}}$. Explain why it is incorrect to believe all of the significant figures of the quoted speed.
5. Work out the percentage uncertainty when a 5 V battery is measured to the nearest 0.2 V.
6. If I don't want to have to correct my watch more than once a week, and I never want my watch to be more than 1s from the correct time, calculate the necessary maximum relative uncertainty of the electronic oscillator which I can tolerate.
7. My two-storey house is 7.05 ± 0.02 m tall. The ground floor is 3.2 ± 0.01 m tall. How tall is the first floor?
8. I want to measure the resistance of a resistor. My voltmeter can read up to 5 V, with an absolute uncertainty of 0.1 V. My ammeter can read up to 1 A with an absolute uncertainty of 0.02 A. Assuming that my resistor is approximately 10 Ω, calculate the absolute uncertainty of the resistance I measure using the formula $R = V/I$. Assume that I choose the current to make the relative uncertainty as small as possible.

Extension problems

9. The angle of refraction θ_r for a light ray in a medium of refractive index n which is incident from a vacuum at an angle θ_i is obtained from Snell's law: $n \sin\theta_r = \sin\theta_i$. Calculate θ_r and its associated error if $\theta_i = 25.0 \pm 0.1\ ^\circ$ and n=1.54 $\pm$ 0.01.