E2 Relative Uncertainties

$^{9}/_{12}$

As elsewhere in this book, give an appropriate number of significant figures (e.g. giving an uncertainty to 3 sf, or giving a measurement to 2 dp if the uncertainty is $\pm\ 0.1$, would be wrong). Please make sure that the unit of absolute uncertainty is clear - so 20.34 mA $\pm\ 20$ µA or (20.34 ± 0.02) mA are both appropriate, but 20.34 mA $\pm$ 20 would not be clear. Note that 'nearest millimetre' implies an absolute uncertainty of $\pm\ 0.5$ mm not $\pm\ 1$ mm.

E2.1 Calculate the relative uncertainty, in percent, of:

a) A length of 50.4 cm measured using a metre rule to $\pm\ 0.5$ mm.

b) A current of 240 mA measured to the nearest milliamp.

c) A time of 0.62 s measured using a stopwatch to the nearest 0.01 s.

d) An angle of 43° measured to the nearest degree with a protractor.

e) A time of 4 minutes 32 seconds measured to the nearest second.

E2.2 Write the following measurements using an absolute uncertainty with an appropriate number of significant figures (e.g. as 12 mA $\pm\ 1$ mA).

a) A time of 97.35 seconds measured to $\pm\ 0.1\%$.

b) A voltage of 1.629 V measured to $\pm\ 5\%$.

E2.3 What is the relative uncertainty of a frequency of 20 MHz (exactly) measured to the nearest 10 kHz?

E2.4 Give the relative uncertainty required in a clock which is put right at noon on Sunday, and by the following Sunday noon must have an error of no more than 5 seconds.

E2.5 What is the percentage inaccuracy in a measurement of the speed of light (which is 3.00×10^8 m s^{-1}) which comes out as 2.76×10^8 m s^{-1}?

E2.6 An experiment is conducted to find the acceleration of a dropped object (which should be 9.81 m s^{-2}). The measurement obtained is 9.62 m s$^{-2} \pm 1.5\%$. Is the experiment accurate?

E2.7 A car should have a braking distance at 30.0 mph of 15.0 m $\pm\ 3\%$ or less. What is the minimum measured braking distance which would lead to the car failing the test?