$^{8}/_{10}$

E3 Propagating Uncertainties

You will be penalized for an inappropriate number of significant figures (e.g. giving an uncertainty to 3 sf, or giving a measurement to 2 dp if the uncertainty is $\pm\ 0.1$). Please make sure that the unit of absolute uncertainties 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.

Calculate the relative uncertainty, in percent, of:

E3.1 A resistance which is worked out from a voltage known to 3% and a current known to 7%. (Equation: $R = \frac{V}{I}$)

E3.2 A frequency which is worked out from a time period known to 2%. (Equation: $f = \frac{1}{T}$)

E3.3 The density of a cuboid block of iron whose lengths are known to 2% and whose mass is known to 0.1%. (Equation: density $= \frac{\text{mass}}{\text{volume}}$)

E3.4 The time taken for a marble to fall by a distance known to 4%. (Equation: distance $= \frac{1}{2}gt^2$)

E3.5 The resistivity of a constantan wire if the resistance is known to 8%, the diameter to 2% and the length to 5%. (Equation: resistivity $= \frac{RA}{L}$, where A is the cross sectional area)

E3.6 Give the speed (with relative uncertainty) of a car which travels (20.0 ± 0.1) m in $(1.3\ \pm\ 0.1)$ s.

E3.7 Give the frequency (with absolute uncertainty) of a wave which travels at $(320\ \pm\ 15)$ m s^{-1} and has a wavelength of $(32.2\ \pm\ 0.3)$ cm. (Equation: frequency $= \frac{\text{speed}}{\text{wavelength}}$)

E3.8 Two resistors, each of $6\,\Omega$ resistance ($\pm\ 2\%$) are connected in series. What is the relative uncertainty of the total resistance? (Total resistance of resistors in series = sum of the resistances.)

E3.9 I need to put 3.0 kg of flour in a bowl for making some bread. My scales (which read to the nearest 5 g) only go up to 1.000 kg, so I measure out three equal helpings of flour separately, then put them in the bowl. What is the absolute uncertainty of the mass of flour in the bowl afterwards?

E3.10 The speed of a trolley before and after $(1.7\ \pm\ 0.1)$ s of acceleration is measured. Before the acceleration, the trolley moved (100 ± 1) mm in (1.78 ± 0.01) s; after the acceleration it moved the same distance in $(0.74\ \pm\ 0.01)$ s. Calculate the relative uncertainty of the measured acceleration. $\left(\text{Equation: acceleration} = \frac{\text{change in velocity}}{\text{time of acceleration}}\right)$