CHEMISTRY 31
Quiz 2 - 10 minutes
Solutions

1. A student needs to weigh out about 1 g of Mg but his balance is broken. Instead, he cuts of a length of Mg rod and measures its length and width. The rod's diameter is 0.231 $\pm$ 0.004 cm and its length is 19.2 $\pm$ 0.3 cm. Given that the density of Mg is 1.738 g/cm^3 and the equation for the volume of a cylinder (rod) of diameter d and length L is $V = \pi d^2 L/4$, calculate the mass of Mg and the absolute uncertainty in the mass (both in g with the proper number of sig figs).

mass = ρV (where ρ = density)
mass = $\rho\pi d^2 L/4$ = (1.738 g/cm^3)π(0.231 $\pm$ 0.004 cm)^2(19.2 $\pm$ 0.3 cm)/4
At this point, we can, hopefully, recognize that this is a mixed operations problem because it has an exponent and then multiplication and division.
For the first step, we can calculate d^2 and $S_{d\wedge 2}$:
d^2 = (0.231 cm)^2 = 0.05336 cm^2 and $S_{d\wedge 2}/d^2 = 2S_d/d$ = 2(0.004 cm)/(0.231 cm) = 0.0346
[note: we can convert this back to an absolute uncertainty, but we don't need to because in the next step (multiplication/division) we need it as a relative uncertainty]
mass = (1.738 g/cm^3)π(0.05336 cm^2 $\pm$ 0.0346 *rel. unc.*)(19.2 $\pm$ 0.3 cm)/4 = 1.3985 g
$S_{mass}/mass = [(S_{d\wedge 2}/d^2)^2 + \cancel{(S_\rho/\rho)^2} + (S_L/L)^2]^{0.5} = [(0.0346)^2 + (0.3/19.2)^2]^{0.5}$
$S_{mass}/mass$ = 0.0380 or S_{mass} = 0.0380*(1.3985 g) = 0.0531 g
mass $\pm$ S_{mass} = 1.3985 $\pm$ 0.0531 g or = **1.40 $\pm$ 0.05 g** (correct # sig figs)