Uncertainty Problems

1. A student measures the radius of a sphere to be $r = 0.31 \pm 0.001$ [m].

   (a) Compute the volume of the sphere with uncertainty.

   (b) Express the radius as well as the volume with proper significant figures.

2. In an experiment on the conservation of angular momentum L, a student needs to find the angular momentum of a uniform disc of mass M and radius R as it rotates with angular velocity ω. She makes the following measurements:

$$
\begin{aligned}
M &= 1.10 \pm 0.01 \ [\text{kg}] \\
R &= 0.250 \pm 0.005 \ [\text{m}] \\
\omega &= 21.5 \pm 0.4 \ [\text{rad/s}]
\end{aligned}
$$

   and then calculates $L = \frac{1}{2}MR^2\omega$. What is her answer for L with uncertainty?

3. A visitor to a medieval castle measures the depth of a well by dropping a stone and timing its fall. He finds the time of the fall to be $t = 3.0 \pm 0.5$ [s] and calculates the depth using $d = \frac{1}{2}gt^2$. What is the depth with uncertainty, if he takes $g = 9.80$ [m/s^2] with negligible uncertainty?

4. If you measure two independent variables as

$$
\begin{aligned}
x &= 6.0 \pm 0.1 \\
y &= 3.0 \pm 0.1
\end{aligned}
$$

   calculate $q = xy + x^2/y$ with uncertainty.