1) Calculate the uncertainty for each of the measurements on the following equipment:

a) Electronic mass balance

   Absolute uncertainty: ± 0.01 g
   Measurement including absolute uncertainty: 12.68 ± 0.01 g
   % uncertainty: \( \frac{0.01}{12.68} \times 100 = 0.08\% \)

b) Digital thermometer

   Absolute uncertainty: ± 0.1 °C
   Measurement including absolute uncertainty: 31.4 ± 0.1 °C
   % uncertainty: \( \frac{0.1}{31.4} \times 100 = 0.3\% \)

c) Digital pH meter

   Absolute uncertainty: ± 0.01
   Measurement including absolute uncertainty: 7.00 ± 0.01
   % uncertainty: \( \frac{0.01}{7.00} \times 100 = 0.1\% \)

d) Measuring cylinder

   Absolute uncertainty: ± 0.5 cm³
   Measurement including absolute uncertainty: 43.0 ± 0.5 cm³
   % uncertainty: \( \frac{0.5}{43.0} \times 100 = 1\% \)
Topic 11 Calculating uncertainties

2) Propagating errors practice

A sample of aluminium is found to have a mass of 11.26 ± 0.05 g and a volume of 4.31 ± 0.01 cm³

a. Calculate the percent uncertainties in the mass and the volume:
   mass: \( \frac{0.05}{11.26} \times 100 = 0.4 \% \)
   volume: \( \frac{0.01}{4.31} \times 100 = 0.2 \% \)

b. What is the experimental value for the density of the aluminium? (with uncertainty)
   Density = mass/volume
   Density = \( \frac{11.26}{4.31} \) = 2.61 g cm⁻³
   2.61 g cm⁻³ ± 0.6 %
   Convert back to absolute uncertainty:
   \( \frac{0.6}{100} \) × 2.61 = 0.01566
   2.61 ± 0.02 g cm⁻³

c. Given that the density of aluminium is 2.71 g cm⁻³, what is the percentage error?
   % error = \( \frac{(2.61 - 2.71)}{2.71} \times 100 = -3.7 \% \) (or 3.7 %)