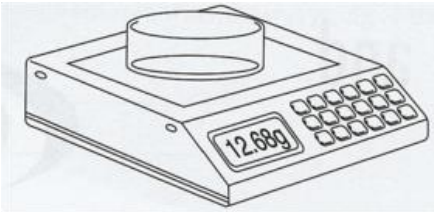
Calculating uncertainties (answer key)

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: (0.01/12.68) × 100 = 0.08 %

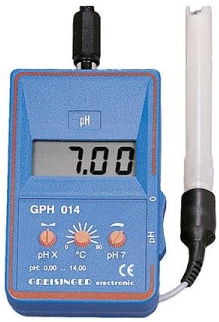
b) Digital thermometer

Absolute uncertainty: ± 0.1 °C

Measurement including absolute uncertainty: 31.4 ± 0.1 °C

% uncertainty: (0.1/31.4) × 100 = 0.3 %

c) Digital pH meter

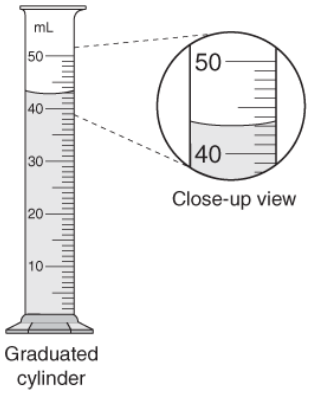


Absolute uncertainty: ± 0.01

Measurement including absolute uncertainty: 7.00 ± 0.01

% uncertainty: (0.01/7.00) × 100 = 0.1 %

d) Measuring cylinder

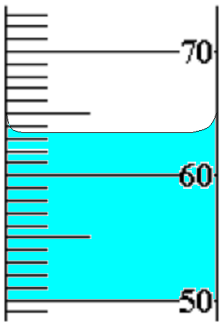


Absolute uncertainty: ± 0.5 cm^3

Measurement including absolute uncertainty: 43.0 ± 0.5 cm^3

% uncertainty: (0.5/43.0) × 100 = 1 %

e) Measuring cylinder

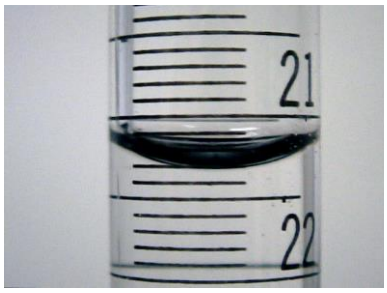


Absolute uncertainty: ± 0.5 cm^3

Measurement including absolute uncertainty: 63.5 ± 0.5 cm^3

% uncertainty: (0.5/63.5) × 100 = 0.8 %

f) Burette



Absolute uncertainty: ± 0.05 cm^3

Measurement including absolute uncertainty: 21.30 ± 0.05 cm^3

% uncertainty: (0.05/21.30) × 100 = 0.2 %

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 cm^3

a. Calculate the percent uncertainties in the mass and the volume:
mass: (0.05/11.26) × 100 = 0.4 %
volume: (0.01/4.31) × 100 = 0.2 %

b. What is the experimental value for the density of the aluminium? (with uncertainty)
Density = mass/volume
Density = 11.26/4.31 = 2.61 g cm^{-3}
2.61 g cm^{-3} ± 0.6 %
Convert back to absolute uncertainty:
(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 = ((2.61 – 2.71) / 2.71) × 100 = –3.7 % (or 3.7 %)