Lab Report

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Topic:
1.2 Measurements and uncertainties
Aim:
Use available instruments to measure physical quantities.
Equipments:
1. Thermometer, Measuring cylinder
2. Vernier caliper
3. Digital balance
4. Stop watch
5. micrometer screw gauge

1 The length of a pen

Use **vernier caliper** to measure the length.
The length of the pen is $138.52mm \pm 0.02mm$.

2 The inner and outer width of a measuring cylinder

Use **vernier caliper** to measure the inner and outer width.
The outer width is $34mm \pm 1mm$ and the inner width is $27.81mm \pm 0.07mm$.

3 The diameter of a piece of wire

Use **micrometer screw gauge** to measure the diameter of wire and get the raw data below.
The diameter of the wire is $1.255mm \pm 0.002mm$

4 The mass of water in a measuring cylinder

Use **digital balance** to measure the mass. The total mass is $124.6g \pm 0.1g$ and the mass of the measuring cylinder (container) is $53.5g \pm 0.1g$ The mass of water = total mass - mass of the measuring cylinder=$178.1 - 124.6 = 53.5g$.
Thus the mass of water with its uncertainty is $53.5g \pm 0.02g$.

5 The volume of water in a measuring cylinder

Use the **measuring cylinder**, the volume of water is $54.3cm^3 \pm 0.2cm^3$.

6 The temperature of water

Use the **thermometer** to measure the temperature, the temperature of water is $24.5°C \pm 0.5°C$.

7 The time for a piece of paper to fall from the desk

Use the **stop watch** to record the time, the time for a piece of paper to fall from desk is $1.0s \pm 0.1s$.

8 Determine the density of a metal cylinder

Use the **verier caliper** to measure the height and diameter of the metal cylinder and the **digital balance** to measure the mass of the metal cylinder.
The raw data table is shown below.

Sample number	Diameter (d) (mm)	Height (h) (mm)	Mass (m) (g)
1	19.92 ± 0.01	31.83 ± 0.01	77.4 ± 0.1
2	19.94 ± 0.01		
3	19.91 ± 0.01		

The mean value of the diameter is

$$d = \frac{19.92 + 19.94 + 19.91}{3} \approx 19.92mm$$

and the uncertainty is

$$\Delta d = \frac{19.94 - 19.91}{2} = 0.015 \approx 0.02mm$$

.
Thus the diameter is $19.92mm \pm 0.02mm = 1.992cm \pm 0.002cm$.
Then calculate the volume of the cylinder:

$$V = Ah = \pi r^2 \cdot h = \frac{\pi d^2}{4} \cdot h = \frac{3.14 \cdot 1.992^2}{4} \cdot 3.183 = 9.92cm^3$$

.
Thus the main value of density:

$$\rho = \frac{m}{V} = \frac{77.4}{9.92} = 7.80g/cm^3$$

Because

$$\rho = \frac{m}{V} = \frac{m}{\frac{\pi d^2}{4} \cdot h} = \frac{4m}{\pi d^2 h}$$

, the fractional uncertainty

$$\frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + 2\frac{\Delta d}{d} + \frac{\Delta h}{h}$$

,

$$\Delta\rho \approx 0.1g/cm^3$$

.
In conclusion, the density $\rho = 7.8g/cm^3 \pm 0.1g/cm^3$.