Teaching skills and subject expertise

A-level Physics

Practical skills for 2016

Session 1 Handbook

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Use the apparatus provided to make the measurements stated. For each quantity measured estimate the uncertainty in your measurement. Express this as a percentage uncertainty.

1. Temperature of room
   Use the thermometer provided to measure room temperature. Estimate the uncertainty in your measurement.

2. Diameter of a wire
   Use the micrometer screwgauge to measure the diameter of the wire. What is the uncertainty in your measurement.
   Now calculate the cross-sectional area of the wire. What is the uncertainty in the area?

3. Volume of the rectangular block
   Use the ruler provided to measure the length, width and height of the rectangular block. Use this data to calculate the volume of the block. Estimate the uncertainty and percentage uncertainty in each measurement. What is the percentage uncertainty in the volume?

4. Thickness of a single sheet of paper
   Use the ruler provided to measure the thickness of a single sheet of paper by measuring the thickness of the 'pile' of paper. What is the uncertainty in your value for a single sheet?

5. Time period of a mass on a spring
   Displace the mass (vertically) downwards and release. Time 10 complete oscillations of the mass/spring system. Repeat this two more times (ie 3 readings in total). Use this data to find the mean time period (for one oscillation).
   Estimate the uncertainty in your value for time period.

6. Length of a metal wire
   Use the metre ruler to measure the length of the metal wire.
   Estimate the uncertainty in your measurement.

7. Angle measurement
   Use the protractor the measure the marked angle drawn on the card. What is the uncertainty in your measurement.
   Use the ruler to measure lengths '*o*' and '*h*'. Use the measure lengths and trigonometry to find the marked angle. Use the uncertainty in the measured lengths to estimate the uncertainty in the angle.

1. Temperature of room
Use **new** rule of half scale division. Room temperature = 19 + 0.5 ^{o}C

2. Diameter of Wire
Effectively have to take reading at zero (jaws closed) and reading on wire.
Uncertainty on each 'reading' is half a scale division or 0.005mm.
Uncertainty in reading is 0.005 +0.005 = 0.01 mm
Diameter = 0.29 ± 0.01 mm
If several readings taken, take mean ± 0.5 X spread (if all identical, error is ± 0.01mm)
Area
Cross sectional area = 0.0661 mm^2
% error in diameter = (0.01 X 100)/0.29 = + 3.4%
% error in area = 2 x 3.4% = + 6.8 % or 7% (since this is an estimate)

3. Volume of Rectangular Block
Use of ruler for each measurement has uncertainty of 0.5 mm at each end of scale.
Uncertainty on each length measurement = ± 1 mm
Length = 75 ± 1mm % uncertainty = ± 1.3%
Width = 75 ± 1 mm % uncertainty = ± 1.3%
Height = 45 ± 1 mm % uncertainty = ± 2.5 %
Uncertainty in volume = ± 5.1%
Volume = 253 ± 13 cm^3
(NB With uncertainty of 13 cm^3 you could reasonably argue the value should be quoted to 2 sf . I.e. Volume = (2.5 + 0.1) x 10^2 cm^3)

4. Thickness of single sheet of Paper
Use of ruler for each measurement has uncertainty of 0.5 mm at each end of scale
Thickness of 100 sheets = 9 mm ± 1mm
% error = (1 x 100)/9 = 11%
% error in a single sheet will also be 11%
Hence Thickness of single sheet = 0.09 ± 0.01 mm

5. Time Period of a mass on spring
Mass on spring = 0.500 kg. resolution of stopclock = ± 0.01 s
Times for 10 oscillations: 8.71, 8.85, 8.93s Uncertainty = 0.5 x range = 0.5 x 0.22 = .11s
Mean time for 10 oscillations = 8.83 + 0.11 i.e. error = + 1.2%
Same uncertainty in 1 oscillation
Mean Time period = 0.883s
Time period = 0.883 ± 0.011 s Since the uncertainty is an approximation, the third sf is not justified and it is more realistic to quote the final time period as 0.88 ± 0.01 s
(It is quite possible to achieve a 'set' of timings where it would be justified to quote an additional decimal place in the final time period E.g. 8.80, 8.84,8.86 s gives a mean of 8.83 ± 0.03s. Time period = 0.883 ± 0.003 s)

6. Length of Metal wire

Measured Length = 51.2 cm

Measurement with ruler with mm scale would normally give an uncertainty of ± 1 mm

BUT

Kinks in wire do not allow measurement to this precision.

Estimate error to be ± 2 – 5 mm depending on amount of kinking

E.g. Length = 51.2 ± 0.3 cm

7. Angle Measurement

Using a protractor with 1^o protractor has to be positioned at zero and read at the angle value. This gives an uncertainty of $0.5^o + 0.5^o = 1^o$

Measured angle = $35^o \pm 1^o$

By length measurements: length 'o' = 10.7 ± 0.1 cm % error = ± 0.9%

Length 'h' = 18.7 ± 0.1 cm % error = ± 0.5%

Using sine of angle = 10.7/18.7 Gives angle = 34.9^o

Uncertainty is ± 1.4% (NB error in sine value is not exactly same as error in angle, but will be approximately the same in this instance)

Gives Angle = 34.9 ± 0.5^o