Advanced Higher Physics

TUTORIAL

Uncertainties

1 Three packages have to be added to the payload of the Space Shuttle. Their masses have been measured as follows:
$m_1 = (112 \pm 1)$ kg $m_2 = (252 \pm 2)$ kg and $m_3 = (151 \pm 1)$ kg.
Calculate the total mass to be added and the uncertainty in the total.

2 When using a travelling microscope the following measurements were made.
Reading 1 = (112.1 ± 0.2) mm Reading 2 = (114.5 ± 0.2) mm.
Calculate:
(a) the percentage uncertainty in the sum of these readings
(b) the percentage uncertainty in the difference of these readings

3 A block of building material has been carefully machined to undergo tests. Its dimensions and mass are as follows:

length = 0.050 ± 0.001 m
breadth = 0.100 ± 0.001 m
height = 0.040 ± 0.001 m
mass = 0.560 ± 0.002 kg

(a) From this data, calculate the density of this material.
(b) Find the uncertainty in this value of density and express it as a percentage.

4 The radius of a sphere is measured to be $(1.2 \pm 0.1) \times 10^{-2}$ m.
If the volume of a sphere is given as $\frac{4}{3} \pi r^3$, where r is the radius of the sphere, calculate the volume of the sphere, quoting the uncertainty in your answer.

5 A uniform disc is to be used as a flywheel in a new design of small engine. Its moment of inertia has to be known. The following method is used:

The diameter of the disc is measured with a metre stick at 8 different positions round the rim and its mass is measured on a balance which was accurate to 10 g.

Diameters	0.245 m	0.249 m	0.255 m	0.248 m
	0.243 m	0.247 m	0.251 m	0.246 m

Mass 4.04 kg

Use the formula for the moment of inertia $= \frac{1}{2} M R^2$, where R is the radius of the disc. Find the moment of inertia, quoting a value for the uncertainty associated with your answer.

6 Calculate the refractive index of a glass block from the following information:
Angle of incidence = $(46 \pm 1)°$ Angle of refraction = $(28 \pm 1)°$.
Make sure you quote an uncertainty in your answer.