

# MATHEMATICS

## Level One

### “Units”

**Background:** In surveying there are many different ways of representing **data**. All data has to be given a type of **units**, i.e. metres kilometres, hectares acres, m<sup>2</sup> and m<sup>3</sup>.

Sometimes when numbers are very large, we add a prefix to the type of unit to lessen the number of digits that need to be used. For example, 1,000 meters (1,000m) is the same as 1 kilometre (1km). It is also the same distance as 100,000 centimetres (100,000cm) and 1,000,000 millimetres (1,000,000mm). Alternatively, we may use powers of 10 to help us specify the measurements in a **standard form**. One kilometre (1km) can also be written as  $1 \times 10^6$ mm.

If we wished to write down the radius of the earth, we could write it in the following forms.

6,374km                      6,374,000m                      6,374,000,000mm    or.... in standard form  
6.374 x 10<sup>3</sup> km              6.374000 x 10<sup>6</sup>m              6.374 x 10<sup>9</sup>mm

1) All of the following measurements are in metres, express them in millimetres then into standard form (m)

- |             |                |
|-------------|----------------|
| a) 0.00567m | e) 2.356m      |
| b) 0.00483m | f) 0.00156m    |
| c) 0.034m   | g) 0.00000456m |
| d) 0.867m   | h) 123.163m    |

2) Complete the following table below by converting the numbers into the required form.

Measurements	Given data	Unit specified	Standard form
Equatorial Circumference	40075.01km	m	m
Mean angular velocity of the earth	Express the value in millimetres (mms <sup>-1</sup> )	ms <sup>-1</sup>	7.792115x10 <sup>-5</sup> ms <sup>-1</sup>
Mean Radius of the earth	6374km	m	m
Broadcast Frequency of GPS satellite	1227.6MHz	Hz (NB 1MHz = 1,000,000Hz)	Hz

All measurements (including surveying ones) contain **some** error, which is usually very small, called random errors. These can be caused by manufacturing imperfections, and the uncertainty inherent in all measurements. (Could you measure a line to the nearest tenth of a millimetre, with your ruler?)

Listed below are the errors associated with some distance measurement equipment. These errors have a constant part as well as a part that is proportional to the distance measured. Eg: If it was stated that the error was  $3\text{mm} + 5 \text{ ppm}$  then the error on a 3km line would be  $3\text{mm} + (5\text{mm} \times 10^{-6} \times 3\text{km})$  which equals a total error of  $\pm 18\text{mm}$ . Remember that there are 1 million millimetres in a kilometre. (Note: the 3km needs to be converted to mm).

3) Calculate the error for a 1km, 5 km and 10km line for each specification

- a)  $5\text{mm} + 3\text{ppm}$
- b)  $1\text{mm} + 2\text{ppm}$
- a)  $4\text{mm} + 4\text{ppm}$
- b)  $2\text{mm} + 2\text{ppm}$