THE USE OF 'SCIENTIFIC' NOTATION AT INTERMEDIATE LEVEL
Probably best included after 'Capacitors and Inductors', page 28 in Intermediate Licence textbook, 5th Edition, 2009.

There is a way of expressing very large or very small numbers without having to write down all the zeros, this is normally referred to as 'Scientific Notation' and sometimes as 'Standard Notation'. There is a variation known as 'Engineering Notation', which is the one most used for amateur radio purposes.

This way of handling numbers really comes into its own at the Advanced level, where you need to be able to do calculations using Megahertz, picofarads and the like. You are less likely to make a mistake keying in a number using Engineering Notation than entering a string of nine or twelve zeros. However, at Intermediate level there are no such calculations but you do need to know what Engineering Notation means. So, how does it work?

First of all you need to think of numbers in two parts, the main figures and the number of times it is multiplied, or divided, by ten. This sounds far more complicated than it really is; let's look at some examples.

Imagine you are dealing with a very high potential difference, of say two thousand volts. You will know that this can be written as 2000V, or you can write it as 2kV (remember, the k for kilo moves the decimal point three places to the left). This is the same as saying that 2kV is 2 x 10 x 10 x 10 volts; each 'x 10' adds a zero to the main figure, so multiplying by 10 three times adds three zeros to the main figure '2', taking us back to the 2000 we started with. Still seems complicated? Stay with it, it gets easier!

You may already be aware that 10 x 10 can be written as 10^2 and 10 x 10 x 10 can be written as 10^3. So, we could write 2000V as 2 x 10^3 volts. In Engineering Notation something 'x $10^{3'}$ means 'kilo'; 10kΩ could be written as 10 x 10^3Ω, 3500Hz could be written as 3.5 x 10^3Hz and so on.

Looking now at Mega, that means 'one million', or you could think of it as 'x10' six times to add the six zeros to the main figure. So 7,000,000Hz, or 7MHz, in Engineering Notation would be 7 x 10^6Hz. Following this logic can you work out what the Engineering Notation for Giga would be? Check in the summary at the end.

OK, so what about the sub-units; the tiny values? Well, it works in much the same way but because the numbers are smaller than 1, we use a negative number to show how many times the main figure has been *divided* by 10. For example, 45mA, can be thought of as 45 divided by 10 x 10 x 10 (1000) Amps, would be 45 x 10^{-3}A. To put it another way, 'milli' is something 'x $10^{-3'}$.

Micro is the next step down in size where we are taking about 'divided by a million' so the Engineering Notation for micro uses 10^{-6}. Nano is the next step and that can be written as 10^{-9}. What do you think pico will be? Check in the summary at the end.

You can also swap between sub-units using the Engineering Notation. For example, imagine you see a project in a book and it shows a 4700pF capacitor and you need to carry out a calculation. You could write that as 4700 x 10^{-12}F, or you could write it as 4.7 x 10^{-9}F, because 4700pF is the same as 4.7nF; remember, in changing from pF to nF you move the decimal point three places to the left so you reduce the x 10^{-12} to x 10^{-9}.

Summary

The Engineering Notation helps us to express very large or very small numbers without having to write down all the zeros.
At Intermediate level you need to recall the Engineering Notation for key units and sub-units and be able to change between them, but there will be no calculations requiring you to use the notation.
The 'three zero' steps in the units and sub-units translate into changes of 'x 10^{3}' with each level of unit or sub-unit:

- Giga = x 10^{9}
- Mega = x 10^{6}
- Kilo = x 10^{3}
- Milli = x 10^{-3}
- Micro = x 10^{-6}
- Nano= x 10^{-9}
- Pico = x 10^{-12}