Introduction Sheet 2
Manipulating Scientific Forms

Rules to Remember:

Scientific Form

In order to write and manipulate very large and very small numbers in physics, it is standard practice to write them in **Scientific Form** $a \times 10^p$ where $1 < a < 10$ and p is a non-zero integer. When actually doing a calculation, it is advisable to always use scientific form for each quantity appearing in the formulae. However, you should be aware that often the input to or result of a calculation isn't put in scientific form for numbers up to about 1000 and as small as about 0.001; for example, it is easier to quickly appreciate the quantity 0.78 rather than 7.8×10^{-1}. Therefore, as a rule of thumb, you need not write your answers in scientific form if p is $1, 2, -1$, or -2, though it's OK if you do.

Examples

$$67800 = 6.78 \times 10^4 \qquad 0.000054 = 5.4 \times 10^{-5}$$

$$(4 \times 10^4) \times (3 \times 10^7) = 12 \times 10^{11} = 1.2 \times 10^{12} \qquad \frac{3 \times 10^6}{4 \times 10^9} = 0.75 \times 10^{-3} = 7.5 \times 10^{-4}$$

$$2.2 \times 10^2 + 3.4 \times 10^3 = 3.62 \times 10^3 \qquad (8 \times 10^6)^{\frac{1}{3}} = 2 \times 10^2$$

Prefixes

Another way to make large or small numbers manageable is to use **prefixes** on the unit symbols that alter the physical units by a mutiple. Typically the multiples are 1000's, with the most commonly used being

10^{-15}	femto (f)	10^{-12}	pico (p)	10^{-9}	nano (n)	10^{-6}	micro (μ)	10^{-3}	milli (m)
10^3	kilo (k)	10^6	mega (M)	10^9	giga (G)	10^{12}	tera (T)	10^{15}	peta (P)

e.g. $5 \times 10^{-5}\text{J} = 5 \times 10^1 \times 10^{-6}\text{J} = 50\mu\text{J}$, $2 \times 10^7\text{m}^2 = 2 \times 10^1 \times 10^6\text{m}^2 = 20\text{km}^2$.

It is a matter of popularity whether one uses scientific notation or prefixes, e.g. one commonly uses km (10^3 metres) but not Mm (10^6 metres). It is advisable to remove prefixes on quantities input to a calculation by rewriting them in scientific form first. **For the test sheet, you should also give your answers in scientific notation without prefixes on the unit symbols.**

Practice Questions:

P1 Evaluate in scientific form:

a) 0.00125 b) 20700 c) $(2.5 \times 10^6) \times (2 \times 10^{-12})$
d) $\frac{1.25\times10^4}{5\times10^7}$ e) $\frac{3.6\times10^{-8}}{6\times10^{-4}}$ f) $\sqrt{6.4 \times 10^5}$
g) $(4 \times 10^4)^{-\frac{1}{2}}$ h) $3 \times 10^{10} + 3.07 \times 10^{12}$ i) $7 \times 10^{-4} - 6.13 \times 10^{-2}$

P2 Rewrite the following quantities in scientific form without prefixes on the unit symbols

a) 0.01mm b) 3.3μA c) 22kms^{-1} d) 144nm^2 e) 0.7PWmm^{-2}

P3 Two semiconducting layers of material, of thicknesses 4.5×10^{-6}m and 2×10^{-5}m, are bonded one on top of the other. What is the total thickness?

P4 The power dissipated by a resistance R when current I flows is given by $P = I^2R$. Calculate P when $R = 4 \times 10^4\Omega$ and $I = 3 \times 10^{-3}$A.

P5 The acceleration a (in units of ms^{-2}) produced by the application of a force F (in units of N) to a mass m (in units of kg), is given by Newtons 2nd law

$$F = ma\ .$$

(i) If $m = 3 \times 10^5$kg and $a = 4 \times 10^{-2}$ms^{-2}, find F.
(ii) If $m = 2 \times 10^{-4}$kg and $a = 6 \times 10^5$kms^{-2}, find F.
(iii) If $m = 1.3 \times 10^{19}$kg and $F = 2.6 \times 10^5$N, find a

P6 A spring of spring constant k has a strain energy W when extended by an amount x, where

$$W = \frac{1}{2}kx^2\ .$$

Find W when
(i) $k = 1.2$Jm^{-2}, $x = 2 \times 10^{-3}$m.
(ii) $k = 1.2 \times 10^4$Jm^{-2}, $x = 5 \times 10^{-3}$mm.