1.3 Estimation of physical values

Scientists, including physicists, often need to estimate the size of physical quantities. It is a useful skill for students to develop, and can help with the checking of answers to numerical problems. If students can quickly estimate the size of an answer, they can see if their actual answers are sensible.

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Estimation usually involves a rough calculation, which can be done quickly. For example, if we wanted to find the ground area of the classroom, we could quickly pace out the length and width of the classroom and take 1 pace to be approximately *1m*. Multiplying the two would give us a rough estimate of the ground area in m^2.

(1) Make a rough estimate of the volume of the room you are in. Explain how you obtained your estimate.

Estimating requires that students have some knowledge of the approximate size of things. Approximate sizes are often given in *powers of 10*. For example, visible light has a wavelength of $10^{-7}m$ (It actually ranges from *390-700nm* or $3.9x10^{-7}$ - $7.0x10^{-7}m$); the diameter of an atom is around $10^{-10}m$ (It actually ranges from $1x10^{-10}$ - $5x10^{-10}m$), etc.

If we want to make a rough comparison between the magnitude of one thing and another, we can just compare *powers of 10*. For example, the wavelength of visible light is approximately $\frac{10^{-7}}{10^{-10}} = 10^3 = 1000$ times bigger than the width of an atom.

(2) Open the following: https://htwins.net/scale2/
Find the size, in metres, of the following (to the nearest power of 10):

1) *Observable universe*
2) *Saturn*
3) *Milky Way*
4) *Human*
5) *1 Light year*
6) *VY Canis Majoris*
7) *The Sun*
8) *Earth-Sun distance*
9) *Ant*
10) *Skin cell*
11) *Largest virus*
12) *Width of DNA*
13) *carbon atom*
14) *helium nucleus*
15) *top quark*

(3) Compare the following sizes:

1) *Earth-Sun distance with size of observable universe*

2) *A skin cell with a human*

3) *a nucleus with an atom*

4) *The size of the sun with the size of Saturn*

(4) How long would it take light to travel across the width of a carbon atom? (Note: light travels at $3 \times 10^8 ms^{-1}$ *in a vacuum.)*

(5) How long would it take light to travel across the Milky Way galaxy?