

## Worksheet 1.1: Solutions

### The size of things

No.	Answer																																												
1	Many objects are possible, including the examples given below.																																												
	<table><tr><th>Size range (m)</th><th>Object</th><th>Object size</th><th>Object size (nm)</th></tr><tr><td><math>10^0</math> to <math>10^{-1}</math></td><td>1-metre ruler</td><td>1.0 m</td><td>1 000 000 000</td></tr><tr><td><math>10^{-1}</math> to <math>10^{-2}</math></td><td>Sugar cube</td><td>Length 1 cm</td><td>10 000 000</td></tr><tr><td><math>10^{-2}</math> to <math>10^{-3}</math></td><td>Ant</td><td>Length 4 mm</td><td>4 000 000</td></tr><tr><td><math>10^{-3}</math> to <math>10^{-4}</math></td><td>Dressmaker's pin</td><td>Diameter 0.6 mm</td><td>600 000</td></tr><tr><td><math>10^{-4}</math> to <math>10^{-5}</math></td><td>Human hair</td><td>Diameter 75 <math>\mu\text{m}</math></td><td>75 000</td></tr><tr><td><math>10^{-5}</math> to <math>10^{-6}</math></td><td>Red blood cells</td><td>Diameter 5 <math>\mu\text{m}</math></td><td>5 000</td></tr><tr><td><math>10^{-6}</math> to <math>10^{-7}</math></td><td>Mitochondrion</td><td>Length 0.5 <math>\mu\text{m}</math></td><td>500</td></tr><tr><td><math>10^{-7}</math> to <math>10^{-8}</math></td><td>Yellow fever virus</td><td>Length <math>2 \times 10^{-8}</math> m</td><td>20</td></tr><tr><td><math>10^{-8}</math> to <math>10^{-9}</math></td><td>Buckyball</td><td>Diameter 1 nm</td><td>1</td></tr><tr><td><math>10^{-9}</math> to <math>10^{-10}</math></td><td>Copper atom</td><td>Diameter 260 pm</td><td>0.260</td></tr></table>	Size range (m)	Object	Object size	Object size (nm)	$10^0$ to $10^{-1}$	1-metre ruler	1.0 m	1 000 000 000	$10^{-1}$ to $10^{-2}$	Sugar cube	Length 1 cm	10 000 000	$10^{-2}$ to $10^{-3}$	Ant	Length 4 mm	4 000 000	$10^{-3}$ to $10^{-4}$	Dressmaker's pin	Diameter 0.6 mm	600 000	$10^{-4}$ to $10^{-5}$	Human hair	Diameter 75 $\mu\text{m}$	75 000	$10^{-5}$ to $10^{-6}$	Red blood cells	Diameter 5 $\mu\text{m}$	5 000	$10^{-6}$ to $10^{-7}$	Mitochondrion	Length 0.5 $\mu\text{m}$	500	$10^{-7}$ to $10^{-8}$	Yellow fever virus	Length $2 \times 10^{-8}$ m	20	$10^{-8}$ to $10^{-9}$	Buckyball	Diameter 1 nm	1	$10^{-9}$ to $10^{-10}$	Copper atom	Diameter 260 pm	0.260
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2	Objects listed in the ranges $10^{-7}$ to $10^{-8}$ m (100 nm to 10 nm) and $10^{-8}$ to $10^{-9}$ m (10 nm to 1 nm).																																												
3	6 mm = 6 000 000 nm. We require a size of 100 nm maximum; hence, the figure must be decreased by a factor of 6 000 000/100, i.e. 60 000.																																												
4	$2.5 \times 10^{-10}$ m = 0.25 nm. The figure must be increased by a factor of 4 (1/0.25).																																												
5	<p><b>a</b> 2 <math>\mu\text{m}</math> = 2 000 nm. The tape must therefore be 2000 cm long, i.e. 2 m.</p> <p><b>b</b> 330 mm = 330 000 000 nm. The tape must therefore be 330 000 000 cm, or 3300 km long.</p>																																												