Testing your maths skills

Brain-gym for the physics-muscle in your head (It hurts to start with, but gets easier with practise)

These problems will challenge you to work with powers and units, rearrange equations and use your calculator carefully. Helpful formulae for volume and surface area are given on the last page, as are the answers.

Lay out your working clearly, work step by step, and check your answers. If you get one wrong, go back and try again. Do not be disheartened if they seem difficult to start with, persevere and seek help – you will improve. Importantly, have fun!

1. How many mm^2 are there in

   (a) $1cm^2$?
   ....

   (b) 1 m^2 ?
   ....

   (c) 1 km^2 ?
   ....

2. How many cm^3 are there in

   (a) $1mm^3$?
   ....

   (b) 1 m^3?
   ....

3. A piece of A4 paper is 210 × 297 mm. All measurements are to the nearest mm. Calculate its area in (a) mm^2, (b) cm^2, (c) m^2. Give answers to the correct number of significant figures.

   ....

   ....

   a) Area = ... mm^2

   b) Area = ... cm^2

   c) Area = ... m^2

4. A plastic toy is supplied in a cubic box, 4.0 cm each side. How many of them pack into a carton 80 × 52 × 70 cm? (Students often get the wrong answer and can't see why. Visualise the actual problem don't just rely on maths!)

5. A copper atom has a diameter of 217 pm (pico-meters). How many of them would fit inside $1mm^3$ of copper to 3 sig. fig? (Tip: for simplicity, treat them as cubes of side 217 pm)

6. Water has a density of 1.0 g cm^{-3}. Express this in (a) kg cm^{-3}, (b) kg m^{-3}, (c) kg mm^{-3}

....

....

a) Density = ...kg cm^{-3}

b) Density = ...c kg m^{-3}

c) Density = ... kg mm^{-3}

7. A regular block of metal has sides 12.2 × 3.7 × 0.95 cm, and a mass of 107g.
Find its density in Kg m^{-3} to a suitable number of significant figures.

8. A measuring cylinder is filled with 1.00 litres of water. The column of water inside forms a regular cylinder 32.0 cm high. What is (a) the area of the surface of the water (in mm^2)? (b) the internal diameter of the cylinder (in mm)?
(TIP: Visualise the problem clearly. Draw a diagram if it helps. Use the equation or the volume of a cylinder)

9. The diameter of the sun is 1.4×10^6 km. Its average density is 1.4 g cm^{-3}. What is its mass in kg?
(TIP: The trick here is to convert the units carefully before you start)

10. The total energy arriving in the Earth's upper atmosphere from the sun is 174×10^{15} Watts. Given that the Earth's diameter is 12.8×10^3 km, what is the average intensity of this radiation in W m^{-2}?
(TIP: Think about the units carefully. What does W m^{-2} mean?)

GEOMETRICAL EQUATIONS

arc length	$= r\theta$
circumference of circle	$= 2\pi r$
area of circle	$= \pi r^2$
surface area of cylinder	$= 2\pi rh$
volume of cylinder	$= \pi r^2 h$
area of sphere	$= 4\pi r^2$
volume of sphere	$= \dfrac{4}{3}\pi r^3$

Answers:

1. a) 10^2 (100)
   b) 10^6 (1,000,000)
   c) 10^{12}
2. a) 10^{-3} (1/1000)
   b) 10^6 (1,000,000)
3. a) 6.237×10^4 mm^2 (62,370 mm^2)
   b) 6.237×10^2 cm^2 (623.7 cm^2)
   c) 6.237×10^{-2} m^2 (0.06237 m^2)
4. 4420
5. 9.79×10^{19}
6. a) 1×10^{-3} kg cm^{-3}
   b) 1×10^6 kg m^{-3}
   c) 1×10^{-6} kg mm^{-3}
7. 2.50×10^3 kg m^{-3}
8. a) 3125 mm^2
   b) 63.1 mm
9. 2.0×10^{30} kg
10. 338 W m^{-3}