**Skill Sheet: Metric Units and Standard Form**

***What You Need to Know:***

***Examiners***

***Top Tip***

*Always state the units used when you calculate an answer – there can be marks for this*

Designers carry out calculations using the following units:

* Length: millimetres (mm) and metres (m).
* Mass: kilograms (kg) and tonnes (T).
* Force: newtons (N).
* Electrical resistance: ohms (Ω).

The values of these units may be given in ‘standard form’. This is a way of writing down very large or small numbers easily. For example, 1000000000 = 1 x 109. The index value (in the example: 9) shows the number of zeros that follow the value. If the index number is negative, this shows that the number is less than one in value, and the index represents how many places it is after the decimal point.

|  |  |  |
| --- | --- | --- |
| **Letter** | **Word** | **Multiplier** |
| p | pico | X 10-12 |
| n | nano | X 10-9 |
| μ | micro | X 10-6 |
| m | milli | X 10-3 |
| k | kilo | X 103 |
| M | mega | X 106 |
| G | giga | X 109 |
| T | tera | X 1012 |

**Table 1**

Instead of standard form, there may be a letter before the unit, to multiply the value (as in kg or mm). These are shown in the table 1. For example:

* 3 millimetres = 3 mm = 0.003 m  *(= 3 x 10-3 m)*
* 6.9 meganewtons = 6.9 MN *(= 6.9 x 106 N)*

It is often necessary to convert between units during calculations:

* 10 mm = 1 cm; 100 cm = 1 m
* 1000 kg = 1 T

In addition, you may need to know that volume or capacity is measured in litres (l) and that

1 l = 1000 ml = 1000 cm3 = 1000000 mm3 (= 1 x 106 mm3).

***Example:***

A container of polymer resin has a capacity of 0.24 m3. It is being used to fill moulds that each require 80 cm3 of the resin. How many moulds can be filled from a full container of resin?

***Answer:***

80 cm3 = 8 x 10-5 m3

0.24 / 8 x 10-5 = 3000 moulds (or 3 x 103 moulds)

***Now Try These:***

1. Re-write the value 0.000000089 m a) in standard form and b) using the correct SI multiplier letter.

a) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Convert 67.2 tonnes into kilograms.

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**Practice Sheet: Units and Standard Form**

***Now Try These:***

1. State the units of measurement for:
2. force.

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1. electrical resistance.

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1. State 0.36 μm in standard form.

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1. Convert 4.75 x 10-2 tonnes into kg.

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1. Add up the following values, presenting your answer in meters:

1.03 m, 62 cm, 560 mm, 17 cm, 43 mm

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1. A sheet of material has an area of 4.5 m2. It is to be cut into pieces of area 90 cm2. Assuming that there is no waste, calculate the number of pieces that will be cut from the sheet.

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1. A toy contains 47 g of polymer. Assuming that 6% of the polymer is lost as waste during manufacturing, calculate the total amount of material needed to make 24000 toys. Your answer should be in kg.

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**Answers:**

**Skill Sheet: Metric units and standard form**

1. a) 8.9 x 10-8 m

b) 89 nm

1. 67.2 x 1000 = 67200 kg

**Practice Sheet: Metric units and standard form**

1. a) newtons (N)

b) ohms (Ω)

1. 3.6 x 10-7 m
2. 47.5 kg
3. 1.03 + 0.62 + 0.56 + 0.17 + 0.043 = 2.423 m
4. 4.5 m2 = 45000 cm2 (=4.5 x 104 cm2)

4.5 x 104 / 90 = 500 containers

1. Efficiency of material use = 100 – 0.06 = 94%

Mass of polymer in needed to make one toy = 47 / 0.94 = 50 g

Mass of polymer needed to make 24000 toys = 24000 x 50 = 1200000 g = 1200 kg (or 1.2 x 103 kg)