

STUDY TIPS

PME1.2: UNITS, PREFIXES, CONVERSIONS

In Physics we commonly use SI units (kilograms, metres, seconds) and prefixes, and we assume that you can convert between them. It is also assumed that you can give your answers in Scientific Notation. See table below.

| Prefix | Symbol | Meaning | Example | Calculation with answer in Scientific Notation |
|--------|--------|------------|----------------|---|
| pico | p | 10^{-12} | 15 picofarad | $15 \text{ pF} = (15 \times 10^{-12})\text{F} = 1.5 \times 10^{-11}\text{F}$ |
| nano | n | 10^{-9} | 35 nanosecond | $35 \text{ ns} = (35 \times 10^{-9})\text{s} = 3.5 \times 10^{-8}\text{s}$ |
| micro | μ | 10^{-6} | 52 microamp | $52 \text{ }\mu\text{A} = (52 \times 10^{-6})\text{A} = 5.2 \times 10^{-5}\text{A}$ |
| milli | m | 10^{-3} | 50 millivolt | $50 \text{ mV} = (50 \times 10^{-3})\text{V} = 5.0 \times 10^{-2}\text{V}$ |
| centi | c | 10^{-2} | 10 centimetre | $10 \text{ cm} = (10 \times 10^{-2})\text{m} = 0.1\text{m}$ |
| kilo | k | 10^3 | 3000 kilo ohm | $3000 \text{ k}\Omega = (3000 \times 1000) \Omega = 3.0 \times 10^6\Omega$ |
| mega | M | 10^6 | 3000 megalitre | $3000 \text{ Ml} = (3000 \times 10^6)\text{l} = 3.0 \times 10^9\text{l}$ |
| giga | G | 10^9 | 125 gigawatt | $125 \text{ GW} = (125 \times 10^9)\text{W} = 1.25 \times 10^{11}\text{W}$ |

Conversions between units

Example 1

Convert 1 km to millimetres

Step 1: Write down the relationship between km and mm

$$1 \text{ km} = 1000 \text{ m and } 1 \text{ m} = 1000 \text{ mm}$$

$$\therefore 1 \text{ km} = 1000 \text{ } 000 \text{ mm}$$

Step 2: Convert to Scientific Notation

$$1 \text{ km} = 1000 \text{ } 000 \text{ mm} = 1.0 \times 10^6 \text{ mm}$$

Example 2

Convert 0.3 gram to milligrams

Step 1: Write down the relationship between grams and milligrams

$$1 \text{ gram} = 1000 \text{ milligrams} = 1.0 \times 10^3 \text{ mg}$$

Step 2: Write down the given quantity as a multiple

$$0.3 \text{ g} = 0.3 \times 1 \text{ g} = 0.3 \times 10^3 \text{ mg}$$

Step 3: Convert to Scientific Notation
 $0.3 \times 10^3 \text{mg} = 300 \text{mg} = 3.0 \times 10^2 \text{mg}$

Example 3

Convert $1 \mu\text{m}$ to kilometres

Step 1: Write down the relationship between kilometres and μm first

$$1 \text{ km} = 1000 \text{ m} = 10^3 \text{m} \text{ and } 1 \text{ m} = 10^6 \mu\text{m}$$

$$\therefore 1 \text{ km} = 10^3 \times 10^6 = 10^9 \mu\text{m}$$

Step 2: **Now** write down the relationship between μm and km

$$1 \text{ km} = 10^9 \mu\text{m} \therefore 1 \mu\text{m} = 10^{-9} \text{km}$$

Step 3: Make sure the answer is in Scientific Notation (which in this case it is)

Exercise 1

Complete the following conversions, giving your answers in Scientific Notation.

| | | | | | |
|-----|---|---------------|-----------------|---|----|
| 1m | = | cm | 1cm | = | m |
| 1m | = | mm | 1mm | = | m |
| 1m | = | μm | $1 \mu\text{m}$ | = | m |
| 1cm | = | mm | 1mm | = | cm |
| 1km | = | m | 1m | = | km |
| 1km | = | cm | 1cm | = | km |
| 1km | = | mm | 1mm | = | km |
| 1kg | = | g | 1g | = | kg |
| 1kg | = | mg | 1mg | = | kg |
| 1kg | = | μg | $1 \mu\text{g}$ | = | kg |
| 1g | = | mg | 1mg | = | g |
| 1g | = | μg | $1 \mu\text{g}$ | = | g |
| 1mg | = | μg | $1 \mu\text{g}$ | = | mg |

Other Conversions

To change from hours to seconds we multiply by 3600 since there are (60×60) seconds in 1 hour. Conversely, we divide by 3600 to change from seconds to hours

Velocity may be given in km h^{-1} . To change to ms^{-1} involves two conversions:

$$1 \text{ km h}^{-1} = 1000 \text{ m h}^{-1} = (1000/3600) \text{ ms}^{-1} = (1/3.6) \text{ ms}^{-1}.$$

Example 4

$60 \text{ kmh}^{-1} = (60/3.6) = 16.7 \text{ ms}^{-1}$. To change from kmh^{-1} to ms^{-1} **divide** by 3.6

Example 5

$20 \text{ ms}^{-1} = 20 \times 3.6 = 72 \text{ kmh}^{-1}$. To change from ms^{-1} to kmh^{-1} **multiply** by 3.6

Area:

$$1 \text{ m}^2 = 10000 \text{ cm}^2 = 10^4 \text{ cm}^2; \text{ or } 1 \text{ cm}^2 = 10^{-4} \text{ m}^2$$

$$1 \text{ m}^2 = 1000000 \text{ mm}^2 = 10^6 \text{ mm}^2; \text{ or } 1 \text{ mm}^2 = 10^{-6} \text{ m}^2$$

Volume

$$1 \text{ m}^3 = 1000000 \text{ cm}^3 = 10^6 \text{ cm}^3; \text{ or } 1 \text{ cm}^3 = 10^{-6} \text{ m}^3$$

$$1 \text{ m}^3 = 1000000000 \text{ mm}^3 = 10^9 \text{ mm}^3; \text{ or } 1 \text{ mm}^3 = 10^{-9} \text{ m}^3$$

Example 6

$50 \text{ m}^2 = 50 \times 10^4 \text{ cm}^2 = 5.0 \times 10^5 \text{ cm}^2$. *Note* answer is in Scientific Notation

Example 7

$68 \text{ mm}^2 = 68 \times 10^{-6} \text{ m}^2 = 6.8 \times 10^{-5} \text{ m}^2$ *Note* answer is in Scientific Notation

Example 8

$450 \text{ m}^3 = 450 \times 10^6 \text{ cm}^3 = 4.5 \times 10^8 \text{ cm}^3$. *Note* answer is in Scientific Notation

Example 9

$122 \text{ mm}^3 = 122 \times 10^{-9} \text{ m}^3 = 1.22 \times 10^{-7} \text{ m}^3$ *Note* answer is in Scientific Notation

Exercise 2

(a) Convert 7 cm^2 to mm^2

(b) Convert $3 \times 10^3 \text{ m}^2$ to cm^2

(c) Convert 0.04 km^2 to m^2

(d) Convert $6 \times 10^{-2} \text{ m}^2$ to cm^2

(e) Convert 80 mm^3 to cm^3

(f) Convert 30 m^3 to cm^3

(g) Convert $2 \times 10^5 \text{ cm}^3$ to m^3

(h) Convert 0.06 mm^3 to m^3

(i) Convert 45 kmh^{-1} to ms^{-1}

(j) Convert 26 ms^{-1} to kmh^{-1}

(k) Convert 11 g cm^{-3} to kg m^{-3}

(l) Convert $5 \text{ cm}^2 \text{ s}^{-1}$ to $\text{m}^2 \text{ h}^{-1}$

(m) Convert 8 kg m^{-2} to g cm^{-2}

(n) Convert $380 \text{ cm}^3 \text{ s}^{-1}$ to $\text{m}^3 \text{ h}^{-1}$

ANSWERS

Exercise 1

| | | | |
|-------|----------------|-------------|--------------|
| 1m = | 10^2 cm | 1cm = | 10^{-2} m |
| 1m = | 10^3 mm | 1mm = | 10^{-3} m |
| 1m = | 10^6 μ g | 1 μ m = | 10^{-6} m |
| 1cm = | 10 mm | 1mm = | 10^{-1} cm |
| 1km = | 10^3 m | 1m = | 10^{-3} km |
| 1km = | 10^5 cm | 1cm = | 10^{-5} km |
| 1km = | 10^6 mm | 1mm = | 10^{-6} km |
| 1kg = | 10^3 g | 1g = | 10^{-3} kg |
| 1kg = | 10^6 mg | 1mg = | 10^{-6} kg |
| 1kg = | 10^9 μ g | 1 μ g = | 10^{-9} kg |
| 1g = | 10^3 mg | 1mg = | 10^{-3} g |
| 1g = | 10^6 μ g | 1 μ g = | 10^{-6} g |
| 1mg = | 10^3 μ g | 1 μ g = | 10^{-3} mg |

Exercise 2

- | | |
|--|---|
| (a) 7×10^2 mm ² (700 mm ²) | (b) 3×10^7 cm ² |
| (c) 4×10^4 m ² | (d) 6×10^2 cm ² |
| (e) 8×10^{-2} cm ³ | (f) 3×10^7 cm ³ |
| (g) 0.2 m ³ | (h) 6×10^{-11} m ³ |
| (i) Convert 12.5 ms ⁻¹ | (j) 93.6 kmh ⁻¹ |
| (k) 1.1×10^4 kg m ⁻³ | (l) 1.8 m ² h ⁻¹ |
| (m) 0.8 g cm ⁻² | (n) 1.36 m ³ h ⁻¹ |