**Unit 4**

**Measurement**

**Topic A: Metric system of measurement**

* International system of units
* Metric conversion
* The unit factor method

**Topic B: Metric units for area and volume**

* Convert units of area and volume
* The relationship between mL, g and cm3

**Topic C: Imperial system**

* The system of imperial units
* Imperial unit conversion

**Topic D: Converting between metric and imperial units**

* Imperial and metric conversions

**Unit 4 Summary**

**Unit 4 Self - test**

**Topic A: Metric System of Measurement**

**International System of Units**

**Metric system (SI – international system of units):** the most widely used system of

measurement in the world. It is based on the basic units of meter, kilogram, second, etc.

**SI common units:**

|  |  |  |
| --- | --- | --- |
| **Quantity** | **Unit** | **Unit symbol** |
| **Length** | meter | m |
| **Mass (or weight)** | gram | kg |
| **Volume** | litre | L |
| **Time** | second | s |
| **Temperature** | degree (Celsius) | 0C |

**Metric prefixes (SI prefixes):**  large and small numbers are made by adding SI prefixes, which is based on multiples of 10.

**Key metric prefix**:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Prefix** | **Symbol (abbreviation)** | **Power of 10** | **Multiple value** | **Example** |
| mega | M | 106 | 1,000,000 | 1 Mm = 1,000,000 m |
| kilo- | k | 103 | 1,000 | 1 km = 1,000 m |
| hecto- | h | 102 | 100 | 1 hm = 100 m |
| deka- | da | 101 | 10 | 1 dam = 10 m |
| **meter/gram/liter** |  | 1 |  |  |
| deci- | d | 10-1 | 0.1 | 1 m = 10 dm |
| centi- | c | 10-2 | 0.01 | 1 m = 100 cm |
| milli- | m | 10-3 | 0.001 | 1 m = 1,000 mm |
| micro | µ | 10-6 | 0.000 001 | 1 m = 1,000,000 µm |

**Metric prefix for length, weight and volume**:

Large

Small

|  |  |  |  |
| --- | --- | --- | --- |
| **Prefix** | **Length (m - meter)** | **Weight (g - gram)** | **Liquid volume (L - liter)** |
| mega (M) | Mm (Megameter) | Mg (Megagram) | ML (Megaliter) |
| kilo (k) | km (Kilometer) | kg (Kilogram) | kL (Kiloliter) |
| hecto (h) | hm (hectometer) | hg (hectogram) | hL (hectoliter) |
| deka (da) | dam (dekameter) | dag (dekagram) | daL (dekaliter) |
| **meter/gram/liter** | m (meter) | g (gram) | L (liter) |
| deci (d) | dm (decimeter) | dg (decigram) | dL (deciliter) |
| centi (c) | cm (centimeter) | cg (centigram) | cL (centiliter) |
| milli (m) | mm (millimeter) | mg (milligram) | mL (milliliter) |
| micro (µ) | µm (micrometer) | µg (microgram) | µL (microliter) |

**Metric Conversion**

**Metric conversion table:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Value** | 1,000 | 100 | 10 | 1 | **.** | 0.1 | 0.01 | 0.001 |
| **Prefix** | kilo | hecto | deka | **meter (m)**  **gram (g) liter (L)** | **.** | deci | centi | milli |
| **Symbol** | k | h | da |  | **.** | d | c | m |

Larger Small

**Steps for metric conversion through decimal movement:**

* + Identify the number of places to move on the metric conversion table.
  + Move the decimal point.
* Convert a ***smaller*** unit ***to*** a ***larger*** unit: move the decimal point to the ***left***.
* Convert a ***larger*** unit ***to*** a ***smaller*** unit: move the decimal point to the ***right***.

**Example**: 326 mm = (?) m

* + Identify mm(*millimeters*) and m (*meters*) on the conversion table.

Count places from mm to m: 3 places   meter **.** d c m

3 2 1

* + Move 3 decimal places. (1 m = 1000 mm)

Convert a smaller unit (mm) to a larger (m) unit: move the decimal point to the left.

326. mm = 0.326 m Move the decimal point three places to the left (326 = 326**.**).

**Example:** 4.675 hg = (?) g

* + Identify hg(*hectograms*) and g(*grams*) on the conversion table.

Count places from hg to g: 2 places h da gram

1 2

* + Move 2 decimal places. (1 hg = 100 g)

Convert a larger unit (hg) to a smaller (g) unit: move the decimal point to the right.

4.765 hg = 476.5 g Move the decimal point two places to the right.

**Example:**  30.5 mL = (?) kL

* + Identify mL(*milliliters*) and kL (*kiloliters*) on the conversion table.

Count places from mL to kL: 6 places   k h da liter.d c m

6 5 4 3 2 1

* + Move 6 decimal place. (1 kL = 1,000,000 mL)

Convert a smaller unit (mL) to a larger (kL) unit: move the decimal point to the left.

30.5 mL = 0.0000305 kL Move the decimal point six place to the left (add 0s).

**The Unit Factor Method**

**Convert units using the unit factor method (or the factor-label method)**

* Write the original term as a fraction (over 1). Example: 10g can be written as
* Write the conversion formula as a fraction or

Example: 1m = 100 cm can be written as or

(Put the desired or unknown unit on the top.)

* Multiply the original term by or (Cancel out the same units).

**Metric conversion using the unit factor method:**

**Example:** 1200 g = (?) kg

* Write the original term (the left side) as a fraction:
* Write the conversion formula as a fraction. 1 kg = 1000 g: “kg” is the desired unit.
* Multiply: 1200 g = The units “g” cancel out.

=

= 1.2 kg

**Example:** 30 cm = (?) mm

* Write the original term (the left side) as a fraction:
* Write the conversion formula as a fraction. 1 cm = 10 mm:

“mm” is the desired unit.

* Multiply: 30 cm = The units “cm” cancel out.

=

= 300 mm

**Adding and subtracting SI measurements:**

**Example**: 3 m 3000 mm 1 m = 1,000 mm

2000 mm 2000 mm

1000 mm

Combine after converting to the same unit.

**Example:** 25 kg 25000 g 1 kg = 1000 g

+ 4 g + 4 g

25004 g

**Topic B: Metric Units for Area and Volume**

**Convert Units of Area and Volume**

**Area unit conversion**

* Area unit conversion: convert the length or distance ***twice***.

Since the units of area are always expressed as square units (in m2, cm2, ft2, yd2, etc.)

**Example**: The area of a square is side squared (*A = s*2). *s*

(Convert the unit of the side twice.)

* Steps for area unit conversion:

**Steps Example:** 3200 cm2 = ( ? ) m2

* Determine the number of decimal places it Convert cm to m: move ***2*** decimal places left.

would move with ordinary units of length. 1m = 100cm

* ***Double*** this number, and move that number ***2*** × 2 = 4, move 4 places left for area.

of decimal places for units of area. 3200. cm2 = 0.3200 m2 =0.32 m2

(Since area is in m2, cm2, ft2, yd2, etc.)

**Example:** Convert.

0.03 km2 = ( ? ) m2 km to m: move **3** decimal places right (1km = 1,000cm)

0.03 km2 = 0030000. m2 = 30000 m2  ***2*** × 3 = 6,move 6 places right for area.

**Volume unit conversion**

* Volume unit conversion:convert the length or distance ***three times***.

Since the units of volume are always expressed as cubic units (in m3, cm3, ft3, yd3, etc.)

**Example**: The volume of a cube is side cubed (*V = s*3). *s*

(Convert the unit of the side three times.)

* Steps for volume unit conversion:

**Steps Example:** 3m3 = ( ? ) cm3

* Determine the number of decimal places it m to cm: move ***2*** decimal places right.

would move with ordinary units of length. 1m = 100cm

* ***Triple*** this number, and move that number ***3*** × 2 = 6, move 6 places right for volume.

of decimal places for units of volume. 3m3 = 3000000 cm33 = 3.

(Since volume is in m3, cm3, ft3, yd3, etc.)

**Example:** Convert.

5300 mm3 = ( ? ) cm3 mm to cm: move **1** place left. 1cm = 10 mm

5300 mm3 = 5.3 cm3 ***3*** × 1 = 3, move 3 places left for volume.

(5300 = 5300.)

**The Relationship between *mL*, *g* and cm3**

**How are mL, g, and cm3 related?**

* Recall: millimeter = mL, gram = g, cubic centimeter = cm3
* A cube takes up 1 cm3 of space (1 cm × 1 cm × 1 cm = 1cm3). (cm3 = cc (cubic centimeter) in chemistry and medicine) 1cm
* A cube holds 1 mL of water and has a mass of 1 gram at 40 C. 1cm 1cm

**The relationship between mL, g and cm3 formulas:**

1 cm3 = 1 mL = 1 g

Or 1 cm3 =1 mL 1 mL = 1 g 1 cm3 = 1 g

**Example:** Convert.

1. 16cm3 = ( ? ) g

16cm3 = 16 g1 cm3 = 1 g

1. 9 L = ( ? ) cm3

9 L = 9000 mL 1 L = 1,000 mL

= 9000 cm3 1 mL = 1 cm3

1. 35 cm3 = (?) cL

35cm3 = 35 mL 1 cm3 = 1 mL

= 3.5 cL move 1 decimal place left. c m 450 kg = (?) L

1. 450 kg = 450,000 g1 kg = 1,000 g

= 450,000 mL 1 g = 1 mL

= 450 L 1 L = 1,000 mL

**Example**: A swimming pool that measures 10 m by 8 m by 2 m. How many ***kiloliters*** of water

will it hold?

*V* = *w* *l h* = (8m) (10m) (2m) = 160 m3 160 m3 = ( ? ) kL

160m3 = 160,000,000 cm31 m = 100 cm, **3** × 2 = 6, move 6 places right for volume.

160,000,000 cm3 =160,000,000 mL1 mL = 1 cm3

160,000,000 mL= 160 kL 1 kL = 1,000,000 mL

160 m3 =160 kL The swimming pool will hold 160 kL of water.

**Topic C: Imperial System**

**The System of Imperial Units**

**Imperial system units:** a system of measurement units originally defined in England, including the foot, [pound](https://www.collinsdictionary.com/dictionary/english/pound), quart, ounce, gallon, mile, yard, etc.

**Length, weight, liquid volume and time:**

|  |  |
| --- | --- |
| **Quantity** | **Units** |
| Length | inch, foot, yard, mile, etc. |
| Weight | pound**,** ounce, ton, etc. |
| Liquid volume | fluid ounce, pint, quart, gallon, cup, teaspoon, etc. |
| Time | year, week, day, hour, minute, second, etc. |
| Temperature | degree / Fahrenheit (0F) |

**Imperial equivalents:**

|  |  |  |
| --- | --- | --- |
| **Unit name** | **Symbol (abbreviation)** | **Relationship** |
| ***Length*** |  |  |
| inch | in. or ” |  |
| foot | ft. or ’ | 1ft = 12 in |
| yard | yd. | 1yd = 3 ft |
| mile | mi. | 1 mi = 5280 ft |
| ***Weight*** |  |  |
| ounce | oz. |  |
| pound | lb. | 1 lb = 16 oz |
| ton | ton | 1 ton = 2000 lb |
| ***Liquid volume*** |  |  |
| fluid ounce | fl oz. |  |
| pint | pt. | 1 pt = 16 fl oz |
| quart | qt. | 1 qt = 2 pt |
| gallon | gal. | 1 gal = 4 qt |
| cup | c. | 1 c = 8 fl oz |
| teaspoon | tsp. | 3 tsp = 1 tbsp |
| tablespoon | tbsp. | 16 tbsp = 1 c |
| ***Time*** |  |  |
| second | s. | 1 min. = 60 s |
| minute | min. | 1 hr = 60 min = 3600 s |
| hour | hr. | 1 d = 24 hr |
| day | d. | 1 wk = 7 d |
| week | wk. | 1 yr = 52 wk |
| year | yr. | 1 yr = 365 d |

**Imperial Unit Conversion**

**Imperial conversion using the unit factor method:**

* Write the original term as a fraction (over 1). Example: 10g can be written as
* Write the conversion formula as a fraction or

Example: 1 ft = 12 in can be written as or

(Put the unknown or desired unit on the top.)

* Multiply the original term by or (Cancel out the same units).

**Example:** 4 ft = ( ? ) in

* Write the original term (the left side) as a fraction: 
* Write the conversion formula as a fraction. 1 ft = 12 in:  “in” is the desired unit.
* Multiply: 4 ft = = 48 in The units “ft” cancel out.

**Example:** 20 qt = ( ? ) pt

* Write the original term as a fraction: 
* Write the conversion formula as a fraction. 1 qt = 2pt:  “pt” is the desired unit.
* Multiply: 20 qt = 40 ptThe units “qt” cancel out.

**Example:** 8 mi = ( ? ) yd mi" to ft 𝐭o yd

* Write the original term as a fraction: 
* Write the conversion formula as a fraction.

1 mi = 5280 ft:  “ft” is the desired unit.

1 yd = 3 ft:  “yd” is the desired unit.

* Multiply: 8 mi = 14080 yd

**Topic D: Converting between Metric and Imperial Units**

**Imperial and Metric Conversion**

**Key imperial and metric unit conversions:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Quantity** | **Metric to imperial** | **Imperial to metric** | **Abbreviation** |
|  | 1 m ≈ 39 in | 1 in = 2.54 cm | inch: in. or ” |
| **Length** | 1 m ≈ 3.28 ft | 1 ft ≈ 30.48 cm | foot: ft. or ’ |
|  | 1 m ≈ 1.09 yd | 1 mi ≈ 1.61 km | yard: yd. |
|  | 1 km ≈ 0.6214 mi | 1 yd ≈ 0.914 m | mile: mi. |
|  | 1kg ≈ 2.2 1b | 1 oz ≈ 28.35 g | pound: lb. |
| **Weight** | 1 g ≈ 0.035 oz | 1 lb ≈ 454 g | ounce: oz. |
|  | 1 ton ≈ 910 kg |  |  |
|  | 1 L ≈ 0.264 gal | 1 qt ≈ 0.946 L | gallon: gal. |
| **Volume** | 1 L ≈ 2.1 pt | 1 gal ≈ 3.79 L | pint: pt. |
|  | 1 L ≈ 1.06 qt | 1 pt ≈ 470 mL | quart: qt. |
|  | 1 mL = 0.2 tsp | 1 tsp = 5 mL | teaspoon: tsp. |

**Imperial - metric unit conversion** (the unit factor method):

* Write the original term as a fraction (over 1). Example: 10 gal can be written as
* Write the conversion formula as a fraction or

Example: 1mL = 0.2 tsp can be written as or

(Put the desired or unknown unit on the top.)

* Multiply the original term by or (Cancel out the same units).

**Example:** 2 ft = (?) m

* Write the original term (the left side) as a fraction: 
* Write the conversion formula as a fraction. 1 m ≈ 3.28 ft:  “m” is the desired unit.
* Multiply: 0.61m

**Example:** 120 oz = (?) kg “oz” to “g” to “kg”

* Write the original term (the left side) as a fraction: 
* Write the conversion formula as a fraction. 1 oz ≈ 28.35 g: “g” is the desired unit.
* Multiply:  = 3.402 kg 1 kg = 1000 g

**Example:** 250 mL = (?) tsp

* Original term to fraction: 250 mL =
* Conversion formula: 1 tsp = 5 mL: “tsp” is the desired unit.
* Multiply: 250 mL =

= 50 tsp

**Example:** 10560 yd = (?) mi “yd” to “ft” to “mi”

* Original term to fraction: 10560 yd =
* Conversion formula: 3ft = 1yd: “ft” is the desired unit.

1 mi = 5280 ft: “mi” is the desired unit.

* Multiply: 10560 yd = ∙

=

= 6 mi

**Example:**  Two towns are 600 miles apart. How many kilometers separate them?

* 600 miles = (?) km
* Original term to fraction: 600 mi =
* Conversion formula: 1 km ≈ 0.6214 mi: “km” is the desired unit.
* Multiply: 600 miles =

965.6 km

The distance between two towns is 965.6 km.

**Unit 4: Summary**

**Measurement**

**Metric system (SI – international system of units):** the most widely used [system of measurement](http://en.wikipedia.org/wiki/Units_of_measurement) in the world. It is based on the basic units of meter, kilogram, second, etc.

**Imperial system units:** a system of measurement units originally defined in England, including the foot, [pound](https://www.collinsdictionary.com/dictionary/english/pound), quart, ounce, gallon, mile, yard, etc.

**Metric prefixes (SI prefixes):** large and small numbers are made by adding SI prefixes, which is based on multiples of 10.

**Steps for metric conversion through decimal movement:**

* + Identify the number of places to move on the metric conversion table.
  + Move the decimal point.
* Convert a ***smaller*** unit ***to*** a ***larger*** unit: move the decimal point to the ***left***.
* Convert a ***larger*** unit ***to*** a ***smaller*** unit: move the decimal point to the ***right***.

**Convert units using the unit factor method (or the factor-label method):**

* + Write the original term as a fraction (over 1). Example: 10g can be written as
  + Write the conversion formula as a fraction or

Example: 1m = 100 cm can be written as or

(Put the desired or unknown unit on the top.)

* + Multiply the original term by or (Cancel out the same units).

**Key metric prefix**:

|  |  |  |  |
| --- | --- | --- | --- |
| **Prefix** | **Symbol (abbreviation)** | **Power of 10** | **Example** |
| mega | M | 106 | 1 Mm = 1,000,000 m |
| kilo- | k | 103 | 1 km = 1,000 m |
| hecto- | h | 102 | 1 hm = 100 m |
| deka- | da | 101 | 1 dam = 10 m |
| **meter/gram/liter** |  | 1 |  |
| deci- | d | 10-1 | 1 m = 10 dm |
| centi- | c | 10-2 | 1 m = 100 cm |
| milli- | m | 10-3 | 1 m = 1,000 mm |
| micro | µ | 10-6 | 1 m = 1,000,000 µm |

**Metric conversion table:**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Value** | 1,000,000 | 1,000 | 100 | 10 | 1 | **.** | 0.1 | 0 .01 | 0.001 | 0.000 001 |
| **Prefix** | Mega | kilo | hecto | deka | **meter (m)**  **gram (g) liter (L)** | **.** | dec | centi | milli | micro |
| **Symbol** | M | k | h | da |  | **.** | d | c | m | µ |

Larger Small

**Steps for area unit conversion:**

* + Determine the number of decimal places it would move with ordinary units of length.
  + ***Double*** this number, and move that number of decimal places for units of area.

**Steps for volume unit conversion:**

* + Determine the number of decimal places it would move with ordinary units of length.
  + ***Triple*** this number, and move that number of decimal placed for units of volume.

| **The relationship between mL, g and cm3 formulas:**   * + A cube holds 1 mL of water and has a mass of 1 gram at 40 C.   + 1 cm3 = 1 mL = 1 g   Or 1 cm3 = 1 mL 1 mL = 1 g 1 cm3 = 1 g |
| --- |

**Unit 4: Self - Test**

**Measurement**

**Topic A**

1. Convert each measurement using the metric conversion table**.**
2. 439 mm = ( ? ) m
3. 2.236 hg = ( ? ) g
4. 48.3 mL = ( ? ) kL
5. 2.5 kg = ( ? ) hg
6. Convert each measurement using the unit factor method.
7. 7230 g = (?) kg
8. 52 cm = (?) mm
9. 3.4 dL = ( ? ) L
10. 52 daL = (?) cL
11. Combine.
12. 7 m – 3000 mm = ( ? ) mm
13. 63 kg + 6 g = ( ? ) g
14. 0.72 L + 4.58 L – 10mL = ( ? ) mL
15. 25.3 km + 357 dam = ( ? ) km

**Topic B**

1. Convert.
2. 7400 cm2 = ( ? ) m2
3. 0.09 km2 = ( ? ) m2
4. 5m3 = ( ? ) cm3
5. 567 mm3 = ( ? ) cm3 .
6. Complete.
7. A cube holds 1 mL of water and has a mass of

1 gram at ( ) 0C.

1. 38 cm3 = ( ) g
2. 5 L = ( ) cm3
3. 27 cm3 = ( ? ) cL
4. 76 cm3 of water at 4°C has a mass of ( ) g.
5. 18 L of water has a volume of \_\_\_\_\_\_\_\_\_\_\_   cm3 .
6. 257 kg = ( ? ) L
7. A fish box that measures 45 cm by 35 cm by 25 cm.

How many kiloliters of water will it hold?

**Topic C**

1. Convert the following imperial system units.
2. 9 ft to inches
3. 47 qt to pints
4. 4 mi to yards
5. 9276 pounds to tons

**Topic D**

1. Convert.
2. 8 ft. to meters
3. 268 oz. to kilograms
4. 465 mL to tsp
5. 15840 yd. to miles
6. Two towns are 450 miles apart. How many

kilometers separate them?