

Conversion of Units of Measurement

Measuring is one of the human activities that we perform daily. A tailor measures the length of the dress, a butcher measures the weight of the meat, a surveyor measures the area of large land masses, and so on.

The ability to measure objects is always connected to the history of our civilization. During ancient times, our ancestors used their fingers, hands, and feet to determine the length of an object. In this era, humans had varying ways of measuring objects.

Eventually, after the French revolution in the late 18th century, a standardized way of measurement was developed (i.e., the metric system). Today, not only do we have a convention of measurement units but also advanced technological tools to measure objects.

In this module, you'll learn what measurement is, the units of measurement (for length, weight, volume, time, and temperature), and how to convert units in the metric system.

What is Measurement?

Measurement is the provision of a numerical value to present and describe the magnitude or amount of a particular object.

We use **measurement units** to provide a more accurate description of the object's measurement. Some examples of measurement units are meters, liters, grams, inches, Fahrenheit, and so on.

For instance, if we want to determine how long a piece of wood is, we measure its length. To do this, we use a particular SI unit of measurement (e.g., meters) and provide a number that describes the length of this wood (e.g., this wood is 3 meters long).

Since there are a lot of measurement units being used around the world, a standardized set of measurement units have been adopted by several countries. This is called the **SI Units of Measurement** which is more commonly known as the **Metric System** (e.g., meter, gram, liter).



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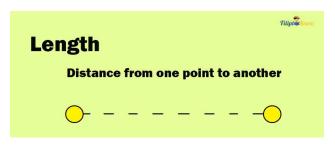
Conversion of Units of Measurement

On the other hand, there's also the **Imperial System** or **US Standard Units** which is also commonly used in the Philippines (e.g., feet, yards, pounds, etc.).

What Are the Different Ways To Measure Objects?

There are different ways to measure objects depending on the particular trait we want to describe or show.

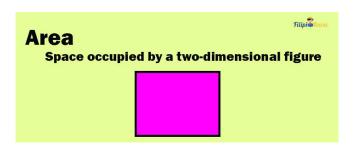
1. Length



This refers to the distance from one point to another. In other words, this describes how long or short an object is. Commonly used measurement units are meters, centimeters, inches, feet, and so on.

The SI base unit for length is a meter.

2. Area





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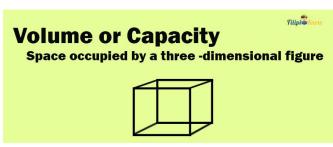
Conversion of Units of Measurement

This refers to the amount of space occupied by a two-dimensional figure. In other words, it tells us the <u>amount of surface covered by a plane figure</u>. Commonly used measurement units are square meters, square kilometers, square yards, and so on.

Metric units of the area have an exponent of 2 to indicate that we are measuring the amount of two-dimensional space occupied (e.g., the square meter is written as m²).

The SI base unit for the area is square meters (m²).

3. Volume or Capacity



The amount of space occupied or enclosed by a three-dimensional figure. Commonly used measurement units are cubic meters, cubic kilometers, cubic yards, and so on.

Metric units of volume have an exponent of 3 to indicate that we are measuring the amount of three-dimensional space occupied (e.g., a cubic meter is written as m³).

4. Mass





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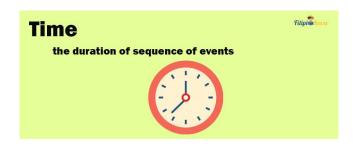
Conversion of Units of Measurement

<u>In Physics, mass and weight mean differently</u>. Mass refers to the amount of matter an object has while weight refers to the amount of force that gravity exerts on an object.

The SI base units for mass and weight are different. The kilogram is the SI base unit for mass while Newton is the SI base unit for weight.

However, outside a Physics classroom, these terms are often used interchangeably. Many people perceive mass and weight as the same thing which refers to how heavy an object is. To avoid ambiguity and confusion in our discussion, we will strictly use in this article the word "mass" to refer to the heaviness of an object

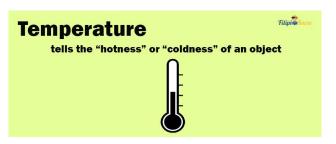
5. Time



This refers to the duration of the sequence of events. For instance, we measure time to determine how long you are reading this reviewer.

The SI base unit for time is seconds.

6. Temperature





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Conversion of Units of Measurement

Temperature tells us how hot or cold an object is. <u>In Physics, the temperature is the average</u> <u>kinetic energy of the particles of an object</u>. The primary way to measure temperature is through a thermometer.

SI base unit for temperature is Kelvin (K). However, the more popular units used are Celsius (°C) and Fahrenheit (°F).

In this review, we are going to discuss the conversion of measurement units for length, area, volume, mass, time, and temperature. However, keep in mind that these are not just the ways to measure objects. For instance, we can also measure their luminous intensity, electric current, amount of substance, and so on.

Metric System Units of Length

We learned earlier that meter (m) is the SI base unit for length. This means that other metric units for length are derived from meters. For instance, a kilometer (km) means 1000 meters.

In the metric system, we use prefixes to indicate that a particular metric unit is a multiple of the base unit. For example, the prefix "kilo" means 1000 times the base unit. So, 1 km = 1000 meters.

There are six prefixes used in the metric system, and we list them below together with their equivalent value in the base unit.

1 kilometer (km)	1000 meters
1 hectometer (hm)	100 meters
1 decameter (dam)	10 meters
1 meter (m)	1 meter
1 decimeter (dm)	0.1 meter
1 centimeter (cm)	0.01 meter



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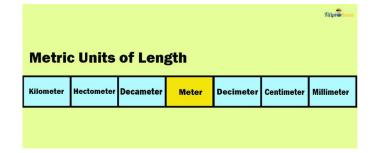


Conversion of Units of Measurement

1 millimeter (mm)

0.001 meter

An easier way to visualize these prefixes is by using a table:

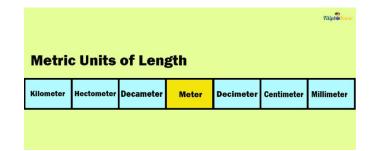


It's up to you whether you want to memorize the conversion table above. However, it is advisable to remember the equivalent value of each prefix in terms of the base unit. These prefixes also apply to metric units for area and mass.

Converting Metric Units of Length

The easiest way to convert metric units is by simply moving decimal places.

For instance, let us convert 375 meters to kilometers by looking at the table of prefixes below.



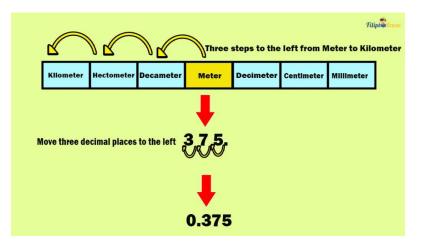
Note that in the table above, there are three steps to the left from meter to kilometer. This means we need to move three decimal places to the left in 375 meters to get its equivalent in kilometers.



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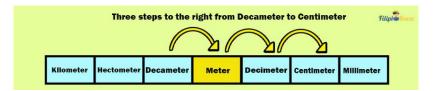
Conversion of Units of Measurement



This means that 375 meters are equal to 0.375 kilometers.

Sample Problem 1: Convert 98.35 decameters to centimeters

Solution: Looking at the table of metric units of length, there are three steps to the right from decameters to centimeters.



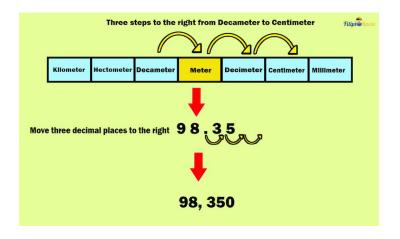
This implies that we must move three decimal places to the right to convert 98.35 decameters to centimeters.



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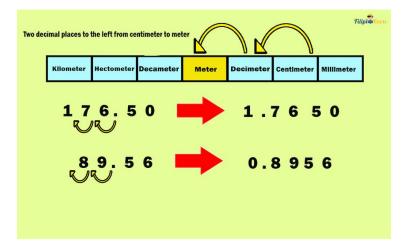
Conversion of Units of Measurement



Hence, 98.35 decameters = 98,350 centimeters

Sample Problem 2: A ribbon was divided into two strips. The first strip measures 176.50 centimeters while the second one measures 89.56 centimeters. What is the length of the original ribbon in meters?

Solution: From centimeters to meters, there are two steps to the left. Hence, to convert centimeters to meters, we simply move two decimal places to the left.





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Conversion of Units of Measurement

- Moving two decimal places in 176.50 centimeters results in 1.7650 meters.
- Moving two decimal places in 89.56 centimeters results in 0.8956 meters.

Adding the length of the strips converted to meters: 1.7650 m + 0.8956 m = 2.6606 m.

Hence, the length of the original ribbon is 2.6606 or 2.66 meters.

Metric System Units of Area

The SI base unit for the area is a square meter (m²). Like the metric units of length, the metric units for the area are derived from the base unit (i.e., square meters).

The prefixes you have learned in the metric units for length apply to metric units for the area as well. Again, these prefixes indicate that a particular metric unit is a multiple of the base unit.

There are six prefixes used in the metric system, and we list them below together with their equivalent value in the base unit. Note that all metric units for the area have a superscript of 2 to indicate that we are dealing with square units.

1 sq. kilometer (km ²)	1000 m ²
1 sq. hectometer (hm ²)	100 m ²
1 sq. decameter (dam ²)	10 m ²
1 sq. meter (m²)	1 m ²
1 sq. decimeter (dm ²)	0.1 m
1 sq. centimeter (cm ²)	0.01 m ²
1 sq. millimeter (mm ²)	0.001 m ²

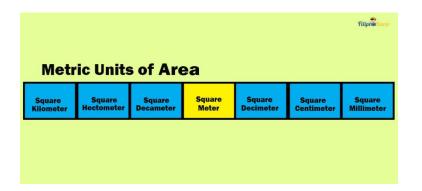
Just like for length, it is easier to visualize these prefixes by using a table:



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Conversion of Units of Measurement



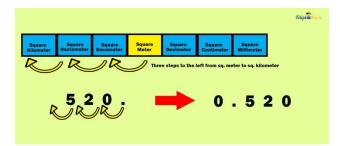
Converting Metric Units of Area

The method of converting metric units of the area is similar to the method we use for the conversion of metric units of length. That is, by moving decimal places.

Let us convert 520 m² to km². By looking at the table, there are three steps to the left from square meters to square kilometers.

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Square Kilometer	Square Hectometer	Square Decameter	Square Meter	Square Decimeter	Square Centimeter	Square Millimeter	
R	1 R	JR	J Thre	e steps to the	left from sq. me	eter to sq. kilor	eter

We move three decimal places to the left in 520 m² to obtain its equivalent in km².





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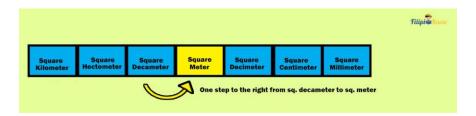
Conversion of Units of Measurement

Thus, 520 m^2 is equal to 0.52 km².

Since we always use the table of prefixes of metric units, I highly recommend memorizing the horizontal arrangement of these prefixes. They are not that hard to remember since there are only six prefixes. This is much easier than memorizing the conversion units.

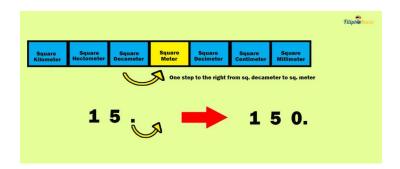
Sample Problem: Every square meter of land in a province costs PHP 4,000. Jennie plans to buy a 15-square decameter of land in this province. How much will Jennie have to pay to purchase the land?

Solution: Since the pricing of the land is expressed as PHP 4,000 per square meter (m²), we have to convert 15 square decameters (dam²) to square meters (m²) to accurately calculate the land price.



From square decameter to square meter, there's one step to the right.

Hence, we move one decimal to the right in 15 dam² to convert it into m²:



Thus, 15 dam² is equal to 150 m².



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Conversion of Units of Measurement

Now, since the price of the land is PHP 4000 per square meter (m^2), then a 15 dam² or 150 m² of land will cost:

150 x 4000 = 600,000

The answer is PHP 600,000.

Metric System Units of Volume

The SI base unit for volume is cubic meters (m³). Like length, the metric units for volume or capacity are derived from cubic meters (m³).

There are six prefixes used in the metric system, and we list them below together with their equivalent value in the base unit. Note that all metric units for volume have a superscript of 3 to indicate that we are dealing with cubic units.

1 cubic kilometer (km ³)	1000 m ³
1 cubic hectometer (hm ³)	100 m ³
1 cubic decameter (dam ³)	10 m³
1 cubic meter (m ³)	1 m³
1 cubic decimeter (dm ³)	0.1 m³
1 cubic centimeter (cm ³)	0.01 m ³
1 cubic millimeter (mm ³)	0.001 m ³

Just like for length and area, it is easier to visualize these prefixes by using a table:



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Metric	Units of	f Volume	e / Cap	acity		
Cubic	Cubic	Cubic	Cubic	Cubic	Cubic	Cubic
Kilometer	Hectometer	Decameter	Meter	Decimeter	Centimeter	Millimeter

The **liter** is another metric unit used for volume/capacity. The liter is a special name for cubic decimeter (dm^3). Thus, 1 liter is equal to 1 cubic decimeter ($1 L = 1 dm^3$).

Like any metric unit, prefixes are also used to derive other metric units for volume. For instance, the prefix "milli" in milliliter indicates that this unit is equal to thousandths (0.001) of a liter.

Although a liter is a metric unit for volume, there's no need to put a superscript of 3 on it, or other metric units based on it.

Here are the other six prefixes associated with liter:

1 kiloliter (kL)	1000 L
1 hectoliter (hL)	100 L
1 decaliter (daL)	10 L
1 liter (L)	1 L
1 deciliter (dL)	0.1 L
1 centiliter (cL)	0.01 L
1 milliliter (mL)	0.001 L

Again, it's easier to visualize these prefixes by using a table:



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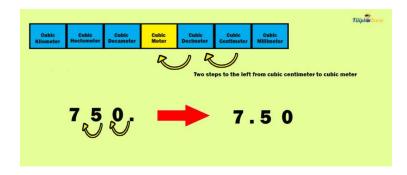
						Filipi Shnow
Metric	Units of	f Volume	e / Capa	acity (Lit	ter)	
Kilometer	Hectoliter	Decaliter	Liter	Deciliter	Milliliter	Kilometer
Kilometer	Hectoliter	Decaliter	Liter	Decliiter	Milliter	Kilometer

Converting Metric Units of Volume

Converting metric units of volume is similar to converting metric units for length and area.

Sample Problem 1: A shoe box has a volume of 750 cm³. Determine its volume in m³.

Solution: There are two steps to the left from cm³ to m³. Hence, we move two decimal places to the left in 750 cm³ to transform it into m³.



Therefore, 750 cm³ is equivalent to 7.5 m³.

Sample Problem 2: A large tank can be filled with 250 L of water. A water pipe puts 200 cL of water into the tank per minute. How long can the pipe fill the large tank?

Solution: To determine how long the pipe can fill the large tank, we simply divide 250L by 200 cL. However, we cannot perform this immediately since the given measurements differ in units.



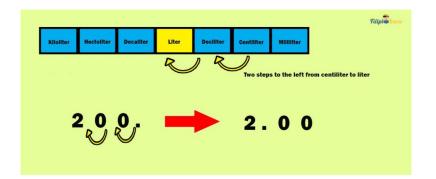
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Conversion of Units of Measurement

First, let us convert 200 cL to L.

Looking at the table of prefixes, notice that there are two steps to the left from cL to L. Hence, we move two decimal places to the left in 200 cL to convert it into L.



Hence, 200 cL = 2 L

We can now divide 250 L by 2 L. Dividing 250 L by 2 L, we'll obtain

250 ÷ 2 = 175

This means that the tank can be filled by the pipe after 175 minutes. This is equivalent to 2 hours and 55 minutes.

Metric System Units of Mass

The SI base unit for mass is kilogram (kg). However, note that "gram" is the primary basis for the derivation of other metric units for mass. "Gram" can be viewed as the "meter" in terms of mass.

There are six prefixes used in the metric system, and we list them here with their equivalent value in terms of the base unit.

1 kilogram (kg) 1000 g



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Conversion of Units of Measurement

1 hectogram (hg)	100 g
1 decagram (dag)	10 g
1 gram (g)	1 g
1 decigram (dg)	0.1 g
1 centigram (cg)	0.01 g
1 milligram (mg)	0.001 g

It's easier to visualize these prefixes by using a table:

Metric Units of Mass	
Kilogram Hectogram Decagram Gram Decigram Centigr	am Milligram

Converting Metric Units of Mass

Sample Problem 1: Myrna bought cough syrup with a mass of 50 grams. Determine its mass in milligrams.

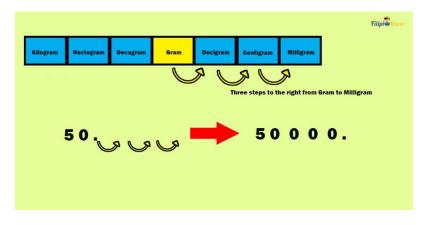
Solution: Referring to the table of prefixes, there are three steps to the right from gram (g) to milligram (mg). Thus, we have to move three decimal places to the right to convert 50 g to mg:



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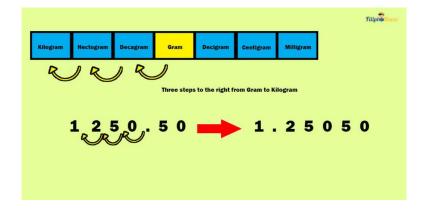
Conversion of Units of Measurement



Therefore, the cough syrup's mass is equal to 50,000 mg.

Sample Problem 2: Rosie bought 1250.50 grams of mangoes. What is the mass of the mangoes that Rosie bought in kilograms?

Solution: Let us convert 1250.50 grams to kilograms first. There are three steps to the left from grams (g) to kilograms (kg). Hence, we need to move three decimal places to the left in 1250.50 g to convert it into kilograms (kg).



Hence, 1250.50 grams is equal to 1.25050 kilograms.



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Conversion of Units of Measurement

Converting Units of Time

Let's now discuss how to convert units of time. Unlike the metric units for length, area, volume, or mass, moving decimal places is not applicable for converting units of time. Instead, we have to refer to the conversion values for each unit.

Shown below is the conversion of time units:

1 hour60 minutes1 day24 hours1 week7 days1 month4 weeks1 year12 months1 decade10 years1 century100 years1 millennium1000 years	1 minute	60 seconds
1 week7 days1 month4 weeks1 year12 months1 decade10 years1 century100 years	1 hour	60 minutes
1 month4 weeks1 year12 months1 decade10 years1 century100 years	1 day	24 hours
1 year12 months1 decade10 years1 century100 years	1 week	7 days
1 decade10 years1 century100 years	1 month	4 weeks
1 century 100 years	1 year	12 months
	1 decade	10 years
1 millennium 1000 years	1 century	100 years
	1 millennium	1000 years

To convert one unit of time to another, follow these steps:

- 1. Identify the given and to which unit we are going to convert it.
- 2. Determine the relationship between the given units.
- 3. Express the relationship between the given units as a conversion factor in a fractional form such that the denominator has a unit that is the same as the original unit.
- 4. Multiply the given measurement by the conversion factor.

Let us apply the steps above to answer some examples.



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Conversion of Units of Measurement

Sample Problem 1: How many hours are there in 5 days?

Solution:

Step 1: Identify the given and to which unit we are going to convert it.

The problem is asking us to convert 5 days into hours.

Step 2: Determine the relationship between the given units.

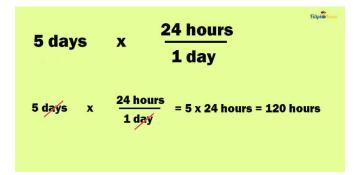
There are 24 hours in one day. In other words, 1 day = 24 hours.

Step 3: Express the relationship between the given units as a conversion factor in a fractional form such that the denominator has a unit that is the same as the original unit.

In the previous step, we're able to determine that 1 day is equivalent to 24 hours. Express this as a fraction with the unit that matches the original unit as the denominator. Since the original unit is "days," we must express the conversion factor as 24 hours/1 day.

Step 4: *Multiply the given measurement by the conversion factor.*

Now, let us multiply 5 days by 24 hours/1 day:



Hence, there are 120 hours in 5 days.



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Conversion of Units of Measurement

Sample Problem 2: Rhodora plans to go on a vacation to Lemongate Beach for 8 weeks. How many days will Rhodora be on a vacation?

Solution:

Step 1: Identify the given and to which unit we are going to convert it.

The problem is asking us to convert 8 weeks to days

Step 2: Determine the relationship between the given units.

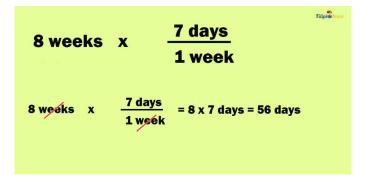
There are 7 days in one week or 1 week = 7 days.

Step 3: Express the relationship between the given units as a conversion factor in a fractional form such that the denominator has a unit that is the same as the original unit.

In the previous step, we're able to determine that 1 week is equivalent to 7 days. Express this as a fraction with the unit that matches the original unit as the denominator. Since the original unit is "week," we must express the conversion factor as 7 days/1 week.

Step 4: *Multiply the given measurement by the conversion factor.*

Now, let us multiply 8 weeks by 7 days/1 week:



Hence, Rhodora will be on vacation for 56 days.



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Conversion of Units of Measurement

Sample Problem 3: A worker is paid PHP 0.5 per minute for his job. How much will the worker earn if he works for a total amount of time equivalent to 25 days?

Solution: The worker's wage is expressed as PHP 0.5 per minute. Therefore, we have to convert 25 days to minutes first before we can determine the worker's earnings.

Step 1: Identify the given and to which unit we are going to convert it.

The problem is asking us to convert 25 days to minutes.

Step 2: Determine the relationship between the given units.

Note that before we can convert days to minutes, we have to convert days to hours first. Afterward, we will convert the result to minutes. This means that we will be dealing with two relationships in this problem.

- Relationship #1 (days to hours) : There are 24 hours in 1 day or 1 day = 24 hours.
- Relationship #2 (hours to minutes): There are 60 minutes in 1 hour or 1 hour = 60 minutes.

Step 3: Express the relationship between the given units as a conversion factor in a fractional form such that the denominator has a unit that is the same as the original unit.

Express the relationships we derived from Step 2 as conversion factors:

- For relationship #1 (days to hours), the original unit is days, so we have 24 hours/1 day
- For relationship #2 (hours to minutes), the original unit now is hours, so we have 60 minutes/1 hour

Step 4: *Multiply the given measurement by the conversion factor.*

Multiply the 25 days by the two conversion factors.



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Thus, there are 36,000 minutes in 25 days.

Remember, the wage of the worker is expressed as PHP 0.5 per minute. If the worker renders 36,000 minutes of work, he will earn $36,000 \times 0.5 =$ PHP 18,000.

Sample Problem 4: 504 hours is equivalent to how many weeks?

Solution:

Step 1: Identify the given and to which unit we are going to convert it.

The problem is asking us to convert 504 hours to weeks.

Step 2: Determine the relationship between the given units.

To convert hours to weeks, we first need to convert hours to days. Afterward, we convert days to weeks. Thus, we will be dealing with two relationships of the unit of time in this problem:

- Relationship #1 (hours to days): There are 24 hours in 1 day or 1 day = 24 hours
- Relationship #2 (days to weeks): There are 7 days in 1 week or 1 week = 7 days

Step 3: Express the relationship between the given units as a conversion factor in a fractional form such that the denominator has a unit that is the same as the original unit.

Express the relationships we derived from Step 2 as conversion factors:



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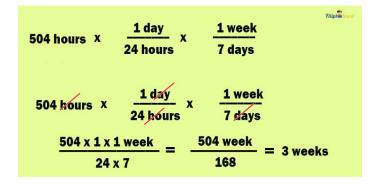


Conversion of Units of Measurement

- For relationship #1 (hours to days), the original unit is hours, so we have 1 day/24 hours
- For relationship #2 (days to weeks), the original unit now is days, so we have 1 week/7 days

Step 4: *Multiply the given measurement by the conversion factor.*

Multiply the 504 hours by the two conversion factors.



Thus, 504 hours is equal to 3 weeks.

Converting Units of Temperature

Kelvin, Celsius, and Fahrenheit are the units of measurement for temperature. In this section, we will focus only on the conversion of Celsius to Fahrenheit and vice versa.

To convert Celsius to Fahrenheit, use a conversion formula. We will discuss these formulas in this section.

How To Convert Celsius to Fahrenheit

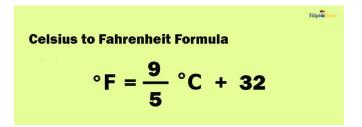
Shown below is the formula to convert Celsius to Fahrenheit:



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Conversion of Units of Measurement



To use this formula, insert the given temperature expressed in Celsius into the formula and perform the calculation. The resulting value is the equivalent temperature in Fahrenheit.

Sample Problem 1: The freezing point of water is 0°C. What is the freezing point of water in Fahrenheit?

Solution: Applying the formula to convert Celsius to Fahrenheit:

$${}^{\circ}F = \frac{9}{5} {}^{\circ}C + 32$$

$${}^{\circ}F = \frac{9}{5} (0) + 32$$

$${}^{\circ}F = 32$$

Substitute ${}^{\circ}C = 0$ in the formula

Hence, the freezing point of water in Fahrenheit is 32°F.

Sample Problem 2: The average body temperature is 37°C. What is the average body temperature in Fahrenheit?

Solution: Applying the formula to convert Celsius to Fahrenheit:



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Conversion of Units of Measurement

$${}^{\circ}F = \frac{9}{5} {}^{\circ}C + 32$$

$${}^{\circ}F = \frac{9}{5} (37) + 32$$

$${}^{\circ}F = \frac{9(37)}{5} + 32 = 98.6$$

Substitute $^{\circ}C = 37$ in the formula

Hence, the average body temperature in Fahrenheit is 98.6°F.

How To Convert Fahrenheit to Celsius

Shown below is the formula to convert Fahrenheit to Celsius:

Fahrenheit to Celsius Formula ° $\mathbf{C} = \frac{5}{9}$ (°F - 32)

The formula above can be derived using the formula for the conversion of Celsius to Fahrenheit. All you have to do is perform some basic algebra (in particular, <u>solving a linear equation</u>).



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Conversion of Units of Measurement

${}^{\circ}F = \frac{9}{5} {}^{\circ}C + 32$
$5(^{\circ}F) = 5(\frac{9}{5} \circ C + 32)$
$5^{\circ}F = 9^{\circ}C + 5(32)$
$-9^{\circ}C = -5^{\circ}F + 5(32)$
$\frac{-9^{\circ}C}{-9} = \frac{-5^{\circ}F}{-9} + \frac{5(32)}{-9}$ $^{\circ}C = \frac{5}{9}^{\circ}F + \frac{5(32)}{-9}$
${}^{\circ}C = \frac{5}{9} {}^{\circ}F - \frac{5}{9} (32)$
$^{\circ}C = \frac{5}{9} (^{\circ}F - 32)$

Celsius to Fahrenheit formula Multiply both sides of the equation by 5 Distributive Property Transposition Method

Divide both sides of the equation by -9

To use the formula, just insert the given temperature expressed in Fahrenheit into the formula and perform the calculation. The resulting value is the equivalent temperature in Celsius.

Sample Problem 1: Convert 32 °F to °C

Solution:

$${}^{\circ}C = \frac{5}{9} ({}^{\circ}F - 32)$$

$${}^{\circ}C = \frac{5}{9} (32 - 32)$$

$${}^{\circ}C = \frac{5}{9} (0) = 0$$

Substitute ${}^{\circ}F = 32$ in the formula

Hence, 32 °F is equal to 0°C.

Sample Problem 2: The required storage temperature of a certain drug is 59 °F. What is its equivalent in °C?



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Conversion of Units of Measurement

Solution:

$${}^{\circ}C = \frac{5}{9} ({}^{\circ}F - 32)$$
$${}^{\circ}C = \frac{5}{9} (59 - 32)$$
$${}^{\circ}C = \frac{5}{9} (27) = 15$$

Substitute $^{\circ}F = 59$ in the formula

Therefore, 59 °F is equal to 15 °C.



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