

Converting between Units

Physics problems frequently ask you to convert between different units of measurement. For example, you may measure the number of feet your toy car goes in three minutes and thus be able to calculate the speed of the car in feet per minute, but that's not a standard unit of measure, so you need to convert feet per minute to miles per hour, or meters per second, or whatever the physics problem asks for.

For another example, suppose you have 180 seconds — how much is that in minutes? You know that there are 60 seconds in a minute, so 180 seconds equals three minutes. Here are some common conversions between units:

- ✓ 1 m = 100 cm = 1000 mm (millimeters)
- ✓ 1 km (kilometer) = 1000 m
- ✓ 1 kg (kilogram) = 1000 g (grams)
- ✓ 1 N (Newton) = 10^5 dynes
- ✓ 1 J (Joule) = 10^7 ergs
- ✓ 1 P (Pascal) = 10 ba
- ✓ 1 A (Amp) = .1 Bi
- ✓ 1 T (Tesla) = 10^4 G (Gauss)
- ✓ 1 C (Coulomb) = 2.9979×10^9 Fr

The conversion between CGS and MKS is almost always just a factor of 10, so converting between the two is simple. But what about converting to and from the FPI system? Here are some handy conversions that you can come back to as needed:

✓ Length:

- 1 m = 100 cm
- 1 km = 1000 m
- 1 in (inch) = 2.54 cm
- 1 m = 39.37 in
- 1 mile = 5280 ft = 1.609 km
- 1 Å (angstrom) = 10^{-10} m

✓ Mass:

- 1 kg = 1000 g
- 1 slug = 14.59 kg
- 1 u (atomic mass unit) = 1.6605×10^{-27} kg

✓ Force:

- 1 lb (pound) = 4.448 N
- 1 N = 10^5 dynes
- 1 N = 0.2248 lb

✓ Energy:

- 1 J = 10^7 ergs
- 1 J = 0.7376 ft-lb

- 1 BTU (British Thermal Unit) = 1055 J
- 1 kWh (kilowatt hour) = 3.600×10^6 J
- 1 eV (electron Volt) = 1.602×10^{-19} J

Power:

- 1 hp (horsepower) = 550 ft-lb/s
- 1 W (Watt) = 0.7376 ft-lb/s

Because conversions are such an important part of physics problems, and because you have to keep track of them so carefully, there's a systematic way of handling conversions: You multiply by a conversion constant that equals one, and where the units you don't want cancel out.

EXAMPLE



- Q.** A ball drops 5 meters. How many centimeters did it drop?
- A.** The correct answer is 500 centimeters. To perform the conversion, you do the following calculation:

$$5.0 \text{ meters} \times \frac{100 \text{ centimeters}}{\text{meters}} = 500 \text{ centimeters}$$

Note that 100 centimeters divided by 1 meter equals 1 because there are 100 centimeters in a meter. In the calculation, the units you don't want — meters — cancel out.

- 9.** How many centimeters are in 2.35 meters?

Solve It

- 10.** How many seconds are in 1.25 minutes?

Solve It

11. How many inches are in 2.0 meters?

Solve It

12. How many grams are in 3.25 kg?

Solve It

Converting Distances

Sometimes you have to make multiple conversions to get what you want. That demands multiple conversion factors. For example, if you want to convert from inches to meters, you can use the conversion that 2.54 centimeters equals 1 inch — but then you have to convert from centimeters to meters, which means using another conversion factor.

Try your hand at this example question that involves multiple conversions:



Q. Convert 10 inches into meters.

A. The correct answer is 0.245 m.

1. You know that 1 inch = 2.54 centimeters, so start with that conversion factor and convert 10 inches into centimeters:

$$10 \text{ in} \times \frac{2.54 \times \text{cm}}{1 \text{ in}} = 25.4 \text{ cm}$$

2. Convert 25.4 cm into meters by using a second conversion factor:

$$10 \text{ in} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{1 \text{ m}}{100 \text{ cm}} = 0.254 \text{ m}$$

13. Given that there are 2.54 centimeters in 1 inch, how many centimeters are there in 1 yard?

Solve It

14. How many centimeters are in a kilometer?

Solve It

15. How many inches are in an angstrom, given that 1 angstrom (\AA) = 10^{-8} cm?

Solve It

16. How many inches are in a meter, given that there are 2.54 cm in 1 inch?

Solve It

Converting Times

Physics problems frequently ask you to convert between different units of time: seconds, minutes, hours, and even years. These times involve all kinds of calculations because measurements in physics books are usually in seconds, but can frequently be in hours.



Q. An SUV is traveling 2.78×10^{-2} kilometers per second. What's that in kilometers per hour?

A. The correct answer is 100 km/hr.

1. You know that there are 60 minutes in an hour, so start by converting from kilometers per second to kilometers per minute:

$$2.78 \times 10^{-2} \frac{\text{km}}{\text{sec}} \times \frac{60 \text{ sec}}{1 \text{ minute}} = 1.66 \text{ km/minute}$$

2. Because there are 60 minutes in an hour, convert this to kilometers per hour using a second conversion factor:

$$2.78 \times 10^{-2} \frac{\text{km}}{\text{sec}} \times \frac{60 \text{ sec}}{1 \text{ minute}} \times \frac{60 \text{ minutes}}{1 \text{ hour}} = 100 \text{ km/hr}$$

17. How many hours are in 1 week?

Solve It

18. How many hours are in 1 year?

Solve It