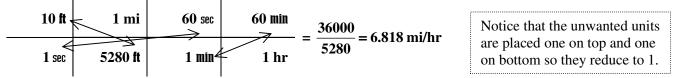# Unit Conversions

When you are dealing with data that has units, you must be aware of how the units change when arithmetic operations are performed on them.

- *When you multiply* 3 ft *by* 4 ft *to find area the units are* ft $\times$ ft *which are* ft^2.

- *When you divide* m^2 *by* m *the units are* $\dfrac{m^2}{m}$ *which are* m.

> To use multiple units that are not the same, you must **convert the units into a common unit**. For example, you cannot use feet/second and miles/hour in the same calculation. You must make them both the same.
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> *An example of disastrous consequences: NASA has crash-landed spacecraft onto Mars twice because some calculations were done in metrics and some were done in Imperial units!*

- The process for doing this is to set up a fraction chart so that the units you are trying to get rid of reduce out and are replaced by the units you want.

- Then multiply the top numbers together and multiply the bottom numbers together.

- Divide the resulting numbers.

- EXAMPLE: To convert 10 ft/sec to mi/hr, the problem is set up like this:

$$\frac{10\text{ ft}}{1\text{ sec}} \quad \frac{1\text{ mi}}{5280\text{ ft}} \quad \frac{60\text{ sec}}{1\text{ min}} \quad \frac{60\text{ min}}{1\text{ hr}} \; = \; \frac{36000}{5280} = 6.818 \text{ mi/hr}$$

> Notice that the unwanted units are placed one on top and one on bottom so they reduce to 1.

In these problems, the units have been placed in the right spot. You only need to place numbers.

1. Convert 4 gallons to pints

$$\frac{\text{gallons}}{} \quad \frac{\text{quarts}}{\text{gallon}} \quad \frac{\text{pints}}{\text{quart}} \; =$$

2. Convert 60 mi/hr to ft/s

$$\frac{\text{mi}}{\text{hr}} \quad \frac{\text{hr}}{\text{min}} \quad \frac{\text{min}}{\text{s}} \quad \frac{\text{ft}}{\text{mi}} \; =$$

3. Convert 1 mile to inches

$$\frac{\text{mi}}{} \quad \frac{\text{ft}}{\text{mi}} \quad \frac{\text{in}}{\text{ft}} \; =$$

4. Convert 44 ft/s to mi/hr

$$\frac{\text{ft}}{\text{sec}} \quad \frac{\text{sec}}{\text{min}} \quad \frac{\text{min}}{\text{hr}} \quad \frac{\text{mi}}{\text{ft}} \; =$$

5. Convert 25 km/hr to m/s

$$\frac{km}{hr} \quad \bigg| \quad \frac{m}{km} \quad \bigg| \quad \frac{hr}{min} \quad \bigg| \quad \frac{min}{sec} \quad =$$

6. How many seconds are there in a year?

$$\frac{yr}{\ } \quad \bigg| \quad \frac{day}{yr} \quad \bigg| \quad \frac{hr}{day} \quad \bigg| \quad \frac{min}{hr} \quad \bigg| \quad \frac{sec}{min} \quad =$$

7. Convert the speed of light, 3.0×10^8 m/s to km/day

$$\frac{m}{sec} \quad \bigg| \quad \frac{km}{m} \quad \bigg| \quad \frac{sec}{min} \quad \bigg| \quad \frac{min}{hr} \quad \bigg| \quad \frac{hr}{day} \quad =$$

8. Convert 3 ft^2 to in^2

$$\frac{ft^2}{\ } \quad \bigg| \quad \frac{in}{ft} \quad \bigg| \quad \frac{in}{ft} \quad =$$

9. Convert 2 mi^2 to in^2

$$\frac{mi}{\ } \quad \bigg| \quad \frac{ft}{mi} \quad \bigg| \quad \frac{ft}{mi} \quad \bigg| \quad \frac{in}{ft} \quad \bigg| \quad \frac{in}{ft} \quad =$$

10. Convert 12 km/hr to cm/s

$$\frac{km}{hr} \quad \bigg| \quad \frac{m}{km} \quad \bigg| \quad \frac{cm}{m} \quad \bigg| \quad \frac{hr}{min} \quad \bigg| \quad \frac{min}{sec} \quad =$$

11. Convert 3.2 yd/min to mi/hr

$$\frac{yd}{min} \quad \bigg| \quad \frac{ft}{yd} \quad \bigg| \quad \frac{mi}{ft} \quad \bigg| \quad \frac{min}{hr} \quad =$$

12. Convert the speed of an electron in a hydrogen atom (2,200 km/s) to cm/hr

$$\frac{km}{sec} \quad \bigg| \quad \frac{m}{km} \quad \bigg| \quad \frac{cm}{m} \quad \bigg| \quad \frac{sec}{min} \quad \bigg| \quad \frac{min}{hr} \quad =$$

In addition to metric prefixes, here are some equalities that may prove useful for the following unit conversions:

1 ft = 0.30 m	1 in = 2.54 cm	1 mile = 1609 m	2.21 lb = 1 kg

13. Convert 62.4 lb into g

14. Convert 1 mile into km

15. Convert the 1 week into seconds

16. Convert 34 km into cm

17. Convert 75 ft^2 into m^2

18. Convert 3 feet to cm

19. Convert 6.3 ft^2 to m^2

20. Convert 28 km to mm.

21. Convert 45 g to lb.

22. Convert the speed 25 m/s into km/h

23. Convert the speed 90 mi/h into m/s

24. Convert the speed 9.8 m^3 into ft^3

25. Convert 170 cm/min to mm/s

26. Convert 450 m/s to m/h.

27. Convert 85 cm/min to m/s.

28. Change 25 km/h to m/s

CONVERSION FACTORS

1 meter (m) = 100 centimeters (cm) = 1,000 millimeters (mm)
1 kilometer (km) = 1,000 meters (m)

1 kilogram (kg) = 1,000 grams (g)

1 mile (mi) = 5280 feet (ft)
3 feet (ft) = 1 yard (yd)

4 quarts (qt) = 1 gallon (gal)
2 pints (pt) = 1 quart (qt)
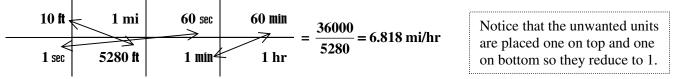
Unit Conversions

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- EXAMPLE: To convert 10 ft/sec to mi/hr, the problem is set up like this:

$$\frac{10 \text{ ft}}{1 \text{ sec}} \quad \frac{1 \text{ mi}}{5280 \text{ ft}} \quad \frac{60 \text{ sec}}{1 \text{ min}} \quad \frac{60 \text{ min}}{1 \text{ hr}} = \frac{36000}{5280} = 6.818 \text{ mi/hr}$$

Notice that the unwanted units are placed one on top and one on bottom so they reduce to 1.

In these problems, the units have been placed in the right spot. You only need to place numbers.

1. Convert 4 gallons to pints

$$\frac{4 \text{ gallons}}{} \quad \frac{4 \text{ quarts}}{1 \text{ gallon}} \quad \frac{2 \text{ pints}}{1 \text{ quart}} = 32 \text{ pints}$$

2. Convert 60 mi/hr to ft/s

$$\frac{60 \text{ mi}}{1 \text{ hr}} \quad \frac{1 \text{ hr}}{60 \text{ min}} \quad \frac{1 \text{ min}}{60 \text{ s}} \quad \frac{5280 \text{ ft}}{1 \text{ mi}} = 88 \text{ ft/s}$$

3. Convert 1 mile to inches

$$\frac{1 \text{ mi}}{} \quad \frac{5280 \text{ ft}}{1 \text{ mi}} \quad \frac{12 \text{ in}}{1 \text{ ft}} = 63{,}360 \text{ in}$$

4. Convert 44 ft/s to mi/hr

$$\frac{44 \text{ ft}}{1 \text{ sec}} \quad \frac{60 \text{ sec}}{1 \text{ min}} \quad \frac{60 \text{ min}}{1 \text{ hr}} \quad \frac{1 \text{ mi}}{5280 \text{ ft}} = 30 \text{ mi/hr}$$

5. Convert 25 km/hr to m/s

$$\frac{25 \text{ km}}{1 \text{ hr}} \cdot \frac{1000 \text{ m}}{1 \text{ km}} \cdot \frac{1 \text{ hr}}{60 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ sec}} = 6.9\overline{4} \text{ m/s}$$

6. How many seconds are there in a year?

$$\frac{1 \text{ yr}}{} \cdot \frac{364 \text{ day}}{1 \text{ yr}} \cdot \frac{24 \text{ hr}}{1 \text{ day}} \cdot \frac{60 \text{ min}}{1 \text{ hr}} \cdot \frac{60 \text{ sec}}{1 \text{ min}} = 31,449,600 \text{ s}$$

7. Convert the speed of light, 3.0×10^8 m/s to km/day

$$\frac{300,000,000 \text{ m}}{1 \text{ sec}} \cdot \frac{1 \text{ km}}{1000 \text{ m}} \cdot \frac{60 \text{ sec}}{1 \text{ min}} \cdot \frac{60 \text{ min}}{1 \text{ hr}} \cdot \frac{24 \text{ hr}}{1 \text{ day}} = 2.597 \times 10^{10} \text{ km/day}$$

8. Convert 3 ft^2 to in^2

$$\frac{3 \text{ ft}^2}{} \cdot \frac{12 \text{ in}}{1 \text{ ft}} \cdot \frac{12 \text{ in}}{1 \text{ ft}} = 432 \text{ in}^2$$

9. Convert 2 mi^2 to in^2

$$\frac{2 \text{ mi}}{} \cdot \frac{5280 \text{ ft}}{1 \text{ mi}} \cdot \frac{5280 \text{ ft}}{1 \text{ mi}} \cdot \frac{12 \text{ in}}{1 \text{ ft}} \cdot \frac{12 \text{ in}}{1 \text{ ft}} = 8,028,979,200 \text{ in}^2$$

10. Convert 12 km/hr to cm/s

$$\frac{12 \text{ km}}{1 \text{ hr}} \cdot \frac{1000 \text{ m}}{1 \text{ km}} \cdot \frac{100 \text{ cm}}{1 \text{ m}} \cdot \frac{1 \text{ hr}}{60 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ sec}} = 333.\overline{3} \text{ cm/s}$$

11. Convert 3.2 yd/min to mi/hr

$$\frac{3.2 \text{ yd}}{1 \text{ min}} \cdot \frac{3 \text{ ft}}{1 \text{ yd}} \cdot \frac{1 \text{ mi}}{5280 \text{ ft}} \cdot \frac{60 \text{ min}}{1 \text{ hr}} = 0.1\overline{09} \text{ mi/hr}$$

12. Convert the speed of an electron in a hydrogen atom (2,200 km/s) to cm/hr

$$\frac{2,200 \text{ km}}{1 \text{ sec}} \cdot \frac{1000 \text{ m}}{1 \text{ km}} \cdot \frac{100 \text{ cm}}{1 \text{ m}} \cdot \frac{60 \text{ sec}}{1 \text{ min}} \cdot \frac{60 \text{ min}}{1 \text{ hr}} = 219,996,400 \text{ cm/hr}$$

In addition to metric prefixes, here are some equalities that may prove useful for the following unit conversions:

1 ft = 0.30 m	1 in = 2.54 cm	1 mile = 1609 m	2.21 lb = 1 kg

13. Convert 62.4 lb into g

$$\frac{62.4\,\text{lb}}{1} \cdot \frac{1\,\text{kg}}{2.21\,\text{lb}} \cdot \frac{1000\,\text{g}}{1\,\text{kg}} = 28{,}235.3\,\text{g}$$

14. Convert 1 mile into km

$$\frac{1\,\text{mi}}{1} \cdot \frac{1609\,\text{m}}{1\,\text{mi}} \cdot \frac{1\,\text{km}}{1000\,\text{m}} = 1.609\,\text{km}$$

15. Convert the 1 week into seconds

$$\frac{1\,\text{wk}}{1} \cdot \frac{7\,\text{day}}{1\,\text{wk}} \cdot \frac{24\,\text{hr}}{1\,\text{day}} \cdot \frac{3600\,\text{s}}{1\,\text{hr}} = 604{,}800\,\text{s}$$

16. Convert 34 km into cm

$$\frac{34\,\text{km}}{1} \cdot \frac{1000\,\text{m}}{1\,\text{km}} \cdot \frac{100\,\text{cm}}{1\,\text{m}} = 3{,}400{,}000\,\text{cm}$$

17. Convert 75 ft^2 into m^2

$$\frac{75\,\text{ft}^2}{1} \cdot \frac{0.3\text{m}}{1\text{ft}} \cdot \frac{0.3\text{m}}{1\text{ft}} = 6.75\,\text{m}^2$$

18. Convert 3 feet to cm

$$\frac{3\,\text{ft}}{1} \cdot \frac{0.3\,\text{m}}{1\,\text{ft}} \cdot \frac{100\,\text{cm}}{1\,\text{m}} = 90\,\text{cm}$$

19. Convert 6.3 ft^2 to m^2

$$\frac{6.3\,\text{ft}^2}{1} \cdot \frac{0.3\,\text{m}}{1\,\text{ft}} \cdot \frac{0.3\,\text{m}}{1\,\text{ft}} = 0.567\,\text{m}^2$$

20. Convert 28 km to mm.

$$\frac{28\,\text{km}}{1} \cdot \frac{1000\,\text{m}}{1\,\text{km}} \cdot \frac{1000\,\text{mm}}{1\,\text{m}} = 28{,}000{,}000\,\text{mm}$$

21. Convert 45 g to lb.

$$\frac{45\,\text{g}}{1} \cdot \frac{1\,\text{kg}}{1000\,\text{g}} \cdot \frac{2.21\,\text{lb}}{1\,\text{kg}} = 0.09945\,\text{lb}$$

22. Convert the speed 25 m/s into km/h

$$\frac{25\,\text{m}}{\text{s}} \cdot \frac{3600\,\text{s}}{1\,\text{hr}} \cdot \frac{1\,\text{km}}{1000\,\text{m}} = 90\,\text{km / h}$$

23. Convert the speed 90 mi/h into m/s

$$\frac{90\,\text{mi}}{\text{hr}} \cdot \frac{1\,\text{hr}}{3600\,\text{s}} \cdot \frac{1609\,\text{m}}{1\,\text{mi}} = 40.2\,\text{m / s}$$

24. Convert the speed 9.8 m^3 into ft^3

$$\frac{3\,\text{m}^3}{1} \cdot \frac{1\,\text{ft}}{0.3\,\text{m}} \cdot \frac{1\,\text{ft}}{0.3\,\text{m}} \cdot \frac{1\,\text{ft}}{0.3\,\text{m}} = 111.\overline{1}\,\text{ft}^3$$

25. Convert 170 cm/min to mm/s

$$\frac{170\,\text{cm}}{\text{min}} \cdot \frac{1\,\text{min}}{60\,\text{s}} \cdot \frac{10\,\text{mm}}{1\,\text{cm}} = 28.3\,\text{mm / s}$$

26. Convert 450 m/s to m/h.

$$\frac{450\,\text{m}}{\text{s}} \cdot \frac{3600\,\text{s}}{1\,\text{hr}} = 1{,}620{,}000\,\text{m / h}$$

27. Convert 85 cm/min to m/s.

$$\frac{85\,\text{cm}}{\text{min}} \cdot \frac{1\,\text{min}}{60\,\text{s}} \cdot \frac{1\,\text{m}}{100\,\text{cm}} = 0.0014\,\text{m / s}$$

28. Change 25 km/h to m/s

$$\frac{25\,\text{km}}{\text{hr}} \cdot \frac{1\,\text{hr}}{3600\,\text{s}} \cdot \frac{1000\,\text{m}}{1\,\text{km}} = 6.9\,\text{m / s}$$

Unit Conversions

Some students find this difficult at first, but once it is demonstrated enough times they catch on.

Some students may not clearly understand that square and cubic units are not the same as first-degree units. You might have to draw a line, square and cube with the same length on the board and show that the have dimensions.

It is recommended that you project the first two pages onto a whiteboard and go through at least a third of them as a class. Make sure to emphasize why the units are placed where they are placed (this is the key to the whole process). It may take students a number of problems before everyone gets the idea.

Problems 13-28 may be used as practice problems once students get the idea. Some students may, at first, need guidance in placing units correctly in these problems.

NOTE:
Depending on how well versed your students are in metric and Imperial units of measure, you may need to print the conversion factors on fourth page and provide each group with a copy. To save for future use, print them on cardstock or laminate them.