

Chapter 1

Conversions and Unit Systems

1. Consult an appropriate source to determine the conversion factors associated with the following conversions:
 - a. number of *dashes* per teaspoon
 - b. number of *teaspoons* per tablespoon
 - c. number of *tablespoons* per cup
 - d. number of *cups* per quart
 - e. number of *quarts* per gallon

a) 4 dashes = 1 tsp (some cookbooks say 8 dashes = 1 tsp)
b) 3 tsp = 1 tablespoon (one would think that 2 tsp = 1 tablespoon)
c) 16 tablespoons = 1 cup
d) 4 cups = 1 quart
e) 4 quarts = 1 gallon

2. Consult an appropriate source to determine the meaning of the following units (remember to look up the proper pronunciation as well):
 - a. coomb b. scruple c. cord of wood d. ream of paper

a) coomb is an English unit of capacity; 1 coomb = 4 imperial bushels = 4.13 U.S. bushels
b) scruple = 20 grains, an apothecary measurement
c) cord = cut fuel wood, 4 ft x 4 ft x 8 ft = 128 ft³
d) ream = formerly 480 sheets, now 500; printer's ream = 516

3. Consult an appropriate source to determine the meaning of the following units:
 - a. gill b. degree-day c. ton versus metric ton d. long ton versus short ton

a) gill is a liquid measure; gill = 4 fluid ounces (1/4 pint) or 7.216 in³ in the U.S. customary system; gill = 5 fluid ounces (1/4 pint) or 8.670 in³ in the British imperial system.
b) degree day is used to estimate the quantity of fuel and power consumption.
c) ton in the U.S. customary system = 2240 pounds = a long ton; 2000 pounds is a short ton
metric ton = 1000 kg which is a unit of mass
d) long vs short; there is 240 pounds difference (a unit of weight)

4. How many "hins" are in a "bath"? How many "baths" are in a gallon?

1 hin = 1.012 gallons; 1 bath = 6 hins = 6.073 gallons

5. What is the relationship between an ounce (16 ounces per pound) and a fluid ounce (16 ounces equals one pint)?

Ounce is a unit of weight 16 ounces per pound; Ounce is a unit of volume 16 ounces per pint; A pint of liquid should equal a pound in weight; good subject for an experiment.

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6. What is the origin of the “horsepower”? Why would anyone wish to express power in the unit of horsepower? How many watts are in one horsepower?

Horsepower was originated to show farmers the number of horses that could be replaced by farm machinery. 746 W per HP.

7. The unit for volume flow rate is gallons per minute, but cubic feet per second is preferred. Use the conversion factor tables in Appendix A to obtain a conversion between these two units.

$$\text{gpm} \times 2.228 \times 10^{-3} = \text{cfs}$$

8. Which is heavier—a grain or a dram? Express both in the appropriate English fundamental unit.

A grain is a unit of weight in the U.S. customary system; a grain is an avoirdupois unit

which equals 0.002285 ounces or 0.036 dram. So 1000 grains = 36 drams; a dram is therefore heavier.

$$1 \text{ grain} = 0.002285 \text{ ounces} \quad 1 \text{ dram} = 0.06347 \text{ ounces}$$

$$1 \text{ ounce} = 437.6 \text{ grains} \quad 1 \text{ ounce} = 15.76 \text{ drams}$$

9. How many years does a furlong designate? Furthermore, if a furlong is a linear measurement, what does this have to do with “years”? Why?

1 furlong = 220 yards; 220 became associated with the furlong because British plowmen dug furrows equal in length to 220 yards.

10. What is the difference between troy weight and avoirdupois weight? Express a pound in each of these systems in terms of grains.

Avoirdupois weight is a system of weights & measures based on

$$1 \text{ pound} = 16 \text{ ounces} = 7,000 \text{ grains} = 453.59 \text{ grams}$$

Troy weight is a system of weight in which the grain is the same as in the avoirdupois system, but the pound contains 12 ounces, 240 pennyweights or 5760 grains.

$$1 \text{ grain avoirdupois} = 1 \text{ grain troy}$$

11. Is something called a “log” a unit of measure for liquid or dry goods? What is the conversion between a log and the appropriate SI unit?

$$\text{A log is a liquid measure. } 1 \text{ log} = 0.674 \text{ pint} \times \frac{4.73176473 \times 10^{-4} \text{ m}^3}{\text{pint}} = 3.189 \times 10^{-4} \text{ m}^3$$

12. In the plastics industry, what is a gaylord?

A gaylord is 1000 lbm of plastic (pellets used in an extrusion process are usually measured in terms of gaylords).

13. A shotgun gauge refers to what dimension of the firearm?

The gauge of a firearm is a unit of measurement. It expresses the diameter of barrel, found by the weight of a solid lead sphere that fits in the bore of the firearm. However, it is expressed as the inverse of the sphere's weight as a fraction of a pound. Thus, a 1/12th pound lead sphere fits into a 12-gauge bore.

14. Nine gage wire and eleven gage wire are both used extensively in making chain link fence material. What are the diameters of these wires? What other wire diameters exist, and what is the standard used in sizing wires?

The standard used in sizing wires is found in the Table of American Wire Gage sizes. There are wire sizes for electrical conducting wire, for sheet metal and much more.

15. Sheet metal screws are sized according to what standard? What is the difference between a machine screw and a sheet metal screw?

Sheet metal screws come in sizes that range from #4 to #14 (diameters that range from 0.11 to 0.25 inches). These screws are made to fasten sheet metal and are designed to be self tapping.

Machine screws are threaded, and they range from size 000 to size 12 (diameters ranging from 0.034 in to 0.216 inches).

Published charts are available on the internet.

Measurement Scales

16. What is the Forel Ule scale used to measure?

The Forel-Ule Scale is a specially developed color standard, used to provide a measure of color in water. Each color standard or designation is identified by a roman numeral: at one end of the spectrum is deep sea blue; at the other is a muddy yellowish-brown.

www.lamotte.com/pages/common/pdf/instruct/5907.pdf

17. What is the Snellen Fraction?

A Snellen Fraction is expressed as a ratio (such as 20/20 or 20/100), and is used for measuring the acuity or sharpness of a person's eyesight for objects at a distance, and named for the Dutch ophthalmologist Herman Snellen (1834-1908).

from <http://www.unc.edu/~rowlett/units/dictS.html>

18. The Scoville Unit is a measure of what?

A Scoville Unit is a measure of the concentration of capsaicin in a substance. Capsaicin is the "hot" ingredient in chile peppers. A measurement of 40 000 Scoville units indicates that an extract from the pepper can be diluted 40 000 to 1 with sugared water; the "heat" of the capsaicin will still be barely detectable by the human tongue.

Such measurements are now made with a liquid chromatograph.

The Scoville Unit was developed in 1912 by the American pharmacologist Wilbur L. Scoville. Actual chile peppers have capsaicin concentrations from 5000 to 500 000 Scoville units.

<http://www.unc.edu/~rowlett/units/dictS.html>

19. What is the Shore Hardness scale used to measure?

The Shore Hardness scale is measured with a Shore durometer. The hardness is a measure of the hardness of plastic, rubber, or similar material. The durometer uses a steel pin to indent the material. The depth of the indentation is read by a calibrated spring meter.

<http://www.unc.edu/~rowlett/units/dictD.html#duro>

20. The Shade number is used as a measure of what?

The Shade Number is a unit of light transmission for the protective glasses used in welding. If T is the fraction of visible light transmitted, the shade number is

$$SN = 1 + 7(-\log_{10} T)/3.$$

So, for example, if 1% of the light is transmitted, the shade number is 4."

<http://www.unc.edu/~rowlett/units/dictH.html>

21. The Beaufort scale measures what?

The Beaufort Scale is an empirical measurement used to estimate wind speed by observing the effects of the wind. Thus sailors can judge wind speed by observing the wind's effect on the waves. The scale was first devised by the British admiral Sir Francis Beaufort (1774-1857).

<http://www.unc.edu/~rowlett/units/dictB.html>

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22. What scale is used to measure the “strength” of an earthquake? What is actually being measured?

The Richter scale is used. It ranges from 4 (strong enough to crack plaster), to 9 (widespread destruction).

The Mercalli scale is also used. It ranges from I (people cannot feel a tremor, but machines are able to record it) to XII (extensive damage).

23. What is the Numeric Rating Scale (NRS-11) used to measure?

Pain

24. To what does “Carat Purity” refer?

1 carat = 200 mg; used as a unit of weight for precious stones.
Carat purity is measured or expressed by an equation:

$$\text{Carat Purity} = 24(m_{\text{gold}}/m_{\text{total}})$$

in which m_{gold} is the mass of pure gold or platinum in the material, and m_{total} is the total mass of the material. So 18 carat gold is 18 parts gold, and 6 parts of another metal that forms an alloy with gold.

25. Canned foods are quite common. How are can sizes measured or expressed by can manufacturers? What are the difference in can size specifications used in the U.S.? What is used in the metric system?

Can dimensions are shown by numbers such as “502 x 512 can.” Three digits in each number. The numbers in the preceding designation: the first number (502) refers to the can diameter, the second number (512) refers to the can height. The three digits indicate a measurement. Referring to “502”, the first digit represents an inch measure, and the second two digits represent 16ths of an inch. So “502” means $5\frac{2}{16}$ in. A good source of information is can companies or manufacturers, or experienced cooks who studied home economics in the 1950’s.

Miscellaneous Measurements

26. Why is a mile 5,280 ft?

The word “Mile” comes from the Latin “mille” meaning one thousand.

The Roman army measured a mile as 1000 paces and this was equal to 2000 steps.

The average marching stride \approx 5 ft. Romans measured the mile (1000 paces) as roughly 5000 ft.

Britain adopted mile as a unit of measurement, but farmers insisted it be related to the furlong (used extensively in Britain).

The Roman mile is a little longer than $7\frac{1}{2}$ furlongs. Rather than change the furlong, Britain changed mile and made it equal to 8 furlongs, which is 1760 yards or 5280 ft.

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27. By what must a quart be multiplied to obtain a bushel?

Note that a bushel is a dry measure while a quart is normally thought of as a liquid measure. However, in ancient times, 1 bushel = 7.68 dry quarts.

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28. What is a "hat trick"?

A hat trick is an informal unit of quantity which equals 3.

It is used in sports in counting goals, especially if the goals are scored by the same player. It is familiar in North American ice hockey.

<http://www.unc.edu/~rowlett/units/dictH.html>

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29. How long is the circumference of a racetrack; i.e., how many laps must be made in a one mile race?

1 mile = circumference of racetrack

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30. What is the significance of an acre, and how many square feet are contained in one? Which is larger, an acre or an arpent?

An acre \approx amount of land that could be plowed in one day with a team of oxen.

An arpent \approx French equivalent, roughly.

1 acre = 160 square rods = 4840 square yards = 43,560 ft².

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31. What is the definition of the body mass index? What is yours?

The Body Mass Index or BMI is a measure of weight to height ratio in humans used in studies of weight management. The BMI is equal to a person's mass ("weight") M (in kilograms) divided by the square of his or her height H (in meters): $BMI = M/H^2$. If measurements are made in traditional English units, the equivalent formula is $BMI = 703.07 \cdot M/H^2$, where M is measured in pounds and H in inches."

<http://www.unc.edu/~rowlett/units/dictB.html>

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32. How many barleycorns are in an inch?

3 barleycorns = 1 in.

33. How many inches are in a fistmele?

A fistmele is a traditional unit of distance, which equals the width of a clenched fist with the thumb extended. This length is about 6.5 inches or 16.5 centimeters. The unit is used in archery, and also in kayaking.

<http://www.unc.edu/~rowlett/units/dictB.html>

34. Use the conversion factor tables in Appendix A to develop a conversion factor between gallons and cubic feet.

$$1 \text{ gallon} \times \frac{3.785411784 \times 10^{-3}}{\text{gallon}} \times \frac{1 \text{ ft}^3}{2.8316846592 \times 10^{-2}} = 0.1337 \text{ ft}^3$$

35. What is the equation for calculating the heat index?

The heat index is a measure of the combined effect of heat transfer by convection and by vaporization on the human body.

The heat index is calculated from temperature T (in °F) and relative humidity H (expressed as a fraction; that is, $H = 0.65$ if the relative humidity is 65%). The formula used is

$$\begin{aligned} HI = & -42.379 + 2.04901523 T + 1014.333127 H - 22.475541 TH - .00683783 T^2 - 548.1717 \\ & H^2 \\ & + 0.122874 T^2 H + 8.5282 TH^2 - 0.0199 T^2 H^2. \end{aligned}$$

<http://www.unc.edu/~rowlett/units/dictH.html>

36. How long is a "handbreadth"? How long is a "finger"? How many fingers are in a handbreadth?

A handbreadth is a linear measurement approximating the width of the hand, from $2\frac{1}{2}$ to 4 inches, but most often taken to be 4 in.

Ancient measurement, 1 handbreadth = 2.915 in. = 4 fingers
1 finger = 0.728 in.

37. Consult an appropriate source to determine the conversion factors that apply to
a. parsecs per mile b. stadia per mile

a) $1 \text{ parsec} = 1.918 \times 10^{13} \text{ miles}$

b) $1 \text{ stadium} = 607 \text{ ft} \times \frac{1 \text{ mile}}{5280 \text{ ft}} = 0.115 \text{ miles}$

38. The quantity called a “measure” is used in measuring the capacity of dry goods as well as liquid goods. What is the conversion between a measure and a bushel (dry goods)? What is the conversion between a measure and a gallon?

39. How is blood pressure expressed? Why isn’t the result expressed in psig or kPa?

40. How are shoes sized; i.e., what is the relationship between shoe sizes and any other commonly used unit?

Shoe sizes express the approximate length of the shoe, or of the length of the last, the form on which the shoe is made.

<http://www.unc.edu/~rowlett/units/dictS.html#shot>
