Halliday/Resnick/Walker 7e
Chapter 1

1. Using the given conversion factors, we find

(a) the distance *d in rods* to be

$$d = 4.0 \text{ furlongs} = \frac{(4.0 \text{ furlongs})(201.168 \text{ m/furlong})}{5.0292 \text{ m/rod}} = 160 \text{ rods},$$

(b) and that distance *in chains* to be

$$d = \frac{(4.0 \text{ furlongs})(201.168 \text{ m/furlong})}{20.117 \text{ m/chain}} = 40 \text{ chains}.$$

2. The conversion factors $1 \text{ gry} = 1/10 \text{ line}$, $1 \text{ line} = 1/12 \text{ inch}$ and 1 point = 1/72 inch imply that 1 gry = (1/10)(1/12)(72 points) = 0.60 point. Thus, 1 gry^2 = (0.60 point)^2 = 0.36 point^2, which means that $0.50 \text{ gry}^2 = 0.18 \text{ point}^2$.

3. The metric prefixes (micro, pico, nano, …) are given for ready reference on the inside front cover of the textbook (see also Table 1–2).

(a) Since 1 km = 1 × 10^3 m and 1 m = 1 × 10^6 μm,

$$1 \text{km} = 10^3 \text{ m} = (10^3 \text{ m})(10^6 \ \mu\text{m/m}) = 10^9 \ \mu\text{m}.$$

The given measurement is 1.0 km (two significant figures), which implies our result should be written as 1.0 × 10^9 μm.

(b) We calculate the number of microns in 1 centimeter. Since 1 cm = 10^{-2} m,

$$1 \text{cm} = 10^{-2} \text{ m} = (10^{-2} \text{m})(10^6 \ \mu\text{m/m}) = 10^4 \ \mu\text{m}.$$

We conclude that the fraction of one centimeter equal to 1.0 μm is 1.0 × 10^{-4}.

(c) Since 1 yd = (3 ft)(0.3048 m/ft) = 0.9144 m,

$$1.0 \text{ yd} = (0.91 \text{m})(10^6 \ \mu\text{m/m}) = 9.1 \times 10^5 \ \mu\text{m}.$$

4. (a) Using the conversion factors 1 inch = 2.54 cm exactly and 6 picas = 1 inch, we obtain

$$0.80\text{ cm} = (0.80\text{ cm})\left(\frac{1\text{ inch}}{2.54\text{ cm}}\right)\left(\frac{6\text{ picas}}{1\text{ inch}}\right) \approx 1.9\text{ picas}.$$

(b) With 12 points = 1 pica, we have

$$0.80\text{ cm} = (0.80\text{ cm})\left(\frac{1\text{ inch}}{2.54\text{ cm}}\right)\left(\frac{6\text{ picas}}{1\text{ inch}}\right)\left(\frac{12\text{ points}}{1\text{ pica}}\right) \approx 23\text{ points}.$$

5. Various geometric formulas are given in Appendix E.

(a) Substituting

$$R = (6.37 \times 10^6\text{ m})(10^{-3}\text{ km/m}) = 6.37 \times 10^3\text{ km}$$

into *circumference* = $2\pi R$, we obtain 4.00×10^4 km.

(b) The surface area of Earth is

$$A = 4\pi R^2 = 4\pi\left(6.37 \times 10^3\text{ km}\right)^2 = 5.10 \times 10^8\text{ km}^2.$$

(c) The volume of Earth is

$$V = \frac{4\pi}{3}R^3 = \frac{4\pi}{3}\left(6.37 \times 10^3\text{ km}\right)^3 = 1.08 \times 10^{12}\text{ km}^3.$$

9. We use the conversion factors found in Appendix D.

$$1\text{ acre}\cdot\text{ft} = (43{,}560\text{ ft}^2)\cdot\text{ft} = 43{,}560\text{ ft}^3$$

Since 2 in. = (1/6) ft, the volume of water that fell during the storm is

$$V = (26\text{ km}^2)(1/6\text{ ft}) = (26\text{ km}^2)(3281\text{ft/km})^2(1/6\text{ ft}) = 4.66\times10^7\text{ ft}^3.$$

Thus,

$$V = \frac{4.66 \times 10^7\text{ ft}^3}{4.3560 \times 10^4\text{ ft}^3/\text{acre}\cdot\text{ft}} = 1.1 \times 10^3\text{ acre}\cdot\text{ ft}.$$

10. The metric prefixes (micro (μ), pico, nano, …) are given for ready reference on the inside front cover of the textbook (also, Table 1–2).

(a)

$$1\ \mu\text{century} = \left(10^{-6}\ \text{century}\right)\left(\frac{100\ \text{y}}{1\ \text{century}}\right)\left(\frac{365\ \text{day}}{1\ \text{y}}\right)\left(\frac{24\ \text{h}}{1\ \text{day}}\right)\left(\frac{60\ \text{min}}{1\ \text{h}}\right) = 52.6\ \text{min}.$$

(b) The percent difference is therefore

$$\frac{52.6\ \text{min} - 50\ \text{min}}{52.6\ \text{min}} = 4.9\%.$$

11. A week is 7 days, each of which has 24 hours, and an hour is equivalent to 3600 seconds. Thus, two weeks (a fortnight) is 1209600 s. By definition of the micro prefix, this is roughly $1.21 \times 10^{12}\ \mu\text{s}$.

12. A day is equivalent to 86400 seconds and a meter is equivalent to a million micrometers, so

$$\frac{(3.7\ \text{m})(10^6\ \mu\text{m/m})}{(14\ \text{day})(86400\ \text{s/day})} = 3.1\ \mu\text{m/s}.$$

13. None of the clocks advance by exactly 24 h in a 24-h period but this is not the most important criterion for judging their quality for measuring time intervals. What is important is that the clock advance by the same amount in each 24-h period. The clock reading can then easily be adjusted to give the correct interval. If the clock reading jumps around from one 24-h period to another, it cannot be corrected since it would impossible to tell what the correction should be. The following gives the corrections (in seconds) that must be applied to the reading on each clock for each 24-h period. The entries were determined by subtracting the clock reading at the end of the interval from the clock reading at the beginning.

CLOCK	Sun. -Mon.	Mon. -Tues.	Tues. -Wed.	Wed. -Thurs.	Thurs. -Fri.	Fri. -Sat.
A	−16	−16	−15	−17	−15	−15
B	−3	+5	−10	+5	+6	−7
C	−58	−58	−58	−58	−58	−58
D	+67	+67	+67	+67	+67	+67
E	+70	+55	+2	+20	+10	+10

Clocks C and D are both good timekeepers in the sense that each is consistent in its daily drift (relative to WWF time); thus, C and D are easily made “perfect” with simple and predictable corrections. The correction for clock C is less than the correction for clock D, so we judge clock C to be the best and clock D to be the next best. The correction that must be applied to clock A is in the range from 15 s to 17s. For clock B it is the range from -5 s to +10 s, for clock E it is in the range from -70 s to -2 s. After C and D, A has the smallest range of correction, B has the next smallest range, and E has the greatest range. From best to worst, the ranking of the clocks is C, D, A, B, E.

14. Since a change of longitude equal to $360°$ corresponds to a 24 hour change, then one expects to change longitude by $360°/24 = 15°$ before resetting one's watch by 1.0 h.

19. We introduce the notion of density:

$$\rho = \frac{m}{V}$$

and convert to SI units: 1 g = 1 × 10^{-3} kg.

(a) For volume conversion, we find 1 cm^3 = (1 × 10^{-2}m)^3 = 1 × $10^{-6}$$m^3$. Thus, the density in kg/m^3 is

$$1\ \text{g/cm}^3 = \left(\frac{1\ \text{g}}{\text{cm}^3}\right)\left(\frac{10^{-3}\ \text{kg}}{\text{g}}\right)\left(\frac{\text{cm}^3}{10^{-6}\ \text{m}^3}\right) = 1\times10^3\ \text{kg/m}^3.$$

Thus, the mass of a cubic meter of water is 1000 kg.

(b) We divide the mass of the water by the time taken to drain it. The mass is found from $M = \rho V$ (the product of the volume of water and its density):

$$M = \left(5700\ \text{m}^3\right)\left(1\times10^3\ \text{kg/m}^3\right) = 5.70\times10^6\ \text{kg}.$$

The time is t = (10h)(3600 s/h) = 3.6 × 10^4 s, so the *mass flow rate* R is

$$R = \frac{M}{t} = \frac{5.70\times10^6\ \text{kg}}{3.6\times10^4\ \text{s}} = 158\ \text{kg/s}.$$

20. To organize the calculation, we introduce the notion of density:

$$\rho = \frac{m}{V}.$$

(a) We take the volume of the leaf to be its area A multiplied by its thickness z. With density ρ = 19.32 g/cm^3 and mass m = 27.63 g, the volume of the leaf is found to be

$$V = \frac{m}{\rho} = 1.430\ \text{cm}^3.$$

We convert the volume to SI units:

$$V = \left(1.430\ \text{cm}^3\right)\left(\frac{1\ \text{m}}{100\ \text{cm}}\right)^3 = 1.430 \times 10^{-6}\ \text{m}^3.$$

Since $V = Az$ with $z = 1 \times 10^{-6}$ m (metric prefixes can be found in Table 1–2), we obtain

$$A = \frac{1.430 \times 10^{-6}\ \text{m}^3}{1 \times 10^{-6}\ \text{m}} = 1.430\ \text{m}^2.$$

(b) The volume of a cylinder of length ℓ is $V = A\ell$ where the cross-section area is that of a circle: $A = \pi r^2$. Therefore, with $r = 2.500 \times 10^{-6}$ m and $V = 1.430 \times 10^{-6}\ \text{m}^3$, we obtain

$$\ell = \frac{V}{\pi r^2} = 7.284 \times 10^4\ \text{m}.$$

23. We introduce the notion of density, $\rho = m/V$, and convert to SI units: 1000 g = 1 kg, and 100 cm = 1 m.

(a) The density ρ of a sample of iron is therefore

$$\rho = \left(7.87\ \text{g/cm}^3\right)\left(\frac{1\ \text{kg}}{1000\ \text{g}}\right)\left(\frac{100\ \text{cm}}{1\ \text{m}}\right)^3$$

which yields $\rho = 7870\ \text{kg/m}^3$. If we ignore the empty spaces between the close-packed spheres, then the density of an individual iron atom will be the same as the density of any iron sample. That is, if M is the mass and V is the volume of an atom, then

$$V = \frac{M}{\rho} = \frac{9.27 \times 10^{-26}\ \text{kg}}{7.87 \times 10^3\ \text{kg/m}^3} = 1.18 \times 10^{-29}\ \text{m}^3.$$

(b) We set $V = 4\pi R^3/3$, where R is the radius of an atom (Appendix E contains several geometry formulas). Solving for R, we find

$$R = \left(\frac{3V}{4\pi}\right)^{1/3} = \left(\frac{3\left(1.18 \times 10^{-29}\ \text{m}^3\right)}{4\pi}\right)^{1/3} = 1.41 \times 10^{-10}\ \text{m}.$$

The center-to-center distance between atoms is twice the radius, or 2.82×10^{-10} m.