

VOLUME 1.

PART 1.

- 1 Measurement.
- 2 Motion Along a Straight Line.
- 3 Vectors.
- 4 Motion in Two and Three Dimensions.
- 5 Force and Motion — I.
- 6 Force and Motion — II.
- 7 Kinetic Energy and Work.
- 8 Potential Energy and Conservation of Energy.
- 9 Center of Mass and Linear Momentum.
- 10 Rotation.
- 11 Rolling, Torque, and Angular Momentum.

PART 2.

- 12 Equilibrium and Elasticity.
- 13 Gravitation.
- 14 Fluids.
- 15 Oscillations.
- 16 Waves — I.
- 17 Waves — II.
- 18 Temperature, Heat, and the First Law of Thermodynamics.
- 19 The Kinetic Theory of Gases.
- 20 Entropy and the Second Law of Thermodynamics.

VOLUME 2.

PART 3.

- 21 Electric Charge.
- 22 Electric Fields.
- 23 Gauss' Law.
- 24 Electric Potential.
- 25 Capacitance.
- 26 Current and Resistance.
- 27 Circuits.
- 28 Magnetic Fields.
- 29 Magnetic Fields Due to Currents.
- 30 Induction and Inductance.
- 31 Electromagnetic Oscillations and Alternating Current.
- 32 Maxwell's Equations; Magnetism of Matter.

PART 4.

33 Electromagnetic Waves.

34 Images.

35 Interference.

36 Diffraction.

37 Relativity.

PART 5.

38 Photons and Matter Waves.

39 More About Matter Waves.

40 All About Atoms.

41 Conduction of Electricity in Solids.

42 Nuclear Physics.

43 Energy from the Nucleus.

44 Quarks, Leptons, and the Big Bang.

Chapter 1

1. Various geometric formulas are given in Appendix E.

(a) Expressing the radius of the Earth as

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

its circumference is $s = 2\pi R = 2\pi(6.37 \times 10^3 \text{ km}) = 4.00 \times 10^4 \text{ km}$.

(b) The surface area of Earth is $A = 4\pi R^2 = 4\pi(6.37 \times 10^3 \text{ km})^2 = 5.10 \times 10^8 \text{ km}^2$.

(c) The volume of Earth is $V = \frac{4\pi}{3} R^3 = \frac{4\pi}{3}(6.37 \times 10^3 \text{ km})^3 = 1.08 \times 10^{12} \text{ km}^3$.

2. The conversion factors are: 1 gry = 1/10 line, 1 line = 1/12 inch and 1 point = 1/72 inch. The factors imply that

$$1 \text{ gry} = (1/10)(1/12)(72 \text{ points}) = 0.60 \text{ point}.$$

Thus, $1 \text{ gry}^2 = (0.60 \text{ point})^2 = 0.36 \text{ point}^2$, 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 $1 \text{ km} = 1 \times 10^3 \text{ m}$ and $1 \text{ m} = 1 \times 10^6 \mu\text{m}$,

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

The given measurement is 1.0 km (two significant figures), which implies our result should be written as $1.0 \times 10^9 \mu\text{m}$.

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

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

We conclude that the fraction of one centimeter equal to $1.0 \mu\text{m}$ is 1.0×10^{-4} .

(c) Since $1 \text{ yd} = (3 \text{ ft})(0.3048 \text{ m/ft}) = 0.9144 \text{ m}$,

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

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. Given that 1 furlong = 201.168 m, 1 rod = 5.0292 m and 1 chain = 20.117 m, we find the relevant conversion factors to be

$$1.0 \text{ furlong} = 201.168 \text{ m} = (201.168 \cancel{\text{ m}}) \frac{1 \text{ rod}}{5.0292 \cancel{\text{ m}}} = 40 \text{ rods},$$

and

$$1.0 \text{ furlong} = 201.168 \text{ m} = (201.168 \cancel{\text{ m}}) \frac{1 \text{ chain}}{20.117 \cancel{\text{ m}}} = 10 \text{ chains}.$$

Note the cancellation of m (meters), the unwanted unit. Using the given conversion factors, we find

(a) the distance d in rods to be

$$d = 4.0 \text{ furlongs} = (4.0 \text{ furlongs}) \frac{40 \text{ rods}}{1 \text{ furlong}} = 160 \text{ rods},$$

(b) and that distance in chains to be

$$d = 4.0 \text{ furlongs} = (4.0 \text{ furlongs}) \frac{10 \text{ chains}}{1 \text{ furlong}} = 40 \text{ chains}.$$

6. We make use of Table 1-6.

(a) We look at the first (“cahiz”) column: 1 fanega is equivalent to what amount of cahiz? We note from the already completed part of the table that 1 cahiz equals a dozen fanega. Thus, 1 fanega = $\frac{1}{12}$ cahiz, or 8.33×10^{-2} cahiz. Similarly, “1 cahiz = 48 cuartilla” (in the already completed part) implies that 1 cuartilla = $\frac{1}{48}$ cahiz, or 2.08×10^{-2} cahiz. Continuing in this way, the remaining entries in the first column are 6.94×10^{-3} and 3.47×10^{-3} .

(b) In the second (“fanega”) column, we find 0.250, 8.33×10^{-2} , and 4.17×10^{-2} for the last three entries.

(c) In the third (“cuartilla”) column, we obtain 0.333 and 0.167 for the last two entries.

(d) Finally, in the fourth (“almude”) column, we get $\frac{1}{2} = 0.500$ for the last entry.

(e) Since the conversion table indicates that 1 almude is equivalent to 2 medios, our amount of 7.00 almudes must be equal to 14.0 medios.

(f) Using the value (1 almude = 6.94×10^{-3} cahiz) found in part (a), we conclude that 7.00 almudes is equivalent to 4.86×10^{-2} cahiz.

(g) Since each decimeter is 0.1 meter, then 55.501 cubic decimeters is equal to 0.055501 m^3 or 55501 cm^3 . Thus, 7.00 almudes = $\frac{7.00}{12}$ fanega = $\frac{7.00}{12}(55501 \text{ cm}^3) = 3.24 \times 10^4 \text{ cm}^3$.

7. 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

$$V = (26 \text{ km}^2)(1/6 \text{ ft}) = (26 \text{ km}^2)(3281 \text{ ft/km})^2(1/6 \text{ ft}) = 4.66 \times 10^7 \text{ ft}^3.$$

Thus,

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

8. From Fig. 1-4, we see that 212 S is equivalent to 258 W and $212 - 32 = 180$ S is equivalent to $216 - 60 = 156$ Z. The information allows us to convert S to W or Z.

(a) In units of W, we have

$$50.0 \text{ S} = (50.0 \text{ S}) \left(\frac{258 \text{ W}}{212 \text{ S}} \right) = 60.8 \text{ W}$$

(b) In units of Z, we have

$$50.0 \text{ S} = (50.0 \text{ S}) \left(\frac{156 \text{ Z}}{180 \text{ S}} \right) = 43.3 \text{ Z}$$

9. The volume of ice is given by the product of the semicircular surface area and the thickness. The area of the semicircle is $A = \pi r^2/2$, where r is the radius. Therefore, the volume is

$$V = \frac{\pi}{2} r^2 z$$

where z is the ice thickness. Since there are 10^3 m in 1 km and 10^2 cm in 1 m, we have

$$r = (2000 \text{ km}) \left(\frac{10^3 \text{ m}}{1 \text{ km}} \right) \left(\frac{10^2 \text{ cm}}{1 \text{ m}} \right) = 2000 \times 10^5 \text{ cm}.$$

In these units, the thickness becomes

$$z = 3000 \text{ m} = (3000 \text{ m}) \left(\frac{10^2 \text{ cm}}{1 \text{ m}} \right) = 3000 \times 10^2 \text{ cm}$$

which yields $V = \frac{\pi}{2} (2000 \times 10^5 \text{ cm})^2 (3000 \times 10^2 \text{ cm}) = 1.9 \times 10^{22} \text{ cm}^3$.

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

11. (a) Presuming that a French decimal day is equivalent to a regular day, then the ratio of weeks is simply $10/7$ or (to 3 significant figures) 1.43.

(b) In a regular day, there are 86400 seconds, but in the French system described in the problem, there would be 10^5 seconds. The ratio is therefore 0.864.

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. The time on any of these clocks is a straight-line function of that on another, with slopes $\neq 1$ and y -intercepts $\neq 0$. From the data in the figure we deduce

$$t_C = \frac{2}{7}t_B + \frac{594}{7}, \quad t_B = \frac{33}{40}t_A - \frac{662}{5}.$$

These are used in obtaining the following results.

(a) We find

$$t'_B - t_B = \frac{33}{40}(t'_A - t_A) = 495 \text{ s}$$

when $t'_A - t_A = 600 \text{ s}$.