1.7 EXERCISES

Unit Conversion Practice

Ex 1.7.1. A car travels at a speed of 65 miles per hour (mph). What is the speed in meters/second?

Ex 1.7.2. In Astronomy, a common unit of distance is a light-year (ly), which is equal to the distance that light travels in one year, which is taken to be 365.25 days. How much is one ly in meters?

Ex 1.7.3. The density of aluminum is 2.7 grams per cubic-centimeter. (a) What is the density in kilogram/cubic meter? (b) What is the density in lb/ft^3?

Ex 1.7.4. Astronomical unit (AU) is a measure of distance that is equal to the average distance between the Earth and the Sun. One AU is approximately equal to 150 million kilometers. Evaluate the average distances between the Sun and following planets, Mercury, Mars, and Jupiter, in AU if these distance in meter are 5.79×10^{10} m, 2.28×10^{11} m and 7.78×10^{11} m respectively.

Significant Figures and Uncertainties

Ex 1.7.5. Evaluate the following to the correct number of significant figures/digits. (a) $2.52 + 1.008$, (b) 3.01×5, (c) $2.51/\pi$, (d) $\pi(1.5)^2$, (e) $3.5^{1/3}$, (f) $\sqrt{5.34}$, (g) $15.5 \times (1.1)^{1/4}$, (h) π^2 (Trick question!).

Ex 1.7.6. The side of a square plate is measured to be 2.1 cm $\pm$ 0.1 cm. (a) What are the absolute and relative uncertainties in the measured value of the side? (b) Find the perimeter and the area of the square to the approprtiate significant figures. (c) Find the absolute and relative uncertainties in the perimeter and the area of the square.

Ex 1.7.7. The radius of a circle was measured to be 3.55 cm $\pm$ 0.05 cm. (a) Find the circumference and the area of the circle to the approprtiate significant figures. (b) Find the absolute and relative uncertainties in the circumference and the area of the circle.

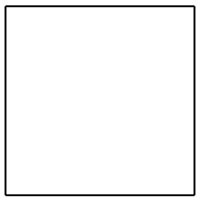
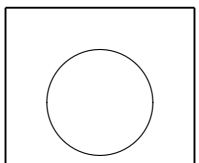


Figure 1.10: Exercise 1.7.8

Ex 1.7.8. Use a ruler with mm markings to measure the side of the given square in Fig. 1.10, and find the average values and uncertainties in the values of of the perimeter and the area. (Note: Your measurements will have an average value and an uncertainty, which you will use to deduce the average values and uncertainties in the perimeter and the area.)



Ex 1.7.9. Use a ruler with mm markings to measure the diameter of the given circle in Fig. 1.11, and calculate the average and the uncertainties of circumference and area. (Note: Your measurements will have an average value and an uncertainty.)

Ex 1.7.10. The diameter of a spherical ball of mass 20.0 ± 0.1 grams was measured by a micrometer and found to be 16.582 mm$\pm$0.002 mm. (a) Find the average volume of the sphere. (b) Find the absolute and relative uncertainties of the volume. (c) Find the density of the ball, giving both the average value and the uncertainty.

Ex 1.7.11. The diameter of a spherical steel ball was measured by a Vernier caliper to be 10.35 mm $\pm$ 0.01 mm. Assume the density of steel to be 7.8 g/cm^3. (a) Find the average volume of the sphere. (b) Find the absolute and relative uncertainties in the volume. (c) Find the mass of the sphere, giving both the average value and the uncertainty.

Ex 1.7.12. The height and diameter of a platinum cylindrical rod are found to be 39.000 mm$\pm$0.001 mm and 390 mm$\pm$1 mm respectively. Find its volume, giving both the average value and the uncertainty.

Order of Magnitude

Ex 1.7.13. Estimate the amount of blood pumped by your heart in a day.

Ex 1.7.14. Estimate the total number of hair on your head.

Ex 1.7.15. Estimate the total mass of all the water in the oceans of the Earth.

Ex 1.7.16. Estimate the amount of gasoline used in cars each year in the United States of America.

Dimensional Analysis

Ex 1.7.17. A physics student claims that he has found a new force that depends on the density D, the velocity v, and the acceleration a as given by the following relation.

$$F = D\, v^6/a^2.$$

(a) Check the dimensions to decide if the equation makes sense. (b) If this force depends only D, v, and a, predict the form of the relation by finding the correct powers for each of these quantities in the magnitude of the force.

Ex 1.7.18. Hooke's law gives the magnitude of the force of a spring by $F = kx$, where x is the stretching or compression and k the spring constant. Find the dimensions of the spring constant.

Ex 1.7.19. By using dimensional analysis, find a formula for the oscillation frequency of a mass m attached to a spring of spring constant k. Note that the magnitude of the spring force is $F = k\Delta l$, where Δl is the stretching or compression of the spring.