24. The metric prefixes (micro (μ), pico, nano, …) are given for ready reference on the inside front cover of the textbook (see also Table 1–2) and Appendix E contains a variety of geometry formulas. The surface area A of each grain of sand of radius $r = 50$ μm $= 50 \times 10^{-6}$ m is given by $A = 4\pi(50 \times 10^{-6}\,\text{m})^2 = 3.14 \times 10^{-8}\,\text{m}^2$. A cube has six equal faces so the indicated surface area is 6 m^2. The number of spheres (the grains of sand) N which have a total surface area of 6 m^2 is given by

$$N = \frac{6 \text{ m}^2}{3.14 \times 10^{-8} \text{ m}^2} = 1.91 \times 10^8.$$

We introduce the notion of density (which the students have probably seen in other courses):

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

so that the mass can be found from $m = \rho V$, where $\rho = 2600$ kg/m^3. Thus, using $V = 4\pi r^3/3$, the mass of each grain is

$$m = \left(\frac{4\pi \left(50 \times 10^{-6} \text{ m}\right)^3}{3} \right) \left(2600 \ \frac{\text{kg}}{\text{m}^3} \right) = 1.36 \times 10^{-9} \text{ kg.}$$

Therefore, the total mass M is given by

$$M = Nm = \left(1.91 \times 10^8\right)\left(1.36 \times 10^{-9} \text{ kg}\right) = 0.260 \text{ kg.}$$