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). The surface area A of each grain of sand of radius $r = 50\,\mu\text{m} = 50\times10^{-6}$ m is given by $A = 4\pi(50\times10^{-6})^2 = 3.14\times10^{-8}$ m^2 (Appendix E contains a variety of geometry formulas). 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

$$m = \left(\frac{4\pi\left(50\times10^{-6}\,\text{m}\right)^3}{3}\right)\left(2600\,\frac{\text{kg}}{\text{m}^3}\right) = 1.36\times10^{-9}\ \text{kg}\ .$$

We observe that (because a cube has six equal faces) 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

$$N = \frac{6\,\text{m}^2}{3.14\times10^{-8}\,\text{m}^2} = 1.91\times10^8\ .$$

Therefore, the total mass M is given by

$$M = Nm = \left(1.91\times10^8\right)\left(1.36\times10^{-9}\ \text{kg}\right) = 0.260\,\text{kg}\ .$$