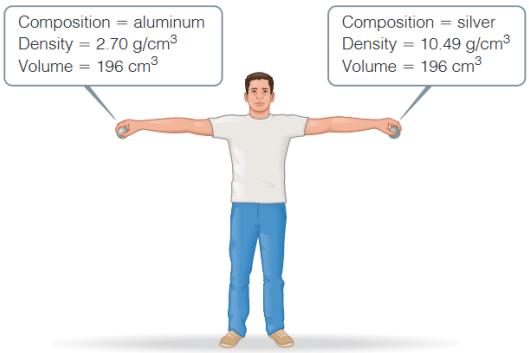
Exercise 1.4

Consider the two spheres shown here, one made of silver and the other of aluminum. (**a**) What is the mass of each sphere in kg? (**b**) The force of gravity acting on an object is $F = mg$, where m is the mass of an object and g is the acceleration of gravity (9.8 m/s^2). How much work do you do on each sphere it you raise it from the floor to a height of 2.2 m? (**c**) Does the act of lifting the sphere off the ground increase the potential energy of the aluminum sphere by a larger, smaller, or same amount as the silver sphere? (**d**) If you release the spheres simultaneously, they will have the same velocity when they hit the ground. Will they have the same kinetic energy? If not, which sphere will have more kinetic energy? [Section 1.4]



[TYPO: Replace "it" with "if."]

Solution

Part (a)

The mass of each sphere is obtained by multiplying its density by the volume.

$$m_{\text{Al}} = \rho_{\text{Al}} V = \left(2.70 \frac{\cancel{\text{g}}}{\cancel{\text{cm}^3}}\right)(196 \cancel{\text{cm}^3}) \times \frac{1 \text{ kg}}{1000 \cancel{\text{g}}} \approx 0.529 \text{ kg}$$

$$m_{\text{Ag}} = \rho_{\text{Ag}} V = \left(10.49 \frac{\cancel{\text{g}}}{\cancel{\text{cm}^3}}\right)(196 \cancel{\text{cm}^3}) \times \frac{1 \text{ kg}}{1000 \cancel{\text{g}}} \approx 2.06 \text{ kg}$$

Part (b)

The work one has to do to raise each sphere is the product of its weight and the distance raised.

$$w_{\text{Al}} = F_{\text{Al}} \times d = (m_{\text{Al}} g) \times d \approx (0.529 \text{ kg}) \left(9.8 \frac{\text{m}}{\text{s}^2}\right)(2.2 \text{ m}) \approx 11 \text{ J}$$

$$w_{\text{Ag}} = F_{\text{Ag}} \times d = (m_{\text{Ag}} g) \times d \approx (2.06 \text{ kg}) \left(9.8 \frac{\text{m}}{\text{s}^2}\right)(2.2 \text{ m}) \approx 44 \text{ J}$$

Part (c)

The act of lifting the aluminum sphere raises its potential energy by a smaller amount ($\approx$ 11 J) compared to the silver sphere ($\approx$ 44 J).

Part (d)

Since kinetic energy is dependent on the mass,

$$E_k = \frac{1}{2}mv^2,$$

the silver sphere will have more kinetic energy (≈ 44 J) than the aluminum sphere (≈ 11 J) when they hit the floor.