

Work Problems

1. According to Newton's universal law of gravitation, the gravitational force of attraction between two masses m_1 and m_2 that are separated by a distance r is given by

$$F = \frac{Gm_1m_2}{r^2},$$

where $G = 6.673 \times 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2$ is the gravitational constant. Find the work done in propelling a 38 g Twinkie ($m_1 = 0.038 \text{ kg}$) a distance of 2,290 km ($h = 2.29 \times 10^6 \text{ m}$) above the surface of the Earth. The mass of the Earth is $m_2 = 5.98 \times 10^{24} \text{ kg}$ and its radius is $R = 6.38 \times 10^6 \text{ m}$.

2. Find the work done in emptying water from a half-full vertical cylindrical tank with radius 2 m and height 6 m by pumping water out of the top of the tank.

Note: The (mass) density of water is $\rho = 1,000 \text{ kg/m}^3$ and its weight density is $\rho g = (1,000 \text{ kg/m}^3)(9.80 \text{ m/s}^2) = 9,800 \text{ N/m}^3$, or equivalently 62.4 lb/ft^3 .

3. A storage tank has a triangular cross-section and is 3 ft deep, 2 ft across at the top and 2 ft long. If the bottom of the tank is 4 ft above the ground, then how much work is done in completely filling the tank with gasoline, which has a weight density of 42 lb/ft^3 , from the ground through an opening in the bottom?