

## Work Problems

1. Find the work done in pushing a cart 20 ft along a level road if 90 lb of constant force is being applied.
2. How much work is required to lift a 15 kg object vertically 4 m?
3. Find the work done in stretching a spring from 8 in to 10 in if
  - (a) 18 lb of force is required to stretch the spring from its natural length of 5 in to a length of 9 in.
  - (b) 18 in·lb of work is required to stretch the spring from its natural length of 5 in to a length of 9 in.

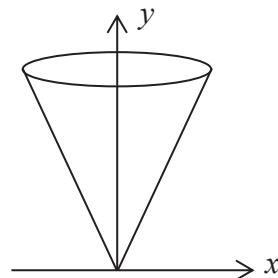
4. According to Newton's universal law of gravitation, the gravitational force of attraction between two masses  $m_1$  and  $m_2$  that are separated by a distance  $r$  is given by

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

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 34 g Twinkie ( $m_1 = 0.034 \text{ kg}$ ) a distance of 2,670 km ( $h = 2.67 \times 10^6 \text{ m}$ ) 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  $R = 6.38 \times 10^6 \text{ m}$ .

5. Suppose an open tank is in the shape of a right circular cone having diameter 4 m across the top and height 6 m.

- (a) Find the work done in emptying water from the tank if it is initially filled to a height of 3 m and the water is pumped out over the top edge of the tank.
- (b) Find the work done in filling the tank with water to a height of 3 m if it is initially empty by pumping water in through a hole in the bottom of the tank.



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

6. Each end of a 5 ft long storage tank is in the shape of the region bounded by the curves  $y = 1/x$ ,  $y = -1/x$ ,  $y = 1$ , and  $y = 2$ , as illustrated, where  $x$  and  $y$  are measured in feet and where the bottom of the tank is 1 ft above the ground. How much work is done in completely filling the tank with gasoline, which has a weight-density of  $42 \text{ lb/ft}^3$ , by pumping the gasoline from the ground up into the tank through an opening in its bottom?

