Chapter 7.5 Work

1. Hooke's Law for springs
    a. Formula: $F = kx$
    b. Use the given force and displacement to solve for k.
    c. Write the integral and solve. $\int_a^b kx\, dx$

Example: A force of 200 pounds is used to compress a spring 4 inches. How much work is done compressing the spring from 4 to 8 inches.

Solve for k. $200 = k(4)$ $50 = k$

Solve integral.

2. Law of Universal Gravitation
    a. $F = \dfrac{C}{x^2}$
    b. Use the given values to solve for C. Use 4000 miles for the radius of the earth.
    c. Write the integral and solve. $\int_a^b \dfrac{C}{x^2}\, dx$

Example: A satellite weighs 10 metric tons on the surface of the earth. How much work is done propelling it 1000 miles above Earth?

Solve for C. $10 = \dfrac{C}{(4000)^2}$ $C = 160{,}000{,}000$

Solve integral.

3. Emptying a Straight-sided Tank
   a. Work = (Weight of layer)(Distance moved)
   b. Calculate the area of the base of the tank. Multiply the area times the density of the liquid.
   c. Solve integral. $\int_a^b Weight\ of\ layer\ (Distance\ function)\ dy$

Example: A rectangular tank full of water is 5 feet by 8 feet by 6 feet tall. Water has a weight of 62.4 pounds per cubic foot. How much work is done emptying half of the tank by pumping the water over the top tank?

Calculate the weight of a layer of water. Weight = (5 ft)(8 ft)(62.4 pounds/ft^3) = 2496 pounds/ft

Solve integral.
$$\int_3^6$$

4. Expanding Gas
   a. Work = Pressure (Change in Volume)
   b. Calculate the k. Pressure = k/V
   c. Solve integral. $\int_a^b \frac{k}{V} dV$

Example: A gas with an initial volume of 2 cubic feet and a pressure of 400 psf expands to a volume of 4 cubic feet. Find the work done by the expanding gas.

Calculate k. $400 = \frac{k}{2}$ k = 800

Solve integral.
$$\int_2^4$$

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