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Work

Defn: $F = m \cdot a$ (Newton's 2nd law of motion)

Defn: $W = f \cdot d$. (work).

Ex 1:

a) How much work to lift an 10lb book.
2 feet above the table.

b) How much work to lift a 10kg bag up
2 meters. ($g \approx 10 \text{ m/s}^2$).

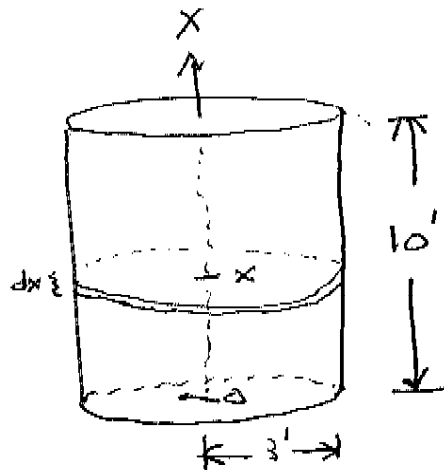
If an object moves along the x-axis in the positive direction from a to b and a force $f(x)$ acts on the object where f is a cont. fun, then the work done is

$$W = \int_a^b f(x) dx$$

Ex 2: A particle is moved along the x-axis by a force that measures $5x$ pounds at a point x -ft from the origin. Find the work done in moving the particle from the origin to a pt 4 ft from the origin.

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Ex 3: Find the work required to pump all the water out of the top of a completely filled tank (see pic) The density of water is 62.5 lbm/ft^3



$$A(x) = 9\pi \text{ ft}^2$$

$$V(x) = 9\pi dx \text{ ft}^3$$

$$m(x) = 9\pi \cdot 62.5 dx \text{ lbm}$$

$$f(x) = 9\pi (62.5)(32) dx \frac{\text{lbm} \cdot \text{ft}}{\text{s}^2}$$

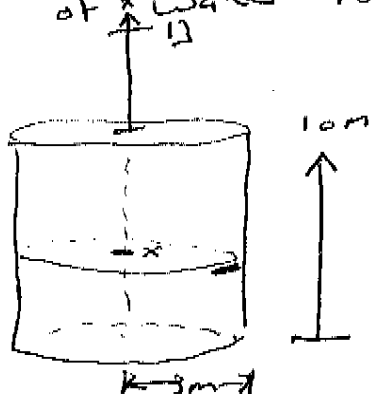
$$= 9\pi (62.5) dx \frac{\text{slug} \cdot \text{ft}}{\text{s}^2}$$

$$w(x) = 9\pi (62.5)(10-x) dx \frac{\text{slug} \cdot \text{ft}^2}{\text{s}^2}$$

$$W = \int_0^{10} 9\pi (62.5)(10-x) dx$$

$$= \frac{\text{slug} \cdot \text{ft}^2}{\text{s}^2}$$

Ex 4: Find the work required to pump all the water out of the tank to a height 3 m above the top of the tank. The density of water is 1000 kg/m^3 .



$$A(x) = 9\pi \text{ m}^2$$

$$V(x) = 9\pi dx \text{ m}^3$$

$$m(x) = 9000\pi dx \text{ kg}$$

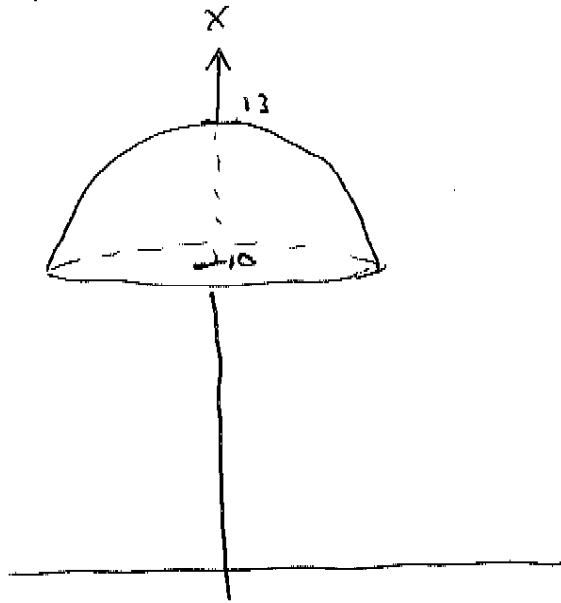
$$f(x) = \cancel{90000\pi} 90000\pi dx \frac{\text{kg} \cdot \text{m}}{\text{s}^2} = \text{N}$$

$$w(x) = 90000\pi (13-x) dx \text{ N} \cdot \text{m}$$

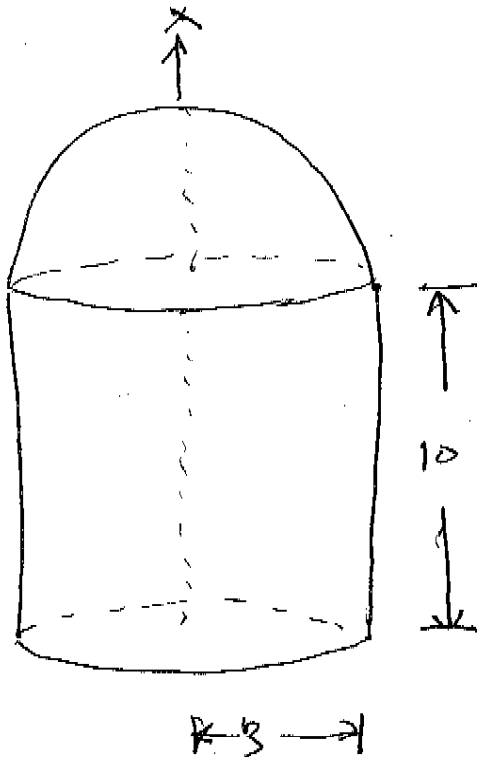
$$W = \int_0^{10} 90000\pi (13-x) dx \text{ N} \cdot \text{m}$$

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Ex 5: Empty the tank



Ex 6:



Empty the tank.