1. Recall how we calculated work given both (a) a constant force and (b) a variable force.

(a) F constant
$W = F\cdot d$

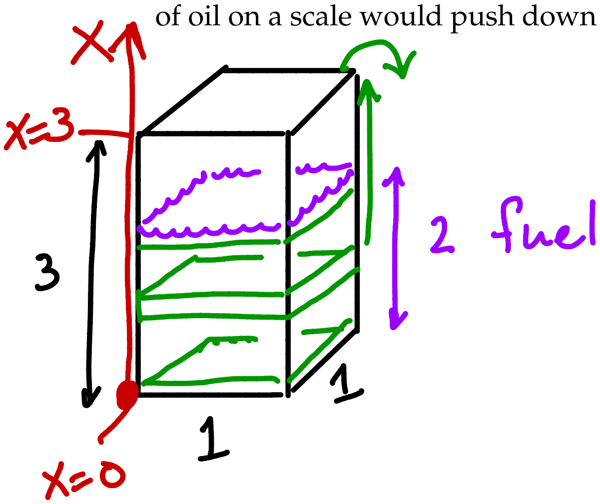
(b) $W = \int_a^b \underbrace{F(x)}_{F}\ \cdot \underbrace{dx}_{d}$

units • lb, ft, ft·lb

• N, m, N·m = J

2. A rectangular fuel oil tank has dimensions 1m × 1m on the base and is 3 m in height. Assume the depth of the oil in the tank is 2 m. How much work is required to pump all the oil out of the top of the tank.

(Facts to use: No. 2 fuel oil is roughly 900 kg/m^3. Hence, So the weight (force) density at sea level on earth, of heating oil, is $(9.81\text{m/s}^2)\cdot(900\text{kg/m+}^3) = 8829\text{N/m}^3$. This means that a cubic meter of oil on a scale would push down 8829 N, compared to 1 kg of something pushing 9.81 N.)



• Different slices of liquid are moved/lifted different distance

• So here distance $\underline{\underline{d}}$ is not constant!

• Pick an orientation. So x = height of oil.

• Integrate w/ dx from x=0 to x=2

• For a slice w/ height x and thickness dx

$$F = (\text{weight of slice}) = \underbrace{(1\cdot 1\cdot dx)\ m^3}_{V} \cdot \underbrace{\left(\frac{8829N}{m^3}\right)}_{F/V} = 8829N$$

$$d = 3 - x$$

$$W = \int_0^2 8829(3-x)\,dx = 8829\int_0^2 (3-x)\,dx$$

$$= 8829\left(3x - \tfrac{1}{2}x^2\right)\Big|_0^2 = 8829(6-2) = 35316\ Nm$$

$$= 35316\ J$$

$$\begin{array}{r} 8829 \\ \times\ 4 \\ \hline 35316 \end{array}$$

Section 2.5: Work and Mass (Extra)

1. Recall how we calculated work given both (a) a constant force and (b) a variable force.

2. A rectangular fuel oil tank has dimensions $1\text{m} \times 1\text{m}$ on the base and is 3 m in height. Assume the depth of the oil in the tank is 2 m. How much work is required to pump all the oil out of the top of the tank.

   (Facts to use: No. 2 fuel oil is roughly 900 kg/m^3. Hence, So the weight (force) density at sea level on earth, of heating oil, is $(9.81\text{m/s}^2) \cdot (900\text{kg/m}+^3) = 8829\text{N/m}^3$. This means that a cubic meter of oil on a scale would push down 8829 N, compared to 1 kg of something pushing 9.81 N.)