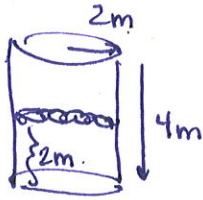**Instructions**: Show all work. Use exact answers unless otherwise asked to round.

1. A cylindrical tank 4 meters high with a radius of 2 meters is half-full. Find the work done pumping the water out over the top edge.
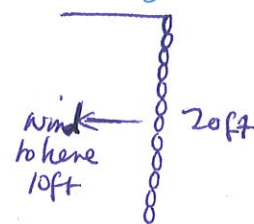

density of water = k

$$W = \int_0^2 (4-y) \, k \cdot \pi (2)^2 \, dy =$$

$$4k\pi \left[4y - \tfrac{1}{2}y^2 \right]_0^2 = 4k\pi \left[8-2 \right] = 4k\pi \left[6 \right] =$$

$$24k\pi$$

2. A 20-foot chain that weighs 3 lbs/ft hangs from a winch 20-feet high. Find the work done to wind up half the chain.

density 3 lbs/ft

weight = 3y

wind to here 10ft   20ft

$$W = \int_0^{10} (20-y) \cdot 3y \, dy =$$

$$\int_0^{10} 60y - 3y^2 \, dy = 30y^2 - y^3 \Big|_0^{10} = 30(100) - 1000$$

$$= 2000 \text{ ft} \cdot \text{lbs}$$