1. A circular swimming pool with diameter 8 m and height 1.5 m contains water 1 m deep. Please set up but do not evaluate the integral that would calculate the work done in pumping the water out of the pool. Note: the density of water is 1000 kg/m$^3$.

**Solution:**
We divide the water (not the tank) into horizontal slices with $0 \leq y \leq 1$. The thickness is $dy$. The Volume each slice is
\[ V_i = \pi r^2 dy = 16\pi dy \text{ m}^3 \]
The mass at each slice is
\[ m_i = 1000 \frac{\text{kg}}{\text{m}^3} V_i = 1000 \frac{\text{kg}}{\text{m}^3} 16\pi dy \text{ m}^3 = 16,000\pi dy \text{ kg}. \]
The force at each slice is
\[ F_i = m_i g = 16,000\pi dy \text{ kg} \left(9.8 \frac{\text{m}}{s^2}\right) = 16,000 \cdot 9.8\pi dy \text{ N}. \]
The height/distance that we have to lift is $1.5 - y$. So
\[ W_i = F_i \times \text{distance} \]
\[ = 16,000 \cdot 9.8\pi dy \text{ N} (1.5 - y) \]
\[ = 16,000 \cdot 9.8\pi (1.5 - y) dy \text{ J}. \]
So the total work is
\[ \text{Work} = 16,000 \cdot 9.8\pi \int_0^1 (1.5 - y) dy. \]

2. A force of 10 newtons is required to hold a string stretched 4 cms beyond its natural length. How much work is done to stretch it from its natural position to 6 cms past its natural position? (5 points)

**Solution:**
First convert to meters! So 4cm becomes 0.04m and so on. The force is $f(x) = kx$ so putting in the given information we have that $f(0.04) = k(0.04) = 10$ and solving for $k$ we get
\[ k = \frac{10}{0.04} = 250. \]
Since work is $W = \int_a^b kxdx$ then using $a = 0$ (the natural state) with $b = .06$ (the extended state). Then
\[ W = \int_0^{0.06} 250xdx \]
\[ = \left[ 250 \frac{x^2}{2} \right]_0^{0.06} \]
\[ = 250 \frac{(0.06)^2}{2} \]
\[ = .45 \text{ J}. \]