**3**. [7 points] After the successful splashdown of the Artemis II mission, the Orion spacecraft is hoisted from the surface of Pacific Ocean by a crane onto the recovery ship. Before the crane begins lifting, the combined weight of the Orion capsule and the trapped seawater is 12,000 pounds. As soon as the hoisting begins, the trapped seawater drains out of the capsule at a constant rate of 20 pounds per second. The capsule is lifted until it reaches the deck of the ship, 50 feet above the surface of the water. The crane lifts the capsule at a constant vertical rate of 2 feet per second.

**a**. [3 points] Let $C(h)$ be the combined weight of the capsule and the trapped water, in pounds, when the capsule is $h$ feet above the surface of the water. Write an expression for $C(h)$.

*Solution:* Observe that

$$\frac{dC}{dh} = \frac{dC}{dt} \Big/ \frac{dh}{dt} = -20/2 = -10$$

Hence, $C(h)$ is a linear function of $h$ with slope $-10$. Given the weight of the capsule at sea level ($h = 0$) is 12,000 pounds, we obtain

$$C(h) = 12000 - 10h.$$

**Answer:** $C(h) =$ $12000 - 10h$

**b**. [4 points] Write an expression involving one or more integrals that represents the total work required to move the Orion capsule from the surface of the water to the deck of the ship using the crane. Your answer should not involve the letter $C$. **Do not** evaluate your integral. Include units.

*Solution:* Suppose the Orion capsule has already been lifted to a height $h$ feet above the sea surface. The work required to lift it an additional $\Delta h$ feet is given by:

$$C(h)\,\Delta h = (12000 - 10h)\,\Delta h.$$

Therefore, the total work required to lift the capsule from the surface of the pacific ocean to the deck of the ship is given by

$$W = \int_0^{50} (12000 - 10h)\,\mathrm{d}h.$$

**Answer:** $\displaystyle\int_0^{50} (12000 - 10h)\,\mathrm{d}h$ **Units:** $\mathrm{ft} \cdot \mathrm{lb}$