9. [7 points] Emily is transporting a chocolate ice cream cone up 1 story of East Hall to her friend. However, there is a hole in the bottom of the cone and ice cream drips out in a steady stream.

The mass of the cone is 200 grams and there are initially 100 grams of ice cream in the cone. The ice cream drips out at a rate of 4 grams/sec. Emily spends 10 seconds raising the cone at a constant rate of 0.5 m/sec to reach her friend.

a. [3 points] What is the total mass in grams of the cone and the ice cream in the cone when Emily has lifted it a vertical distance $\ell$ m?

Solution: When Emily has lifted the cone a vertical distance of $\ell$ m, she has lifted for $2\ell$ sec. Therefore, $8\ell$ grams of ice cream has dripped out of the cone. The cone and ice cream start at 300 grams.

\[
\text{Mass} = 300 - 8\ell \text{ grams}
\]

b. [4 points] Write, but do not evaluate, an integral that represents the total amount of work (in grams m$^2$/sec$^2$) done by Emily lifting the cone filled while the ice cream drips. You may assume the acceleration due to gravity is $g = 9.8$ m/sec$^2$.

Solution: The work to lift the rocket between $\ell$ and $\ell + \Delta \ell$ m is

\[
\Delta W = 9.8(300 - 8\ell)\Delta \ell.
\]

Hence, the total work is below.

\[
\text{Work} = \int_{0}^{5} 9.8(300 - 8\ell)d\ell \text{ grams m}^2/\text{sec}^2
\]