1. [7 points] At a wildlife sanctuary, Diego fills the giraffes' water bowl at a constant rate of 0.5 gallons per minute. The rate in gallons per minute at which the giraffes drink from the bowl, t **minutes** after 8am, is given by $r(t)$. Suppose there are 12 gallons of water in the bowl at 10am.

  a. [3 points] Write an expression possibly involving one or more integrals for the amount of water, in gallons, the giraffes drink between 9am and noon.

  > *Solution:* The rate that the giraffes drink water is given by $r(t)$, and so the total amount they drink from 9am to noon is given by
  >
  > $$\int_{60}^{4(60)} r(t) \ dt = \int_{60}^{240} r(t) \ dt.$$

  b. [4 points] Write an expression possibly involving one or more integrals for the amount of water, in gallons, in the bowl at 8am.

  > *Solution:*   The volume of water in the bowl at 10am is 12 gallons, and so subtracting the change in volume between 8am and 10am will give the amount of water in the bowl at 8am.
  > The water is added to the bowl at a rate of 0.5 gallons per minute, and removed at a rate of $r(t)$ gallons per minute, and so the rate of change of volume of water in the bowl is $0.5 - r(t)$ gallons per minute. Therefore, the amount of water, in gallons, in the bowl at 8am is:
  >
  > $$12 - \int_{0}^{2(60)} 0.5 - r(t) \ dt = 12 - \int_{0}^{120} 0.5 - r(t) \ dt = \int_{0}^{120} r(t) \ dt - 48.$$