

3a.  $r \frac{\text{gallons}}{\text{year}} \cdot 200 \text{ years} = 200r \text{ gallons}$

3b. Using the method of separation of variables:

$$\begin{aligned}\frac{dR}{R} &= 0.05dt \\ \ln |R| &= 0.05t + C \\ R(t) &= Ce^{0.05t} \\ R(0) &= r = Ce^0 = C \\ R(t) &= re^{0.05t}\end{aligned}$$

3c. The amount of oil used is the definite integral of the rate of use. Therefore letting  $x =$  the number of years until the oil supply is used up and  $t = 0$  be the current year,

$$\begin{aligned}\int_0^x re^{0.05t} dt &= 200r \\ r \left( \frac{e^{0.05t}}{0.05} \right) \Big|_0^x &= 200r \\ e^{0.05x} - 1 &= 200(0.05) = 10 \\ e^{0.05x} &= 11 \\ 0.05x &= \ln(11) \\ x &= \frac{\ln(11)}{0.05} \approx 47.9579 \approx 48 \text{ years}\end{aligned}$$