Show all your work in a neat and organized manner.

1. Compute \( \int_0^1 \frac{1}{1+4x} \, dx \)

   **Solution:**
   In \( \int_0^1 \frac{1}{1+4x} \, dx \), the complication is the denominator, \( 1+4x \). Let’s try the substitution
   \[
   u = 1 + 4x
   \]
   \[
   du = 4 \, dx \quad \text{or, equivalently}
   \]
   \[
   \frac{1}{4} \, du = dx
   \]
   The limits of integration change also:
   \[
   x = 0 \quad \Rightarrow \quad u = 1 + 4 \cdot 0 = 1
   \]
   \[
   x = 1 \quad \Rightarrow \quad u = 1 + 4 \cdot 1 = 5
   \]
   Then
   \[
   \int_0^1 \frac{1}{1+4x} \, dx = \int_1^5 \frac{1}{u} \frac{1}{4} \, du
   \]
   \[
   = \frac{1}{4} \int_1^5 \frac{1}{u} \, du
   \]
   \[
   = \frac{1}{4} \ln |u| \bigg|_1^5
   \]
   \[
   = \frac{1}{4} (\ln 5 - \ln 1)
   \]
   \[
   = \frac{1}{4} \ln(5)
   \]

2. Suppose that the rate at which a chemical product is formed in a reaction is
   \[
   \frac{dP}{dt} = 6e^{-3t}
   \]
   where \( t \) is measured in minutes and \( P \) in moles. If there is no product at time 0, write the solution for all time.

   **Solution:**
   \[
   P(t) = \int 6e^{-3t} \, dt
   \]
   \[
   = 6 \int e^{-3t} \, dt \quad \text{we will set} \quad u = -3t, \ du = -3 \, dt \quad \text{or} \quad \frac{1}{3} \, du = dt
   \]
   \[
   = 6 \int e^u \frac{1}{3} \, du
   \]
   \[
   = -2 \int e^u \, du
   \]
   \[
   = -2e^u + C
   \]
   \[
   = -2e^{-3t} + C
   \]
   Since \( P(0) = 0 \), we have
   \[
   0 = P(0)
   \]
   \[
   = -2e^{-3 \cdot 0} + C
   \]
   \[
   = -2 \cdot 1 + C
   \]
   which will give us \( C = 2 \). This means \( P(t) = -2e^{-3t} + C \) should be written as \( P(t) = -2e^{-3t} + 2 \), or, as is the custom, \( P(t) = 2 - 2e^{-3t} \).