1. Complete the following important integral formulas:

(i) \( \int x^n \, dx = \frac{x^{n+1}}{n+1} \) \( \quad \text{if } n \neq -1. \)

(ii) \( \int \frac{1}{x} \, dx = \int x^{-1} \, dx = \ln |x| \)

(iii) \( \int \frac{1}{ax + b} \, dx = \frac{1}{a} \ln |ax + b| \)

(iv) \( \int e^{ax+b} \, dx = e^{ax+b} \)

(v) \( \int \frac{1}{\sqrt{1-x^2}} \, dx = \sin^{-1} x \)

(vi) \( \int \frac{1}{1+x^2} \, dx = \tan^{-1} x \)

2. If the slope at each point of the graph of \( f(x) \) is given by \( \frac{2x+1}{4+x^2} \).

Find a formula for \( f(x) \) if its graph passes through \((2, 0)\).

3. Perform the following integrals:

a. \( \int_0^1 \frac{x + 2x^3}{1 + x^2 + x^4} \, dx \)

b. \( \int \frac{1}{\sqrt{4-9x^2}} \, dx \)

c. \( \int \frac{4 + x}{\sqrt{1 - 9x^2}} \, dx \)

d. \( \int_0^{\ln 2} \frac{e^t}{1 + e^{2t}} \, dt \)

e. \( \int \frac{e^{2t}}{1 + e^{2t}} \, dt \)
1. The population $P(t)$, at time $t$, hours of a bacteria is given by $P(t) = 5e^{2t}$ in thousands.

   (a) What is the initial population of the bacteria?

   (b) Give a formula for the growth rate of the population of the bacteria.

   (c) What did you observe about the growth rate?

   (d) Explain what is meant by the doubling time for the population. Find this time.

**Exponential Growth and Decay (5.8).** A quantity $y$ is said to grow or decay exponentially with growth constant $k$ if $y$ satisfies the following differential equation:

Moreover, if $C$ is the initial value of $y$, $y(t) =$

2. It is known that radioactive substances decays exponentially. If the half-life of Polonium-210 is about 138 days, find its decay constant.

3. A cypress beam found in the tomb of Sneferu in Egypt contained 55% of the amount of Carbon-14 found in living cypress wood. Estimate the age of the tomb given that Carbon-14 has a half-life of 5730 years.

**Area Between Two Curves (6.1).** Assuming that $f(x) > g(x)$ for $a \leq x \leq b$, find the area between the curves $y = f(x)$ and $y = g(x)$ using Riemann sum. Draw a picture below representing the area you found and its integral formula.

Area =

4. Find the area enclosed by the graphs of $y = x^3 - x$ and $y = 3x$. Give a sketch of the graphs first.

5. Find the area bounded between the two curves $x = \sin y$ and $x = \sin 2y$ for $0 \leq y \leq \pi$. (You may use the identity $\sin 2y = 2 \sin y \cos y$.)
1. Find the volume of the solid shown below by integrating the area of vertical cross-section perpendicular to the $x$-axis.

2. Consider a solid whose base is the region bounded by the lines $y = x^3$, $y = 8$, and the $y$-axis. Find the volume of the solid in each of the following cases:

   a. The cross sections perpendicular to the $y$-axis are squares.
   
   b. The cross sections perpendicular to the $y$-axis are rectangles of height $\sqrt{y}$.
   
   c. The cross sections perpendicular to the $y$-axis are semicircles.