1. Differentiate the following:

\[ \frac{d}{dq} \cos(q) = -\sin(q) \]

\[ \frac{d^2}{dy^2}(y^5 + 4y) = \frac{d}{dq}(5y^4 + 4) = 20y^3 \]

2. Solve the following integrals:

\[ \int \frac{1}{r} \, dr = \ln(r) + C \]

\[ \int_{0}^{\pi} \sin(\omega) \, d\omega = -\cos(\omega) \bigg|_{0}^{\pi} = (-1) + 1 = 2 \]

\[ \int_{0}^{\tau} e^{-3t} \, dt = -\frac{1}{3} e^{-3\tau} \bigg|_{0}^{\tau} = -\frac{1}{3} e^{-3\tau} + \frac{1}{3} \]

(Evaluate at \( \tau \to \infty \) \( \to \frac{1}{3} \))

3. Solve the following for \( f(x) \):

\[ \frac{df}{dx} = 4 \quad f(x) = \int 4 \, dx = 4x + C \]

\[ \frac{df}{dx} = x \quad f(x) = \int x \, dx = \frac{1}{2} x^2 + C \]

4. Evaluate or re-express the following:

\[ \frac{e^{2x}}{e^{-4x}} = \exp(6x) \]

\[ \ln(x/y) + \ln(y) - \ln(z) \]

\[ \sin^2(\theta) + \cos^2(\theta) = 1 \]
5. Sketch the following two functions and label any descriptive features:

\[ f(x) = 1 - \exp(-x) \quad \text{and} \quad g(y) = \tan(y) \]

6. The mixer drawn below combines two streams containing A, B and the infamous C. Assuming steady state operation, what is the rate and composition of the unknown stream?

\[
\begin{align*}
\text{Accumulation} &= \text{Input} - \text{Output} + \text{Generation} - \text{Consumption} \\
\text{Total:} &\quad 0 = 40 \text{ kg/hr} + n - 100 \text{ kg/hr} \quad \Rightarrow \quad n = 60 \text{ kg/hr}
\end{align*}
\]

**Balance on A:** \[ 0 = 20 \text{ kg/hr} + m_A n - 25 \text{ kg/hr} \quad \Rightarrow \quad m_A = \frac{5}{60} = 0.08 \]

**Balance on B:** \[ 0 = m_B n - 25 \text{ kg/hr} \quad \Rightarrow \quad m_B = \frac{25}{60} = 0.42 \]

**Balance on C:** \[ 0 = 20 \text{ kg/hr} + m_C n - 50 \text{ kg/hr} \quad \Rightarrow \quad m_C = \frac{30}{60} = 0.5 \]

So, the unknown stream flows at **60 kg/hr and is 8% A, 42% B and 50% C**