

Daily Integral

Jar Jar Binks

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1 Easy

Problem 1. Evaluate the following

$$\int_0^2 \frac{x^3}{x^2 + 4} dx$$

$$x = 2 \tan \theta$$

$$dx = 2 \sec^2 \theta d\theta$$

$$x = 0$$

$$u = 0$$

$$x = 2$$

$$u = \frac{\pi}{4}$$

Now we can transform the integral from

$$\begin{aligned} \int_0^2 \frac{x^3}{x^2 + 4} dx &= 2 \int_0^{\pi/4} \frac{8 \tan^3 \theta \sec^2 \theta}{4 \tan^2 \theta + 4} d\theta \\ &= 4 \int_0^{\pi/4} \tan^3 \theta d\theta \\ &= 4 \int_0^{\pi/4} \tan \theta (\sec^2 \theta - 1) d\theta \\ &= 4 \int_0^{\pi/4} \tan \theta \sec^2 \theta - \tan \theta d\theta \\ &= 4 \int_0^{\pi/4} \tan \theta \frac{d[\tan \theta]}{d\theta} d\theta + 4 \int_0^{\pi/4} \frac{-\sin \theta}{\cos \theta} d\theta \\ &= 2 \left[\tan^2 \theta \right]_0^{\pi/4} + 4 \left[\ln \cos \theta \right]_0^{\pi/4} \\ &= 2 + 4 \ln \left(\frac{1}{2} \right)^{1/2} \\ &= 2 - \ln 4 \end{aligned}$$