# Math Diversion 976

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December 20, 2025

Mental toughness is essential to success.
— Vince Lombardi

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Source: The Ether of Great Mathematical Ideas
Title:  An easy indefinite integral
 Presenter: Patrick
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## 1 Problem

Perform the indefinite integral

$$I = \int x^3 e^{x^2}\, dx\,. \tag{1}$$

## 2 Solution

Let's try an likely expression to differentiate first!

$$D_x\left(x^2 e^{x^2}\right) = 2x e^{x^2} + 2x^3 e^{x^2}\,. \tag{2}$$

Now, integrate through:

$$x^2 e^{x^2} = 2\int x e^{x^2}\, dx + 2I\,. \tag{3}$$

On solving for $I$:

$$I = \tfrac{1}{2}x^2 e^{x^2} - \int x e^{x^2}\, dx\,. \tag{4}$$

But

$$\int x e^{x^2}\, dx = \tfrac{1}{2}\int e^{x^2}\, d(x^2) = \tfrac{1}{2}e^{x^2}\,. \tag{5}$$

On using this result in (4), we have that

$$I = \tfrac{1}{2}x^2 e^{x^2} - \tfrac{1}{2}e^{x^2} + C = \tfrac{1}{2}(x^2-1)e^{x^2} + C\,. \tag{6}$$