

Differentiation of standard functions

Objectives:

- ◇ Learn what the derivatives are of some frequently used functions, like x^n and $\sin(x)$
- ◇ Be able to evaluate use a 'Table of standard derivatives' to work out derivatives of functions

Key points:

You won't be expected to memorize all derivatives of all functions you ever come across. **But** there are some very popular functions it is worth knowing the derivatives of.

The skill you are trying to learn is to identify a function you are given with a pattern you can see in a 'Table of standard derivatives'.

For example, the function $f(x) = 7x^3$ is an example of pattern kx^n with $k = 7$, $n = 3$ so knowing that $\frac{d(kx^n)}{dx} = knx^{n-1}$ allows you to deduce that $\frac{d(7x^3)}{dx} = 21x^2$.

As a second example, if $g(x) = \ln\left(\frac{x}{\pi}\right)$ then you have an example of a function of the pattern: $\ln(kx)$, with $k = \pi^{-1}$ (or $\frac{1}{\pi}$). Hence, knowing $\frac{d\ln(kx)}{dx} = 1/x$ means that $\frac{dg}{dx} = \frac{1}{x}$.

You need to be pretty competent with using powers to accurately find derivatives, so some practice with terms like x^{-2} and $x^{-3/2}$ may be useful.

One key fact is that you can differentiate a **sum of terms** all separately and add the answers together. **Warning: You cannot do the same with products** (you will learn the 'product rule' used in this case in later studies).

Differentiation also doesn't have to be about the variable x . Lots of examples use x as the variable, but sometimes it might be y or t or some other letter. The letter on the bottom of the derivative symbol tells you the variable to be using. So,

$$\frac{d(x^3 + x^{-3})}{dx} = 3x^2 - 3x^{-4} \quad \text{and} \quad \frac{d(t^3 + t^{-3})}{dt} = 3t^2 - 3t^{-4}$$

Final warning: when differentiating $\sin(x)$ and $\cos(x)$ **you must use radians** not degrees.

Recommended links:

Highly recommended: HELM notes (Excellent resource, including engineering examples)

Highly recommended: Table of derivatives Rules for differentiating (Engineering First Aid Kit Handouts – table of standard derivatives, and rules for differentiation)

Other links: Mathtutor notes (more mathematically formal discussions)