

Section 2: Differentiating trigonometric functions

Solutions to Exercise level 1

$$1. \text{ (i) } y = \sin 4x \Rightarrow \frac{dy}{dx} = 4 \cos 4x$$

$$\text{(ii) } y = \cos 3x \Rightarrow \frac{dy}{dx} = -3 \sin 3x$$

$$\text{(iii) } y = \tan 2x \Rightarrow \frac{dy}{dx} = 2 \sec^2 2x$$

$$2. \text{ (i) } y = x^2 \sin x$$

$$\text{Let } u = x^2 \Rightarrow \frac{du}{dx} = 2x$$

$$\text{Let } v = \sin x \Rightarrow \frac{dv}{dx} = \cos x$$

$$\begin{aligned} \text{using the product rule: } \frac{dy}{dx} &= u \frac{dv}{dx} + v \frac{du}{dx} \\ &= x^2 \cos x + 2x \sin x \end{aligned}$$

$$\text{(ii) } y = \frac{\cos x}{1+x}$$

$$\text{Let } u = \cos x \Rightarrow \frac{du}{dx} = -\sin x$$

$$\text{Let } v = 1+x \Rightarrow \frac{dv}{dx} = 1$$

$$\begin{aligned} \text{using the quotient rule: } \frac{dy}{dx} &= \frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2} \\ &= \frac{(1+x) \times -\sin x - \cos x \times 1}{(1+x)^2} \\ &= \frac{-(1+x) \sin x - \cos x}{(1+x)^2} \end{aligned}$$

$$\text{(iii) } y = \sin(1+x^2)$$

$$\text{Let } u = 1+x^2 \Rightarrow \frac{du}{dx} = 2x$$

$$y = \sin u \Rightarrow \frac{dy}{du} = \cos u$$

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using the chain rule: $\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx} = \cos u \times 2x$
 $= 2x \cos(1 + x^2)$

(iv) $y = \sin^2 x$

Let $u = \sin x \Rightarrow \frac{du}{dx} = \cos x$

$y = u^2 \Rightarrow \frac{dy}{du} = 2u$

using the chain rule: $\frac{dy}{dx} = 2u \cos x = 2 \sin x \cos x$

(v) $y = \cos^3 4x$

Let $u = \cos 4x \Rightarrow \frac{du}{dx} = -4 \sin 4x$

$y = u^3 \Rightarrow \frac{dy}{du} = 3u^2$

using the chain rule: $\frac{dy}{dx} = 3u^2 \times -4 \sin 4x = -12 \cos^2 4x \sin 4x$

(vi) $y = e^{\tan x}$

Let $u = \tan x \Rightarrow \frac{du}{dx} = \sec^2 x$

$y = e^u \Rightarrow \frac{dy}{du} = e^u$

using the chain rule: $\frac{dy}{dx} = e^u \times \sec^2 x = e^{\tan x} \sec^2 x$

(vii) $y = \ln(\cos x)$

Let $u = \cos x \Rightarrow \frac{du}{dx} = -\sin x$

$y = \ln u \Rightarrow \frac{dy}{du} = \frac{1}{u}$

using the chain rule: $\frac{dy}{dx} = \frac{1}{u} \times -\sin x = -\frac{\sin x}{\cos x} = -\tan x$

(viii) $y = e^{2x} \sin x$

Let $u = e^{2x} \Rightarrow \frac{du}{dx} = 2e^{2x}$

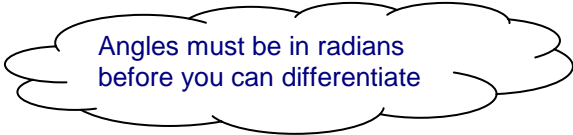
Let $v = \sin x \Rightarrow \frac{dv}{dx} = \cos x$

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using the product rule: $\frac{dy}{dx} = 2e^{2x} \sin x + e^{2x} \cos x$
 $= e^{2x}(2 \sin x + \cos x)$

3. $y = \cos x^\circ = \cos \frac{\pi x}{180}$

using the chain rule, $\frac{dy}{dx} = -\frac{\pi}{180} \sin \frac{\pi x}{180} = -\frac{\pi}{180} \sin x^\circ$



Angles must be in radians
before you can differentiate