

In this investigation, you will use either:

- (1) Symbolab at <https://www.symbolab.com/> or
- (2) Wolfram Alpha <https://www.wolframalpha.com/examples/mathematics/calculus-and-analysis/>

PART A - Derivatives of composite functions

1. We know:

- a. the derivatives of polynomial based functions as well as any functions in the form of $f(x) = x^n$ using the power rule.
- b. the derivative of sinusoidal functions, $y = \sin(x)$ and $y = \cos(x)$
- c. the derivative of the exponential function, $y = e^x$.

2. Use Symbolab or Wolframalpha to determine the derivatives of the following functions.

- a. $y = (x^3 - 2x)^4$
- b. $y = (4x^3 - x)^{-2}$
- c. $y = \sin(x^2)$
- d. $y = \sin\left(\frac{1}{x}\right)$
- e. $y = \cos(x^4 - x^3)$
- f. $y = \cos(e^x)$
- g. $y = e^{x^3}$
- h. $y = e^{x^4 - x^3}$
- i. $y = \sqrt{\cos(x)}$
- j. $y = (\sin x)^2$ or also written as $y = \sin^2(x)$

3. Now that you have determined the derivatives of the given functions, explain any patterns in the derivatives that you notice. Hence, propose a conjecture as to how to take derivatives of the composite function $y = f(g(x))$

PART B - Derivatives of products of functions

4. Use Symbolab or Wolframalpha to determine the derivatives of the following functions.

- $y = x^2 \sin(x)$
- $y = \left(\frac{1}{x}\right) \sin(x)$
- $y = (x^4 - x^3) \cos(x)$
- $y = e^x \cos(x)$
- $y = x^3 e^x$
- $y = (x^4 - x^3) e^x$

5. Now that you have determined the derivatives of the given functions, explain any patterns in the derivatives that you notice. Hence, propose a conjecture as to how to take derivatives of the product of 2 functions: $y = f(x) \times g(x)$

6. Practice: Q3,acdegh and Q7acdeghjkn

3. Differentiate the following

- | | | | | | |
|-----|-------------------------------|-----|-----------------|-----|--------------------|
| (a) | $e^x \sin x$ | (b) | $x \log_e x$ | (c) | $e^x(2x^3 + 4x)$ |
| (d) | $x^4 \cos x$ | (e) | $\sin x \cos x$ | (f) | $(1 + x^2) \tan x$ |
| (g) | $\frac{4}{x^2} \times \sin x$ | (h) | $x e^x \sin x$ | (i) | $x e^x \log_e x$ |

7. Differentiate the following

- | | | | | | | | |
|-----|----------------------|-----|-----------------------|-----|-------------------------|-----|----------------------|
| (a) | e^{2x+1} | (b) | $2e^{4-3x}$ | (c) | $2e^{4-3x^2}$ | (d) | $\sqrt{e^x}$ |
| (e) | $e^{\sqrt{x}}$ | (f) | $\frac{1}{2}e^{2x+4}$ | (g) | $\frac{1}{2}e^{2x^2+4}$ | (h) | $\frac{2}{e^{3x+1}}$ |
| (i) | e^{3x^2-6x+1} | (j) | $e^{\sin(\theta)}$ | (k) | $e^{-\cos(2\theta)}$ | (l) | $e^{2 \log_e(x)}$ |
| (m) | $\frac{2}{e^{-x}+1}$ | (n) | $(e^x - e^{-x})^3$ | (o) | $\sqrt{e^{2x+4}}$ | (p) | e^{-x^2+9x-2} |