1. In the following quiz, you'll apply the rules you learned in the previous videos to differentiate some functions.

We learned how to differentiate polynomials using the power rule: $\frac{d}{dx}\left(ax^b\right) = abx^{b-1}$. It might be helpful to remember this as 'multiply by the power, then reduce the power by one'.

Using the power rule, differentiate $f(x) = x^{173}$.

- ⭘ $f'(x) = 172x^{173}$
- ⭘ $f'(x) = 173x^{172}$
- ⭘ $f'(x) = 174x^{172}$
- ⭘ $f'(x) = 171x^{173}$

Using the power rule, differentiate $f(x) = x^{173}$.

- ⭘ $f'(x) = 172x^{173}$
- ⦿ $f'(x) = 173x^{172}$
- ⭘ $f'(x) = 174x^{172}$
- ⭘ $f'(x) = 171x^{173}$

✓ Correct

The power rule makes differentiation of terms like this easy, even for large and scary looking values of b.

2. The videos also introduced the sum rule: $\frac{d}{dx}\left[f(x) + g(x)\right] = \frac{df(x)}{dx} + \frac{dg(x)}{dx}$.

This tells us that when differentiating a sum we can just differentiate each term separately and then add them together again. Use the sum rule to differentiate $f(x) = x^2 + 7 + \frac{1}{x}$

- ⭘ $f'(x) = 2x + \frac{1}{x^2}$
- ⭘ $f'(x) = 2x + 7 - \frac{1}{x^2}$
- ⭘ $f'(x) = 2x + \frac{1}{x}$
- ⦿ $f'(x) = 2x - \frac{1}{x^2}$

✓ Correct

The sum rule allows us to differentiate each term separately.

3. In the videos we saw that functions can be differentiated multiple times. Differentiate the function $f(x) = e^x + 2\sin(x) + x^3$ twice to find its second derivative, $f''(x)$.

○ $f''(x) = xe^{x-1} - 2\cos(x) + 6x$

○ $f''(x) = e^x + 2\cos(x) + 3x^2$

○ $f''(x) = e^x + \sin(x) + 3x^2$

◉ $f''(x) = e^x - 2\sin(x) + 6x$

⊘ **Correct**
You used the sum rule, power rule and knowledge of some specific derivatives to calculate this. Well done!

4. Previous videos introduced the concept of an anti-derivative. For the function $f'(x)$, it's possible to find the anti-derivative, $f(x)$, by asking yourself what function you'd need to differentiate to get $f'(x)$. For example, consider applying the "power rule" in reverse: You can go from the function abx^{b-1} to its anti-derivative ax^b.

Which of the following could be anti-derivatives of the function $f'(x) = x^4 - \sin(x) - 3e^x$? (Hint: there's more than one correct answer...)

☑ $f(x) = \frac{1}{5}x^5 + \cos(x) - 3e^x + 4$

⊘ **Correct**
Differentiating $f(x)$ gives the intended $f'(x)$. We also see that when calculating anti-derivatives we can add any constant, since the derivative of a constant is zero. We might write this as $f(x) = \frac{1}{5}x^5 + \cos(x) - 3e^x + c$, where c can be any constant.

☑ $f(x) = \frac{1}{5}x^5 + \cos(x) - 3e^x - 12$

⊘ **Correct**
Differentiating $f(x)$ gives the intended $f'(x)$. We also see that when calculating anti-derivatives we can add any constant, since the derivative of a constant is zero. We might write this as $f(x) = \frac{1}{5}x^5 + \cos(x) - 3e^x + c$, where c can be any constant.

☐ $f(x) = 4x^3 - \cos(x) - 3e^x$

☐ $f(x) = 5x^5 - \sin(x) + 3e^x + 7$

☐ $f(x) = \frac{1}{5}x^5 - \cos(x) - 3e^x + 1$

5. The power rule can be applied for any real value of b. Using the facts that $\sqrt{x} = x^{\frac{1}{2}}$ and $x^{-a} = \frac{1}{x^a}$, calculate $\frac{d}{dx}\left(\sqrt{x}\right)$.

- ⦿ $\frac{d}{dx}\left(\sqrt{x}\right) = \frac{1}{2\sqrt{x}}$
- ◯ $\frac{d}{dx}\left(\sqrt{x}\right) = -\frac{1}{2\sqrt{x}}$
- ◯ $\frac{d}{dx}\left(\sqrt{x}\right) = \frac{1}{2}\sqrt{x}$
- ◯ $\frac{d}{dx}\left(\sqrt{x}\right) = \frac{2}{x^2}$

✓ Correct

This can also be useful when the power is a negative number. If you'd like to you can check that the power rule agrees with the derivative of $\frac{1}{x}$ that you've already seen.