1. **Review:** How do you differentiate each of the following (all involving some type of powers)?

   (a) $\frac{d}{dx} x^5 = 5x^4$  \hspace{2cm} \text{Power Rule}

   (b) $\frac{d}{dx} (1-4x)^{-3} = -3(1-4x)^{-4} \frac{d}{dx} (1-4x) = -3(1-4x)^{-4} (-4) = 12(1-4x)^{-4}$  \hspace{2cm} \text{Power Rule and Chain Rule}

   (c) $\frac{d}{dx} (e^x) = e^x$

   (d) $\frac{d}{dx} \left( \frac{3x^5}{e^{10}} \right) = e^{10} \cdot \frac{d}{dx} \left( \frac{3x^5}{e^{10}} \right) = e^{10} \cdot \left( \frac{3}{10} \cdot 5x^4 \right) = \frac{3}{2} e^{10} \cdot x^4$

   (e) $\frac{d}{dx} (\ln x^4) = \frac{d}{dx} (4 \ln x) = 4 \cdot \frac{1}{x} = \frac{4}{x}$  \hspace{2cm} \text{ln and constant multiple}

   (f) $\frac{d}{dx} (\ln (2x-3)^{-1}) = \frac{d}{dx} \left( -4 \ln (2x-3) \right) = -4 \cdot \frac{1}{2x-3} \cdot \frac{d}{dx} (2x-3) = -8 \cdot \frac{1}{2x-3}$  \hspace{2cm} \text{ln and chain rule}

   (g) $\frac{d}{dx} (\ln x)^6 = 6 \cdot (\ln x)^5 \cdot \frac{d}{dx} (\ln x) = \frac{6(\ln x)^5}{x}$  \hspace{2cm} \text{Chain Rule and power rule with \ln}

2. **New:** How do you differentiate a constant to a variable power or a variable to a variable power?

   **LOG DIFFERENTIATION**

   In order to do this, you must set your problem equal to $y$.

   Remember that you made up the $y$, so you do not want any $y$'s in your answers.

   (a) $\frac{d}{dx} (2^x) = 2^x \ln 2$

   (b) $\frac{d}{dx} (3^{10x}) = 3^{10x} \ln 3 \cdot 10x^9$

   (c) $\frac{d}{dx} (x^x) = x^x \ln x + x^x \frac{1}{x}$

   $\frac{d}{dx} (e^{10x}) = e^{10x} \cdot 10x^9$  \hspace{2cm} \text{Constant}

   $\frac{d}{dx} (\ln x^4) = \frac{4}{x}$  \hspace{2cm} \text{Constant}

   $\frac{d}{dx} (\ln (2x-3)^{-1}) = -8 \cdot \frac{1}{2x-3}$  \hspace{2cm} \text{Constant}

   $\frac{d}{dx} (\ln x)^6 = \frac{6(\ln x)^5}{x}$  \hspace{2cm} \text{Constant}
Problems involving \(e^{u(x)}\), \(\ln(u(x))\), \(a^{u(x)}\), and \(x^{u(x)}\); find the derivative of each.

1. \(y = x^{2x}\)
2. \(y = 3^x\)

3. \(f(x) = x^{lnx}\)
4. \(f(x) = 4^x\)

5. If \(y = a^{u(x)}\), where \(a\) is a constant, derive a rule for \(y'\).
   (In the future, you may use your rule, or simply use log differentiation to avoid memorizing one more rule. Your choice!)

6. \(y = \ln\left(x\sqrt{x^2 - 4}\right)\)
7. \(y = \ln\left(\frac{x-1}{x+1}\right)\)

8. \(f(x) = \frac{x(2x-1)^{3/2}}{\sqrt{4-3x}}\)