1. Determine whether the following statements are true or false, giving an explanation or a counterexample.

   (a) The slope of the tangent line to $f(x) = e^x$ is never zero.

   (b) $f(x) = e^x$ is the only function such that $f'(x) = f(x)$ for all x.

   (c) $\frac{d}{dx}e^x = xe^{x-1}$

   (d) The nth derivative $\frac{d^n}{dx^n}x^3 + 2x = 9$ equals 0 for any integer $n \geq 3$.

   (e) $\frac{d}{dx}\left(\frac{x^2-4}{x+2}\right) = \frac{2x}{1} = 2x$

2. Find the equation of the tangent line to the given function at $x = a$.

   (a) $y = 2e^x - 4x^2 + 3x; \qquad a = 0$

   (b) $f(x) = 4x^2 - 3x + 1; \qquad a = 2$

3. Let

$$f(x) = \begin{cases} x^2 - 2 & x \geq 2; \\ 3x - 4 & x < 2. \end{cases}$$

   (a) Is f continuous?

   (b) Find a formula giving the slope of the secant line intersecting $f(x)$ when $x = 2$ and $x = 2 + h$. You should have different answers for $h < 0$ and $h > 0$. Why?

   (c) Find the limit of these slopes as $h \to 0^-$ and $h \to 0^+$.

   (d) Is f differentiable?

4. Do each problem in two ways: use the product or quotient rule, and then rewrite the function and apply the power rule.

   (a) $f(t) = (2t + 1)(t^2 - 2)$

   (b) $h(t) = \frac{t^2 - 1}{t - 1}$

5. Derive the derivatives of $\sec x$, $\csc x$, $\tan x$, and $\cot x$ given

$$\frac{d}{dx}\sin x = \cos x \qquad \frac{d}{dx}\cos x = -\sin x.$$

6. Use the limit definition to show that if $f(x)$ is differentiable and $f(x) \neq 0$, then $1/f(x)$ is differentiable and

$$\frac{d}{dx}\left(\frac{1}{f(x)}\right) = -\frac{f'(x)}{f^2(x)}$$

   Can you use this fact plus the product rule to prove the full quotient rule?