1.) a) Using the limit definition of the derivative, compute $f'(x)$ if $f(x) = \frac{3}{5 - 2x}$.

b) Find the equation of the tangent line to $f$ at $x = 2$.

2.) Given that $f(0) = 2$, $g(0) = 3$, $f'(0) = 5$, $g'(0) = 7$, and $f'(3) = \pi$ compute the following.
   a) $h'(0)$ if $h(x) = f(x)g(x)$

   b) $j'(0)$ if $j(x) = \frac{f(x)}{g(x)}$

   c) $k'(0)$ if $k(x) = f(g(x))$

3.) a) Sketch a graph of a continuous function whose derivative is discontinuous at exactly two points.

b) Sketch a graph of a function which is always positive and decreasing and which satisfies the following:
   \[ \lim_{x \to -\infty} f(x) = \infty; \lim_{x \to \infty} f(x) = 2; \lim_{x \to 1^-} f(x) = 5; \lim_{x \to 1^+} f(x) = 4 \]
4.) Compute $dy/dx$ for each of the following.

a) $y = x^{2004} + 2004x + e^{2004} + \frac{x}{2004} + \ln (2004x) + \text{arctan}(2004x) + \ln(2004)$

b) $y = \sqrt{x} \cos(7x^3)$

c) $y = \frac{e^x + \pi}{\sin 4 - 7x}$

d) $y = \tan(e^{x^2 \text{arcsin}(5x)})$

e) $y^3 + yx^2 + x^2 = 3y^2$ (trisectrix)

5.) Evaluate the following limits.

a) $\lim_{x \to \infty} \frac{x^2}{\ln x}$

b) $\lim_{x \to 0} \frac{\sin (12x) - 12x}{x^3}$

c) $\lim_{x \to 0} \frac{e^x - 1}{\cos x}$

d) $\lim_{x \to 5} \frac{35 - 7x}{2x - 10}$

e) $\lim_{x \to 0} \frac{1}{x}$

f) $\lim_{x \to 0} \frac{1}{x}$
6.) Find the local linearization of $f(x) = \sqrt[3]{x}$ at $a = 27$ and use it to estimate the value of $\sqrt[3]{25}$. Is your estimate too large or too small?

7.) You are standing on a pier, 6 feet above the deck of a boat. Attached to the deck is a line, which you are pulling in at a rate of 3 feet per second. When there are 10 feet of line between your hand and the boat, at what rate is the boat moving across the water?
8.) For the graph of $f$ shown, carefully sketch a graph of $f'$ on the axes below. As an aid, fill in the table below and make sure your graph agrees with the entries in the table.

<table>
<thead>
<tr>
<th>$f$</th>
<th>$f'$ positive</th>
<th>$f'$ negative</th>
<th>$f'$ increasing</th>
<th>$f'$ decreasing</th>
<th>$f''$ concave up</th>
<th>$f''$ concave down</th>
</tr>
</thead>
</table>

9.) The graph shown is of $f'$, NOT $f$. At which labelled point is

a) $f$ greatest?

b) $f$ least?

c) $f'$ greatest?

d) $f'$ least?

e) $f''$ greatest?

f) $f''$ least?

g) $f$ increasing most rapidly?

h) $f$ decreasing most rapidly?

On what interval(s) is

i) $f$ increasing?

j) $f'$ increasing?

k) $f$ concave up?

See old exams and quizzes at http://abacus.bates.edu/~etowne/mathresources.html