1. Consider the function $f$ whose graph is shown below.

(a) Which of the following could be a tangent line for (the graph of) $f$?

(A) $y - 1 = 1(x - 1)$  
(B) $y = 2(x - 1)$  
(C) $y = -x$

(D) $y = -2(x - 2)$  
(E) $y - 1 = -x$

(b) Again referring to the $f$ in problem 1, over which interval is $f$ decreasing? Circle all the options that apply.

(A) $[-4, -2]$  
(B) $[-1, 1]$  
(C) $[0, 3]$  
(D) $[2, 3]$  
(E) $[3, 4]$
2. A function $g$ has a derivative whose graph is shown below. Recall that some problems may have several correct answers. Circle them all.

(a) At which of the following points is it true that $g'$ is increasing? Circle all that apply.

(A) $-4$  (B) $-3$  (C) $-1$  (D) $1$  (E) $2$

(b) At which of the following points is it true that $g$ is increasing?

(A) $-4$  (B) $-3$  (C) $-1$  (D) $1$  (E) $2$

(c) Again referring to the graph of $g'$ above, at which of the points could $g''(x)$ have the value zero?

(A) $-4$  (B) $-3$  (C) $-1$  (D) $0$  (E) $1$

(d) Again referring to the graph of $g'$ above, at which of the points could $g'''(x)$ have the value zero?

(A) $-4$  (B) $-3$  (C) $-1$  (D) $1$  (E) $2$

3. An amount of $2000 is invested at $r\%$ interest compounded continuously. After four years, the account has grown to $2800. Assuming that it continues to grow at this rate for 16 more years, how much will be in the account?

(A) $8976.47$  (B) $9874.23$  (C) $10001.99$

(D) $10756.48$  (E) $2004.35$

4. For each of the next five problems, refer to the table below.
(a) Which of the following is an equation for the line tangent to the graph of $f$ at the point $(2, f(2))$?

(A) $y - 6 = 4(x - 2)$  
(B) $y - 4 = 2(x - 6)$  
(C) $y - 2 = 4(x - 6)$  
(D) $y - 6 = 2(x - 4)$  
(E) $y - 2 = 6(x - 4)$

(b) What is the value of $f(g(f(g(3))))$?

(A) 1  
(B) 2  
(C) 3  
(D) 4  
(E) 5

(c) What is the value of $f'(g(f'(g'(1))))$?

(A) 1  
(B) 2  
(C) 3  
(D) 4  
(E) 5

(d) Let $h(x) = \frac{d}{dx} f \circ g$. What is the value of $h(3)$?

(A) 6  
(B) 8  
(C) 9  
(D) 12  
(E) 15

(e) Let $k(x) = g \circ f$. What is the value of $k'(2)$?

(A) 6  
(B) 8  
(C) 9  
(D) 12  
(E) 16

(f) What is the slope of the line joining the points $(1, f(1))$ and $(2, g(2))$?

(A) $-1$  
(B) 0  
(C) 1  
(D) 2  
(E) 3

5. (40 points) This question is about building more complicated functions from simpler ones. Let $f(x) = x^2$, $g(x) = \sqrt{x}$, $h(x) = x + 1$, $k(x) = 1/x$ and $l(x) = x - 2$. For each function given below, show how it is possible to combine some of the simpler functions above to obtain the given one. For example, if $U(x) = \sqrt{x^2 - 2}$ was given, you could write $U(x) = g \circ l \circ f(x)$, and if $V(x) = ((x + 1)/x)^2$, you could write $V(x) = f \circ (h \cdot k)(x)$.

(a) $H(x) = \left(\frac{1}{x^2 - 2}\right)^2 + 1$

(b) $G(x) = \left(\frac{1}{x^2 - 2} + 1\right)^2$

(c) $L(x) = \frac{x + 1}{x^2 - 2} - 2$
(d) \( K(x) = \frac{1}{(x+1)^2 - 2} \)

(e) \( N(x) = \sqrt{(x - 2)^2 + 1} \)
6. (30 points) Let \( R(x) \) be the rational function defined by
\[
R(x) = \frac{(x + 3)(x - 4)(2x - 7)}{(x + 1)^2(x - 1)}.\]

(a) At which of the following points is \( R \) positive? Circle all the apply.
(A) \(-5\) (B) \(-3\) (C) \(-2\) (D) \(0\) (E) \(3\)

(b) At which of the following points does \( R \) change signs? Circle all the apply.
(A) \(-3\) (B) \(-1\) (C) \(1\) (D) \(7/2\) (E) \(4\)

(c) What is \( \lim_{x \to \infty} R(x) \)?
(A) \(0\) (B) \(1\) (C) \(2\) (D) \(3\) (E) This limit does not exist

7. (30 points) Suppose we know that the function \( f \) has been differentiated and that \( f'(x) = 2x(x^2 - 3)^4 \). Also, the point \((2, 1/5)\) belongs to the graph of \( f \).

(a) Find an equation for the line tangent to the graph of \( f \) at the point \((2, 1/5)\).

(b) Find \( f(1) \). Hint: \( f \) is an antiderivative of \( f' \).

(c) Find the area of the region \( R \) bounded above by the graph of \( f'(x) \), below, by the \( x \)-axis and on the sides by the lines \( x = 0 \) and \( x = 1 \).

8. (42 points)

(a) \( \int 4x - 5 \, dx \)

(b) \( \int 9x^2 - 4x - 1/x \, dx \)

(c) \( \int \frac{x^3 + 2x^2 - x}{x} \, dx \)

(d) \( \int \frac{2x + 3}{x^2 + 3x - 3} \, dx \)

(e) \( \int 6x^5(x^6 + 3)^7 \, dx \)

(f) \( \int x^2e^{x^3} \, dx \)

9. (10 points) Find an equation for the line tangent to the graph of \( f(x) = x \ln(x) - x \) at the point \((1, f(1))\).

10. (30 points) Let \( g(x) = (x - 1)(x + 1)(x - 3) \) and let \( f(x) = 2(x - 1)(x - 3) \).
(a) Find the two values of $x$ for which $f(x) = g(x)$. In other words, where do the graphs intersect. Hint: solve $g(x) - f(x) = 0$.

(b) Set up an integral whose value is the area of the bounded region $R$ caught between the two graphs.

(c) Evaluate this integral to find the area of $R$. 