1. (Calculator Permitted) Let \( f \) be the function given by \( f(x) = 3e^{2x} \) and let \( g \) be the function given by \( g(x) = 6x^3 \). At what value of \( x \) do the graphs of \( f \) and \( g \) have parallel tangent lines?

   (A) \(-0.701\)  (B) \(-0.567\)  (C) \(-0.391\)  (D) \(-0.302\)  (E) \(-0.258\)

2. The radius of a circle is decreasing at a constant rate of 0.1 centimeters per second. In terms of the circumference \( C \), what is the rate of change of the area of the circle, in square centimeters per second?

   (A) \(-(0.2)\pi C\)  (B) \(-(0.1)C\)  (C) \(\frac{(0.1)C}{2\pi}\)  (D) \((0.1)C\)  (E) \((0.1)^2\pi C\)

3. (Calculator Permitted) The first derivative of a function \( f \) is given by \( f'(x) = \frac{\cos^2 x}{x} - \frac{1}{5} \). How many critical values does \( f \) have on the open interval \((0,10)\)?

   (A) One  (B) Three  (C) Four  (D) Five  (E) Seven

4. \( \lim_{x \to \infty} \frac{(2x-1)(3-x)}{(x-1)(x+3)} \) is

   (A) \(-3\)  (B) \(-2\)  (C) 2  (D) 3  (E) nonexistent
5. Let \( f \) be the function given by \( f(x) = |x| \). Which of the following statements about \( f \) are true?

I. \( f \) is continuous at \( x = 0 \).
II. \( f \) is differentiable at \( x = 0 \).
III. \( f \) has an absolute minimum at \( x = 0 \).

(A) I only          (B) II only         (C) III only         (D) I and III only         (E) II and III only

6. If \( f \) is a continuous function and if \( F'(x) = f(x) \) for all real numbers \( x \), then \( \int_1^3 f(2x)dx = \)

(A) \( 2F(3) - 2F(1) \)       (B) \( \frac{1}{2} F(3) - \frac{1}{2} F(1) \)       (C) \( 2F(6) - 2F(2) \)       (D) \( F(6) - F(2) \)       (E) \( \frac{1}{2} F(6) - \frac{1}{2} F(2) \)

7. The graphs of the derivatives of the functions \( f \), \( g \), and \( h \) are shown above. Which of the functions \( f \), \( g \), or \( h \) have a relative maximum on the open interval \( a < x < b \)?

(A) \( f \) only     (B) \( g \) only     (C) \( h \) only     (D) \( f \) and \( g \) only     (E) \( f \), \( g \), and \( h \)
8. If \( \frac{dy}{dt} = ky \) and \( k \) is a nonzero constant, then \( y \) could be

(A) \( 2e^{kty} \)  (B) \( 2e^{kt} \)  (C) \( e^{kt} + 3 \)  (D) \( kty + 5 \)  (E) \( \frac{1}{2}ky^2 + \frac{1}{2} 

9. If \( f(x) = (x-1)(x^2 + 2)^3 \), then \( f'(x) = \)

(A) \( 6x(x^2 + 2)^2 \)  (B) \( 6(x-1)(x^2 + 2)^2 \)  (C) \( (x^2 + 2)^2(x^2 + 3x - 1) \)

(D) \( (x^2 + 2)^2(7x^2 - 6x + 2) \)  (E) \( -3(x-1)(x^2 + 2)^2 \)

10. A particle moves along the \( x \)-axis with velocity given by \( v(t) = 3t^2 + 6t \) for time \( t \geq 0 \). If the particle is at position \( x = 2 \) at time \( t = 0 \), what is the position of the particle at \( t = 1 \)?

(A) 4  (B) 6  (C) 9  (D) 11  (E) 12
11. (2003, AB-6) Let \( f \) be the function defined by

\[
f(x) = \begin{cases} 
\sqrt{x} + 1 & \text{for } 0 \leq x \leq 3 \\
5 - x & \text{for } 3 < x \leq 5 
\end{cases}
\]

(a) Is \( f \) continuous at \( x = 3 \)? Explain why or why not.

(b) Find the average value of \( f(x) \) on the closed interval \( 0 \leq x \leq 5 \).

(c) Suppose the function \( g \) is defined by

\[
g(x) = \begin{cases} 
k\sqrt{x} + 1 & \text{for } 0 \leq x \leq 3 \\
mx + 2 & \text{for } 3 < x \leq 5 
\end{cases}
\]

where \( k \) and \( m \) are constants. If \( g \) is differentiable at \( x = 3 \), what are the values of \( k \) and \( m \)?
12. (2003B, AB/BC-1) (Calculator Permitted) Let $f$ be the function given by $f(x) = 4x^2 - x^3$, and let $\ell$ be the line $y = 18 - 3x$, where $\ell$ is tangent to the graph of $f$. Let $R$ be the region bounded by the graph of $f$ and the $x$-axis, and let $S$ be the region bounded by the graph of $f$, the line $\ell$, and the $x$-axis, as shown above.

(a) Show that $\ell$ is tangent to the graph of $y = f(x)$ at the point $x = 3$.

(b) Find the area of $S$.

(c) Find the volume of the solid generated when $R$ is revolved about the $x$-axis.