Complete all the following on notebook paper.

1. If \( f(x) = 2x^2 + 1 \), then \( \lim_{x \to 0} \frac{f(x) - f(0)}{x^2} \) is
   \[ \text{(A) } 0 \quad \text{(B) } 1 \quad \text{(C) } 2 \quad \text{(D) } 4 \quad \text{(E) nonexistent} \]

2. If \( p \) is a polynomial of degree \( n \), \( n > 0 \), what is the degree of the polynomial \( Q(x) = \int_0^x p(t) \, dt \)?
   \[ \text{(A) } 0 \quad \text{(B) } 1 \quad \text{(C) } n-1 \quad \text{(D) } n \quad \text{(E) } n+1 \]

3. If \( f(x) = 1 + x^3 \), which of the following is NOT true?
   \[ \text{(A) } f \text{ is continuous for all real numbers.} \]
   \[ \text{(B) } f \text{ has a minimum at } x = 0 \, . \]
   \[ \text{(C) } f \text{ is increasing for } x > 0 \, . \]
   \[ \text{(D) } f'(x) \text{ exists for all } x \, . \]
   \[ \text{(E) } f''(x) \text{ is negative for } x > 0 \, . \]

4. Which of the following functions are continuous at \( x = 1 \)?
   
   I. \( \ln x \)
   II. \( e^x \)
   III. \( \ln(e^x - 1) \)
   \[ \text{(A) I only} \quad \text{(B) II only} \quad \text{(C) I and II only} \quad \text{(D) II and III only} \quad \text{(E) I, II, and III} \]
5. If \( \frac{dy}{dx} = x^2 y \), then \( y \) could be

(A) \( 3 \ln \left( \frac{x}{3} \right) \)  
(B) \( e^3 + 7 \)  
(C) \( 2e^3 \)  
(D) \( 3e^{2x} \)  
(E) \( \frac{x^3}{3} + 1 \)

6. The derivative of \( f \) is \( x^4(x-2)(x+3) \). At how many points will the graph of \( f \) have a relative maximum?

(A) None  
(B) One  
(C) Two  
(D) Three  
(E) Four

7. If \( f(x) = e^{\tan^2 x} \), then \( f''(x) = \)

(A) \( e^{\tan^2 x} \)  
(B) \( \sec^2 x e^{\tan^2 x} \)  
(C) \( \tan^2 x e^{\tan^2 x - 1} \)  
(D) \( 2 \tan x \sec^2 x e^{\tan^2 x} \)  
(E) \( 2 \tan x e^{\tan^2 x} \)

8. The slope of the line tangent to the graph of \( \ln(xy) = x \) at the point where \( x = 1 \) is

(A) \( 0 \)  
(B) \( 1 \)  
(C) \( e \)  
(D) \( e^2 \)  
(E) \( 1 - e \)

9. The value of the derivative of \( y = \frac{3x^2 + 8}{4\sqrt{2x+1}} \) at \( x = 0 \) is

(A) \( -1 \)  
(B) \( -\frac{1}{2} \)  
(C) \( 0 \)  
(D) \( \frac{1}{2} \)  
(E) \( 1 \)
10. A particle moves along the x-axis so that at any time \( t \geq 0 \) the acceleration of the particle is \( a(t) = e^{-2t} \). If at \( t = 0 \) the velocity of the particle is \( \frac{5}{2} \) and its position is \( \frac{17}{4} \), then its position at any time \( t > 0 \) is \( x(t) = \)

(A) \( \frac{e^{-2t}}{2} + 3 \)

(B) \( \frac{e^{-2t}}{4} + 4 \)

(C) \( 4e^{-2t} + \frac{9}{2}t + \frac{1}{4} \)

(D) \( \frac{e^{-2t}}{2} + 3t + \frac{15}{4} \)

(E) \( \frac{e^{-2t}}{4} + 3t + 4 \)

11. 2002—AB3B (Calculator Permitted)
A particle moves along the x-axis so that its velocity \( v \) at any time \( t \) for \( 0 \leq t \leq 16 \) is given by \( v(t) = e^{2 \sin t} - 1 \). At time \( t = 0 \), the particle is at the origin.

(a) On the axes provided, sketch the graph of \( v(t) \) for \( 0 \leq t \leq 16 \).

(b) During what intervals of time is the particle moving to the left? Give a reason for your answer.

(c) Find the total distance traveled by the particle from \( t = 0 \) to \( t = 4 \).

(d) Is there any time \( t, 0 < t \leq 16 \), at which the particle returns to the origin? Justify your answer.

12. 2002—AB4B (No Calculator)
The graph of a differentiable function \( f \) on the closed interval \([-3, 15]\) is shown in the figure above. The graph of \( f \) has a horizontal tangent line at \( x = 6 \). Let \( g(x) = 5 + \int_{6}^{x} f(t) \, dt \) for \(-3 \leq x \leq 15 \).

(a) Find \( g(6) \), \( g'(6) \), and \( g''(6) \).

(b) On what intervals is \( g \) decreasing? Justify your answer.

(c) On what intervals is the graph of \( g \) concave down? Justify your answer.

(d) Find a trapezoidal approximation of \( \int_{-3}^{15} f(t) \, dt \) using six subintervals of length \( \Delta t = 3 \).