Complete all the following on notebook paper.

1. Shown above is a slope field for which of the following differential equations?

   (A) \( \frac{dy}{dx} = 1 + x \)  \hspace{1cm} (B) \( \frac{dy}{dx} = x^2 \)  \hspace{1cm} (C) \( \frac{dy}{dx} = x + y \)  \hspace{1cm} (D) \( \frac{dy}{dx} = \frac{x}{y} \)  \hspace{1cm} (E) \( \frac{dy}{dx} = \ln y \)

2. \( \int_{0}^{1} \sqrt{x(x+1)} \, dx = \)

   (A) 0  \hspace{1cm} (B) 1  \hspace{1cm} (C) \frac{16}{15}  \hspace{1cm} (D) \frac{7}{5}  \hspace{1cm} (E) 2

3. The function \( f \) given by \( f(x) = 3x^5 - 4x^3 - 3x \) has a relative maximum at \( x = \)

   (A) -1  \hspace{1cm} (B) \frac{-\sqrt{5}}{5}  \hspace{1cm} (C) 0  \hspace{1cm} (D) \frac{\sqrt{5}}{5}  \hspace{1cm} (E) 1

4. \( \frac{d}{dx}(xe^{\ln x^2}) = \)

   (A) 1 + 2x  \hspace{1cm} (B) \( x + x^2 \)  \hspace{1cm} (C) 3x^2  \hspace{1cm} (D) x^3  \hspace{1cm} (E) x^2 + x^3
5. If \( f(x) = (x-1)^2 + \frac{e^{x-2}}{2} \), then \( f''(2) = \)

(A) 1  
(B) \( \frac{3}{2} \)  
(C) 2  
(D) \( \frac{7}{2} \)  
(E) \( \frac{3+e}{2} \)

6. The line normal to the curve \( y = \sqrt{16-x} \) at the point \((0,4)\) has slope

(A) 8  
(B) 4  
(C) \( \frac{1}{8} \)  
(D) \( -\frac{1}{8} \)  
(E) -8

7. The function \( f' \) is defined on the closed interval \([0,8]\). The graph of its derivative \( f'' \) is shown above.

The point \((3,5)\) is on the graph of \( y = f(x) \). An equation of the line tangent to the graph of \( f' \) at \((3,5)\) is

(A) \( y = 2 \)

(B) \( y = 5 \)

(C) \( y - 5 = 2(x - 3) \)

(D) \( y + 5 = 2(x - 3) \)

(E) \( y + 5 = 2(x + 3) \)
8. (Use graph from 7)
How many points of inflection does the graph of $f$ have?

(A) Two
(B) Three
(C) Four
(D) Five
(E) Six

9. (Use graph from 7)
At what value of $x$ does the absolute minimum of $f$ occur?

(A) 0
(B) 2
(C) 4
(D) 6
(E) 8

10.
If $y = xy + x^2 + 1$, then when $x = -1$, $\frac{dy}{dx}$ is

(A) $\frac{1}{2}$  (B) $-\frac{1}{2}$  (C) $-1$  (D) $-2$  (E) nonexistent
11. 2002—AB1 (Calculator Permitted)

Let \( f \) and \( g \) be the functions given by \( f(x) = e^{x} \) and \( g(x) = \ln x \).

(a) Find the area of the region enclosed by the graphs of \( f \) and \( g \) between \( x = \frac{1}{2} \) and \( x = 1 \).

(b) Find the volume of the solid generated when the region enclosed by the graphs of \( f \) and \( g \) between \( x = \frac{1}{2} \) and \( x = 1 \) is revolved about the line \( y = 4 \).

(c) Let \( h \) be the function given by \( h(x) = f(x) - g(x) \). Find the absolute minimum value of \( h(x) \) on the closed interval \( \frac{1}{2} \leq x \leq 1 \), and find the absolute maximum value of \( h(x) \) on the closed interval \( \frac{1}{2} \leq x \leq 1 \). Show the analysis that leads to your answers.

12. 2002—AB2 (Calculator Permitted)

The rate at which people enter an amusement park on a given day is modeled by the function \( E \) defined by

\[
E(t) = \frac{15600}{(t^2 - 24t + 160)}.
\]

The rate at which people leave the same amusement park on the same day is modeled by the function \( L \) defined by

\[
L(t) = \frac{9890}{(t^2 - 38t + 370)}.
\]

Both \( E(t) \) and \( L(t) \) are measured in people per hour and time \( t \) is measured in hours after midnight. These functions are valid for \( 9 \leq t \leq 23 \), the hours during which the park is open. At time \( t = 9 \), there are no people in the park.

(a) How many people have entered the park by 5:00 P.M. \( (t = 17) \)? Round answer to the nearest whole number.

(b) The price of admission to the park is $15 until 5:00 P.M. \( (t = 17) \). After 5:00 P.M., the price of admission to the park is $11. How many dollars are collected from admissions to the park on the given day? Round your answer to the nearest whole number.

(c) Let \( H(t) = \int_{9}^{t} (E(x) - L(x)) \, dx \) for \( 9 \leq t \leq 23 \). The value of \( H(17) \) to the nearest whole number is 3725.

Find the value of \( H'(17) \) and explain the meaning of \( H(17) \) and \( H'(17) \) in the context of the park.

(d) At what time \( t \), for \( 9 \leq t \leq 23 \), does the model predict that the number of people in the park is a maximum?