1. The domain of the function $\sqrt{1-|x-5|}$ is
   A. $[-1, 5]$
   B. $(3, 6)$
   C. $(-5, 1)$
   D. $[2, 4]$
   E. $[4, 6]$

2. Which function is graphed below?
   A. $\ln(-x)$
   B. $-\ln x$
   C. $e^{-x}$
   D. $-e^{-x}$
   E. $-e^x$
3. One of the following is INCORRECT. Which one? For positive numbers $x, y$

A. $e^{x+y} = e^x e^y$
B. $(e^x)^y = e^{xy}$
C. $\sqrt{x + y} = \sqrt{x} + \sqrt{y}$
D. $\sqrt{xy} = \sqrt{x} \sqrt{y}$
E. $\ln(x^y) = y \ln x$

4. Suppose that $f(x) + g(x) = h(x)$, $\lim_{x \to 2} g(x) = 3$ and $\lim_{x \to 2} h(x) = -1$. If $f$ is continuous, then $f(2)$ must be

A. 2
B. -2
C. 4
D. -4
E. There is not enough information to tell for sure
5. The horizontal asymptote(s) of the function $F(x) = e^{-e^x}$ is (are)

A. $y = e$
B. $y = 0$ and $y = 1$
C. $y = 0$ and $y = 1/e$
D. $y = e^{-e}$
E. There is no horizontal asymptote.

6. Consider the secant line of the curve $y = x^2$ through the points where $x = 2$ and where $x = 4$. The slope of this secant is

A. 4
B. 8
C. 3
D. 6
E. 18
7. If \( \varphi(t) = \sqrt{te^t} \) then \( \varphi'(1) = \)

A. 1  
B. 2e  
C. 3e/2  
D. 1/(2\sqrt{e})  
E. 0

8. In the atmosphere a spherical shock wave, caused by a sonic boom, is traveling outwards at 1/3 km/s. At what rate, in \( \text{km}^2/\text{s} \), does the area occupied by the shock wave increase, 9 seconds after the boom? (The area of a sphere of radius \( r \) is \( 4\pi r^2 \).)

A. 36\pi  
B. 18\pi  
C. 8\pi  
D. 24\pi  
E. 16\pi
9. When $x = -\frac{\pi}{6}$, \( \frac{d}{dx} 3^{\sin x} = \) 

A. \( \ln 3 \)  
B. \( \frac{\sqrt{3}}{2} \)  
C. \( \ln \sqrt{3} \)  
D. 3  
E. \( \sqrt{3} \)  

10. The slope of the tangent line to the curve \( e^x + \cos \pi x + e^y + \cos \pi y = e + 1 \) at (1, 0) is 

A. \( \pi \)  
B. \( -\pi \)  
C. \( \pi e \)  
D. \( e \)  
E. \( -e \)
11. A radioactive substance has a half-life of 50 days. Initially a sample contains 15 mg. After how many days will only 2 mg remain?

A. $50 \ln \frac{15}{2}$
B. $50 \frac{\ln 15}{\ln 2}$
C. $50 \frac{\ln(2/15)}{\ln(1/2)}$
D. $\frac{\ln 2}{50 \ln(2/15)}$
E. $\frac{\ln(15/2)}{50}$

12. A particle moves along the graph of $y = x^2 + x$. When the particle is at the point (1, 2), the x coordinate is increasing at 3 units per second. At that moment, how fast is the distance from the particle to the point (-1, 0) changing?

A. $6\sqrt{2}$
B. $\sqrt{2} + \sqrt{6}$
C. 12
D. $\sqrt{12}$
E. 3
13. If \( f \) is a differentiable function on \(( -\infty, \infty)\), \( f(2) = 4 \), and \( f(6) = 8 \), which of the following statements must be true?

I. There is a \( c \) in \((2, 6)\) such that \( f(c) = 6 \).

II. There is a \( c \) in \((2, 6)\) such that \( f'(c) = 6 \).

III. There is a \( c \) in \((2, 6)\) such that \( f'(c) = 1 \).

A. Only I
B. Only II
C. Only I and II
D. Only I and III
E. Only II and III

14. The absolute maximum and absolute minimum of \( g(x) = x^2 - 2x^4 \) on \([-1, 1]\) are

A. 1 and 0
B. 1 and -1
C. 1/8 and 0
D. 1/4 and -1
E. 1/8 and -1
15. \[ \lim_{x \to 0} \frac{\cos(2x) - \cos(3x)}{x^2} = \]
   A. 5/2
   B. -1/2
   C. 13/2
   D. 1
   E. 0

16. A farmer with \( N \) ft of fencing wants to enclose a rectangular region and then divide it into 3 pens with fencing parallel to one side of the rectangle. What is the largest possible total area of the 3 pens in ft\(^2\)?
   A. \( N^2/9 \)
   B. \( N^2/32 \)
   C. \( N^2/20 \)
   D. \( N^2/8 \)
   E. \( N^2/16 \)
17. Suppose $F$ is a continuous function on $(-\infty, \infty)$. If it has a local extremum at $c$, which of the following must be true?

I. $F'(c) = 0$.
II. $F''(c) = 0$ or $F$ is not differentiable at $c$.
III. $F''(c) \neq 0$.

A. Only I
B. Only II
C. Only III
D. Only I and II
E. Only II and III

18. \[
\frac{d}{dx} \int_1^{x^2} \frac{dt}{1 + t^2} =
\]

A. $-\ln(1 + x^2) + \ln 2$
B. $1/(1 + x^2)$
C. $x^2/(1 + x^2)$
D. $2x/(1 + x^4)$
E. $4x^3/(1 + x^2)$
19. \( \int_{-1}^{0} \frac{dx}{(x - 1)^3} = \)

20. \( \int_{0}^{\pi/2} \cos 3t \, dt = \)

A. \(-5/8\)
B. \(-3/8\)
C. \(-45/16\)
D. \(-1/2\)
E. \(1/2\)
21. If \( h''(x) = e^x(x - 1)^3(x + 2) \), find all open intervals where \( h \) is concave down.

A. \((0, 1)\)
B. \((-\infty, 0)\) and \((1, \infty)\)
C. \((-2, 0)\) and \((0, 1)\)
D. \((-2, 1)\)
E. \((-\infty, -2)\) and \((1, \infty)\)

22. Find all open intervals where \( \varphi(x) = \frac{3 + x^2}{2 - x^2} \) is increasing.

A. \((-\infty, 0)\)
B. \((-\infty, -\sqrt{2})\) and \((-\sqrt{2}, 0)\)
C. \((-\sqrt{2}, \sqrt{2})\)
D. \((0, \sqrt{2})\) and \((\sqrt{2}, \infty)\)
E. \((0, \infty)\)
23. If $f''(x) = 6x + 2$, $f(1) = 2$ and $f'(1) = 4$ then $f(3) =

A. 18
B. 30
C. 34
D. 8
E. 22

24. If $\int_2^4 g(t)dt = 2$ and $\int_2^5 g(t)dt = 6$, then $\int_4^5 g(t)dt =$

A. -4
B. 4
C. -8
D. 8
E. 12
25. \[ \int_{0}^{1} x \sqrt{1 + 3x^2} \, dx = \]

A. 2
B. 2/3
C. 1/3
D. 7/9
E. 5/6