1. True or False?

$$\frac{d}{dx}\int_0^{x^2} \ln(\sin t)\,dt = \ln(\sin x^2).$$

2. The bacteria *E. coli* divides into two every 20 minutes. If there are initially 60 bacteria, find an expression for the number of bacteria after t hours.

3. True or False?

$$\sum_{k=1}^{1008} \left(\frac{1}{2k} - \frac{1}{2k+2} \right) = \frac{1}{2} - \frac{1}{2018}.$$

4. A jogger jogs around a circular track of radius 50 m. In a coordinate system with its origin at the center of the track, her x-coordinate is changing at a rate of $-5/4$ m/s when her coordinates are $(40, 30)$. At what rate is her y-coordinate changing?

5. True or False?

The function

$$f(x) = \frac{x^5}{5} - \frac{4x^3}{3} + 4x$$

has exactly two critical points.

6. Car A travels west at 50 mph and car B travels north at 60 mph, both headed towards the intersection of the two roads. How fast are the cars approaching each other when car A is 0.3 miles from the intersection and car B is 0.4 miles from the intersection?

7. True or False?

The function $f(x) = \sqrt{x + \ln x}$ has an antiderivative.

8. Find the dimensions of a cylinder of volume 1 m^3 of minimal cost if the top and bottom are made of material that costs twice as much as the material for the side.

9. Find the maximum area of a triangle formed by the axes and a tangent line to the graph of $y = (x+1)^{-2}$ with $x > 0$.

10. True or False?

Let f be the function given by

$$f(x) = \begin{cases} x^2 \sin(1/x) & \text{if } x \neq 0 \\ 0 & \text{if } x = 0 \end{cases}.$$

Then the derivative f' is continuous.

Hint. We've seen before that the above function f is differentiable and $f'(0) = 0$ (we used the squeeze theorem). What is $\lim_{x \to 0} f'(x)$...?

11. Which of the following functions f has exactly 2 critical points?

(A) $f(x) = \dfrac{1}{x^2+1}$

(B) $f(x) = \dfrac{x}{x^2+1}$

(C) $f(x) = \dfrac{1}{\sqrt{x^2+1}}$

(D) None of the above

12. Which of the following functions f has an inflection point at $x = 1/\sqrt{2}$?

(A) $f(x) = \dfrac{1}{x^2+1}$

(B) $f(x) = \dfrac{x}{x^2+1}$

(C) $f(x) = \dfrac{1}{\sqrt{x^2+1}}$

(D) None of the above

Note. The functions in (A), (B), and (C) are the same as the ones in the previous question.

13. True or False?

The equation $e^x + \ln x = 0$ has exactly one solution.

14. Let $f(x) = x^{\sin x}$. What is $f'(\pi/2)$?

(A) 0

(B) 1

(C) The derivative doesn't exist.

(D) None of the above.