This is the Mu Applications test. E. NOTA specifies None of the Above. Some important information:
-Faraday's law states that the electromotive force induced in a loop of wire is equal in magnitude to the time derivative of the flux through said loop.
-Work is the integral of force with respect to distance.

1. If $y = t^2 + t$, at what rate does y increase when $t = 2$?

   A. 1 B. 2 C. 4 D. 5 E. NOTA

2. What is the maximum volume of a rectangular prism with surface area 24?

   A. 2 B. 6 C. 8 D. 12 E. NOTA

3. Konwoo's yard is shaped like the region below $y = \sin(x)$ and above the x axis from 0 to π. What is the area of Konwoo's yard?

   A. 1 B. 2 C. π D. 2π E. NOTA

4. Find the equation of the line that is tangent to $y = x^3$ and passes through the point $(3, 27)$.

   A. $y = 18x - 27$ B. $y = 27x - 54$ C. $y = 9x$ D. $y = 18x + 54$ E. NOTA

5. Find $f'(1)$, where
$$f(x) = \sum_{i=0}^{50} x^{2i}$$

   A. 5050 B. 2019 C. 2550 D. 5100 E. NOTA

6. Starting at the point $(0, 0)$, Daniel needs to walk to the point $(1, 1)$ while always moving to the right. The fact that Daniel must cross every y value between 0 and 1 along his trip is a result of which theorem?

   A. Intermediate Value B. Extreme Value
   C. Mean Value D. Ham Sandwich E. NOTA

7. Evaluate
$$\lim_{x\to 0} \frac{\sin(12x)}{3x} - \lim_{x\to\infty} \frac{\sin(12x)}{3x}$$

   A. 0 B. $\frac{15}{4}$ C. 4 D. $-\frac{15}{4}$ E. NOTA

8. A rock is dropped from a height of 20m. If the acceleration due to gravity is $10\frac{\text{m}}{\text{s}^2}$, how many seconds does it take the rock to hit the ground?

   A. 1 B. 2 C. 4 D. 8 E. NOTA

9. The radius of a sphere increases at 1 unit per second starting at $t = 0$, where t is measured in seconds. If the radius of the sphere is 3 at $t = 2$, how fast is the volume of the sphere increasing at $t = 3$, in units cubed per second?

A. 4π B. 16π C. 64π D. 256π E. NOTA

10. Find the volume of the figure formed when the area bound by $y = x^2$ and $y = 4$ is revolved around the y-axis.

A. 8π B. 16π C. 24π D. 36π E. NOTA

11. Find the volume of the figure formed when the square with vertices $(-2, 0), (0, 2), (2, 0)$, and $(0, -2)$ is revolved around the line $x = 1$.

A. 8π B. $4\pi\sqrt{2}$ C. $\frac{23}{3}\pi$ D. $\frac{25}{3}\pi$ E. NOTA

12. Buffy can be approximated as a sphere with radius 2. If Buffy's head is the locus of points within Buffy that are at least 1.5 units from the ground he rests on, what is the volume of his head?

A. $\frac{13}{24}\pi$ B. $\frac{11}{24}\pi$ C. $\frac{13}{12}\pi$ D. $\frac{11}{12}\pi$ E. NOTA

13. Starting at $(0, 1)$, approximate $f(3)$ using Euler's method with three equal subintervals, where $f'(x) = x^2 - 2$.

A. -5 B. -4 C. -3 D. -2 E. NOTA

14. Approximate the positive root of $y = x^2 - 2x - 1$ using 2 iterations of Newton's method starting at the point (3, 2).

A. $\frac{29}{12}$ B. $\frac{25}{12}$ C. $\frac{31}{12}$ D. $\frac{35}{12}$ E. NOTA

15. Approximate $\int_0^4 x^4 + x + 1\,dx$ using Simpson's method with four equal subintervals.

A. 130 B. $\frac{640}{3}$ C. 210 D. $\frac{652}{3}$ E. NOTA

16. A non-ideal spring is modeled by the equation $F = -2x^2$ where F is the restoring force in newtons and x is the displacement in meters. Find the amount of work in Joules it takes to pull the spring from equilibrium to a displacement of 3 meters.

A. 12 B. 18 C. 24 D. 30 E. NOTA

17. What is the smallest area that can be bound by a line segment in the first quadrant passing through the point (4, 8)?

A. 32 B. 64 C. 128 D. 256 E. NOTA

18. The function $y = x^2$ is revolved around the y-axis to create a reservoir to hold liquid. Water is poured in at a rate of π cubic units per second starting at $t = 0$ seconds. At what rate is the water level in the reservoir rising at $t = 8$ seconds?

A. 2 B. 1 C. $\frac{1}{2}$ D. $\frac{1}{4}$ E. NOTA

19. A population of p river rats grows with time t according to the equation $\frac{dp}{dt} = 30p(50 - p)$. If there are initially 100 river rats, find

$$\lim_{t \to \infty} p$$

A. 1500 B. 50 C. 30 D. $\frac{5}{3}$ E. NOTA

20. The radius of a loop of wire varies according to the equation $r = 2t$ for $t > 1$. If a constant magnetic field of 10T is applied perpendicular to the plane of the wire loop, what is the magnitude of the current induced in the wire at $t = 2$?

A. 80 B. 160 C. 80π D. 160π E. NOTA

21. Find $f(0)$, where

$$f(x) = \int_2^x te^{f(t)}\, dt$$

A. $3e$ B. $2e$ C. $-\ln(3)$ D. $\ln(2)$ E. NOTA

22. Andy is riding a very unsafe roller coaster which travels along the curve $y = x^3$. Being very unsafe, the coaster may at any time dismount from the graph and continue in the direction it was traveling. If Andy's ride begins at (-2, 8) and travels upwards, find the area of the intersection of [the locus of points which Andy could possibly reach] and [the locus of points within the rectangle bounded by (-2, -8), (-2, 8), (2, -8), and (2, 8)].

A. $\frac{76}{3}$ B. $\frac{86}{3}$ C. $\frac{32}{3}$ D. $\frac{64}{3}$ E. NOTA

23. Andy has abandoned the dangerous roller coaster and is now sitting on the edge of a merry-go-round, ready to pounce. The merry-go-round has a radius of 1 and is rotating at $\frac{1}{4}$ revolutions per second. At any time, Andy can pounce from the merry-go-round and will travel at 1 foot per second in a direction normal to where he jumped off (directly away from the center of the merry-go-round). Andy has 3 seconds total to move; after 3 seconds, he stops no matter what. What is the area of the locus of points Andy can reach?

A. $\frac{21}{4}\pi$ B. $\frac{9}{2}\pi$ C. $\frac{9}{4}\pi$ D. $\frac{3}{2}\pi$ E. NOTA

24. The line segment from (0, 1) to $(\frac{2}{3}, \frac{1}{2})$ is rotated in every possible orientation in three dimensions about the origin. That is, a given rotation is valid if and only if every point on the segment has the same distance from the origin as it did initially. What is the volume of the locus of points through which the segment moves?

A. $\frac{122}{123}\pi$ B. $\frac{244}{123}\pi$ C. $\frac{122}{375}\pi$ D. $\frac{244}{375}\pi$ E. NOTA

25. Evaluate

$$\int_0^\infty e^{-2t}t^8\,dt$$

A. $\frac{315}{8}$ B. $\frac{330}{7}$ C. $\frac{315}{4}$ D. $\frac{155}{7}$ E. NOTA

26. The area in quadrant 1 bound by the graphs of $y = \sin(x)$, $y = 1$, and $x = 0$ is revolved around the y-axis to form a funky shape. Find the volume of this funky shape.

A. $\frac{\pi^3}{2} - \pi$ B. $\frac{\pi^3}{4} - 2\pi$ C. $\frac{\pi^3}{2} - 2\pi$ D. $\frac{\pi^3}{4} - \pi$ E. NOTA

27. An art sculpture is to be made to match a figure with a base of the graph $y = \frac{1}{2+\cos(\theta)}$ from 0 to 2π with cross sections perpendicular to the x-axis that are squares. Find the volume of this lovely art sculpture.

A. $\frac{\pi\sqrt{3}}{3}$ B. $\frac{4\pi\sqrt{3}}{9}$ C. $\frac{8\pi\sqrt{3}}{9}$ D. $\frac{8\pi\sqrt{3}}{27}$ E. NOTA

28. Often in the real world, it is not necessary to find the exact value for certain problems. Find the exact value of

$$\int_0^{\frac{\pi}{2}} \frac{\ln(1+\sin(x))}{\sin(x)}\,dx$$

A. $\frac{\pi^2}{2}$ B. $\frac{\pi^2}{4}$ C. $\frac{\pi^2}{8}$ D. $\frac{\pi^2}{16}$ E. NOTA

29. Sir Gray D. Yent is standing at the point (2, 4, 4) upon the equation $z = x^3 - 4x - y^2 + 20$. Assuming the positive z is directly upwards, and the positive y direction is north, in what direction should Sir Gray D. Yent walk to ascend as fast as possible?

A. North B. Southeast C. Northwest D. South E. NOTA

30. Two real numbers between 0 and 5 are chosen as legs of a right triangle. What is the average length of the hypotenuse of this triangle?

A. $\frac{5\sqrt{2}}{3} + \frac{5}{3}\ln(1+\sqrt{2})$ B. $\frac{5\sqrt{2}}{6} + \frac{5}{3}\ln(1+\sqrt{2})$
C. $\frac{5\sqrt{5}}{3} + \frac{5}{3}\ln(1+\sqrt{5})$ D. $\frac{5\sqrt{5}}{6} + \frac{5}{3}\ln(1+\sqrt{5})$ E. NOTA