1. Compute \( \int_1^e 9x^2 \ln x \, dx \)
   
   a. \( 2e^3 + 1 \)
   
   b. \( 2e^3 - 2 \)
   
   c. \( 2e^3 \)
   
   d. \( 3e^3 - 3e^2 \)
   
   e. \( 3e^3 - 3e^2 + 3 \)

2. Compute \( \int_1^e \frac{1}{(x-2)^{4/3}} \, dx \)
   
   a. \( -\infty \)
   
   b. \( -3 \)
   
   c. \( -1 \)
   
   d. \( 3 \)
   
   e. \( \infty \)

3. Find the arclength of the parametric curve \( x = t^4 \quad y = \frac{1}{2} t^6 \) for \( 0 \leq t \leq 1 \).
   
   a. \( \frac{61}{54} \)
   
   b. \( \frac{16}{9} \)
   
   c. \( \frac{11}{9} \)
   
   d. \( \frac{1}{9} \)
   
   e. \( \frac{1}{54} \)
4. A 2 meter bar has linear density \( \rho = 1 + x^3 \) kg/m where \( x \) is measured from one end. Find the average density of the bar.

a. 2 kg/m  
b. 3 kg/m  
c. 4.5 kg/m  
d. 5 kg/m  
e. 6 kg/m 

5. A 2 meter bar has linear density \( \rho = 1 + x^3 \) kg/m where \( x \) is measured from one end. Find the center of mass of the bar.

a. \( \frac{5}{7} \) m  
b. \( \frac{5}{6} \) m  
c. \( \frac{6}{5} \) m  
d. \( \frac{7}{5} \) m  
e. \( \frac{42}{5} \) m 

6. If \( y(x) \) satisfies the differential equation \( \frac{dy}{dx} = \frac{x}{y} \) and the initial condition \( y(0) = 3 \), find \( y(4) \).

a. 1  
b. 2  
c. 3  
d. 4  
e. 5
7. Find an integrating factor for the differential equation \( \frac{dy}{dx} = 2xy + \sin x \).
   a. \( e^{-\cos x} \)
   b. \( e^{-\sin x} \)
   c. \( e^{\cos x} \)
   d. \( e^{x^2} \)
   e. \( e^{-x^2} \)

8. A sequence is defined recursively by: \( a_1 = 4 \) and \( a_{n+1} = \sqrt{10a_n - 16} \). Find \( \lim_{n \to \infty} a_n \).
   a. 2
   b. 4
   c. 6
   d. 8
   e. Diverges

9. \( \sum_{n=2}^{\infty} \frac{3^n}{2^{2n-1}} = \)
   a. 2
   b. \( \frac{9}{14} \)
   c. \( \frac{9}{2} \)
   d. 4
   e. Diverges
10. Find the radius of convergence of the series \[ \sum_{n=1}^{\infty} \frac{2^n}{(n+1)^2} (x - 3)^n. \]

a. 0  
b. \( \frac{1}{3} \)  
c. \( \frac{1}{2} \)  
d. 2  
e. 3

11. \( \lim_{x \to 0} \frac{\sin x - x \cos x}{x^3} = \)

a. \( \frac{1}{6} \)  
b. \( \frac{1}{3} \)  
c. \( \frac{1}{2} \)  
d. \( \frac{2}{3} \)  
e. \( \infty \)

12. Suppose the series \( \sum_{n=1}^{\infty} n e^{-n^2} \) is approximated by its 9th partial sum \( \sum_{n=1}^{9} n e^{-n^2} \).

Use an integral to bound the error in this approximation.

a. \( \frac{1}{2} e^{-64} \)  
b. \( \frac{1}{2} e^{-81} \)  
c. \( \frac{1}{2} e^{-100} \)  
d. \( \frac{1}{2} e^{-121} \)  
e. \( \frac{1}{2} e^{-144} \)
13. Find the angle between the vectors $\vec{u} = \langle 1, 1 \rangle$ and $\vec{v} = \langle 1, -2, -1 \rangle$.
   
   a. $0^\circ$
   b. $30^\circ$
   c. $45^\circ$
   d. $60^\circ$
   e. $90^\circ$

14. If $\vec{u}$ points South-West and $\vec{v}$ points Up, which way does $\vec{u} \times \vec{v}$ point?
   
   a. South-East
   b. North-East
   c. North-West
   d. $45^\circ$ Up from North-West
   e. $45^\circ$ Down from North-West

15. Find a unit vector perpendicular to both $\vec{a} = (3, -2, 1)$ and $\vec{b} = (-1, 0, 1)$.
   
   a. $(-2, -4, -2)$
   b. $(-2, 4, -2)$
   c. $(1, -2, 1)$
   d. $\left(\frac{1}{\sqrt{6}}, \frac{2}{\sqrt{6}}, \frac{1}{\sqrt{6}}\right)$
   e. $\left(\frac{1}{\sqrt{6}}, \frac{-2}{\sqrt{6}}, \frac{1}{\sqrt{6}}\right)$
16. Compute \[ \int_{x=2}^{x=4} \frac{8}{x^3 \sqrt{x^2 - 4}} \, dx \]

17. The curve \( y = x^2 \) is rotated about the \( y \)-axis to form a bowl. If the bowl contains \( 8\pi \) cm\(^3\) of water, what is the height of the water in the bowl?
18. A leaking sandbag is lifted 20 ft at 2 ft/sec. The sandbag starts out weighing 50 lb but is leaking sand at 3 lb/sec. How much work is done to lift the sandbag?
   HINT: What is the weight of the bag when it is $y$ ft above the ground?

19. Determine if the series $\sum_{n=0}^{\infty} \frac{(-1)^n 2^n}{n!}$ converges absolutely, converges but not absolutely or diverges.
   If it converges, find the sum. If it diverges, does it diverge to $+\infty$, $-\infty$ or neither?
   
   Circle One: Converges Absolutely  Converges Conditionally  Diverges

   Fill in the Blank: Converges to ____________

   Or Circle One: Diverges to $+\infty$  $-\infty$  Neither