1. Find the area between the curves  \( y = x^2 \) and  \( y = 2x + 3 \).

   a. \( \frac{4}{3} \)
   b. \( \frac{8}{3} \)
   c. \( \frac{16}{3} \)
   d. \( \frac{32}{3} \)
   e. \( \frac{88}{3} \)

2. The base of a solid is the circle  \( x^2 + y^2 = 9 \) and the cross sections perpendicular to the  \( x \)-axis are squares. Find the volume of the solid.

   a. 9
   b. 18
   c. 36
   d. 72
   e. 144

3. Using a trigonometric substitution, the integral  \( \int \frac{dx}{x^2 \sqrt{16 + x^2}} \) becomes

   a.  \( \int \frac{\cos^3 \theta}{16 \sin^2 \theta} \ d\theta \)
   b.  \( \int \frac{\cos^3 \theta}{64 \sin^2 \theta} \ d\theta \)
   c.  \( \int \frac{\cos \theta}{16 \sin^2 \theta} \ d\theta \)
   d.  \( \int \frac{1}{64 \sin^2 \theta \cos \theta} \ d\theta \)
   e.  \( \int \frac{1}{16 \sin^2 \theta \cos \theta} \ d\theta \)
4. Compute \[ \int \frac{2}{x(x-2)} \, dx. \]

   a. \[ \ln|x - 2| - \ln|x| + C \]
   b. \[ \ln|x| - \ln|x - 2| + C \]
   c. \[ \ln|x| + 2 \ln|x - 2| + C \]
   d. \[ \ln|x| - 2 \ln|x - 2| + C \]
   e. \[ 2 \ln|x - 2| - \ln|x| + C \]

5. Use the Middle Sum Rule with \( n = 4 \) intervals to approximate the integral \[ \int_{1}^{9} (9 + x^2) \, dx. \]

   a. 240
   b. 312
   c. 314 \frac{1}{3}
   d. 320
   e. 400

6. Solve the differential equation \[ \frac{dy}{dx} = \frac{4}{3} \frac{x^3}{y^2} \] with the initial condition \( y(0) = 2 \).

   a. \[ y = 2x^{4/3} \]
   b. \[ y = x^{3/4} + 2 \]
   c. \[ y = x^{4/3} + 2 \]
   d. \[ y = \frac{4}{3}x^3 + 8 \]
   e. \[ y = \frac{3}{5}x^4 + 8 \]
7. A sequence \( \{a_n\} \) is defined by \( a_1 = 4 \) and \( a_{n+1} = \sqrt{5a_n^2 - 16} \). Find \( \lim_{n \to \infty} a_n \).

- a. \(-2\)
- b. 2
- c. \(\sqrt{5}\)
- d. 4
- e. Divergent

8. Compute \( \sum_{n=1}^{\infty} \frac{2^{3n+1}}{3^{2n+1}} \)

- a. \(\frac{2}{3}\)
- b. \(\frac{8}{9}\)
- c. \(\frac{16}{3}\)
- d. \(\frac{16}{9}\)
- e. Divergent

9. Compute \( \sum_{n=0}^{\infty} \frac{(-1)^n \pi^{2n}}{(2n)!} \)

HINT: Think about the standard Maclaurin series.

- a. \(-1\)
- b. 1
- c. \(2\pi\)
- d. \(e^\pi\)
- e. Divergent
10. A triangle has vertices \( A = (2 + \sqrt{2}, 3, 3) \), \( B = (2, -1, -1) \) and \( C = (2, 2, 2) \). Find the angle at vertex \( C \).

a. \( \frac{\pi}{4} \)

b. \( \frac{\pi}{3} \)

c. \( \frac{\pi}{2} \)

d. \( \frac{3\pi}{4} \)

e. \( \frac{2\pi}{3} \)

11. If \( \vec{u} \) points Up and \( \vec{v} \) points North-West, which way does \( \vec{u} \times \vec{v} \) point?

a. South-West

b. South-East

c. North-East

d. \( 45^\circ \) Up from North-West

e. \( 45^\circ \) Down from North-West

12. Find the area of a parallelogram with edges \( \vec{a} = (-2, 4, -1) \) and \( \vec{b} = (3, 0, 2) \).

a. 8

b. \( \sqrt{209} \)

c. 209

d. \( 2\sqrt{2} \)

e. \( \frac{1}{2} \sqrt{209} \)
13. (12 points) A water tank has the shape of a hemisphere with radius 5 m. It is filled with water to a height of 3 m. Find the work in Joules required to empty the tank by pumping all of the water to the top of the tank. Give your answer in terms of \( \rho \) (the density of water) and \( g \) (the acceleration of gravity).

14. (12 points) Compute \( \int_{0}^{\pi/4} \sec^3 \theta \tan^3 \theta \, d\theta. \)
15. (12 points) The curve \( y = \frac{x^2}{4} - \frac{\ln x}{2} \) between \( x = 1 \) and \( x = 2 \) is rotated about the \( y \)-axis. Find the area of the resulting surface.

16. (12 points) Find the Maclaurin series (using \( \sum \) notation) for \( f(x) = \frac{2x}{(1-2x)^2} \) by manipulating the derivative of the series for \( g(x) = \frac{1}{1-2x} \). What is the interval of convergence for \( f(x) \) (including endpoints)? Justify your answers.