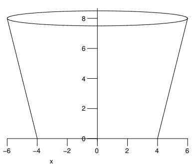
1. Determine the volume of the solid formed by rotating the region bounded by $y = 2^x$ and $y = x^2$ for $0 \le x \le 2$ about the x-axis.

2. Determine the volume of the solid formed by rotating the region bounded by the x-axis and the curve $y = 2e^{-x}$ for $0 \le x \le 2$ about the line $y = -1$.

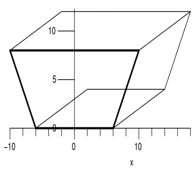
3. Determine the volume of the solid formed by rotating the region bounded by the y-axis, the x-axis, and the curve $y = \cos x$ for $0 \le x \le \dfrac{\pi}{2}$ about the line $x = -1$.

4. Determine the volume of the solid formed by rotating the region bounded by the y-axis, the line $y = x$, and the curve $y = 1 + \sqrt{1 - x^2}$ for $0 \le x \le 1$ about the y-axis.

5. Set up the integral (do not evaluate) to determine the work to empty a full tank of water that is the shape of a right circular cone having bottom radius 4 ft and top radius 6 ft and height 8 ft. Water has density approximately 62.4 lb/ft^3. (See picture)



6. Set up the integral (do not evaluate) to determine the work to empty a full swimming pool of water that has a rectangular bottom with length 12 ft and width 10 ft and rectangular top with length 20 ft and width 10 ft. The pool is 8 ft underground. Water has density approximately 62.4 lb/ft^3. (See picture)



7. Set up the integral (do not evaluate) to determine the force on the trapezoidal side of the pool that is shown above when the pool is full of water.

8. Set up the integral to determine the force on the side of a fish tank that has a length of 4 ft and a heght of 2 ft if the tank is full.

9. Set up the integral to determine the arclength of the curve $y = x^2 + 3x + 1$ on $0 \leq x \leq 2$ (do not evaluate).

10. Set up the integral to determine the arclength of the curve $y = \sin(2x)$ on $0 \leq x \leq \frac{\pi}{2}$ (do not evaluate).

11. Determine the average value of the function $f(x) = \dfrac{3x}{1+x^2}$ on $0 \leq x \leq 5$.

12. Determine the average value of the function $f(x) = \dfrac{8}{1+4x^2}$ on $0 \leq x \leq \dfrac{1}{2}$.

13. Evaluate the integral if it converges. Show divergence otherwise.

    (a) $\displaystyle\int_0^\infty 3xe^{-4x^2}\,dx$

    (b) $\displaystyle\int_0^\infty \frac{4}{1+9x^2}\,dx$

    (c) $\displaystyle\int_1^4 \frac{4}{(x-1)^2}\,dx$

    (d) $\displaystyle\int_1^4 \frac{x}{x^2-1}\,dx$

14. Solve the initial value differential equation for $y(t)$:

$$\frac{dy}{dt} = ty^3 \qquad y(0) = 1$$

15. Solve the initial value differential equation for $y(t)$:

$$\frac{dy}{dt} = t\sqrt{y-1} \qquad y(0) = 5$$

16. Use Euler's Method to approximate $y(1)$ if $\dfrac{dy}{dx} = y + x$ with $y(0) = \dfrac{1}{2}$ and $\Delta x = \dfrac{1}{2}$.

17. Use Euler's Method to approximate $y(1)$ if $\frac{dy}{dx} = \frac{1}{2}y - x$ with $y(0) = 1$ and $\Delta x = \frac{1}{2}$.

18. A tank contains 1000 L of pure water. Brine containing 0.05 kg of salt per liter of water enters the tank at a rate of 5 liters per minute. Brine that contains 0.04 kg of salt per liter of water enters the tank at a rate of 10 liters per minute. The solution is kept thoroghly mixed and drains at a rate of 15 liters per minute.

    (a) Determine a differential equation involving the amount of salt in the tank at a given time, t.

    (b) Solve the differential equation giving the amount of salt in the tank at any time, t.

19. A tank contains 800 L of pure water. Brine containing 0.01 kg of salt per liter of water enters the tank at a rate of 5 liters per minute. Brine that contains 0.02 kg of salt per liter of water enters the tank at a rate of 10 liters per minute. The solution is kept thoroughly mixed and drains at a rate of 15 liters per minute.

    (a) Determine a differential equation involving the amount of salt in the tank at a given time, t.

    (b) Solve the differential equation giving the amount of salt in the tank at any time, t.

20. Solve the initial value first order linear differential equation:

$$y' = 2y + x \qquad\qquad y(0) = 1.$$

21. Give the general solution to the second order differential equation.

$$y'' + 2y' + 5y = 0$$

22. Give the solution to the initial value second order nonhomogeneous differential equation:

$$y'' + 2y' + y = 4\sin x \qquad\qquad y(0) = 0 \qquad y'(0) = 0.$$

23. Tell whether the series converges or diverges and justify your answer by showing reason by a valid test.

    (a) $\sum_{n=1}^{\infty} \frac{1}{n^2+1}$

(b) $\sum_{n=0}^{\infty} \frac{n^2}{2^n}$

24. Determine the given sum:

    (a) $\sum_{n=0}^{\infty} \frac{(-1)^n 3^n}{n!} =$ ____________________

    (b) $9 - 3 + 1 - \frac{1}{3} + \frac{1}{9} - \frac{1}{27} + \cdots =$ ____________________

25. Determine the interval and radius of convergence of the given series:

$$\sum_{n=1}^{\infty} \frac{(-1)^n x^n}{n 2^n}$$

26. Determine the Taylor Series about $x = 0$ for:

    (a) $f(x) = x^2 e^{-x}$

    (b) $g(x) = \frac{1}{1+9x^2}$

    (c) $h(x) = \frac{1}{3} \arctan(3x)$

27. Use the binomial expansion to determine the first 3 terms of the MacLaurin series representing the funtion:

$$f(x) = \frac{1}{\sqrt[3]{1+x}}$$

28. Write out the first three NONZERO terms to the MacLaurin series of

$$f(x) = e^x \cos x$$

29. Use series to approximate $\int_0^1 \frac{e^x - 1}{x} \, dx$. (Write out 4 terms but do not add them.)

30. If $\vec{a} = \langle -3, 2, 5 \rangle$ and $\vec{b} = \langle 6, 2, 3 \rangle$, calculate:

    (a) $\vec{a} + \vec{b}$, $|\vec{a}|$, $\vec{a} \cdot \vec{b}$, $\vec{a} \times \vec{b}$, and $\cos\theta$=angle between $\vec{a}$ and $\vec{b}$.

    (b) Π, the equation of the plane parallel to both $\vec{a}$ and $\vec{b}$ containing the point $P(-1, 9, 2)$.

(c) $\vec{P}$, the projection vector of $\vec{a}$ onto $\vec{b}$.

31. Change from rectangular coordinates to cylindrical coordinates:
$P(1, \sqrt{3}, 2)$ $\quad Q(4, -4, 8)$ $\quad z^2 + 4x^2 + 4y^2 = 9$ $\quad z = x^2 - y^2$

32. Change from rectangular coordinates to spherical coordinates:
$P(1, \sqrt{3}, 2\sqrt{3})$ $\quad Q(7, 7, 0)$ $\quad z = x^2 + y^2$ $\quad 4x^2 + 4y^2 + 4z^2 + 2z = 5$

33. Change from spherical coordinates to rectangular coordinates:
$P(1, 0, \pi/4)$ $\quad Q(3, \pi/3, 5\pi/6)$ $\quad \rho = 2\cos\phi$ $\quad \phi = \pi/6$

34. Sketch the graph of the given surface and identify it.

(a) $f(x, y) = 6 - 2x - 3y$

(b) $f(x, y) = 4x^2 + y^2$

(c) $x^2 - 2x + y^2 + z^2 + 4z + 1 = 0$

(d) $f(x, y) = \sqrt{16 - x^2 - 4y^2}$

(e) $x^2 + 3y^2 = 9$