1. Find and simplify if necessary.
   1a. $D_x[e^{3x^2+1}]$
   1b. $D_x[\ln(3x^2 + 17)]$
   1c. $D_x[(1 + x)^{2x}]$
   1d. $D_x[\sin^3(4x)]$
   1e. $\frac{d}{dx}e^{\tan x}$
   1f. $\frac{d}{dx}[\ln x]^{2x+3}$
   1g. $D_x[17^{3x^2+1}]$
   1h. $D_x[\ln(\cos(4x))]$

2. Integrate each of the following using an appropriate method.
   2a. $\int \ln x \, dx$
   2b. $\int \sin^2 x \, dx$
   2c. $\int \sin^3 x \, dx$
   2d. $\int x^2 \sin x \, dx$
   2e. $\int \frac{x^3-2x^2+4x+1}{x^3-x^2-x+1} \, dx$
   2f. $\int \frac{x^3}{\sqrt{1-x^2}} \, dx$
   2g. $\int x^2 \arctan x \, dx$
   2h. $\int e^x \cos x \, dx$
   2i. $\int \frac{x}{x^4+4x^2+8} \, dx$
   2j. $\int \frac{x^4+2x^2+2}{x^3+x^2} \, dx$
   2k. $\int \frac{x^2}{\sqrt{4-x^2}} \, dx$
   2l. $\int_0^\infty \frac{dx}{\sqrt{x}}$
   2m. $\int_0^\infty \frac{x}{x^2+1} \, dx$

3. Find the limit.
   3a. $\lim_{x \to \infty} x^\frac{1}{x}$
   3b. $\lim_{n \to \infty} \frac{12n^{17}+188n^7-19n}{4n^{18}-n^9+10}$
   3c. $\lim_{x \to \infty} [1 + \frac{c}{x}]^x$ where $c$ is a constant and $c \neq 0$
   3d. $\lim_{n \to \infty} \frac{n^{17,000}}{e^n}$

4. Let
   $$s_N = \sum_{n=5}^{N} \frac{8(3^n)}{(4^n+2)}$$

   for $N = 5, 6, 7, \ldots$. Find a formula for $s_N$ as we did in class (Thus backing up your formula with algebra. Your formula should not have a $\sum$ sign in it nor have ... in it.) Does the infinite series $\sum_{n=5}^{\infty} \frac{8(3^n)}{(4^n+2)}$ converge or diverge? If it converges, find its sum.
5. Decide if the given series is: absolutely convergent, conditionally convergent, or divergent.

5a. \( \sum_{n=1}^{\infty} (-1)^n \frac{1}{\sqrt{n}} \)

5b. \( \sum_{n=1}^{\infty} (-1)^n \frac{(3^n)n!}{(2n)^n} \)

5c. \( \sum_{n=1}^{\infty} (-1)^n \frac{n}{n^2 + n^2} \)

5d. \( \sum_{n=1}^{\infty} (-1)^{n+1} \frac{1}{5n} \)

5e. \( \sum_{n=1}^{\infty} (-1)^{n+1} \frac{n}{10(n+1)} \)

5f. \( \sum_{n=2}^{\infty} (-1)^n \frac{1}{n \ln n} \)

5g. \( \sum_{n=1}^{\infty} (-1)^{n+1} \frac{n^4}{2^n} \)

5h. \( \sum_{n=1}^{\infty} (-1)^{n+1} \frac{n}{n^2 + 1} \)

5i. \( \sum_{n=1}^{\infty} \cos(n\pi) \frac{1}{n} \)

5j. \( \sum_{n=1}^{\infty} (-1)^n \frac{\sin n}{n} \)

5k. \( \sum_{n=1}^{\infty} (-1)^{n+1} \frac{1}{\sqrt{n(n+1)}} \)

5l. \( \sum_{n=1}^{\infty} \frac{(-3)^{n+1}}{n^2} \frac{1}{n^2 + 1} \)

6. Consider the following formal power series. Make a diagram (as we did in class) indicating for which \( x \)'s this series is: absolutely convergent, conditionally convergent, divergent. Indicate your reasoning. Don’t forget to check the endpoints.

6a. \( \sum_{n=1}^{\infty} (-1)^{n-1} \frac{x^n}{n} \)

6b. \( \sum_{n=0}^{\infty} \frac{x^n}{n!} \)

6c. \( \sum_{n=1}^{\infty} \frac{(x-2)^n}{n} \)

6d. \( 1 + \frac{x-3}{2} + \frac{(x-3)^2}{2^2} + \frac{(x-3)^3}{3^2} + \ldots + \frac{(x-3)^{n-1}}{(n-1)^2} + \ldots \)

6e. \( \sum_{n=1}^{\infty} \frac{(x+1)^n}{\sqrt{n}} \)

6f. \( \sum_{n=1}^{\infty} (-1)^{n-1} \frac{x^{2n-1}}{2n-1} \)

6g. \( \sum_{n=1}^{\infty} n! \frac{(x - 1)^n}{n} \)

7. Recall the geometric series.

\[
\sum_{n=0}^{\infty} r^n = \frac{1}{1 - r}
\]

which is valid for \( |r| < 1 \).

7a. Using the geometric series, find a power series representation for \( f(t) = \frac{1}{9+t} \) about \( t = 0 \) and say when it is valid.

7b. Using the geometric series, find a power series representation for \( g(x) = \frac{7}{9+4x} \) about \( x = 3 \) and say when it is valid.

8. Express as integral(s) the volume of the solid obtained by revolving the given region \( R \) about the given axis of revolution.

8a. \( R \) is the region in the first quadrant bounded by the parabola \( y^2 = 8x \) and the line \( x = 2 \). Axis of revolution is the \( x \)-axis. (disk/washer method)

8b. \( R \) is the region bounded by the parabola \( y^2 = 8x \) and the line \( x = 2 \). Axis of revolution is the \( x \)-axis. (disk/washer method)
8c. $R$ is the region bounded by the parabola $y^2 = 8x$ and the line $x = 2$. Axis of revolution is the $y$-axis. (disk/washer method)

8d. $R$ is the region bounded by the parabola $y = 4x - x^2$ and the $x$-axis. Axis of revolution is the line $y = 6$. (disk/washer method)

8e. $R$ is the region bounded by the parabola $y^2 = 8x$ and the line $x = 2$. Axis of revolution is the line $x = 2$. (shell method)

8f. $R$ is the region bounded by the circle $x^2 + y^2 = 4$. Axis of revolution is the line $x = 3$. (shell method)

8g. $R$ is the region bounded by $y = -x^2 - 3x + 6$ and $x + y - 3 = 0$. Axis of revolution is: (a) the line $x = 3$, and (b) the line $y = 0$. (you choose the method).

9. WORK: For units of let’s use in.-lb. where distance is in inches (in.) and force is in pound (lb).

   Hooke’s Law: Under appropriate conditions a spring that is stretched $x$ units beyond its natural length pulls back with a force $F(x) = kx$ where $k$ is a (positive) constant (called the spring constant or spring stiffness).

9a. When a particle is located at a distance $x$ inches from the origin, a force of $F(x) = x^2 + 2x$ pounds acts on it. How much work is done in moving it from $x = 1$ to $x = 3$?

9b. A force of 9 pounds is required to stretch a spring from its natural length of 6 inches to a length of 8 inches.

   (a) Find the work done in stretching the spring from its natural length to a length of 10 inches.

   (b) Find the work done in stretching the spring from a length of 7 inches to a length of 9 inches.

10. Express the length following curves as integral(s).

10a. The curve $y = x^{3/2}$ from $x = 0$ to $x = 5$.

10b. The curve $x = 3y^{3/2} - 1$ from $y = 0$ to $y = 4$.

10c. The arc $24xy = x^4 + 48$ from $x = 2$ to $x = 4$.

10d. The arc of the catenary $y = \frac{1}{2}a(e^{x/a} + e^{-x/a})$ from $x = 0$ to $x = a$.

10e. The curve $x = t^2$, $y = t^3$ from $t = 0$ to $t = 4$.

10f. The cycloid $x = \theta - \sin\theta$, $y = 1 - \cos\theta$ for $\theta = 0$ to $\theta = 2\pi$.