NOTE: When asked to set up an integral, do not simplify or evaluate the integral. All limits of integration must be written as exact values.

For problems 1-2, let \( f(x) = 2e^{3x} \) on the interval \( 1 \leq x \leq 3 \).

1. Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the arc length of the curve on the interval. (6 pts)

2. Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the surface area of the solid generated when the curve on the given interval is rotated around the
   a. \( x \)-axis. (6 pts)
   
   b. \( y \)-axis. (6 pts)

For problems 3-4, a curve is defined by the parametric equations \( x = 3 \sin t \) and \( y = 2 \cos t \) for \( 0 \leq t \leq 2\pi \).

3. Use your calculator to sketch the graph of the parametric curve. Indicate direction and label the initial and terminal points, with both \( t \) and \((x, y)\), as exact values. (5 pts)

4. Eliminate the parameter to find a Cartesian equation for the curve. Simplify the equation. (5 pts)
For problems 5-8 a curve is defined by the parametric equations \( x = 2t^2 \) and \( y = 3t^3 - 9t \) for \(-2 \leq t \leq 2\).

5. Use your calculator to sketch the graph of the parametric curve. Indicate direction and label the initial and terminal points \( t = 0 \), with both \( t \) and \((x, y)\), as exact values. (5 pts)

6. Analytically (without the use of your calculator) find \( \frac{dy}{dx} \) in parametric form. Show all work. (5 pts)

7. Analytically (without using your calculator) find all points, both \( t \) and \((x, y)\) as exact values, on the curve where the tangent line is horizontal. Show your work. Label the points and sketch the tangent lines on the graph in problem 5. (5 pts)

8. Set up (DO NOT EVALUATE OR SIMPLIFY) the integral that gives the length of the curve on the interval \(-\sqrt{3} \leq t \leq \sqrt{3}\). (5 pts)
For problems 9-10 use the polar equation \( r = 1 + 2 \sin \theta \) on the interval \( 0 \leq \theta \leq 2\pi \).

9. Sketch the polar curve. (3pts)

10. Find one set of polar coordinates, \((r, \theta)\) as exact values on the interval \( 0 \leq \theta \leq 2\pi \) which satisfies the equation each time the curve intersects the x or y-axis. Show your work! Label these points on the graph in problem 9. (7 pts)
11. Accurately sketch and label \( r_1 \) and \( r_2 \). (3 pts)

12. Find and label the polar coordinates \((r, \theta)\) as exact values, of all points of intersection \((\text{collision})\) of the two curves, \( r_1 \) and \( r_2 \) on the interval \([0,2\pi] \). Show your work. (5 pts)

13. Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the common area enclosed by both curves. Shade this region on the graph. (7 pts)

14. Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the area, enclosed in the first quadrant, that lies inside the curve \( r_1 \) and outside the curve \( r_2 \). Shade this region on the graph. (7 pts)
Note: When discussing convergence, please state (in words) whether you are talking about a sequence or a series. All values should be written as exact and not approximations! Make sure to use appropriate and complete notation.

For problems 15-18, let \( a_n = \frac{8}{3^{n-1}} \) for \( n \geq 1 \).

15. Give the first four terms of \( \{a_n\} \). (4 pts)

16. Analytically determine if \( \{a_n\} \) converges. If so, to what number? (4 points)

17. Using \( s_n = \sum_{i=1}^{n} a_i \), write out the exact values of the individual terms for each of the first four partial sums, \( s_1, s_2, s_3, s_4 \). (Don’t add up the terms.) (4 pts)

18. Does \( \sum_{n=1}^{\infty} a_n \) converge? Explain why or why not. If it does converge, analytically determine what number it converges to? (4 points)
19. Analytically determine if \( \sum_{n=0}^{\infty} \arctan(3n) \) converges or diverges. Show your work and explain. 

(4 pts)

20. Write the number .171717\ldots as an infinite series. Use this series to analytically find its sum as a rational number. Show your work. (6 pts)