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 1-4, let R be the region bounded by \( f(x) = \arcsin(2x) \) and \( y = 0 \) from \( x = 0 \) to \( x = 1/2 \). Using the shaded region on the graph below.

1. (5 pts) Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the volume when the region is revolved around the x-axis using the disk/washer method. (5 pts)

2. (5 pts) Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the volume when the region is revolved around the y-axis using the disk/washer method.

3. (5 pts) Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the volume when the region is revolved around the y-axis using the shell method.

4. (5 pts) Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the volume when the region is revolved around the line \( x = 1/2 \). State the method that you use.
For problems 5-7 a curve is defined by the parametric equations $x = e^t - t$ and $y = 4e^{t/2}$ for $0 \leq t \leq 1$.

5. (6 pts) 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.

6. (6 pts) Set up (DO NOT EVALUATE OR SIMPLIFY) the integral that gives the length of the curve on the interval $0 \leq t \leq 1$.

7. (6 pts) Set up (DO NOT EVALUATE OR SIMPLIFY) the integral that gives the surface area generated by rotating the curve on the interval $0 \leq t \leq 1$ about the $y$-axis.

8. (8 pts) For the curve given by $x = \frac{1}{2} t^2$ and $y = t^2 + t$, find the slope and concavity at $t = 1$. Provide analytical justification.
9. (10 pts) A plane is flying at a height of 2304 m when a suitcase falls from the cargo area. Because of air resistance, the suitcase trajectory is \( y = 2304 - \frac{x^{3/2}}{6} \). Find the distance the suitcase travels along its path to the ground. Show analytical justification. Be sure to provide an antiderivative for any integrals. Give the answer as an approximation to 2 decimal places.
For problems 10-11, consider the polar curve $r = 4 - 4 \sin \theta$.

10. (6 pts) Fill in the values for $r$ as exact values in the table below. Sketch the curve and plot all the table points on the curve.

<table>
<thead>
<tr>
<th>$\theta$</th>
<th>$r$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>$\pi/6$</td>
<td></td>
</tr>
<tr>
<td>$\pi/2$</td>
<td></td>
</tr>
<tr>
<td>$5\pi/6$</td>
<td></td>
</tr>
<tr>
<td>$\pi$</td>
<td></td>
</tr>
<tr>
<td>$7\pi/6$</td>
<td></td>
</tr>
<tr>
<td>$3\pi/2$</td>
<td></td>
</tr>
<tr>
<td>$11\pi/6$</td>
<td></td>
</tr>
</tbody>
</table>

11. (8 pts) Find $\frac{dy}{dx}$ for this curve. You do not have to simplify the derivative.
For problems 12-13, use the polar curves $r_1 = 4 \cos(2\theta)$ and $r_2 = 2$ on the interval $[0, 2\pi]$ provided on the graph below.

12. (8 pts) Find and list the four points of intersection (collision) of the two curves indicated on the graph above. Leave your answers as polar coordinates $(r, \theta)$ in exact values. Be sure to show that your points satisfy both equations.

<table>
<thead>
<tr>
<th>$r$</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13. (8 pts) Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the area of the shaded region, i.e., the area inside the petals that is also outside the circle.
Multiple Choice Problems 14-18 (4 points each): Each of the following multiple choice questions has only one solution. Circle the response that best answers the question. If your selection is correct, you will receive full credit (4 pts); if you do not circle any possible responses for a question, you will receive 0 points; and if you select an incorrect response, you will be penalized 1 point, i.e., you will receive 4 - 1 for this question.

14. Find the equation of the tangent line for the curve given by $x = 3t - 1$ and $y = t^2$ at the point where $t = 1$.

A) $2x - 3y - 1 = 0$
B) $3y = 2x + 1$
C) $y = 2x - 3$
D) $y - 1 = 2/3t(x - 2)$
E) none of the above.

15. Set up, but do not evaluate, an integral for the area of the surface obtained by rotating the curve $y = \sec x$, $0 \leq x \leq \pi/4$, about the y-axis.

A) $\int_1^{\pi/4} 2\pi \sec x \sqrt{1 + (\sec x \tan x)^2} \, dx$
B) $\int_0^{\pi/4} 2\pi x \sqrt{1 + (\sec x \tan x)^2} \, dx$
C) $\int_1^{\pi/4} 2\pi y \sqrt{1 + \frac{1}{y^2(y^2 + 1)}} \, dy$
D) $\int_0^{\pi/4} 2\pi x \sqrt{1 + (\sec x)^2} \, dx$
E) None of the above.

16. Find the approximate area enclosed by the polar curve $r = \sin \theta \cos^2 \theta$ for $0 \leq \theta \leq \pi/2$.

A) .098175 sq units
B) .167 sq units
C) .154213 sq units
D) .049087 sq units
E) none of the above.
17. Find the corresponding rectangular equation for the curve represented by the parametric equations \( x = 3 + 2 \cos \theta \) and \( y = 1 + \sin \theta \) by eliminating the parameter.

A) \( x^2 + 4y^2 - 6x - 8y + 9 = 0 \)

B) \( x^2 - 4y^2 - 6x + 8y + 1 = 0 \)

C) \( x = 2y + 1 \)

D) \( \frac{x^2 - 9}{4} + \frac{y^2 - 1}{1} = 1 \)

E) none of the above.

18. Let \( R \) be the region bounded by \( y = e^x \), \( y = e \), and \( x = 0 \). Which of the following integrals gives the volume when the region is revolved around the line \( y = 1 \)?

A) \( \int_{0}^{1} \pi (e^x - 1)^2 \, dx \)

B) \( \int_{1}^{e} 2\pi (\ln y)^2 \, dy \)

C) \( \int_{0}^{1} \pi \left( (e - 1)^2 - (e^x - 1)^2 \right) \, dx \)

D) \( \int_{1}^{e} 2\pi y \ln y \, dy \)

E) none of the above.