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1. (24 pts) Consider the region $\mathcal{R}$ in the first quadrant bounded above by $y = \cosh x$, below by $y = 1$, and on the right by $x = \ln 2$.

   (a) Sketch and shade the region $\mathcal{R}$.

   (b) Set up but do not evaluate integrals to determine each of the following:

   I. The volume of the solid generated by rotating $\mathcal{R}$ about the y-axis.

   II. The volume of the solid generated by rotating $\mathcal{R}$ about the line $y = 3$.

   III. The length of the curve $y = \cosh x$ for $0 \le x \le \ln 2$. (Simplify the integrand, eliminating all square roots.)

2. (14 pts) Find the surface area when $y = 6\sqrt{x+7}$ from $x = 0$ to 9 is rotated about the x-axis. Evaluate the corresponding integral.

3. (18 pts) The following two problems are not related.

   (a) Masses $m_1 = 3$ and $m_2 = k$ are located at $(k, -8)$ and $(1, 3k)$, respectively. The moment M_x of the system equals $6k$. What is the value of k?

   (b) Solve the initial value problem. Simplify your answer and express it in the form $y = f(x)$.

$$\frac{\csc^2 x}{y} \cdot \frac{dy}{dx} = \sec^2 x, \quad y\left(\tfrac{\pi}{4}\right) = e^{-\pi/4}$$

4. (24 pts) The following two problems are not related.

   (a) Does $\displaystyle\sum_{n=1}^{\infty} \frac{5 + 3^n}{4^n}$ converge or diverge? If it converges, find the sum.

   (b) i. Is $\left\{ \dfrac{\pi n}{1 - 2n} \right\}$ monotonic? Justify your answer.

   ii. Does $\displaystyle\sum_{n=1}^{\infty} \sin\left(\frac{\pi n}{1 - 2n} \right)$ converge or diverge? If it converges, find the sum.

5. (20 pts) Suppose $\displaystyle\sum_{n=1}^{\infty} a_n$ is a series such that the corresponding sequence of partial sums is given by

$$s_n = \arctan\left(\frac{n^2 + 2}{7 - 3n} \right).$$

   (a) Find a_1 and a_2, the first two terms of the series. You may leave your answer unsimplified.

   (b) Does $\displaystyle\sum_{n=1}^{\infty} a_n$ converge? If so, to what does it converge? Justify your answer.

   (c) Does $\{a_n\}$ converge? If so, to what does it converge? Justify your answer.