1. (8 points) Which of the following integrals diverge? Remember to give a reason for your answer in each case!

\[
\begin{align*}
(a) & \quad \int_0^1 e^{\sin x} \, dx \\
(b) & \quad \int_0^1 \frac{dx}{\sqrt{x}}
\end{align*}
\]

2. (12 points) Consider the curve given by \(y(x) = \ln x\) for \(1 \leq x \leq e\).

(a) Write down an integral for its length.

(b) The curve is rotated about the \(y\)-axis. Write down an integral for the surface area.

**Do NOT evaluate the integrals.**

3. (16 points) Solve the differential equations:

(a) \(\frac{dy}{dx} = e^{x+y}, \quad y(0) = 0.\)

(b) \(y'(t) - t(y(t))^2 = t \quad \text{(general solution)}.\)

4. (8 points) Write down an integral in polar coordinates for the area of the region that lies inside the curve \(r = 2 \cos \theta\) and outside the curve \(r = \sqrt{2}\).

5. (6 points) Consider the differential equation \(y'(t) = 1 - y^2\). Find the limiting behavior of \(y(t)\) (that is, what is \(\lim_{t \to +\infty} y(t)\)) if the initial condition is

\[
\begin{align*}
(a) & \quad y(0) = 0 \\
(b) & \quad y(0) = 2.
\end{align*}
\]

You do not need to solve the equation — a clear explanation in a few words will suffice.

END OF EXAM