1. We want to show that $x > \log_2 x$ for all $x \in \mathbb{R}^+$. First, we note that

$$\int_1^\infty \tan(\alpha)\, d\alpha = \sum_{\beta=0}^{\infty}\left(\beta \cdot \operatorname*{arg\,min}_{\gamma\in\mathbb{C}}\left(1938\gamma^3 + \gamma\right)\right)$$

by the Borsuk–Ulam theorem. Furthermore, $1 = 1 + 1$ by the Banach–Tarski paradox, and thus, we are done.[1] □

2. We want to compute the derivative of $\sin(e^x)$. We have the following.

$$\begin{aligned}\frac{d}{dx}\sin(e^x) &= \cos(e^x)\cdot\frac{d}{dx}e^x && \text{(chain rule)}\\ &= \cos(e^x)\cdot e^x\end{aligned}$$

3. *See margin.*

I have discovered a truly beautiful solution to this problem, but unfortunately, it simply will not fit in this tiny margin.

4. Let A be an orthogonal matrix. We want to show that A^2 is also orthogonal. We have the following.

$$\begin{aligned}\left(A^2\right)^\intercal\left(A^2\right) &= A^\intercal A^\intercal A A\\ &= A^\intercal I A && \text{(orthogonality of } A\text{)}\\ &= A^\intercal A\\ &= I && \text{(orthogonality of } A\text{)}\end{aligned}$$

Thus, A^2 is orthogonal. □

5. *I was unable to find the exact answer to this problem, but I was able to narrow it down to two possibilities (see Table 1).*

Table 1: Possible answers to Problem 5.

True	False
This one seems likely because a lot of mathematical statements are true. For example, $1 + 1 = 2$ and $1 \times 0 = 0$ are both true statements.	This one also makes a lot of sense to me because sometimes things are false. An example of a false statement would be "I am confident in my solution to Problem 1".

6. We simplify the expression as follows.

$$\begin{aligned}&\sqrt{1938^2 + 62^2 + 1938\times 124 + \sin^2(1938) + \cos^2(1938) - 1}\\ =\ &\sqrt{1938^2 + 62^2 + 1938\times 124 + 1 - 1}\\ =\ &\sqrt{1938^2 + 2\times 1938\times 62 + 62^2}\\ =\ &\sqrt{(1938+62)^2}\\ =\ &1938 + 62\\ =\ &2000\end{aligned}$$

[1] This same technique can be easily adapted to prove P=NP.

7. Below is a demonstration of the execution of the merge sort algorithm:

$$
\begin{array}{ccccccccc}
 & 1 & 5 & 2 & 4 & 7 & 8 & 6 & 3 \\
\hookrightarrow & & 5 & & 4 & & 8 & & 6 \\
\hookrightarrow & & & 4 & & & & 8 & \\
\hookrightarrow & & & & & [\text{illegible}] & & & \\
\hookrightarrow & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8
\end{array}
$$

8. *This proof is left as an exercise to the grader.*

9. We want to find the limit of $f(x) = \frac{\sin x}{\ln x}$ as x tends to infinity. Let $g(x) = -\frac{1}{\ln x}$ and $h(x) = \frac{1}{\ln x}$. Note that f is bounded below by g and above by h. Since the logarithm function increases without bound, we have $\lim_{x\to\infty} g(x) = \lim_{x\to\infty} h(x) = 0$. Thus, by the squeeze theorem, we have $\lim_{x\to\infty} f(x) = 0$.

10. *Sorry, Professor — my ~~dog~~ **cyber-dog** ate my solution to this problem.*