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

$$\int_1^\infty \tan(\alpha)\, d\alpha = \sum_{\beta=0}^{\infty} \Big(\beta \cdot \arg\min_{\gamma \in \mathbb{C}} \big(1938\gamma^3 + \gamma\big)\Big)$$

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.

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

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:

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

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.*