This is not a mathematics test. I am not looking for solutions to the following problems; I'm assuming that you can do mathematics. I want to see how you explain concepts, so imagine that you are explaining how to do these problems to someone who does not understand them. Use any references or resources you'd like. Solutions may be handwritten or typed. Spelling and grammar are not a major concern, but legibility and clarity are important. You can ignore the calculus questions if you are not interested in tutoring calculus.

For each problem:

- Do not worry about the solution, you only need to identify the process to set up the problem. If you are not sure how to solve the problem, explain some methods that you tried, why you chose those methods and why they didn't work.

- Include your reasoning for setting up the problem the way you did. This should be more like an essay than a solution to a math problem. (This is also not an essay, you do not need to use a standard essay format and there is no page requirement.) Diagrams may be helpful in some cases, so feel free to draw a picture.

- Make a note of any resources you used as references, and state any definitions, theorems or mneumonics you used. You can ask questions about problems if you need something clarified.

- Choose your favorite problem to explain in person.

1 Basic Math Questions

1.1 Multiplication Algorithm

$$
\begin{array}{r}
983 \\
\times 6 \\
\hline
488 \\
+ 5410 \\
\hline
5898
\end{array}
$$

What is going on here? Is there an algorithm used that also works for other problems? If not, why not?

1.2 Primes and Factoring

How would you determine if 299 is prime? If it is not prime, how would you find its prime factorization?

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2 Algebra Questions

2.1 Word Problems

Explain how to set up the following problem:

Batman can clean up all of the crime in Gotham City in 8 hours working alone. Robin can do the same job alone in 12 hours. If Robin starts crime fighting at 8:00 AM and Batman joins him at 10:00 AM, then at what time will they have all of the crime cleaned up?

2.2 Polynomials

Explain how to solve the following. What techniques are helpful?

$$4x^4 + 5x^3 - 2x^2 + 5x - 6 = 0$$

2.3 Logarithms

What is the definition of a logarithm? Name some properties of logarithms, and explain where they come from.

3 Calculus Questions

3.1 Differentiation

How would you take the derivative of

$$\frac{2^{(\sin x)}}{\cos x}$$

with respect to x? Which differentiation rules would you use and why?

3.2 Integration

How would you evaluate the following integral? Which methods of integration would you suggest and why?

$$\int \cos(\ln(x))dx$$

3.3 Improper Integrals

How would you determine if the following integral is convergent or divergent?

$$\int_0^1 \frac{1}{\sqrt{x^2 + x}}dx$$

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