1. Compute $\frac{d}{dx}(x^2\sin(2x))$
2. Compute $\frac{d}{dx}\frac{x^2+1}{x^2+x-4}$
3. Compute $\frac{d}{dx}(\tan(x+3))^3$
4. Compute $\frac{d}{dx}\sqrt[5]{(x^3+2)^2}$
5. Compute $\frac{d}{dx}\frac{\sin x}{1+\sec x}$
6. Compute $\frac{d}{dx}\frac{\csc^2 x+3}{\pi}$
7. Use induction to prove the $\dfrac{d}{dx}x^n = nx^{n-1}$ for all positive integers n.
8. Find an equation of the tangent line to $y=\sin^3 x\cos x$ at the point where $x=\frac{\pi}{4}$.
9. Find an equation of the tangent line to $y=x\sin x$ at the point where $x=\frac{\pi}{3}$.
10. Find an equation of the tangent line to $y=\sqrt{3x-2}$ at the point where $x=6$.
11. Find equations for all the lines that pass through the point $(2,10)$ and are tangent to the graph of $y=x^2+2x+3$. (Note that the point is not on the graph.)
12. Find equations for all the lines that pass through the point $(1,50/9)$ and are tangent to the graph of $y=\frac{10}{x}$. (Note that the point is not on the graph.)
13. Prove the product formula for derivatives.
14. Prove the quotient formula for derivatives.
15. Explain how the mean value theorem implies that if you average speed over some time interval is 70 miles per hour, then at some time in that interval you were traveling with a speed of 70 miles per hour.
16. Use the linearization of the appropriate function to estimate $\sin(.1)$.
17. Use the linearization of the appropriate function to estimate $\sqrt[3]{999}$.
18. While driving across the country Tom is keeping track of his gas mileage. After getting back on the interstate highway he remembered that he did not compute his gas mileage. He remembers that he traveled 300 miles and used 14.8 gallons of gas. Explain how Tom can use a linear approximation to get a very good approximation of his gas mileage without taking his hands of the steering wheel. Do the approximation and compare your answer with the actual mileage.
19. Back in the ancient days before calculators (so long ago that your instructor was young)every trigonometry book had a table of values for trigonometric functions. A certain table listed the values of $\cos x$ at .1 degree increments. When you look at the table, you notice that near 30 degrees the difference between successive entries in the table are approximately the same. What is that difference? (Use a linear approximation.)
20. Look at the first few derivatives of the function $f(x)=\frac{1}{x}$ and guess a formula

for $f^{[n]}(x)$, the n^{th} derivative of $f(x)$. Show that the formula is correct for any natural number n.

21. Show that for any polynomial $f(x)$ of degree n, the n^{th} derivative of $f(x)$ is a constant given by the leading coefficient of $f(x)$ times $n!$.

22. Use the mean value theorem to prove that any polynomial of degree n has at most n roots for any natural number n. (Hint: Let $S(n)$ be the statement that any polynomial of degree n has at most n roots. In the induction step think about the question "If $g(a) = 0$ and $g(b) = 0$, what does the Mean Value Theorem say about the derivative of g(x)?")

23. One car is traveling straight east from an intersection at 50 miles per hour. Another car is traveling straight north from the intersection at 60 miles per hour. How fast are the cars moving apart at the instant that the east bound car is two miles from the intersection and the north bound car is one mile from the intersection?

24. A 26 foot long ladder is leaning against a building. The bottom is pulled away from the building at the rate of 2 feet per second. How fast is the top dropping when the bottom of the ladder is 10 feet from the building?

25. Water is being pumped into a cone at the rate of 0.5 cubic feet per second. Suppose the cone is five feet tall and has a radius of six feet. (The vertex of the cone is on the bottom.) how fast is the level of water raising when the height of water is 2 feet?

26. A four foot tall child is running toward a building and directly away from a light on the ground. The child is running at four feet per second and she is exactly four feet from the light and sixteen feet from the wall. How fast is the height of her shadow on the wall shrinking?

27. Prove the Mean Value Theorem using Rolles' Theorem.

28. Prove Rolles' Theorem.

29. Compute y' given that $x^4 + y^4 = a^4$ where a is a constant. Find equations of the lines tangent to this function at the points where $x = a/\sqrt[4]{2}$.

30. Compute $\frac{dy}{dx}$ given that $x^2y + y^2x - xy = 1$. Also find an equation of the tangent line through $(1, 1)$.

31. The position of an object along a line is given by $x(t) = 10t + \sin(3t)$ where t is measured in seconds and x is measured in meters. Find the object's velocity and acceleration at time t. State the units.

32. The velocity of an object is given by $v(t) = t^2 + 3t - 7$ where the distance units are feet and the time units are seconds. Find a formula for position and a formula for the acceleration and state the units for each.

33. The acceleration of an object is given by $a(t) = 28t$ where the distance unit is meters and the time unit is minutes. Find formulas for the velocity and position of the object. State the units of each.

34. State conditions under which a continuous function must attain a maximum.

35. Give an example of a continuous function with domain $(0, 1)$ that does not have a maximum.

36. Give an example of a continuous function with domain $[0, \infty)$ that does not have a maximum.

37. A function has domain $[a, b]$. Prove that if a maximum for the function at $x = c$, then either c is an end point or c is a critical point.

38. Let $g(x) = 2x^3 + 3x^2 - 12x + 1$ for $-3 \leq x \leq 2$. Find the maximum and minimum of g in this domain.

39. Let $f(x) = x^{2/3}(x + 3)$ for $-1 \leq x \leq 2$. Find the maximum and minimum for f in this domain.