

1. Compute the following derivatives: (*do not simplify*)

(a) $\frac{d}{dx} (x^5 - 3x^{-\frac{1}{3}} + x^{20})$

(b) $\frac{d}{dx} (x^2 + 5)^3(x^3 - 6x)^6$

(c) $\frac{d}{dx} \sqrt{\frac{3x+1}{x^2+9}}$

(d) $\frac{d}{dx} [\sec(1+x^2) + \cot(x + \sin(x))]$

(e) $\frac{d}{dx} \int_0^{x^3} \frac{1}{1+t^2} dt$

2. Compute the following integrals:

(a) $\int_0^1 5x^4 + x^2 dx$

(b) $\int x(x^2 + 6)^{20} dx$

(c) $\int \cos(x)(3 + \sin(x))^4 dx$

3. Find all of the maximum and minimum points of $f(x) = 3x^4 + 4x^3 - 12x^2$. Justify that the point is a maximum or minimum by using either the first or second derivative test.

4. By using implicit differentiation, find the equation of the tangent line to the curve $y^3 - 2xy + x^2 = 1$ that passes through the point (2,1).

5. By use of linear approximation (or differentials), estimate the volume of material used to make a cylinder can that has both a top and bottom where the inner radius is 2 inches, the height is 5 inches, the thickness of the sides is 0.01 inches, and the material for the top and bottom are 0.02 inches.

6. Twelve yards away from me, a NU fan releases a *Rose Bowl Bound!* balloon. When it is five yards off the ground, the balloon is moving upwards at the speed of 1.5 yards a second. At this point, how fast is the balloon moving away from me?

7. A rectangular box with a square base is being built. The box needs to have a volume of 54 cubic inches. The material for the top and bottom costs \$2 a square inch, while the material for the sides costs \$1 per square inch. Find the dimensions which minimize the cost. Use either a first or second derivative test to show that your answer is a minimum.

8. For the function $f(x) = x^3 - x + 1$, use Newton's Method and $x_0 = 1$ to find x_1 and x_2 as approximations for the zero of this function.

9. Find the area bounded between the curves $y = x^5$ and $y = x$.

10. For the function $f(x) = \frac{x^2}{x^2 - 25}$, $f'(x) = 50 \frac{-x}{(x^2 - 25)^2}$, and $f''(x) = 50 \frac{3x^2 + 25}{(x^2 - 25)^3}$. First answer the questions a) through d) and then sketch the graph of $f(x)$. If there are none of a particular item, write *none*. Determine and indicate either on the graph or on a number line:

(a) the asymptotes,

(b) where the function is increasing and where it is decreasing,

(c) where the function is concave upwards and where it is concave downwards; any inflection points,

(d) the critical points, the local maxima and/or local minima.

11. Use the *definition of the derivative* to compute the derivative of $\frac{1}{x+4}$. (You *must* use the definition of the derivative!)