[20] 1. Compute the following limits. If the limit does not exist, explain why. Do not use L'Hopital's rule.

a) $\lim_{x \to -4} \dfrac{x^2 + 3x - 4}{x^2 + 9x + 20}$

b) $\lim_{x \to 1} \dfrac{2 - x}{x - 1}$

c) $\lim_{x \to \infty} \dfrac{\sqrt{x^2 + 1}}{x}$

d) $\lim_{x \to 0} \dfrac{\sin 3x}{\sin 4x}$

[10] 2. Suppose $f(x) = \sqrt{3x+1}$. Find $f'(x)$ from the DEFINITION of the derivative.

[36] 3. Find $f'(x)$ for the following functions. You need not simplify your answers.

a) $f(x) = 2e^{3x} - 4\sin 6x + 5\cos 2x$

b) $f(x) = (x^2+1)^{1/2}(3+\tan 2x)$

c) $f(x) = \dfrac{x + \sec x}{x^2 + 1}$

d) $f(x) = (x^2 + 3x + 1)^{x^3}$

e) $f(x) = \displaystyle\int_{x^2}^{4} \frac{dt}{1 + t^6}$

f) $f(x) = x \ln(x^2 + 1)$

[8] 4. Find dy/dx by implicit differentiation if $x \ln y + y \ln x = x^2$.

[10] 5. Find an equation of *the* tangent line to $f(x) = xe^{x^2}$ where t crosses the horizontal line $y = -e$.

[8] 6. Find the absolute maximum and absolute minimum of $f(x) = x^3 - 6x^2 + 6$ on $[-1, 2]$.

[10] 7. A 13 ft ladder is leaning against a house when the base starts to slide away. by the time the base is 12 ft from the house, the base is moving at the rate of 5 ft/sec.

a) How fast is the top of the ladder sliding down the wall then?

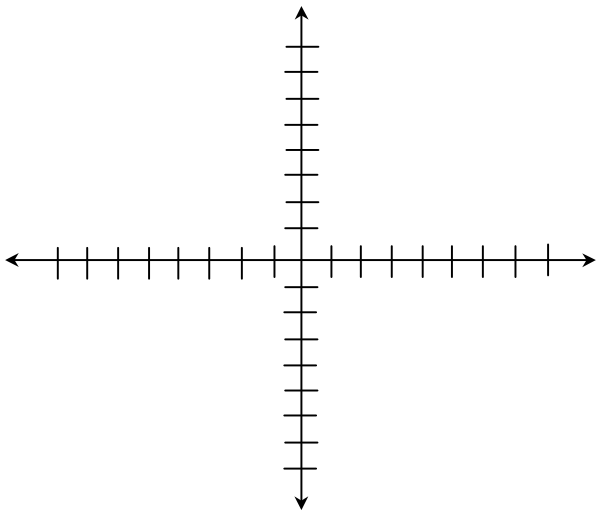
b) At what rate is the area of the triangle formed by the ladder, wall and ground changing then?

[8] 8. Graph the function which satisfies the following conditions.

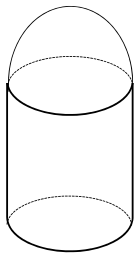
$$\lim_{x\to\infty} f(x)= 2, \qquad \lim_{x\to-\infty} f(x) = 2, \qquad \lim_{x\to 0} f(x) = \infty$$

$$f' > 0 \text{ on } (-\infty, 0) \cup (3, \infty); \qquad f' < 0 \text{ on } (0, 3)$$

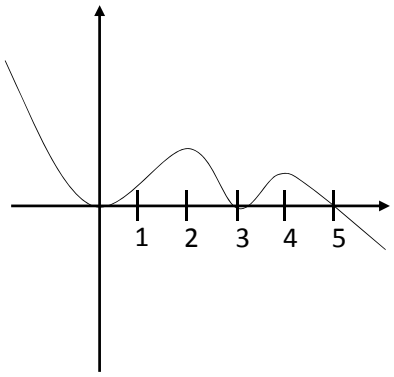
$$f'' > 0 \text{ on } (-\infty, 0) \cup (0, 5); \qquad f'' < 0 \text{ on } (5, \infty)$$



[10] 9. A silo (base not included) is placed on an existing concrete pad with a hemispherical top. It costs $\$10/ft^2$ to construct the hemisphere portion and $\$5/ft^2$ to construct the cylindrical walls. Determine the dimensions if the total volume is $9\pi \text{ft}^3$ to keep the cost to a minimum. Hint: Surface area of a sphere is $4\pi r^2$.



[10] 10. Suppose that the DERIVATIVE f' of a function f has the graph



This graph is not the graph of the function. It is the graph of the derivative of f.

a) Find the intervals where f is increasing/decreasing.

b) Find the intervals where f is concave up/down.

[30] 11. Evaluate the following indefinite integrals.

a) $\int \frac{x^2 + 3x - 1}{x} dx$

b) $\int \frac{(\ln x)^2}{x} dx$

c) $\int (\sec^2 x - \tan x + \cot x) dx$

d) $\int \sin x e^{\cos x} \, dx$

e) $\int (e^{2x} + 4e^{3x} - 4e^{-2x})\, dx$

[18] 12. Find the following definite integrals.

a) $\int_0^3 \frac{x+1}{\sqrt{x^2+2x+4}} dx$

b) $\int_0^{\pi/12} (4\sin 2x - 3\cos 3x) dx$

[20] 13. Let R be the region bounded by $y = x^3$ and $y = 3x^2$. Find the following.

a) Area of R.

b) Volume of the solid obtained by rotating R about the line $x-$axis. SETUP ONLY.

c) Volume of the solid obtained by rotating R about the line $x = -2$. SETUP ONLY.