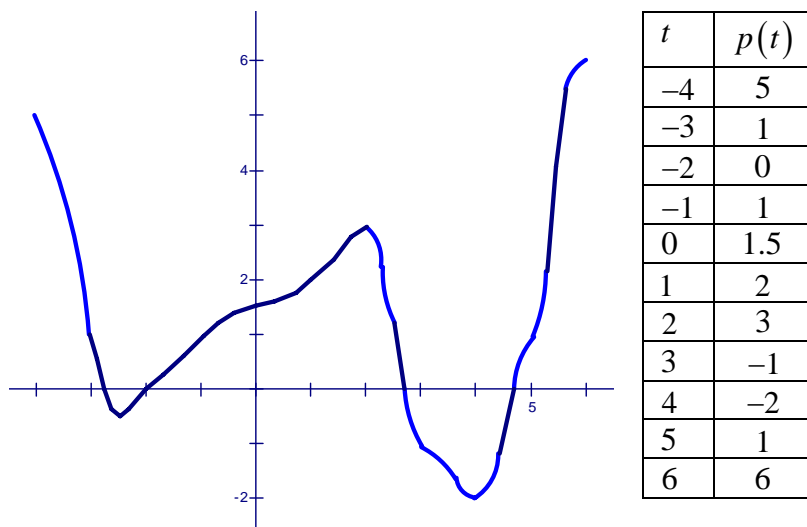


Please do all work on separate paper NEATLY! (If I can't read it or find it I will mark it wrong and will not address appeals on it) Box answers on your work. When graphs are requested, please use graph paper and draw a set of axes and some scaling marks on it.

1. The position  $p(t)$  of a particle moving along a line is given by the graph below (and the coordinates of some of its points are given in the table to the right of it. We only know about the behavior of this particle during times from  $-4$  to  $6$ . (2 points per part)



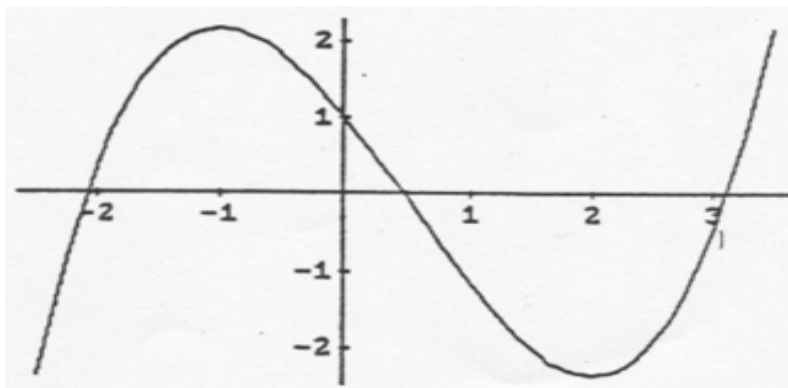
- Find the average velocity of the particle between times  $t = -3$  and  $t = 6$ .
  - Find the equation of the secant line of  $p(t)$  between  $t = -3$  and  $t = 1$ .
  - For what intervals (approximately) is the particle's velocity positive? For what intervals (approximately) is its velocity negative?
2. Suppose we have a non-linear function  $f(x)$  with  $f(3) = 12$  and the average rate of change for  $f$  between  $x$ -values of 3 and 8 is  $-2$ . Determine  $f(8)$ . (2 points)
3. Let  $f(x) = x^3 + 2x^2 - 3x - 5$ . (2 points per part)
- Use one of the **limit** definitions of a derivative to find  $f'(x)$ .
  - Find an equation of the tangent line to the graph of  $f$  at the point  $(3, 31)$ .
4. Given:  $f(x) = \frac{5}{x^2}$  The power rule tells us that  $f'(x) = -\frac{10}{x^3}$ .
- Use one of the **limit definitions** of the derivative to develop this fact. Show all steps clearly. (3 pts)
  - Find an equation of the tangent line to the curve at the point where  $x = -1$ . (2 pts)
  - Draw (on graph paper—big enough to see) a careful graph of  $f(x)$  and the tangent line. (1 pt)
5. We don't have a rule yet to determine  $f'(x)$  if  $f(x) = \sqrt{x^2 + 2x}$  but we can develop this result using the **limit** definition of a derivative. Do it showing all steps. (4 pts)

6. The graph of a function  $f(x)$  is given below. Estimate the values of  $f'(x)$  at the following points ( $\frac{1}{2}$  point each)

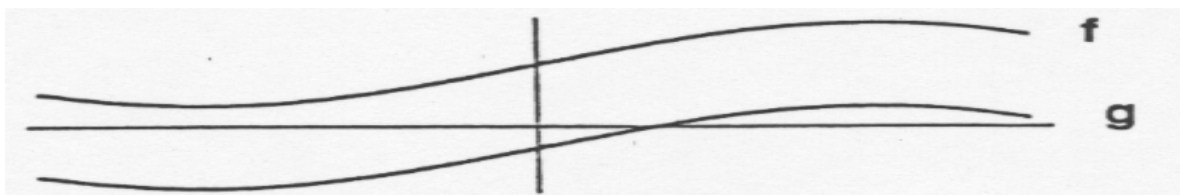
- a.  $x = -2$   
d.  $x = 1.5$

- b.  $x = -1$   
e.  $x = 2$

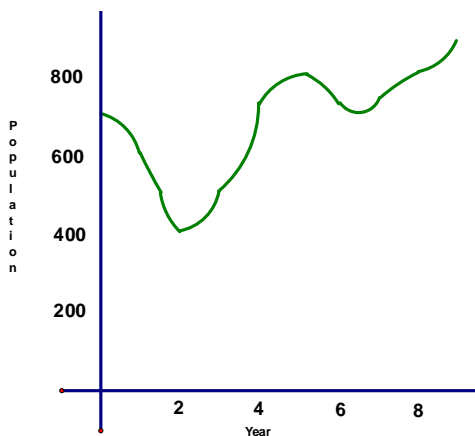
- c.  $x = 0$   
f.  $x = 3$



7. Graphs of two functions  $f(x)$  and  $g(x)$  are shown. What is the derivative of  $h(x) = f(x) - g(x)$  (1 point)



8. The number of deer in a forest  $t$  years after the beginning of a population study is shown by the graph below. Answer each of the following questions. (1 pt for each part)



a. Over which of the following time intervals did the population of deer decline at an average rate of 50 deer per year?

- (i)  $[0,1]$       (ii)  $[1,2]$       (iii)  $[2,3]$   
(iv)  $[1,4]$       (v)  $[5,6]$

b. When was the population increasing most rapidly?

c. Approximately how fast was the population of deer increasing (or decreasing)  $1\frac{1}{2}$  years after the study began?