1. (9) Suppose a function is given by a table of values as follows:

| x	1.1	1.3	1.5	1.7	1.9	2.1
$f(x)$	12	15	21	23	24	25

    (a) Estimate the instantaneous rate of change of f at $x = 1.7$.

    (b) Use your answer in (b) to predict a value for f at $x = 1.8$.

    (c) Is your prediction too large or too small? Explain.

2. (9) *(Read Carefully!)*
   Let $f(T)$ be the time, in minutes, that it takes for an oven to heat up to temperature T °F.

    (a) Give the meaning, in plain English, of $f(300) = 10$.

    (b) What are the units of $f'(T)$?

    (c) Do you think $f'(T)$ would be positive or negative?

    (d) Give the meaning, in plain English, of $f'(300) = 0.1$

3. (6) The graph of f is shown below. Are the following quantities positive, negative, or zero?

(a) $f(A)$ (b) $f'(A)$ (c) $f''(A)$
(d) $f(B)$ (e) $f'(B)$ (f) $f''(B)$
(g) $f(C)$ (h) $f'(C)$ (i) $f''(C)$
(j) $f(D)$ (k) $f'(D)$ (l) $f''(D)$
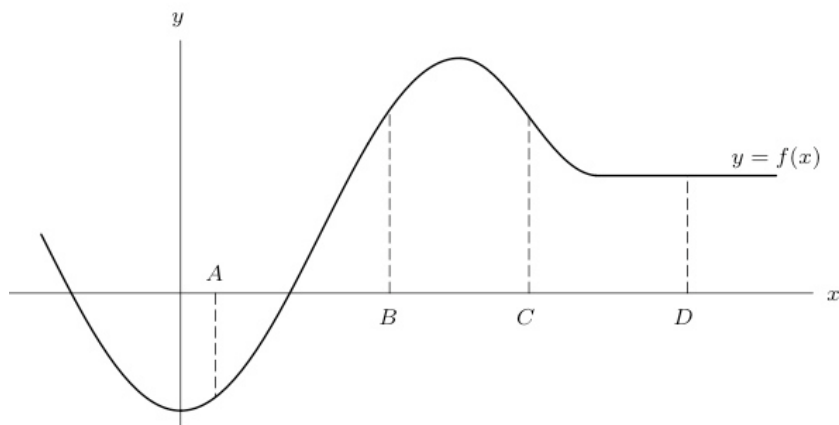
4. (4) The graph of $f(x)$ is to the right. On the graph to the right, **indicate a scale** on the vertical axes and, as accurately as you can, sketch the graph of $f'(x)$.
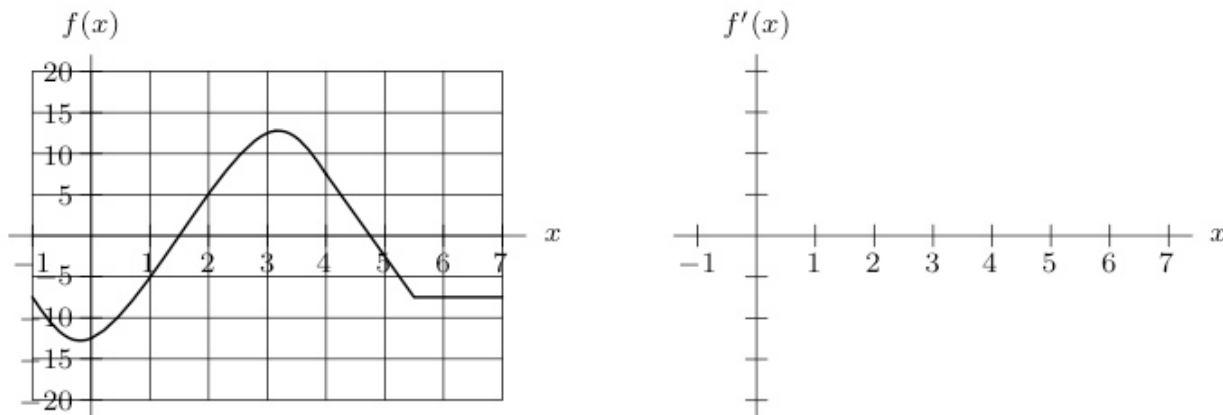
5. (4) A stamp collector has 4500 stamps in his collection on January 1, 2010, and is collecting more stamps at a rate of $r = f(t)$ stamps per week, where t is the time in weeks since January 1, 2010.

Write a formula involving a definite integral expressing the number of stamps in his collection at the end of 2010.

6. (4) Given the table on the right, find $j(0)$ and $j'(0)$, where $j(x) = g(f(x))$.

x	0	1	2	3
$f(x)$	1	3	5	4
$g(x)$	2	-1	0	1
$f'(x)$	3	4	1	-1
$g'(x)$	1	3	2	4

1. $j(0)$

2. $j'(0)$

7. (4) The rate of pollution pouring into a lake is measured every 10 days with the results in the following table. About how much pollution entered the lake in the first 40 days? Include units in your answer.

Time in days	0	10	20	30	40
Rate of pollution (tons/day)	5	7	10	9	8

8. (4) The area of the region under the curve $F(x)$ and above the x axis for $0 \le x \le 3$ is shown below.
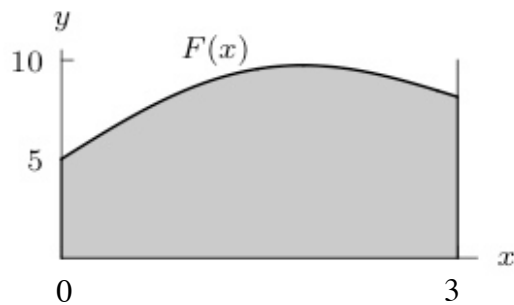
(a) Write the integral that gives this area.

(b) By just looking at the graph, give a lower bound and an upper bound to the area.

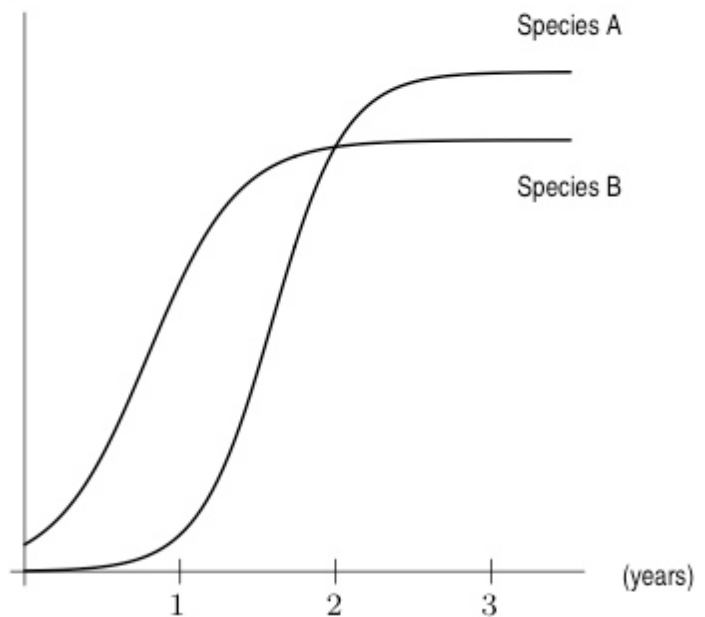9. (15) Find the following derivatives. Do not simplify.

   (a) $f(x) = \cos(x^2)$

   (b) $g(t) = t^3 \ln(t)$

   (c) $h(w) = \dfrac{w - 4}{w^2 + 3}$

10. (4) Equal numbers of two different species of ground squirrels are introduced into an area at time $t = 0$. They have growth rates shown in the figure below.

    (a) Which species has a larger population after 2 years?

    (b) Which species has a larger population after 3 years?

    (c) Which species would you predict to have the largest population after 15 years? Why?

additional squirrels per year

Species A

Species B

(years)

1   2   3

11. (12) The population of Mexico in millions is described by the formula $P(t) = 98e^{0.0114t}$ where t is the number of years after 2000. Include units with your answers.

(a) The population in the year 2020 will be _____.

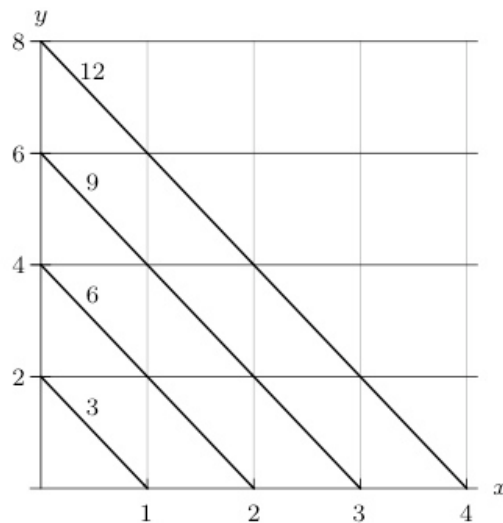(b) In the year 2020, the population will be increasing at a rate of_____.

(c) How long will it take for the population to double?

(d) When will the population be increasing at a rate of 5 million persons per year?

Do Work Below

12. (5) The following figure is a contour diagram of $f(x,y)$.

1. Is $f_x(x,y)$ positive or negative?

2. Is $f_y(x,y)$ positive or negative?

3. Estimate $f(1,4)$.

4. Estimate $f_x(1,4)$.

5. Estimate $f_y(1,4)$.

13. (20) Let $V(s,h) = s^2 h$. Find all first and second order partial derivatives below.

(a) $\dfrac{\partial}{\partial s} V$

(c) $\dfrac{\partial^2}{\partial s^2} V$ or V_{ss}

(b) $\dfrac{\partial}{\partial h} V$

(d) $\dfrac{\partial^2}{\partial h^2} V$ or V_{hh}

(e) $\dfrac{\partial^2}{\partial s \partial h} V$ or V_{sh}