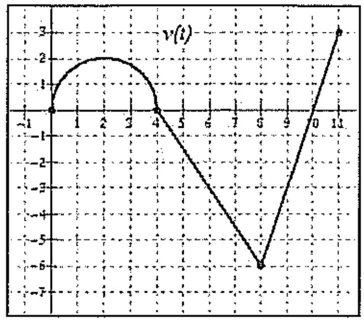
The graph to the right shows the velocity, $v(t)$, of a particle moving along the x-axis for $0 \le t \le 11$. It consists of a semicircle and two line segments. Use the graph and your knowledge of motion to answer the following questions.



1. At what time t, $0 \le t \le 11$, is the speed of the particle the greatest?

2. At which of the times, $t = 2$, $t = 6$ or $t = 9$, is the acceleration of the particle the greatest? Explain your answer.

3. Over what time intervals is the particle moving to the left? Explain your answer.

4. Over what time intervals is the speed of the particle decreasing? Explain your answer.

5. Find the total distance traveled by the particle over the time interval $0 \le t \le 11$.

6. Find the value of $\int_0^{11} v(t)\,dt$ and explain the meaning of this integral in the context of the problem.

7. If the initial position of the particle is $x(0) = 2$, find the position of the particle at time $t = 11$.

3. (noncalculator) The curve with derivative $\frac{dy}{dx} = \frac{3-x}{y+2}$ has $y = -3$ as a tangent line.

At what point is the line tangent to the curve? Determine if the point that you found is a relative maximum point, relative minimum point or neither for the curve. Justify your answer.

4. (calculator active) The rate of change R, in kilometers per hour, of the altitude of a hot air balloon is given by $R(t) = t^3 - 4t^2 + 6$ for time $0 \le t \le 4$, where t is measured in hours. Assume the balloon is initially at ground level.

   a. What is the maximum altitude of the balloon during the interval $0 \le t \le 4$?

   b. At what time is the altitude of the balloon increasing most rapidly?

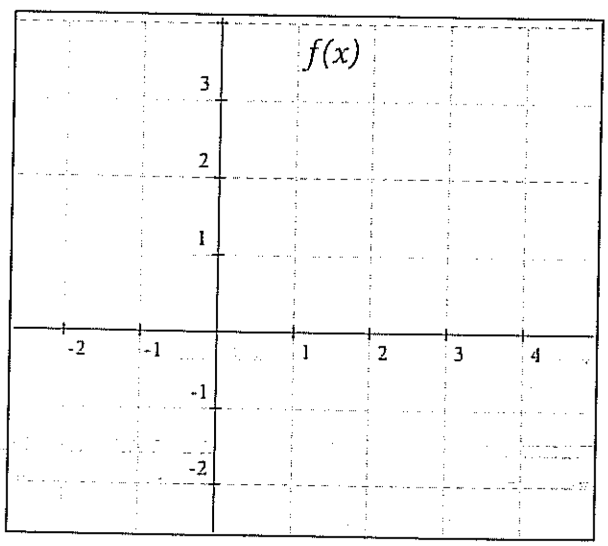
5. (noncalculator) Let f be a function that is continuous on the interval $[-1, 4]$. The function f is twice differentiable except at $x = 1$, and f and its derivatives have the properties indicated in the table below, where "DNE" indicates that the derivatives of f do not exist at $x = 1$.

x	-1	$-1<x<0$	0	$0<x<1$	1	$1<x<2$	2	$2<x<4$	4
$f(x)$	1	positive	0	negative	-1	negative	0	positive	3
$f'(x)$	-6	negative	-1	negative	DNE	positive	-1	positive	8
$f''(x)$	3	positive	0	negative	DNE	negative	0	positive	4

   a. For $-1 < x < 4$, find all values of x at which f has a relative extreme. For each of these x-values, determine whether f has a relative maximum or minimum. Justify your answer.

   b. For $-1 \le x \le 4$, find the maximum value of f. Justify your answer.

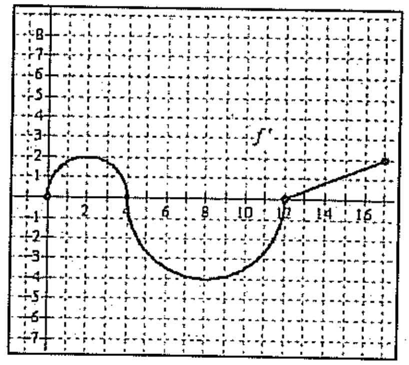
   c. On the axes provided, sketch the graph of a function that has all the characteristics of f.



   d. Let h be the function defined by $h(x) = \int_{-1}^{x} f(t)\,dt$ on the interval $[-1, 4]$.

   For $-1 < x < 4$, find all values of x at which h has a relative extreme. For each of these x-values, determine whether h has a relative maximum or minimum. Justify your answers.

3. The graph below is of the function $f'(x)$, the derivative of the function $f(x)$, on the interval $0 \le x \le 17$. The graph consists of two semicircles and one line segment. Horizontal tangents are located at $x = 2$ and $x = 8$, and a vertical tangent is located at $x = 4$.



(a) On what intervals is $f(x)$ increasing? Justify your answer.

(b) For what values of x does $f(x)$ have a relative minimum value? Justify.

(c) On what intervals, for $0 < x < 17$, is the graph of $f(x)$ concave up? Justify.

(d) For what values of x, for $0 < x < 17$, is $f''(x)$ undefined?

(e) Identify the x-coordinates of all points of inflection of $f(x)$. Justify.

(f) For what value of x does $f(x)$ reach its absolute maximum value? Justify.

(g) If $f(4) = 3$, find $f(12)$.