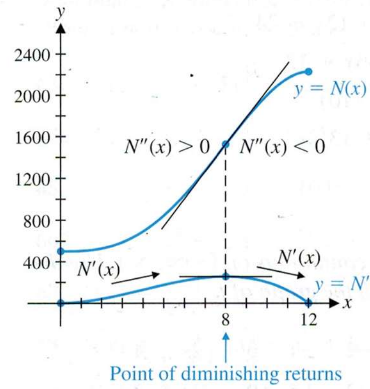
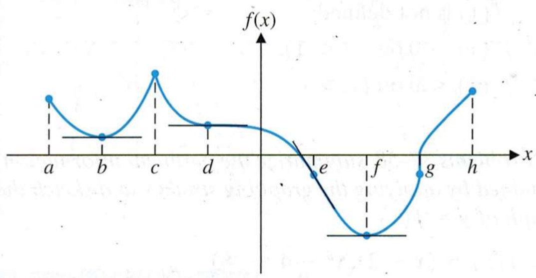
7. $N'(x)$ is increasing on $(0, 8)$ and decreasing on $(8, 12)$. The point of diminishing returns is $x = 8$ and the maximum rate of change is $N'(8) = 256$.



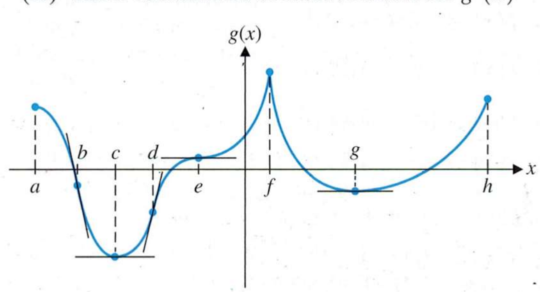
Exercise 12-2

A

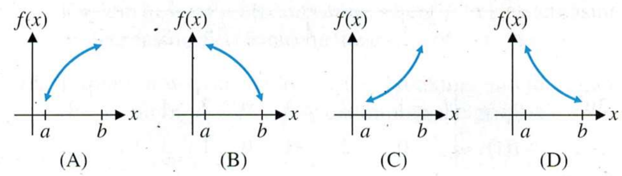
1. Use the graph of $y = f(x)$ to identify
   (A) Intervals on which the graph of f is concave upward
   (B) Intervals on which the graph of f is concave downward
   (C) Intervals on which $f''(x) < 0$
   (D) Intervals on which $f''(x) > 0$
   (E) Intervals on which $f'(x)$ is increasing
   (F) Intervals on which $f'(x)$ is decreasing
   (G) The x coordinates of inflection points
   (H) The x coordinates of local extrema for $f'(x)$



2. Use the graph of $y = g(x)$ to identify
   (A) Intervals on which the graph of g is concave upward
   (B) Intervals on which the graph of g is concave downward
   (C) Intervals on which $g''(x) < 0$
   (D) Intervals on which $g''(x) > 0$
   (E) Intervals on which $g'(x)$ is increasing
   (F) Intervals on which $g'(x)$ is decreasing
   (G) The x coordinates of inflection points
   (H) The x coordinates of local extrema for $g'(x)$



In Problems 3–6, match the indicated conditions with one of the graphs (A)–(D) shown in the figure.



3. $f'(x) > 0$ and $f''(x) > 0$ on (a, b)
4. $f'(x) > 0$ and $f''(x) < 0$ on (a, b)
5. $f'(x) < 0$ and $f''(x) > 0$ on (a, b)
6. $f'(x) < 0$ and $f''(x) < 0$ on (a, b)

In Problems 7–18, find the indicated derivative for each function.

7. $f''(x)$ for $f(x) = 2x^3 - 4x^2 + 5x - 6$
8. $g''(x)$ for $g(x) = -x^3 + 2x^2 - 3x + 9$
9. $h''(x)$ for $h(x) = 2x^{-1} - 3x^{-2}$
10. $k''(x)$ for $k(x) = -6x^{-2} + 12x^{-3}$
11. d^2y/dx^2 for $y = x^2 - 18x^{1/2}$
12. d^2y/dx^2 for $y = x^3 - 24x^{1/3}$
13. y'' for $y = (x^2 + 9)^4$
14. y'' for $y = (x^2 - 16)^5$
15. $f''(x)$ for $f(x) = e^{-x^2}$
16. $f''(x)$ for $f(x) = xe^{-x}$
17. y'' for $y = \dfrac{\ln x}{x^2}$
18. y'' for $y = x^2 \ln x$

In Problems 19–28, find the intervals on which the graph of f is concave upward, the intervals on which the graph of f is concave downward, and the inflection points.

19. $f(x) = x^4 + 6x^2$
20. $f(x) = x^4 + 6x$

21. $f(x) = x^3 - 4x^2 + 5x - 2$

22. $f(x) = -x^3 - 5x^2 + 4x - 3$

23. $f(x) = -x^4 + 12x^3 - 12x + 24$

24. $f(x) = x^4 - 2x^3 - 36x + 12$

25. $f(x) = \ln(x^2 - 2x + 10)$

26. $f(x) = \ln(x^2 + 6x + 13)$

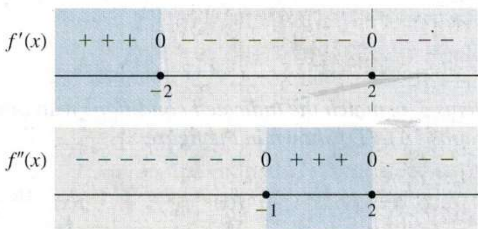
27. $f(x) = 8e^x - e^{2x}$

28. $f(x) = e^{3x} - 9e^x$

In Problems 29–36, f(x) is continuous on $(-\infty, \infty)$. Use the given information to sketch the graph of f.

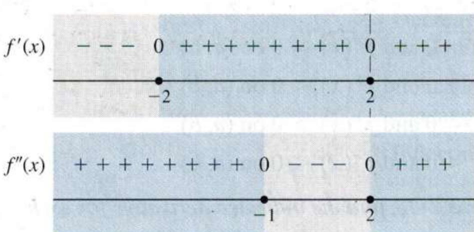
29.

x	−4	−2	−1	0	2	4
$f(x)$	0	3	1.5	0	−1	−3



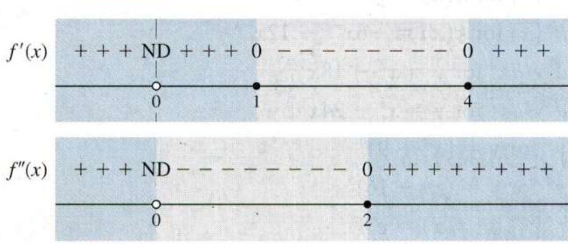
30.

x	−4	−2	−1	0	2	4
$f(x)$	0	−2	−1	0	1	3



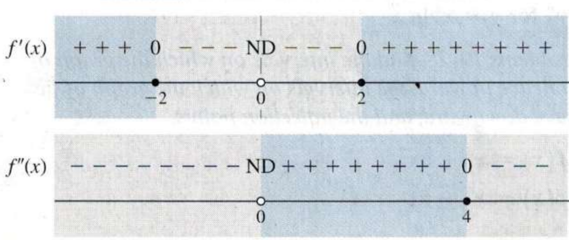
31.

x	−3	0	1	2	4	5
$f(x)$	−4	0	2	1	−1	0



32.

x	−4	−2	0	2	4	6
$f(x)$	0	3	0	−2	0	3



33. $f(0) = 2, f(1) = 0, f(2) = -2;$
$f'(0) = 0, f'(2) = 0;$
$f'(x) > 0$ on $(-\infty, 0)$ and $(2, \infty)$;
$f'(x) < 0$ on $(0, 2)$;
$f''(1) = 0;$
$f''(x) > 0$ on $(1, \infty)$;
$f''(x) < 0$ on $(-\infty, 1)$

34. $f(-2) = -2, f(0) = 1, f(2) = 4;$
$f'(-2) = 0, f'(2) = 0;$
$f'(x) > 0$ on $(-2, 2)$;
$f'(x) < 0$ on $(-\infty, -2)$ and $(2, \infty)$;
$f''(0) = 0;$
$f''(x) > 0$ on $(-\infty, 0)$;
$f''(x) < 0$ on $(0, \infty)$

35. $f(-1) = 0, f(0) = -2, f(1) = 0;$
$f'(0) = 0$, $f'(-1)$ and $f'(1)$ are not defined;
$f'(x) > 0$ on $(0, 1)$ and $(1, \infty)$;
$f'(x) < 0$ on $(-\infty, -1)$ and $(-1, 0)$;
$f''(-1)$ and $f''(1)$ are not defined;
$f''(x) > 0$ on $(-1, 1)$;
$f''(x) < 0$ on $(-\infty, -1)$ and $(1, \infty)$

36. $f(0) = -2, f(1) = 0, f(2) = 4;$
$f'(0) = 0, f'(2) = 0$, $f'(1)$ is not defined;
$f'(x) > 0$ on $(0, 1)$ and $(1, 2)$;
$f'(x) < 0$ on $(-\infty, 0)$ and $(2, \infty)$;
$f''(1)$ is not defined;
$f''(x) > 0$ on $(-\infty, 1)$;
$f''(x) < 0$ on $(1, \infty)$

B *In Problems 37–58, summarize the pertinent information obtained by applying the graphing strategy and sketch the graph of $y = f(x)$.*

37. $f(x) = (x - 2)(x^2 - 4x - 8)$

38. $f(x) = (x - 3)(x^2 - 6x - 3)$

39. $f(x) = (x + 1)(x^2 - x + 2)$

40. $f(x) = (1 - x)(x^2 + x + 4)$

41. $f(x) = -0.25x^4 + x^3$

42. $f(x) = 0.25x^4 - 2x^3$

43. $f(x) = 16x(x - 1)^3$

44. $f(x) = -4x(x + 2)^3$

45. $f(x) = (x^2 + 3)(9 - x^2)$

46. $f(x) = (x^2 + 3)(x^2 - 1)$

47. $f(x) = (x^2 - 4)^2$

48. $f(x) = (x^2 - 1)(x^2 - 5)$

49. $f(x) = 2x^6 - 3x^5$

50. $f(x) = 3x^5 - 5x^4$