1) Use critical numbers and the first derivative test to determine when the function is increasing or decreasing.

a) $f(x) = x^3 + 3x^2 + 1$

b) $f(x) = x^5 - 5x^4 + 100$

c) $f(x) = 3x^4 + 4x^3 - 12x^2$
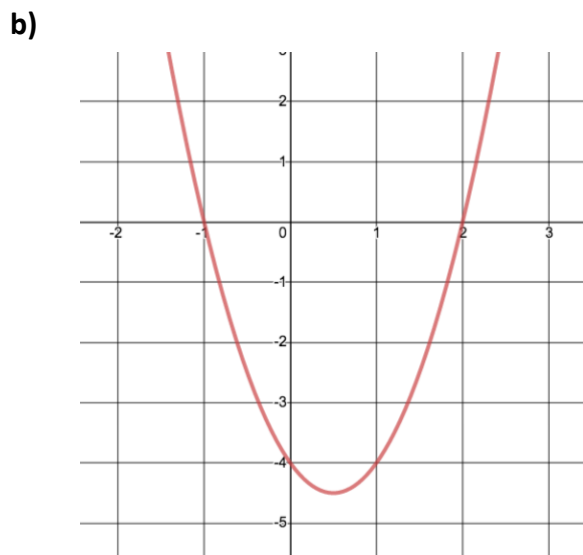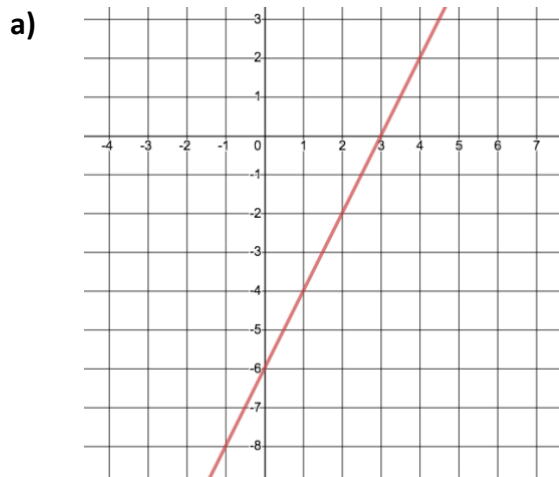
d) $f(x) = (2x - 1)^2(x^2 - 9)$

2) Suppose that $f(x)$ is a differentiable function with the given derivative. Determine the values of x for which $f(x)$ is increasing and decreasing.

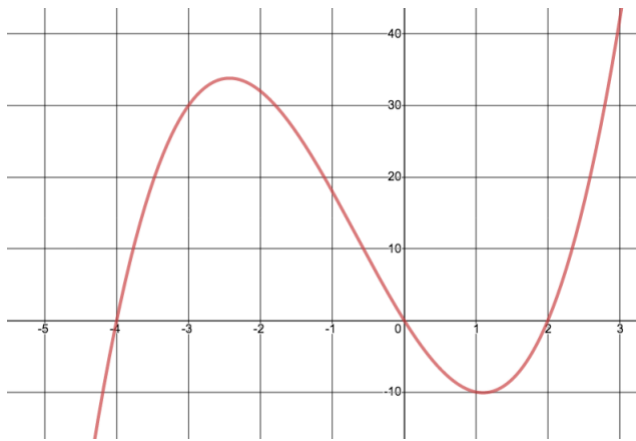**a)** $f'(x) = (x - 1)(x + 2)(x + 3)$

b) $f'(x) = x^2 + 2x - 4$

c) $f'(x) = x^3 + 3x^2 - 4x - 12$

3) Given each graph of $f'(x)$, state the intervals of increase and decrease for the function $f(x)$. Then sketch a possible graph of $f(x)$.
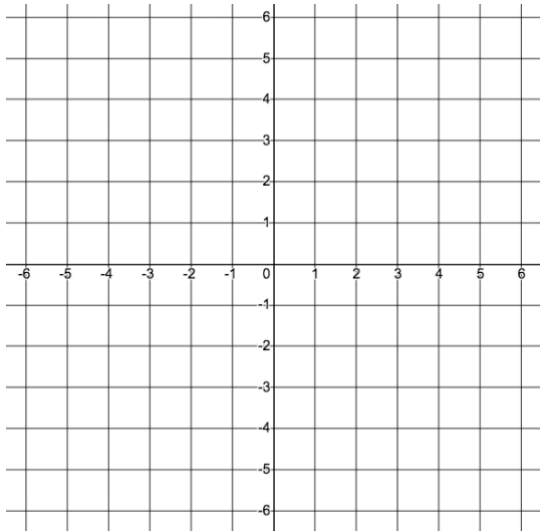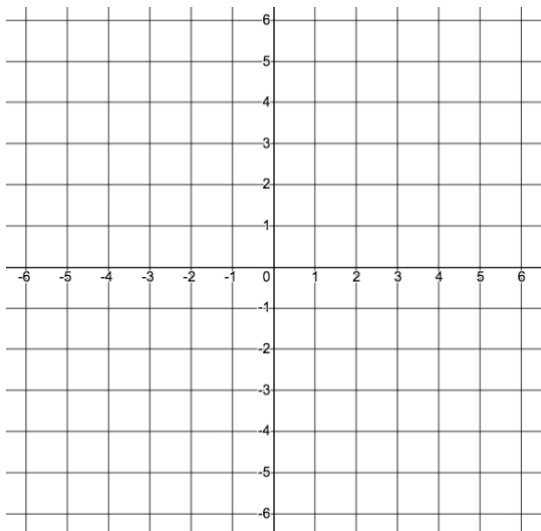
a)

b)

c)

4) Sketch a continuous graph of $f(x)$ given each set of conditions.

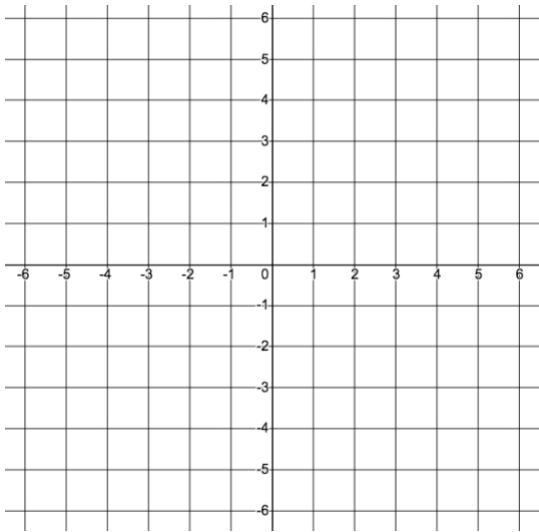**a)** $f'(x) > 0$ when $x < 3$, $f'(x) < 0$ when $x > 3$, $f(3) = 5$

b) $f'(x) > 0$ when $-1 < x < 3$, $f'(x) < 0$ when $x < -1$ and when $x > 3$, $f(-1) = -\frac{20}{27}$, $f(3) = 4$

c) $f'(x) > 0$ when $x \neq 2$, $f(2) = 1$

Answers:

1)a) increasing: $x < -2$, $x > 0$
decreasing: $-2 < x < 0$

b) increasing: $x < 0$, $x > 4$
decreasing: $0 < x < 4$

c) increasing: $-2 < x < 0$, $x > 1$
decreasing: $x < -2$, $0 < x < 1$

d) increasing: $-2 < x < 0.5$, $x > 2.25$
decreasing: $x < -2$, $0.5 < x < 2.25$

2)a) increasing: $-3 < x < -2$, $x > 1$
decreasing: $x < -3$, $-2 < x < 1$

b) increasing: $x < -1 - \sqrt{5}$, $x > -1 + \sqrt{5}$
decreasing: $-1 - \sqrt{5} < x < -1 + \sqrt{5}$

c) increasing: $-3 < x < -2$, $x > 2$
decreasing: $x < -3$, $-2 < x < 2$

3a) increasing: $x > 3$
decreasing: $x < 3$

b) increasing: $x < -1$, $x > 2$
decreasing: $-1 < x < 2$

c) increasing: $-4 < x < 0$, $x > 2$
decreasing: $x < -4$, $0 < x < 2$

4)a)

b)

c)