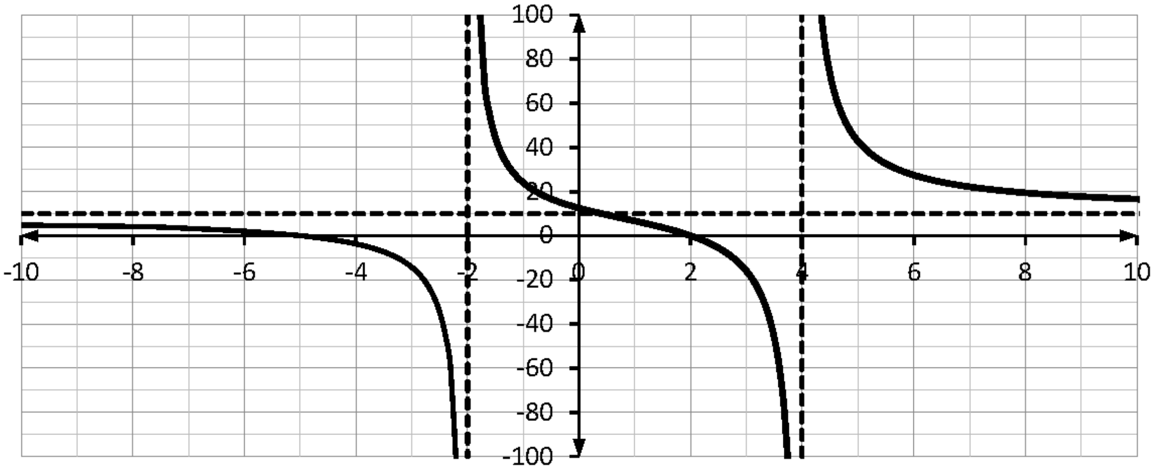
1. The graph of $f(x)$ is shown here.



(a) Find the domain of $f(x)$ in interval notation.

(b) Find the zeros and their corresponding multiplicities.

(c) What is/are the equation(s) of the vertical asymptote(s) of $f(x)$?

(d) What is the behavior near the vertical asymptotes? Fill in the blanks.

$f(x) \to$ _____ as $x \to$ _____ and $f(x) \to$ _____ as $x \to$ _____

$f(x) \to$ _____ as $x \to$ _____ and $f(x) \to$ _____ as $x \to$ _____

(e) What is/are the equation(s) of the horizontal asymptote(s) of $f(x)$?

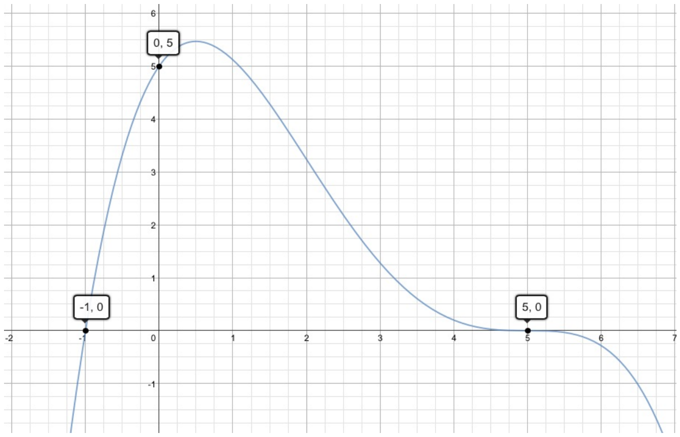
(f) What is the end behavior? Fill in the blanks.

$f(x) \to$ _____ as $x \to$ _____ and $f(x) \to$ _____ as $x \to$ _____

(g) On what interval(s) is $f(x) \geq 0$? Answer in interval notation.

(h) On what interval(s) is $f(x) < 0$? Answer in interval notation.

2. Find a degree 4 polynomial, $g(x)$ whose graph is shown here. Use correct function notation.



3. Consider the polynomial $P(x) = x^3 - 4x^2 - 9x + 36$.

   (a) Factor the polynomial. What are the x-intercepts (zeros) of $P(x)$? What are their corresponding multiplicities?

   (b) To answer this question, complete the table:
   - Column 1: Enter the x-values of all zeros and test points, in order from least to greatest.
   - Column 2: Enter the value of $P(x)$ at the value in Column 1.
   - Column 3: Enter "above," "below" or "on" to indicate if the graph of $P(x)$ is above, below or on the x-axis.

x	$P(x)$	Is the graph of $P(x)$ above, below, or on the x-axis?

   (c) Use your table to solve the inequality $P(x) < 0$. Write your answer in interval notation, and graph your answer on the number line.

   (d) Sketch a graph of $P(x)$. Make sure the x- and y-intercepts and end behavior are correct.

4. Consider the rational function $r(x) = \dfrac{3x+6}{x^2+2x-8}$.

   (a) Find the equation(s) of the horizontal asymptote(s), if any. Explain how you know.

   (b) Determine the end behavior. Fill in the blanks.

   $$r(x) \to \underline{\hspace{2em}} \quad \text{as } x \to \underline{\hspace{2em}} \quad \text{and } r(x) \to \underline{\hspace{2em}} \quad \text{as } x \to \underline{\hspace{2em}}$$

   (c) Find the coordinates of the x-intercepts, if any.

   (d) Find the equation(s) of the vertical asymptote(s), if any.

   (e) Fill out the table below.

      i. Column 1: Enter the x-values of all zeros, vertical asymptotes and test points, in order from least to greatest.

      ii. Column 2: Enter "+", "−", "0" or "undefined," to indicate the sign of $r(x)$ at the value in Column 1.

      iii. Column 3: Enter "zero," "asymptote" or "test point."

   Explain below how you obtain the entry in Column 2 for each of your test points.

x-value	$+$, $-$, 0, or undefined?	zero, asymptote, or test point?

   (f) Determine the behavior near the vertical asymptotes.

   $$r(x) \to \underline{\hspace{2em}} \quad \text{as } x \to \underline{\hspace{2em}} \quad \text{and } r(x) \to \underline{\hspace{2em}} \quad \text{as } x \to \underline{\hspace{2em}}$$

   $$r(x) \to \underline{\hspace{2em}} \quad \text{as } x \to \underline{\hspace{2em}} \quad \text{and } r(x) \to \underline{\hspace{2em}} \quad \text{as } x \to \underline{\hspace{2em}}$$

   (g) Sketch a graph of $r(x)$. Make sure the x- and y-intercepts and end behavior are correct.

5. Consider the function $f(x) = -2x^7 - 4$.

   (a) $f(x)$ is a (circle one) polynomial / rational function.

   (b) Does $f(x)$ have any asymptotes?

   (c) What is the domain of $f(x)$?

   (d) Fill in the blanks to describe the end behavior of $f(x)$.

   $$f(x) \to \underline{\hspace{2em}} \quad \text{as } x \to \underline{\hspace{2em}} \quad \text{and } f(x) \to \underline{\hspace{2em}} \quad \text{as } x \to \underline{\hspace{2em}}$$

   (e) Sketch a graph of $f(x)$. Make sure the end behavior is correct.

6. (a) A function $f(x)$ satisfies all the following.
$f(x) \to \infty$ as $x \to 3^-$
$f(x) \to -\infty$ as $x \to 3^+$
$f(x) \to 4$ as $x \to \infty$
$f(x) \to 4$ as $x \to -\infty$

What information do the first two conditions provide?

What information do the last two conditions provide?

(b) On a separate set of coordinates, sketch the graph of a function $g(x)$ that satisfies all the following.
$f(x) \to \infty$ as $x \to \infty$
$f(x) \to -\infty$ as $x \to -\infty$
and $f(x)$ has the following zeros (x-intercepts) with corresponding multiplicities:
$(-1, 0) \to m = 2$,
$(1, 0) \to m = 1$,
$(4, 0) \to m = 3$,
$(9, 0) \to m = 1$

7. (a) There are infinitely many polynomials of degree 4 that have a zero of multiplicity 2 at $x = 3$, and zeros of multiplicity 1 at $x = 0$ and $x = 10$. Name three of them. Leave your functions in factored form.

(b) Only one polynomial fitting the description in part (a) has a graph that passes through the point $(2, 120)$. Find that polynomial.

8. (a) For what values of x is $x^2 \geq 49$? Use correct notations.

(b) For what values of x is $x^4 < 16$? Use correct notations.