

Modules 1 – Relations and Functions

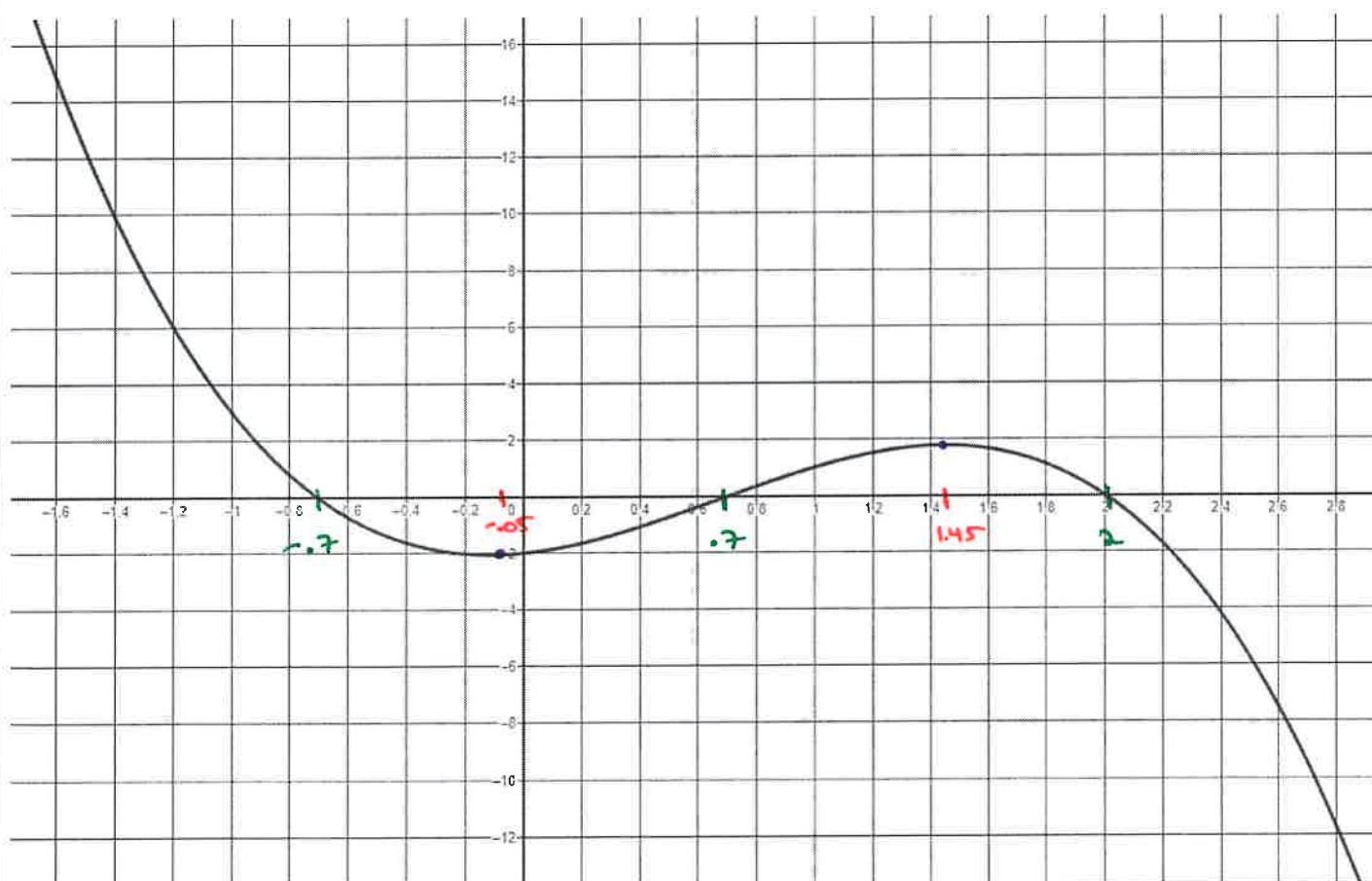
Lesson 2: Linearity, Intercepts, and Symmetry

Lesson 3: Extrema and End Behavior

Lesson 4: Sketching Graphs and Comparing Functions

Notes:

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

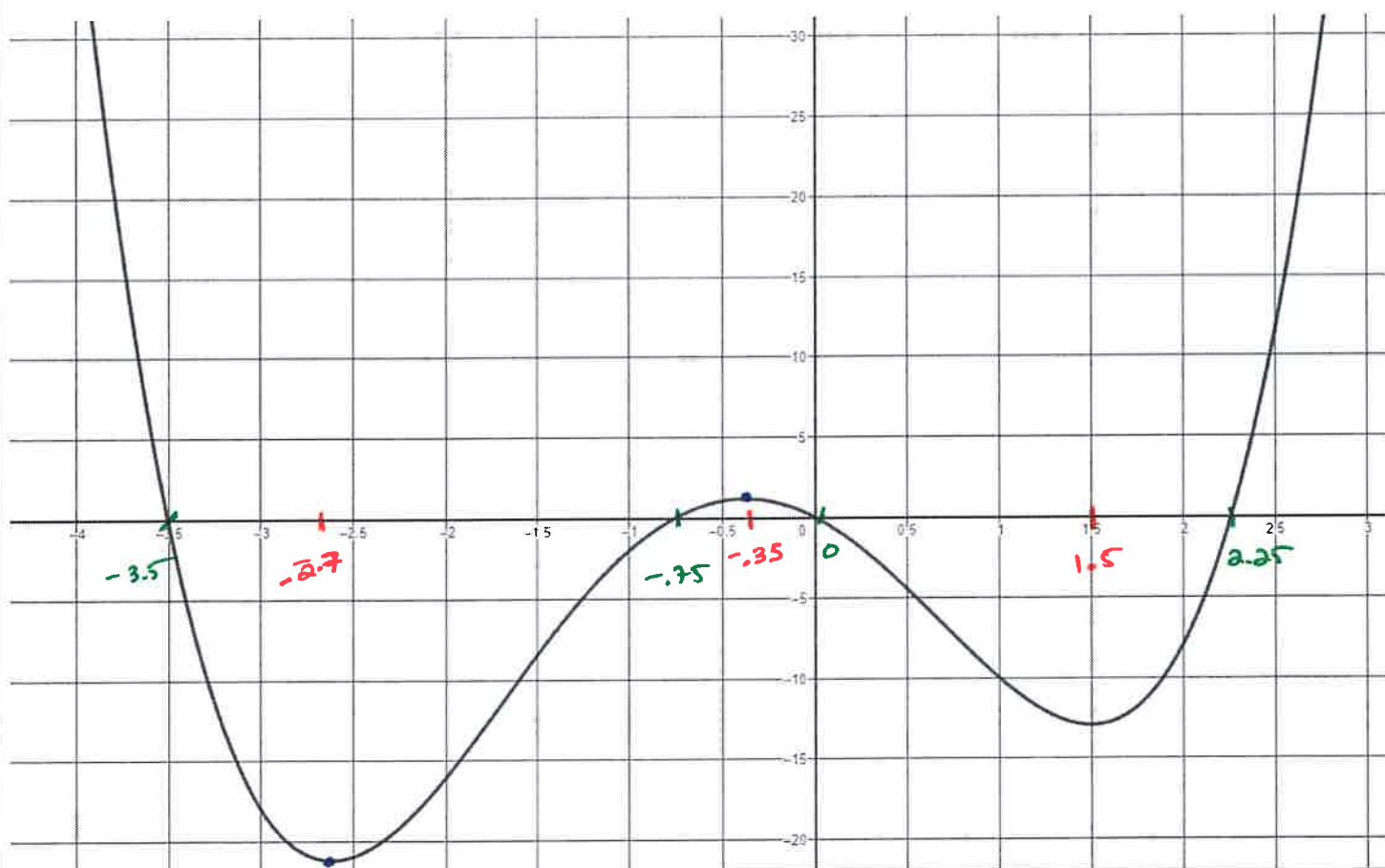


Estimate answers to each of the following questions below. Your answers should prove that you understand each concept.

a. Coordinates of x-intercepts $(-0.7, 0)$ $(0.7, 0)$ $(2, 0)$	b. Coordinates of y-intercept $(0, -2)$	c. Coordinates of Relative (Local) Min/Maxs. min: $(-0.05, -2.1)$ max: $(1.45, 1.9)$	d. End Behavior As $x \rightarrow -\infty$, $y \rightarrow \infty$ As $x \rightarrow \infty$, $y \rightarrow -\infty$
e. Interval(s) of increase $(-0.05, 1.45)$	f. Interval(s) of decrease $(-\infty, -0.05)$ $(1.45, \infty)$	g. Interval(s) of positive function values $(-\infty, -0.7)$ $(0.7, 2)$	h. Interval(s) of negative function values $(-0.7, 0.7)$ $(2, \infty)$

Notes:

2. $f(x) = x^4 + 2x^3 - 7x^2 - 6x$

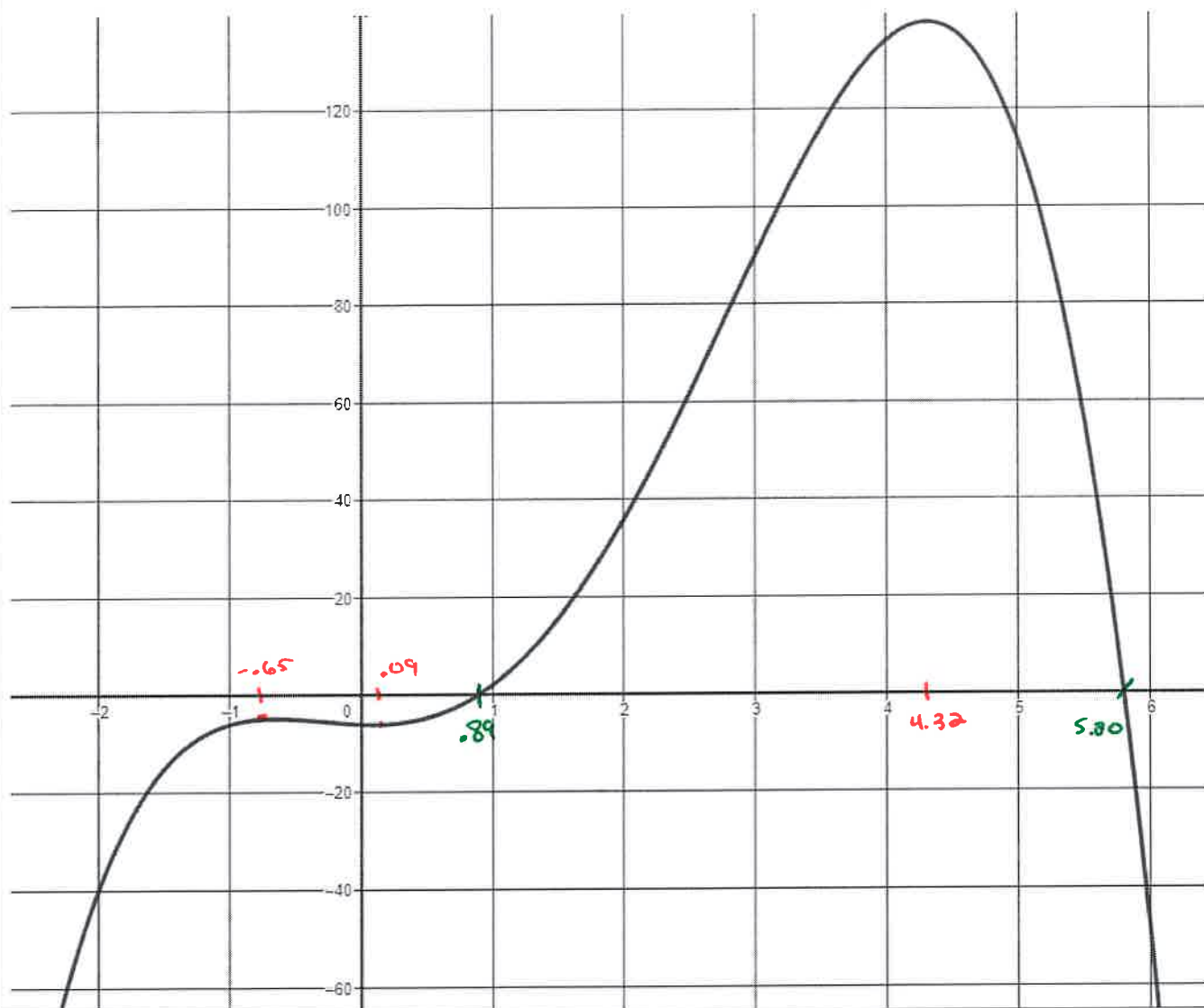


Estimate answers to each of the following questions below. Your answers should prove that you understand each concept.

a. Coordinates of x-intercepts $(-3.5, 0)$ $(-0.75, 0)$ $(0, 0)$ $(2.25, 0)$	b. Coordinates of y-intercept $(0, 0)$	c. Coordinates of Relative (Local) Min/Maxs. min: $(-2.7, -21)$ $(1.5, -12.5)$ max: $(-0.35, 2)$	d. End Behavior As $x \rightarrow -\infty$, $y \rightarrow \infty$ As $x \rightarrow \infty$, $y \rightarrow \infty$
e. Interval(s) of increase $(-2.7, -0.35)$ $(1.5, \infty)$	f. Interval(s) of decrease $(-\infty, -2.7)$ $(-0.35, 1.5)$	g. Interval(s) of positive function values $(-\infty, -3.5)$ $(-0.75, 0)$ $(2.25, \infty)$	h. Interval(s) of negative function values $(-3.5, -0.75)$ $(0, 2.25)$

So far you have been estimating each of the following characteristics of a function. Now, use your estimate knowledge along with your graphing calculator utilities to accurately answer each question to the nearest hundredth.

3. $g(x) = -x^4 + 5x^3 + 5x^2 - x - 6$

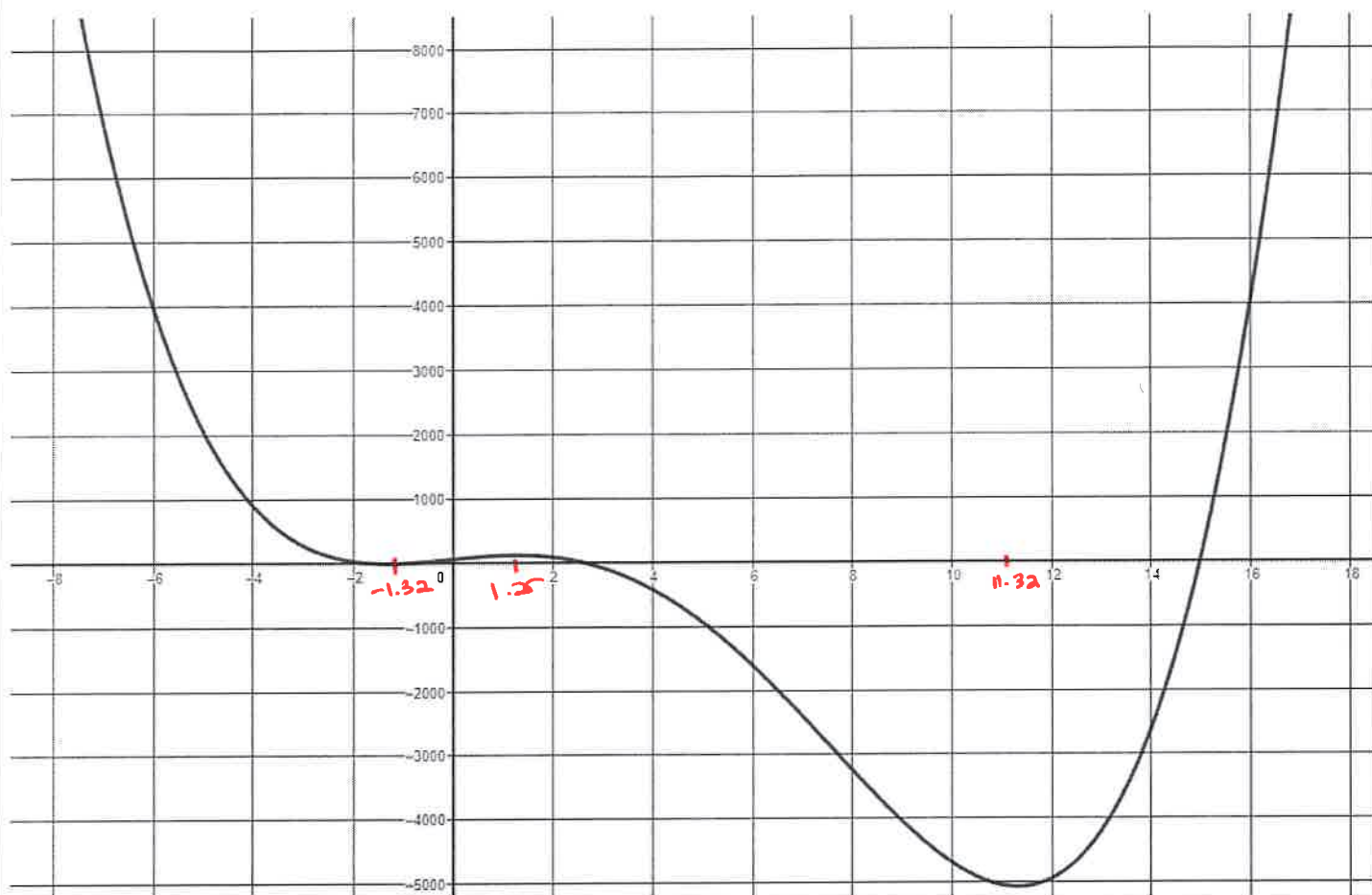


So far you have been estimating each of the following characteristics of a function. Now, use your estimate knowledge along with your graphing calculator utilities to accurately answer each question to the nearest hundredth.

a. Coordinates of x-intercepts $(-0.89, 0)$ $(5.80, 0)$	b. Coordinates of y-intercept $(0, -6)$	c. Coordinates of Relative (Local) Min/Maxs. min: $(-0.65, -4.79)$ max: $(4.32, 137.82)$	d. End Behavior As $x \rightarrow -\infty, y \rightarrow -\infty$ As $x \rightarrow \infty, y \rightarrow -\infty$
e. Interval(s) of increase $(-\infty, -0.65)$ $(0.09, 4.32)$	f. Interval(s) of decrease $(-0.65, 0.09)$ $(4.32, \infty)$	g. Interval(s) of positive function values $(-0.89, 5.80)$	h. Interval(s) of negative function values $(-\infty, -0.89)$ $(5.80, \infty)$

Notes:

4. $f(x) = x^4 - 15x^3 - 5x^2 + 75x + 63$



So far you have been estimating each of the following characteristics of a function. Now, use your estimate knowledge along with your graphing calculator utilities to accurately answer each question to the **nearest hundredth**.

a. Coordinates of x-intercepts

b. Coordinates of y-intercept

c. Coordinates of Relative (Local) Min/Maxs.

d. End Behavior

$(-1.64, 0)$
TRICKY
 $(-0.97, 0)$
 $(2.63, 0)$
 $(14.98, 0)$

$(0, 63)$

min: $(11.32, -5066.82)$
 $(-1.32, -7.18)$
max: $(1.25, 122.08)$

As $x \rightarrow -\infty$, $y \rightarrow \infty$
As $x \rightarrow \infty$, $y \rightarrow \infty$

e. Interval(s) of increase

f. Interval(s) of decrease

g. Interval(s) of positive function values

h. Interval(s) of negative function values

$(-1.32, 1.25)$
 $(11.32, \infty)$

$(-\infty, -1.32)$
 $(1.25, 11.32)$

$(-\infty, -1.64)$
 $(-0.97, 2.63)$
 $(14.98, \infty)$

$(-1.64, -0.97)$
 $(2.63, 14.98)$

Copied from Module 1:4 Extra Example 3.

JOGGING Alicia jogs each morning before school. An app on her phone records her pace over the course of her 40-minute jog. Use the key features of her jog to determine which graph could model it.

Part A
Select the graph that best represents the situation.

☐ A

☒ B

☐ C

☐ D

Part B
What assumption was made to graph the situation.

☐ A Alicia's pace increases and decreases at a constant rate.

☐ B Alicia's maximum speed is 6 miles per hour.

☐ C There are two x-intercepts.

☒ D Alicia's speed is constant from the 20th to 35th minute.

y-intercept: Alicia's starting pace is 0 miles per hour. **NOT C**

Extrema: Alicia's fastest pace, 6 miles per hour, occurs from the 20th to 35th minute of her jog. **NOT D**

Increasing: Alicia's pace is increasing from 0 to 20 minutes. **A or B**

Decreasing: Alicia's pace is decreasing from 35 to 40 minutes. **A or B**

End Behavior: Alicia starts jogging at 0 minutes and stops at 40 minutes. **B**

Notes:

Copied from Module 1:4 Extra Example 4.

Use the table and description to compare the two functions.

x	$f(x)$
-4	0
-2	-1.5
0	-3
2	-4.5
4	-6

The graph of $g(x)$ has a slope of -4 and passes through the points $(0, -3)$ and $(-\frac{3}{4}, 0)$.

Which statements about $f(x)$ and $g(x)$ are true? Select all that apply.

☒ A Both functions are decreasing.

☐ B The y-intercept of $f(x)$ is greater than the y-intercept of $g(x)$.

☒ C $g(x)$ decreases faster than $f(x)$.

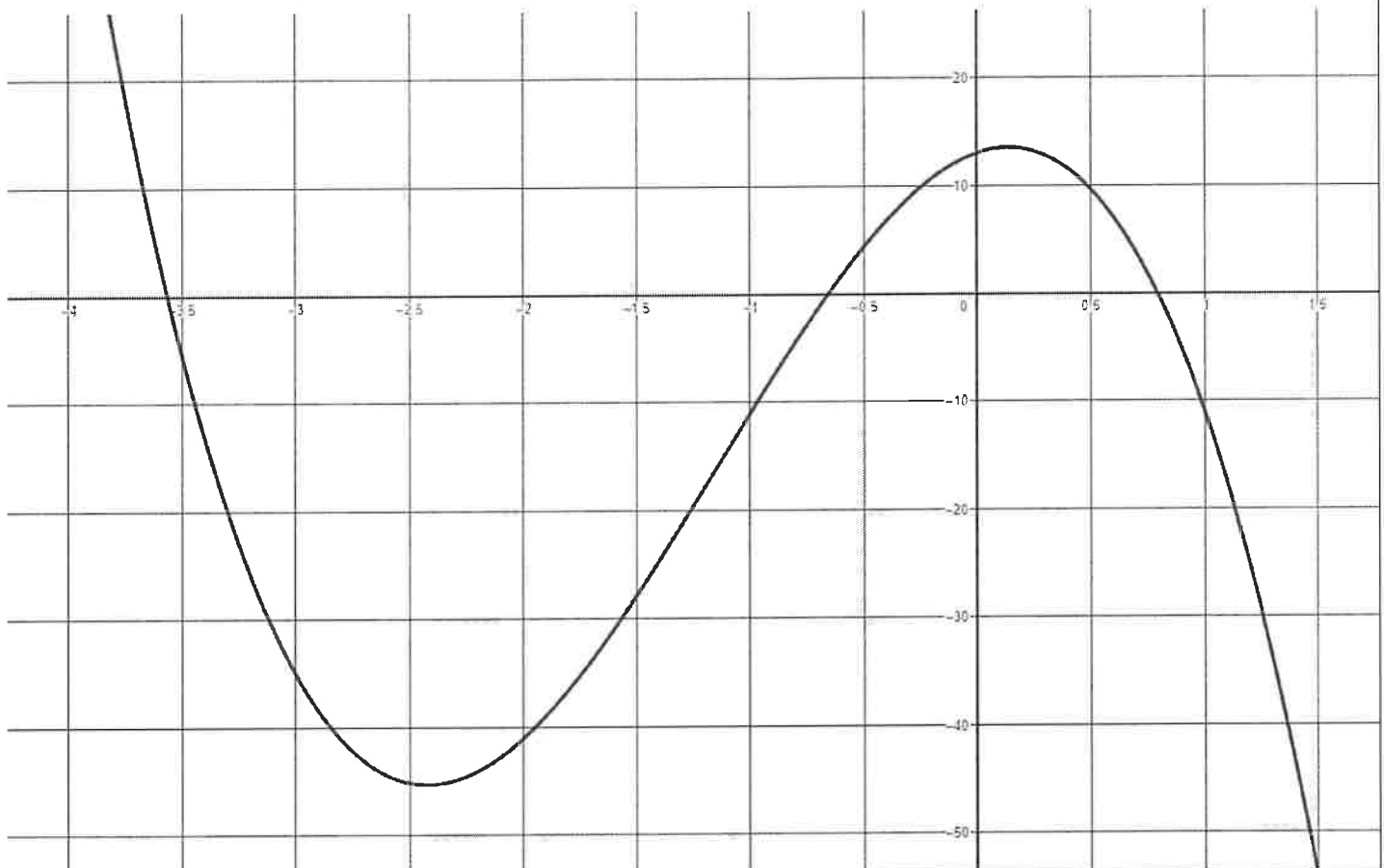
☒ D Both functions have the same y-intercept.

☐ E The x-intercept of $f(x)$ is greater than the x-intercept of $g(x)$.

☐ F $f(x)$ decreases faster than $g(x)$.

Answer each of the following questions below. Your answers must be accurate to 2 decimal places. You can estimate these answers, but you will not receive full credit due to a lack of accuracy.

$$g(x) = -7x^3 - 24x^2 + 7x + 13$$



1. (5 pts.)

a. Coordinates of x-intercepts

$(-3.56, 0)$
 $(-0.66, 0)$
 $(0.79, 0)$

b. Coordinates of y-intercept

$(0, 13)$

2. (4 pts.)

a. Interval(s) of positive function values

$(-\infty, -3.56)$
 $(-0.66, 0.79)$

b. Interval(s) of negative function values

$(-3.56, -0.66)$
 $(0.79, \infty)$

3. (4 pts.) What WINDOW Settings would you use to match the screen shown above?

WINDOW
 $X_{\min} =$
 $X_{\max} =$
 $X_{\text{scl}} =$
 $Y_{\min} =$
 $Y_{\max} =$
 $Y_{\text{scl}} =$

-5
2
0.5
-50
20
10

4. (5 pts.)

Coordinates of Relative (Local) Min/Maxs.

max: $(0.14, 13.49)$

min: $(-2.42, -45.21)$

5. (4 pts.)

a. Interval(s) of increase

$(-2.42, 0.14)$

b. Interval(s) of decrease

$(-\infty, -2.42)$
 $(0.14, \infty)$

6. (3 pts.)

End Behavior

As $x \rightarrow -\infty$, $y \rightarrow \infty$

As $x \rightarrow \infty$, $y \rightarrow -\infty$

Lesson 6: Special Functions

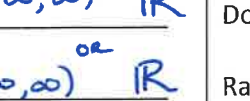
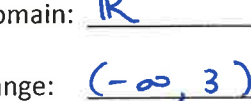
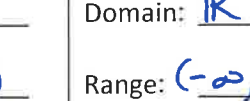
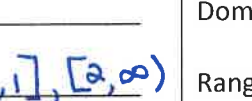
Given:

$$h(x) = \begin{cases} 3-x & \text{if } -8 < x < -3 \\ 9 & \text{if } -3 \leq x < 1 \\ x^2 + 3 & \text{if } 1 \leq x \leq 2 \\ -3 & \text{if } x > 2 \end{cases}$$

1. $f(6) =$	2. $h(-5) =$	3. $g(0) =$	4. $f(-4) =$
8	8	5	-3
5. $h(2)$	6. $h(-2)$	7. $f(5)$	8. $g(3)$
7	9	6	6
9. $g(1)$	10. $f(g(9))$	11. $h(f(3))$	12. $g(f(h(2)))$
2	-1	-3	$-\frac{7}{3}$ or $-2.\bar{3}$

Notes:

Identify the Domain and Range of each function. Assume all the functions are defined on the real number line.

13. Domain: $(-\infty, \infty) \text{ or } \mathbb{R}$ Range: $(-\infty, \infty) \text{ or } \mathbb{R}$ 	14. Domain: $\mathbb{R}$ Range: $(-\infty, 3)$ 	15. Domain: $\mathbb{R}$ Range: $(-\infty, 1] \cup [2, \infty)$ 	16. Domain: $\mathbb{R}$ Range: $(-\infty, 4]$ 
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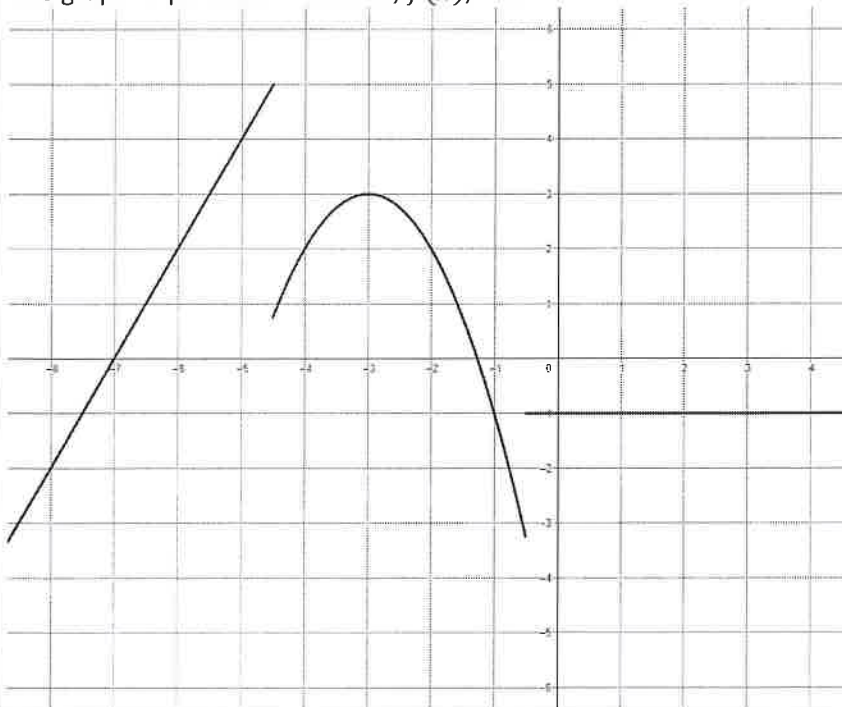
Graph each piecewise function. Identify the Domain and Range of each function. Use your own graph paper for this portion.

17. $f(x) = \begin{cases} x + 1 & \text{if } 0 \leq x < 5 \\ 2x - 4 & \text{if } 5 \leq x < 10 \end{cases}$ Domain: _____ Range: _____	18. $f(x) = \begin{cases} 3x - 4 & \text{if } 0 \leq x < 6 \\ 20 - x & \text{if } 6 \leq x < 12 \end{cases}$ Domain: _____ Range: _____	19. $f(x) = \begin{cases} 20 & \text{if } 0 \leq x < 10 \\ \frac{x}{2} + 15 & \text{if } 10 \leq x < 20 \end{cases}$ Domain: _____ Range: _____
20. $f(x) = \begin{cases} 4x & \text{if } 0 \leq x < 2 \\ -2x + 10 & \text{if } 2 \leq x < 5 \\ 2 & \text{if } 5 \leq x < 10 \end{cases}$ Domain: _____ Range: _____	21. $f(x) = \begin{cases} -2 & \text{if } x < 0 \\ x + 1 & \text{if } 0 \leq x \leq 10 \\ -\frac{1}{2}x + 16 & \text{if } x > 10 \end{cases}$ Domain: _____ Range: _____	22. $f(x) = \begin{cases} 2 & \text{if } x < 1 \\ 2x & \text{if } 1 \leq x \leq 3 \\ 7 - \frac{1}{3}x & \text{if } x > 3 \end{cases}$ Domain: _____ Range: _____
23. $h(x) = \begin{cases} 3 - x & \text{if } -8 < x < -3 \\ 9 & \text{if } -3 \leq x < 1 \\ x^2 + 3 & \text{if } 1 \leq x \leq 2 \\ -3 & \text{if } x > 2 \end{cases}$ Domain: _____ Range: _____	24. $f(x) = \begin{cases} 5 - x & \text{if } x < 2 \\ x - 1 & \text{if } 2 \leq x \leq 10 \end{cases}$ Domain: _____ Range: _____	

Evaluating Piecewise Functions given a graph.

Reminder - When graphing a function, what are you showing?

The graph of piecewise function, $f(x)$, is shown below.



Evaluate each using the graph.

13. $f(1) = -1$

14. $f(-8) = -2$

15. $f(-3) = 3$

16. $f(3) = -1$

17. $f(-1) = -1$

18. $f(-5) = 4$