

## Warm Up Exercises - Fast Five

- Show supporting evidence as you determine the domain of:

$$
f(x)=\sqrt{\frac{2}{(x-1)^{2}}-8}
$$

- Show supporting evidence as you determine
the range of:
$g(x)=\frac{|x|}{x}$
$h(x)=x^{2}-4 x+2$
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## Faster Five

The graph of two functions, $f$ and $g$, is illustrated. Use the graph to answer parts (a)-(f).

(a) $(f+g)(2)$
(b) $(f+g)(4)$
(c) $(f-g)(6)$
(d) $(g-f)(6)$
(e) $(f \cdot g)(2)$
(f) $\left(\frac{f}{g}\right)(4)$

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## Lesson Objectives

- Perform a variety of operations with functions including evaluating functions; add, subtract, multiply, and divide and then analyze the resultant functions in terms of domains and ranges, end behaviours, asymptotes,
- Review \& practice with the composition of functions


\footnotetext{
(C) Operations with Functions Graphic Analysis

- Given the graphs of $f(x)$ and $g(x)$, draw the graph of the following combinations:
- (a) $f+g$
- (b) $f-|g|$



## (C) Operations with Functions Function Analysis

Let $\mathrm{f}(\mathrm{x})=$

## Let $\mathbf{g}(\mathrm{x})=$

(a) $f(x)=x+2$
(a) $g(x)=x^{2}-x-6$
(b) $f(x)=x^{2}+5$
(b) $g(x)=\sqrt{1-x}$
(c) $f(x)=\sqrt{x^{2}-4}$
(d) $f(x)=\frac{1}{x}$
(c) $g(x)=\frac{x^{2}}{x^{2}-1}$
(d) $g(x)=x^{3}$
(e) $f(x)=\frac{x}{x+1}$
(e) $g(x)=\frac{1}{x^{2}}$
(f) $f(x)=2 x-5$
(f) $g(x)=\sqrt[3]{1-x}$

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(C) Operations with Functions -

Function Analysis

- We will work through the pair of equations in question (a) together. Write an equation for each new function. Discuss the domain, range, and intercepts of the newly formed functions
- So $f(x)=x+2 \& g(x)=x^{2}-x-6$
- (i) State D \& R of f and g
- (ii) Evaluate f(2) and g(4)
- (iii) $f(x)+g(x)=(f+g)(x)$
- (iv) $f(x)-g(x)=(f-g)(x)$
- (v) $g(x)-f(x)=(g-f)(x)$
- (vi) $|f(x)-g(x)|$ (absolute value)
- 

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## (C) Operations with Functions Function Analysis

- Write an equation for each new function. Discuss the domain, range, and intercepts of the newly formed functions
- (i) $f(x)+g(x)=(f+g)(x)$
- (ii) $f(x)-g(x)=(f-g)(x)$
- (iii) $g(x)-f(x)=(g-f)(x)$
- (iv) $|f(x)-g(x)|$ (absolute value)
- Graph the following functions on the TI-84 or graphing software to verify

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## (D) Operations with Functions -

Reciprocals

- Write an equation for each new function. Discuss the domain, range, asymptotes, and intercepts of the newly formed functions
- (i) $1 / f(x)$
- (ii) $1 / g(x)$
- Graph the following functions on the TI-84 or graphing software to verify.

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## (E) Operations with Functions -

## Function Composition

- So we have a way of creating a new function $\rightarrow$ we can compose two functions which is basically a substitution of one function into another.
- we have a notation that communicates this idea $\rightarrow$ if $f(x)$ is one functions and $\boldsymbol{g}(\boldsymbol{x})$ is a second function, then the composition notation is $\boldsymbol{\rightarrow} \mathbf{f o g ( x )}$
(C) Operations with Functions -
Function Analysis
- Write an equation for each new function. Discuss the domain, range, and intercepts of the newly formed functions
- (i) $(\mathrm{fg})(\mathrm{x})$
- (ii) $(\mathrm{gf})(\mathrm{x})$
- (iii) $(\mathrm{f} \div \mathrm{g})(\mathrm{x})=(\mathrm{f} / \mathrm{g})(\mathrm{x})$
- (iv) $(g \div f)(x)=(g / f)(x)$
- Graph the following functions on the TI-84 or graphing software to verify.

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## (G) Composition of Functions - Example

- We will now define $f$ and $g$ as follows:
- $f=\{(3,2),(5,1),(7,4),(9,3),(11,5)\}$
- $g=\{(1,3),(2,5),(3,7),(4,9),(5,10)\}$
- We will now work with the composition of these two functions:
- (i) We will evaluate $f \circ g(3)$ (or $f(g(3))$
- (ii) evaluate fog (1)
- (iii) evaluate fog (5) and see what happens $\rightarrow$ why?
- (iv) evaluate $g \circ f(9)$ and $g(f(7)$ and $g \circ g$ (1)

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## (G) Composition of Functions - Example

- We can define $f$ and $g$ differently, this time as graphs:
- We will try the following
- (i) $f(g(3))$ or $f \circ g(3)$
- (ii) $g \circ f(3)$ or $g(f(3))$
- (iii) evaluate $f \circ g(2)$ and $f \circ g(-1)$
- (iv) evaluate $g \circ f(0)$ and $g(f(1))$ and $g \circ g(2)$


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## (G) Composition of Functions - Example

- We can define $f$ and $g$ differently, this time as formulas:
- $f(x)=x^{2}-3 \quad$ and $\quad g(x)=2 x+7$
- We will try the following:
- (i) $f(g(3))$ or $f \circ g(3)$
- (ii) $g \circ f(3)$ or $g(f(3))$
- (ii) $f \circ g(x)$ and $g \circ f(x)$
- (ii) evaluate fog (5)
- (iii) evaluate $g \circ f(9)$ and $g(f(7))$ and $g \circ g$ (1)


## (G) Composition of Functions - Example

- We can define $f$ and $g$ differently, this time as formulas:
- Repeat if $f(x)=-2\left|x^{2}+x-1\right|$ and $g(x)=2^{x}$
- We will try the following:
- (i) $f(g(3))$ or $f \circ g(3)$
- (ii) $g \circ f(3)$ or $g(f(3))$
- (ii) $f \circ g(x)$ and $g \circ f(x)$
- (ii) evaluate fog (5)
- (iii) evaluate $g \circ f(9)$ and $g(f(7))$ and $g \circ g$ (1)
$\qquad$


## (G) Composition of Functions - Example

- For the following pairs of
functions
- (a) Determine fog (x)
- (b) Determine gof (x)
- (c) Graph the original two functions in a square view window \& make
observations about the graph $\rightarrow$ then relate these observations back to the composition result

