Senior High School

DepED
DEPARTMENT OF EDUCATION

General Mathematics

Quarter 1 – Module 14: Domain and Range of Inverse Functions

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ADM

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Quarter 1 – Module 14: Domain and Range of Inverse Functions
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General Mathematics
Quarter 1 – Module 14:
Domain and Range of Inverse Functions

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

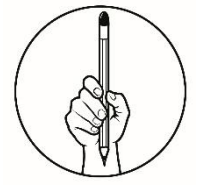
Thank you.

What I Need to Know

In this learning module, you will know more about the domain and range, and how to determine the domain and range of an inverse function. This module was designed and written with you in mind. It is here to help you easily master the procedure in finding the domain and range of an inverse function.

After going through this module, you are expected to:

1. Define domain and range.
2. Find the domain and range of a given inverse function.
3. Represent the domain and range using set builder notation.



What I Know

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. What do you call to the set of all allowable values of the independent variable?
   a. Range
   b. Domain
   c. Real Numbers
   d. Inverse Function

2. Which of the following is not allowed as the value of the independent variable if the function is a fraction?
   a. zero
   b. negative number
   c. decimal number
   d. irrational number

3. What is the domain and range of the function $(x) = x - 5$?
   a. The domain is all real numbers except -5 and the range is all real numbers except 0.
   b. The domain is all real numbers and the range is all real numbers except 0.
   c. The domain is all real numbers except -5 and the range is all real numbers.
   d. The domain and range are all real numbers.

4. What is the inverse of $(x) = 3x + 6$?

a. $f^{-1}(x) = \frac{x+6}{3}$ c. $f^{-1}(x) = \frac{x-6}{3}$

b. $f^{-1}(x) = \frac{3}{x-6}$ d. $f^{-1}(x) = \frac{3}{x+6}$

5. Which of the following pairs of functions is NOT the inverse of each other?

a. $f(x) = 2x + 5 \; and \; g(x) = 2x - 5$

b. $f(x) = 3x \; and \; g(x) = \frac{x}{3}$

c. $f(x) = x - 3 \; and \; g(x) = x + 3$

d. $f(x) = x + 2 \; and \; g(x) = x - 2$

For numbers 6-10, consider the function $f(x) = \frac{3}{x+1}$.

6. What is the domain of the function?

a. $\{x \in R\}$ c. $\{x \neq -1\}$

b. $\{x \neq 0\}$ d. $\{x \neq 1\}$

1. What is the Range of the function?

a. $\{y \neq 0\}$ c. $\{y \neq 3\}$

b. $\{y \neq 1\}$ d. $\{y \neq -1\}$

2. What is the inverse of the function?

a. $f^{-1}(x) = \frac{3+x}{x}$ c. $f^{-1}(x) = \frac{x}{3+x}$

b. $f^{-1}(x) = \frac{3-x}{x}$ d. $f^{-1}(x) = \frac{x}{3-x}$

3. What is the domain of f^{-1}?

a. $\{x \neq 0\}$ c. $\{x \neq -3\}$

b. $\{x \neq 3\}$ d. $\{x \neq -1\}$

4. What is the range of f^{-1}?

a. $\{y \neq 0\}$ c. $\{y \neq 1\}$

b. $\{y \neq y\}$ d. $\{y \neq -1\}$

For numbers 11-15, consider the function $f(x) = x^2 + 2$.

11. What is the domain of the function?

a. $\{x > 2\}$ c. $\{x > 0\}$

b. $\{x \in \neq 2\}$ d. $\{x \in R\}$

12. What is the range of the function?

a. $\{y \geq 2\}$ c. $\{y < 2\}$

b. $\{y > 2\}$ d. $\{y > 0\}$

13. What is the inverse of the function?

a. $f^{-1}(x) = x^2 - 2$ c. $f^{-1}(x) = \sqrt{x-2}$

b. $f^{-1}(x) = 2 + x^2$ d. $f^{-1}(x) = \sqrt{x+2}$

14. What is the domain of f^{-1}?

a. $\{x \geq -2\}$ c. $\{x < -2\}$

b. $\{x \geq 2\}$ d. $\{x < 2\}$

15. What is the range of f^{-1}?

a. $\{y \in R\}$ c. $\{y < 2\}$

b. $\{y \in > 2\}$ d. $\{y > -2\}$

Lesson 1 Finds the Domain and Range of an Inverse Function

Start Lesson 1 of this module by assessing your knowledge of the basic skills in finding the inverse of a function. This knowledge and skill will help you understand easily on how to find the domain and range of an inverse function. Seek the assistance of your teacher if you encounter any difficulty. This topic is about finding the domain and range of an inverse function.

What's In

Recall that a function has an inverse if and only if it is one-to-one and every one-to-one function has a unique inverse function.

Below are the steps in solving for the inverse of a function:

a. Write the function in the form y=f(x);
b. Interchange the x and y variables;
c. Solve for y in terms of x;
d. Replace y by $f^{-1}(x)$;
e. Verify if f and f^{-1} are inverse functions.

Example 1: Find the inverse of $f(x) = 3x - 8$.

Solution: The equation of a function is $y = 3x - 8$. Interchanging the ***x*** and ***y*** variables, we get $x = 3y - 8$.

Solving y for x: $3y = x + 8$

$$y = \frac{x+8}{3}$$

Therefore, the inverse of $f(x) = 3x - 8$ is $f^{-1}(x) = \frac{x+8}{3}$

To verify if f and f^{-1} are inverse functions:

$$f[f^{-1}(x)] = 3\left(\frac{x+8}{3}\right) - 8$$
$$= x+8$$
$$= x$$

$$f^{-1}[f(x)] = \frac{3x-8+8}{3}$$
$$= \frac{3x}{3}$$
$$= x$$

Therefore, f^{-1} is the inverse of f.

Example 2: Find the inverse of $f(x) = \sqrt{2x+1}$.

Solution: The equation of a function is $y = \sqrt{2x+1}$. Interchanging the ***x*** and ***y*** variables, we get $x = \sqrt{2y+1}$.

Solving y for x: $2y = x^2 - 1$

$$y = \frac{x^2-1}{2}$$

Therefore, the inverse of $f(x) = \sqrt{2x+1}$ is $f^{-1}(x) = \frac{x^2-1}{2}$

To verify if f and f^{-1} are inverse functions:

$f[f^{-1}(x)] = \sqrt{2\left(\frac{x^2-1}{2}\right)+1}$

$= \sqrt{x^2-1+1}$

$= x$

$f^{-1}[f(x)] = \frac{\left(\sqrt{2x+1}\right)^2-1}{2}$

$= \frac{2x+1-1}{2}$

$= x$

Therefore, f^{-1} is the inverse of f.

Example 3: Find the inverse of $f(x) = x^2 + 4$.

Solution: The equation of a function is $y = x^2 + 4$. Interchanging the ***x*** and ***y*** variables, we get $x = y^2 + 4$.

Solving y for x: $y^2 = x - 4$

$$y = \sqrt{x-4}$$

Therefore, the inverse of $f(x) = x^2 + 4$ is $f^{-1}(x) = \sqrt{x-4}$

To verify if f and f^{-1} are inverse functions:

$f[f^{-1}(x)] = (\sqrt{x-4})^2 + 4$

$= x - 4 + 4$

$= x$

$f^{-1}[f(x)] = \sqrt{x^2+4-4}$

$= \sqrt{x^2}$

$= x$

Therefore, f^{-1} is the inverse of f.

Notes to the Teacher

The notation f^{-1} is used to represent the inverse of a function f.

To verify that the f and f^{-1} are inverse functions:

$f[f^{-1}(x)]$ and $f^{-1}[f(x)]$ are both equal to x.

What's New

Let's Find Out!

A. Complete the table of each given function.

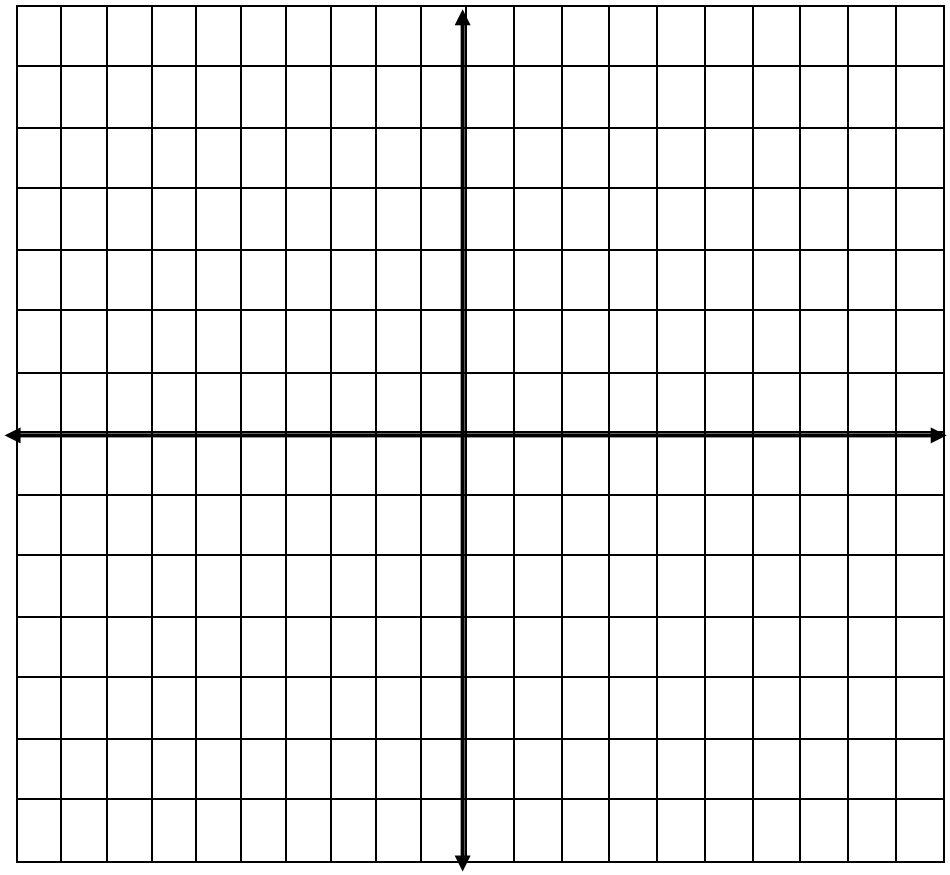
1. $f(x) = 5x + 20$

x	-2	0	2	4	6
f(x)					

2. $f(x) = 4 + \frac{x}{5}$

x	-30	-20	-10	0	10
f(x)					

B. Graph the functions in one Cartesian Plane



C. Answer the following questions:

1. What can you say about the two given functions?

_____
_____
_____
_____
_____

2. Based from the table of values, describe the domain and range of the first function with respect to the domain and range of the other function.

_____
_____
_____
_____
_____

3. What can you say about the graphs of the two functions?

_____
_____
_____
_____
_____

4. Drawing a diagonal line (y=x), what can you say about the graphs with respect to line y=x?

_____
_____
_____
_____
_____
____

5. Can you give any other observation/s?

_____
_____
_____
_____
_____

What is It

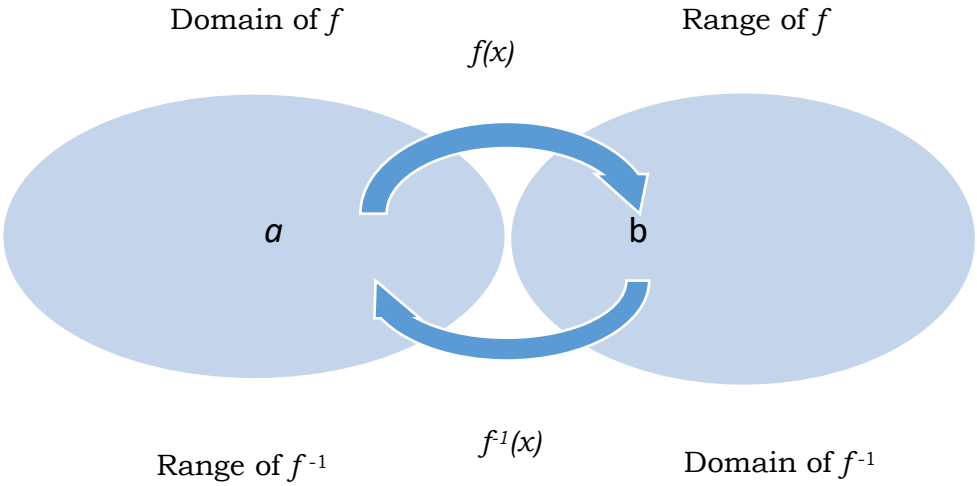
In the activity that you have done, were you able to determine the relationship of the domain and range of the function and its inverse? Have you seen their graphs? You will find out the easy way and understand it clearly as you go through the next session of this module.

From the previous lesson, you already learned that the domain of a function is the set of input values that are used for the independent variable and the range of a function is the set of output values for the dependent variable. But, from this lesson, how will you determine the domain and range of an inverse function?

A relation reversing the process performed by any function f(x) is called inverse of f(x).

To determine the domain and range of an inverse function:

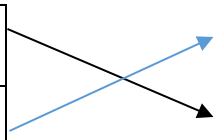
The outputs of the function f are the inputs to f^{-1}, so the range of f is also the domain of f^{-1}. Likewise, because the inputs to f are the outputs of f^{-1}, the domain of f is the range of f^{-1}. We can visualize the situation.



This means that the domain of the inverse is the range of the original function and that the range of the inverse is the domain of the original function.

Original Function

x	2	3	5	10
y	6	8	12	21



Inverse Relation

x	6	8	12	21
y	2	3	5	10

The domain of the original function is (2,3,5,10) and the range is (6,8,12,21). Therefore the domain of the inverse relation will be (6,8,12,21) and the range is (2,3,5,10).

Properties of an Inverse Function

If the f^{-1} inverse function exists,

1. f^{-1} is a one to one function, f is also one-to-one.
2. Domain of f^{-1}= Range
3. Range of f^{-1} = Domain of f.

Example 1. Find the domain and range of the inverse function $\boldsymbol{f^{-1}(x)} = \frac{x+2}{3}$

Solution:

To find the domain and range of an inverse function, go back to the original function and then interchange the domain and range of the original function.

The original function is f(x) = 3x-2. The original function's domain is the set of real numbers and the range is also the set of real numbers. Thus, the domain and range of $\boldsymbol{f^{-1}(x)} = \frac{x+2}{3}$ is the set of all real numbers.

Example 2. Find the domain and range of $\boldsymbol{f(x) = 3x + 12}$ and its inverse.

Solution:

Let $\boldsymbol{y = 3x + 12}$

Interchange x and y: $\boldsymbol{x = 3y + 12}$

Solve for y.

$\boldsymbol{3y = x - 12}$

$\boldsymbol{y = \frac{(x-12)}{3}}$

$\boldsymbol{f^{-1}(x) = \frac{(x-12)}{3}}$

Determine the domain and range of *f* and f^{-1}.

You have $\boldsymbol{f(x) = 3x + 12}$ a and $\boldsymbol{f^{-1}(x) = \frac{(x-12)}{3}}$

Domain of (f) =$\{\boldsymbol{x \in R}\}$Range of (f)= $\{\boldsymbol{y \in R}\}$

Domain of (f^{-1}) = $\{\boldsymbol{x \in R}\}$ Range of (f^{-1}) =$\{\boldsymbol{y \in R}\}$

To verify if f and f^{-1} are inverse functions:

$f[f^{-1}(x)] = 3\left(\frac{x-12}{3}\right) + 12$

= x-12+12

=x

$f^{-1}[f(x)] = \frac{3x-12+12}{3}$

= $3x/3$

= x

Therefore, f^{-1} is the inverse of *f*.

Example 3. Find the domain and range of $\boldsymbol{f(x) = \sqrt{x + 2}}$ and its inverse.

Solution:

Let $\boldsymbol{y = \sqrt{x + 2}}$

Interchange x and y: $\boldsymbol{x = \sqrt{y + 2}}$

Solve for y.

$\boldsymbol{x^2 = y + 2}$

$\boldsymbol{y = x^2 - 2}$

$$f^{-1}(x) = x^2 - 2$$

Determine the domain and range of *f* and f^{-1}.

You have $f(x) = \sqrt{x+2}$ a and $f^{-1}(x) = x^2 - 2$

Domain of (f) $=\{x \geq -2\}$ Range of (f)= $\{y \geq 0\}$

Domain of (f^{-1}) = $\{x \geq 0\}$ Range of (f^{-1}) $=\{\geq -2\}$

To verify if f and f^{-1} are inverse functions:

$f[f^{-1}(x)] = \sqrt{x^2 - 2 + 2}$
$= \sqrt{x^2}$
$= x$

$f^{-1}[f(x)] = \left(\sqrt{x+2}\right)^2 - 2$
$= x+2-2$
$= x$

Therefore, f^{-1} is the inverse of *f*.

Example 4. Consider f(x) = $x^2 - 5$. Find the inverse and its domain and range.

Solution:
Let $y = x^2 - 5$
Interchange x and y: $x = y^2 - 5$

Solve for y.
$y^2 = x + 5$
$y = \sqrt{x+5}$
$f^{-1}(x) = \sqrt{x+5}$

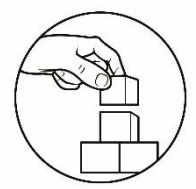
Determine the domain and range of *f* and f^{-1}.
You have $f(x) = x^2 - 5$ and $f^{-1}(x) = \sqrt{x+5}$
Domain of (f) $=\{x \in R\}$ Range of (f)= $\{y > -5\}$
Domain of (f^{-1}) = $\{x > -5\}$ Range of (f^{-1}) $=\{y \in R\}$

To verify if f and f^{-1} are inverse functions:

$f^{-1}[f(x)] = \left(\sqrt{x+5}\right)^2 - 5$
$= x+5-5$
$= x$

$f[f^{-1}(x)] = \sqrt{x^2 - 5 + 5}$
$= \sqrt{x^2}$
$= x$

Therefore, f^{-1} is the inverse of *f*.



What's More

Practice Activity

A. Find the inverse of *f*. Determine the domain and range of each resulting inverse functions. Write your answer inside the box provided.

1. $f(x) = 2x - 1$

$f^{-1} =$	Solution:
Domain	
Range	

2. $f(x) = 5x + 2$

$f^{-1} =$	Solution:
Domain	
Range	

3. $f(x) = \frac{x+2}{5}$

$f^{-1} =$	Solution:
Domain	
Range	

4. $f(x) = x^2 + 2$

$f^{-1} =$	Solution:
Domain	
Range	

5. $f(x) = \sqrt{1 + x}$

$f^{-1} =$	Solution:
Domain	
Range	

What I Have Learned

Think It Over And Complete Me!

A. Complete The Paragraph

Remember that an inverse function is a _____ function. Whereas, the _____ of the inverse function is the range of the one-to-one function and the _____ of the inverse function is the domain of the one-to-one function.

To find the domain and range of an inverse function, go back to the _____ function and then _____ the domain and range of the original function.

B. How is the skill in operating fractions and radicals relevant in determining the domain and range of the inverse function? Explain.

_____
_____
_____
_____
_____
_____
_____
_____

C. You have understood that inverse function is a function that reverses another function. In life, if it so happens that you have done some mistakes, you can only correct it and not reverse it. But if you would be given a chance to reverse one thing in your life, what would it be and why?

_____
_____
_____
_____
_____
_____
_____

What I Can Do

EXPLORE DEEPER AND THINK WISELY

Now that you have deeper understanding of the topic, you are ready to solve the problems below.

1. Temperatures are normally measured in degrees Celsius or degrees Fahrenheit. A temperature reading expressed in degrees Celsius can be converted to degrees Fahrenheit, and vice versa.
   a. Determine a function F that expresses a given temperature in degrees Fahrenheit to degrees Celsius.
      Solution:

   b. Determine a function C that expresses a given temperature in degrees Celsius to degrees Fahrenheit.

      Solution:

   c. Verify if the functions F and C are inverse Functions.
      Solution:

   d. Determine the domain and range of the functions and its inverse.

2. The formula S= (n-2) 180 gives the sum of the measures of the angles of n-sided polygon where n is the input and S is the output.

   a. Solve the formula for n so that S becomes the input and n becomes the output.
   Solution:

   b. Write the formula in (a) as the inverse function of f(x) = (x-2) 180.
   Solution:

   c. Verify is the two functions are inverse functions.

   Solution:

   d. Determine the domain and range of the function and its inverse.

Rubrics:

Score	For letters a and b	For letter c	For letter d
4	The function or formula was determined or formulated with properly shown procedures.	The functions were verified as inverse functions with completely shown procedures.	The domain and range of the function and its inverse were correctly determined and properly written.
3	The function or formula was determined or formulated with partially shown procedures.	The functions were verified as inverse functions with partially shown procedures.	The domain and range of the function and its inverse were correctly determined but it was improperly written.

2	The function or formula was not determined or formulated and other alternative procedures was shown.	The functions were not verified as inverse functions and other alternative procedures was shown.	The domain was correct but the range is incorrect or vice versa.
1	The function or formula was not determined or formulated without any procedure or solution.	The functions were not verified as inverse functions without any procedure.	The domain and range was incorrectly determined and improperly written.

Assessment

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. What do you call to the resulting y-values after we have substituted in the possible x - values?

   a. Range
   b. Domain
   c. Real Numbers
   d. Inverse Function

2. Which of the following is not allowed as the value of the independent variable under the square root sign?

   a. zero
   b. negative number
   c. decimal number
   d. fraction

3. What is the domain and range of the function $(x) = 5x + 2$?
   a. The domain is all real numbers except 2 and the range is all real numbers except 0.
   b. The domain is all real numbers and the range is all real numbers except 0.
   c. The domain is all real numbers except 2 and the range is all real numbers.
   d. The domain and range are all real numbers.

4. What is the inverse of $(x) = 9x + 5$?

   a. $f^{-1}(x) = \frac{x-5}{9}$
   c. $f^{-1}(x) = \frac{x+5}{9}$

b. $f^{-1}(x) = \frac{9}{x-5}$ d. $f^{-1}(x) = \frac{9}{x+5}$

5. Which of the following pair of functions is NOT the inverse of each other?

a. $f(x) = 5x \text{ and } g(x) = \frac{x}{5}$

b. $f(x) = 2 - 3x \text{ and } g(x) = \frac{2-x}{3}$

c. $f(x) = \text{x and } g(x) = \frac{1}{x}$

d. $f(x) = x^2 \text{ and } g(x) = \sqrt{x}$

For numbers 6-10, consider the function $f(x) = \frac{3}{x-2}$.

6. What is the domain of the function?

a. $\{x \neq 3\}$ c. $\{x \neq 2\}$
b. $\{x \neq 0\}$ d. $\{x \neq -2\}$

7. What is the Range of the function?

a. $\{y \neq -2\}$ c. $\{y \neq 3\}$

b. $\{y > 0\}$ d. $\{y \neq 0\}$

8. What is the inverse of the function?

a. $f^{-1}(x) = \frac{2x-3}{x}$ c. $f^{-1}(x) = \frac{x}{2x-3}$

b. $f^{-1}(x) = \frac{2x+3}{x}$ d. $f^{-1}(x) = \frac{x}{2x+3}$

9. What is the domain of f^{-1}?

a. $\{x \neq 0\}$ c. $\{x \neq -2\}$
b. $\{x \neq 2\}$ d. $\{x \neq 3\}$

10. What is the range of f^{-1}?

a. $\{y \neq 3\}$ c. $\{y \neq -2\}$
b. $\{y \neq -3\}$ d. $\{y \neq 2\}$

For numbers 11-15, consider the function $(x) = \sqrt{x-1}$.

11. What is the domain of the function?

a. $\{x \geq -1\}$ c. $\{x \geq 0\}$

b. $\{x \geq 1\}$ d. $\{x < 1\}$

12.What is the range of the function?

a. $\{y < 1\}$ c. $\{y \in R\}$

b. $\{y > 0\}$ d. $\{y > 1\}$

13.What is the inverse of the function?

a. $f^{-1}(x) = x^2 - 1$ c. $f^{-1}(x) = \frac{1}{x^2}$

b. $f^{-1}(x) = x^2 + 1$ d. $f^{-1}(x) = x^2$

14. What is the domain of f^{-1} ?

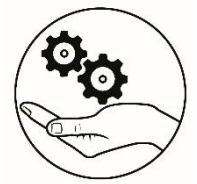
a. $\{x > 1\}$ c. $\{x < 1\}$

b. $\{x \in R\}$ d. $\{x > 0\}$

15. What is the range of f^{-1}?

a. $\{y \geq 1\}$ c. $\{y < 1\}$

b. $\{y \geq -1\}$ d. $\{y \geq 1\}$.

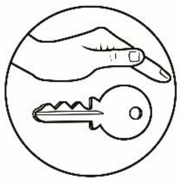


Additional Activities

Give Me More Companions

In this section, you are going to think deeper and test further your understanding of domain and range of inverse function. Ask someone who can help you to find the correct solutions and answer.

Tom and Jerry are school mates and they are playing a number- guessing game. Tom asks Jerry to think of a positive number, triple the number, square the results and then add 7. If Jerry's answer is 43, what was the original number? Use the concept of the inverse function and its domain and range in your solution.



Answer Key

What I Know

1.B
2.D
3.D
4.C
5.A
6.B
7.D
8.B
9.A
10.D
11.D
12.A
13.C
14.B
15.A

What's More

1. $f(x) = 2x - 1$

$f^{1} =$	$\frac{x+1}{2}$
Domain	$\{x \in R\}$
Range	$\{y \in R\}$

2. $f(x) = 5x - 2$

$f^{1} =$	$\frac{x+2}{5}$
Domain	$\{x \in R\}$
Range	$\{y \in R\}$

3. $f(x) = \frac{x+2}{5}$

$f^{1} =$	5x-2
Domain	$\{x \in R\}$
Range	$\{y \in R\}$

4. $f(x) = x^2 + 2$

$f^{1} =$	$\sqrt{x-2}$
Domain	$\{x \geq 2\}$
Range	$\{y \in R\}$

5. $f(x) = \sqrt{1+x}$

$f^{1} =$	$x^2 - 1$
Domain	$\{x \in R\}$
Range	$\{y \geq -1\}$

Assessment

1. A
2. B
3. D
4. C
5. C
6. C
7. D
8. B
9. A
10. D
11. D
12. A
13. C
14. B
15. A

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