<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
<th>Unit</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Videogames and Coordinate Planes</td>
<td>06</td>
<td>Comparing Functions</td>
</tr>
<tr>
<td>02</td>
<td>Contracts, Strings, and Images</td>
<td>07</td>
<td>Conditional Branching</td>
</tr>
<tr>
<td>03</td>
<td>Intro to Definitions</td>
<td>08</td>
<td>Collision Detection</td>
</tr>
<tr>
<td>04</td>
<td>Design Recipe</td>
<td>09</td>
<td>Prepping for Launch</td>
</tr>
<tr>
<td>05</td>
<td>Game Animation</td>
<td>10</td>
<td>Additional Material</td>
</tr>
</tbody>
</table>
01 Videogames and Coordinate Planes
Lesson 1

Reverse-Engineering: How does NinjaCat work?

<table>
<thead>
<tr>
<th>Thing in the game...</th>
<th>What changes about it?</th>
<th>More specifically...</th>
</tr>
</thead>
<tbody>
<tr>
<td>cloud</td>
<td>position</td>
<td>x-coordinate</td>
</tr>
</tbody>
</table>
The coordinates for the PLAYER (NinjaCat) are: \((\underline{\phantom{11}}, \underline{\phantom{11}})\)

The coordinates for the DANGER (Dog) are: \((\underline{\phantom{11}}, \underline{\phantom{11}})\)

The coordinates for the TARGET (Ruby) are: \((\underline{\phantom{11}}, \underline{\phantom{11}})\)
Our Videogame

Created by (write your names):

Background

Our game takes place in:

(space? the desert? a mall?)

The Player

The player is a ____________________________.

The player moves only up and down.

The Target

Your player GAINS points when they hit the target.

The Target is a ____________________________.

The Target moves only to the left and right.

The Danger

Your player LOSES points when they hit the danger.

The Danger is a ____________________________.

The Danger moves only to the left and right.
# Circle of Evaluation Practice

**Time: 5 minutes**

Don't forget to use the computer's symbols for things like multiply and divide!

<table>
<thead>
<tr>
<th>Math</th>
<th>Circle of Evaluation</th>
<th>Racket Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5 \times 10$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$8 + (5 \times 10)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$(8 + 2) - (5 \times 10)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\frac{5 \times 10}{8 - 2}$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Contracts, Strings, and Images
<table>
<thead>
<tr>
<th>Math</th>
<th>Circle of Evaluation</th>
<th>Racket Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 1: (3 * 7) - (1 + 2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 2: 3 - (1 + 2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 3: 3 - (1 + (5 * 6))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 4: (1 + (5 * 6)) - 3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Intro to Definitions
Fast Functions

<table>
<thead>
<tr>
<th>name</th>
<th>domain</th>
<th>range</th>
</tr>
</thead>
<tbody>
<tr>
<td>(EXAMPLE ____</td>
<td>(________) ______________________________</td>
<td></td>
</tr>
<tr>
<td>(EXAMPLE ____</td>
<td>(________) ______________________________</td>
<td></td>
</tr>
<tr>
<td>(define ____</td>
<td>(________) ______________________________</td>
<td></td>
</tr>
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</tbody>
</table>
### Fast Functions

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<td>(EXAMPLE (____  _____)  _________________________)</td>
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<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>(define (_____ _____) ____________________________)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1 Contract

2 Example

3 Definition

04 Design Recipe
Word Problem: rocket-height

Directions: A rocket blasts off, traveling at 7 meters per second. Write a function called ‘rocket-height’ that takes in the number of seconds that have passed since the rocket took off, and which produces the height of the rocket at that time.

Contract and Purpose Statement

Every contract has three parts...

; ___________ ; ___________ → ________

function name domain range

; __________________________

what does the function do?

Examples

Write some examples, then circle and label what changes...

(EXAMPLE(                     )                     )

function name input(s) what the function produces

(EXAMPLE(                     )                     )

function name input(s) what the function produces

Definition

Write the definition, given variable names to all your input values...

(define(                     )

function name variables

what the function does with those variables
Directions: Use the Design Recipe to write a function 'lawn-area', which takes in the width and length of a lawn, and returns the area of the lawn. (Don’t forget: area = length * width!)

Contract and Purpose Statement
Every contract has three parts...

; function name : domain → range ;

; what does the function do?

Examples
Write some examples, then circle and label what changes...

(EXAMPLE(_________________________ )

function name input(s) what the function produces

(EXAMPLE(_________________________ )

function name input(s) what the function produces

Definition
Write the definition, given variable names to all your input values...

(define(_________________________ )

function name variables

what the function does with those variables
Word Problem: red-square

Directions: Use the Design Recipe to write a function 'red-square', which takes in a number (the length of each side of the square) and outputs a solid red rectangle whose length and width are the same size.

Contract and Purpose Statement

Every contract has three parts...

<table>
<thead>
<tr>
<th>Function Name</th>
<th>Domain</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

what does the function do?

Examples

Write some examples, then circle and label what changes...

(EXAMPLE(           )                       )
  Function Name | Input(s) | What the function produces

(EXAMPLE(           )                       )
  Function Name | Input(s) | What the function produces

Definition

Write the definition, given variable names to all your input values...

(define(                     )
  Function Name | Variables | What the function does with those variables
05 Game Animation
Word Problem: update-danger

Directions: Use the Design Recipe to write a function ‘update-danger’, which takes in the danger’s x-coordinate and produces the next x-coordinate, which is 50 pixels to the left.

Contract and Purpose Statement

Every contract has three parts...

; __________ : __________________________ → __________________________

<table>
<thead>
<tr>
<th>function name</th>
<th>domain</th>
<th>range</th>
</tr>
</thead>
</table>

; __________________________

what does the function do?

Examples

Write some examples, then circle and label what changes...

(EXAMPLE( __________________________ ) __________________________ )

<table>
<thead>
<tr>
<th>function name</th>
<th>input(s)</th>
<th>what the function produces</th>
</tr>
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</table>

(EXAMPLE( __________________________ ) __________________________ )

<table>
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<tr>
<th>function name</th>
<th>input(s)</th>
<th>what the function produces</th>
</tr>
</thead>
</table>

Definition

Write the definition, given variable names to all your input values...

(define( __________________________ ) __________________________ ) __________________________

<table>
<thead>
<tr>
<th>function name</th>
<th>variables</th>
<th>what the function does with those variables</th>
</tr>
</thead>
</table>

Word Problem: update-target

Directions: Write a function 'update-target', which takes in the target’s x-coordinate and produces the next x-coordinate, which is 50 pixels to the right.

Contract and Purpose Statement
Every contract has three parts...

; _______________ : ____________________ → ____________________
    function name           domain                  range
 ;

what does the function do?

Examples
Write some examples, then circle and label what changes...

(EXAMPLE( ____________________ ) )
  function name  input(s)  what the function produces

(EXAMPLE( ____________________ ) )
  function name  input(s)  what the function produces

Definition
Write the definition, given variable names to all your input values...

(define( ____________________ )
  function name  variables

  ____________________________________________________________ )
    what the function does with those variables
Comparing Functions

“safe-left?”
DESIGN RECIPE

Sam is in a 640 x 480 yard. How far can he go to the left and right before he’s out of sight?

1. A piece of Sam is still visible on the left as long as...  
   \[ (> \quad x \quad -50) \]

2. A piece of Sam is still visible on the right as long as...  
   ________________

3. Draw the Circle of Evaluation for these two expressions in the circles below:
**Word Problem: safe-left?**

**Directions:** Use the Design Recipe to write a function 'safe-left?', which takes in an x-coordinate and checks to see if it is greater than -50

**Contract and Purpose Statement**
Every contract has three parts...

<table>
<thead>
<tr>
<th>function name</th>
<th>domain</th>
<th>range</th>
<th>what does the function do?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Examples**
Write some examples, then circle and label what changes...

(EXAMPLE(                     ) )

<table>
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<tr>
<th>function name</th>
<th>input(s)</th>
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<tr>
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</table>

(EXAMPLE(                     ) )

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**Definition**
Write the definition, given variable names to all your input values...

(define(                     ) )

<table>
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<tr>
<th>function name</th>
<th>variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

what the function does with those variables
Word Problem: safe-right?

**Directions:** Use the Design Recipe to write a function 'safe-right?', which takes in an x-coordinate and checks to see if it is less than 690.

**Contract and Purpose Statement**

Every contract has three parts...

<table>
<thead>
<tr>
<th>function name</th>
<th>domain</th>
<th>range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

what does the function do?

**Examples**

Write some examples, then circle and label what changes...

(EXAMPLE(        ) )

<table>
<thead>
<tr>
<th>function name</th>
<th>input(s)</th>
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<tbody>
<tr>
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(EXAMPLE(        ) )

<table>
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<th>function name</th>
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</thead>
<tbody>
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<td></td>
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**Definition**

Write the definition, given variable names to all your input values...

(define(        ) )

<table>
<thead>
<tr>
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<th>variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

what the function does with those variables
and / or

Write the Circles of Evaluation for these statements, and then convert them to Racket

1. Two is less than five, and zero is equal to six.

2. Two is less than four or four is equal to six.
**Word Problem: onscreen?**

**Directions:** Use the Design Recipe to write a function 'onscreen?', which takes in the x-coordinate and checks to see if Sam is safe on the left AND safe on the right.

---

**Contract and Purpose Statement**

Every contract has three parts...

; function name : domain → range ; ; what does the function do?

---

**Examples**

Write some examples, then circle and label what changes...

(EXAMPLE( ____________________________ )

  function name    input(s)

  ____________________________ )

what the function produces

(EXAMPLE( ____________________________ )

  function name    input(s)

  ____________________________ )

what the function produces

---

**Definition**

Write the definition, given variable names to all your input values...

(define( ____________________________ )

  function name    variables

  ____________________________ )

what the function does with those variables
Conditional Branching
Word Problem: cost

Directions: Luigi’s Pizza has hired you as a programmer. They offer Cheese ($9.00), Pepperoni ($10.50), Chicken ($11.25) and Broccoli ($10.25). Write a function called cost which takes in the name of a topping and outputs the price of a pizza with that topping.

Contract and Purpose Statement
Every contract has three parts...

<table>
<thead>
<tr>
<th>function name</th>
<th>domain</th>
<th>range</th>
</tr>
</thead>
</table>


Examples
Write some examples, then circle and label what changes...

(EXAMPLE (cost "cheese") )

<table>
<thead>
<tr>
<th>function name</th>
<th>input(s)</th>
<th>what the function produces</th>
</tr>
</thead>
</table>

(EXAMPLE )

<table>
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<th>what the function produces</th>
</tr>
</thead>
</table>

Definition
Write the definition, given variable names to all your input values...

(define (function name variables)
  (cond 
    [ variables ]
    [ variables ]
    [ variables ]
    [ variables ]
    [ variables ]
    [ variables ]))))


**Word Problem: update-player**

**Directions:** Write a function called update-player, which takes in the player’s y-coordinate and the name of the key pressed, and returns the new y-coordinate.

### Contract and Purpose Statement

Every contract has three parts...

<table>
<thead>
<tr>
<th>function name</th>
<th>domain</th>
<th>range</th>
<th>what does the function do?</th>
</tr>
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</table>

### Examples

Write some examples, then circle and label what changes...

(EXAMPLE( update-player 320  "up" )

<table>
<thead>
<tr>
<th>function name</th>
<th>input(s)</th>
<th>what the function produces</th>
</tr>
</thead>
</table>

(EXAMPLE( update-player 100  "up" )

<table>
<thead>
<tr>
<th>function name</th>
<th>input(s)</th>
<th>what the function produces</th>
</tr>
</thead>
</table>

(EXAMPLE( )

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(EXAMPLE( )

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<th>input(s)</th>
<th>what the function produces</th>
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### Definition

Write the definition, given variable names to all your input values...

(define( update-player 320  "up" )

<table>
<thead>
<tr>
<th>function name</th>
<th>variables</th>
</tr>
</thead>
</table>

( )

[ ]

[ ]

[ ]

[ ]

)))
Directions: Write a function called 'line-length', which takes in two numbers and returns the positive difference between them. It should always subtract the smaller number from the bigger one, and if they are equal it should return zero.

Contract and Purpose Statement
Every contract has three parts...

<table>
<thead>
<tr>
<th>function name</th>
<th>domain</th>
<th>range</th>
</tr>
</thead>
<tbody>
<tr>
<td>line-length</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Examples
Write some examples, then circle and label what changes...

(EXAMPLE (line-length 10 5) (- 10 5))

(EXAMPLE (line-length 2 8) (- 8 2))

Definition
Write the definition, given variable names to all your input values...

(define (line-length)
  (cond
    [(< a b) (b - a)]
    [(> a b) (a - b)]
    [else 0]))
The Distance Formula (an example)

The distance between the points (0, 0) and (4, 3) is given by:

\[
\sqrt{(\text{line-length} \ 4 \ 0)^2 + (\text{line-length} \ 3 \ 0)^2}
\]

Convert the formula above into a Circle of Evaluation. (We’ve already gotten you started!)

Convert the Circle of Evaluation into Racket code:
Directions: Write a function distance, which takes FOUR inputs:

- **px**: The x-coordinate of the player
- **py**: The y-coordinate of the player
- **cx**: the x-coordinate of another game character
- **cy**: the y-coordinate of another game character

It should return the distance between the two, using the Distance formula. (HINT: look at what you did on the previous page!)

### Contract and Purpose Statement
Every contract has three parts...

<table>
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<table>
<thead>
<tr>
<th>what does the function do?</th>
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### Examples
Write some examples, then circle and label what changes...

(EXAMPLE(                        )
  function name                   input(s)
  ___________________________________________
  what the function produces

(EXAMPLE(                        )
  function name                   input(s)
  ___________________________________________
  what the function produces

### Definition
Write the definition, given variable names to all your input values...

(define(                        )
  function name                   variables
  ___________________________________________
  what the function does with those variables)
Directions: Write a function collide?, which takes FOUR inputs:

- px: The x-coordinate of the player
- py: The y-coordinate of the player
- cx: the x-coordinate of another game character
- cy: the y-coordinate of another game character

Are the coordinates of the player within 50 pixels of the coordinates of the other character?

Contract and Purpose Statement

Every contract has three parts...

; _______________ : ____________________ → ____________________
  function name                 domain                   range

; ___________________________________________________________
  what does the function do?

Examples

Write some examples, then circle and label what changes...

(EXAMPLE (___________________________________________ )
  function name                input(s)                  what the function produces

(EXAMPLE (___________________________________________ )
  function name                input(s)                  what the function produces

Definition

Write the definition, given variable names to all your input values...

(define(___________________________________________ )
  function name                variables

  _______________________________________________________
  what the function does with those variables
09 Presentation Preparation
Lesson 9

Canny Intro:

Name, Age, Grade:

Game Title:

Back Story:

Characters:

Explain a piece of your code:
Presentation Feedback

For each question, circle the answer that fits best.

Was the introduction catchy?  
No way!  A little.  Definitely!

Did they talk about their characters?  
No way!  A little.  Definitely!

Did they explain the code well?  
No way!  A little.  Definitely!

Did they speak slowly enough?  
No way!  A little.  Definitely!

Did they speak loudly enough?  
No way!  A little.  Definitely!

Were they standing confidently?  
No way!  A little.  Definitely!

Did they make eye contact?  
No way!  A little.  Definitely!
Presentation Feedback

For each question, circle the answer that fits best.

Was the introduction catchy?  No way!   A little.   Definitely!

Did they talk about their characters? No way!   A little.   Definitely!

Did they explain the code well? No way!   A little.   Definitely!

Did they speak slowly enough? No way!   A little.   Definitely!

Did they speak loudly enough? No way!   A little.   Definitely!

Were they standing confidently? No way!   A little.   Definitely!

Did they make eye contact? No way!   A little.   Definitely!
Directions: Write a function called red-shape, which takes in the name of a shape and draws that shape (solid and red). Add an else clause that produces a sensible output.

Contract and Purpose Statement
Every contract has three parts...

; function name : domain [ ] range ;

what does the function do?

Examples
Write some examples, then circle and label what changes...

(EXAMPLE ( red-shape "circle" ) (circle 50 "solid" "red") )

function name [ input(s) ] [ what the function produces ]

(EXAMPLE ( ) )

function name [ input(s) ] [ what the function produces ]

(EXAMPLE ( ) )

function name [ input(s) ] [ what the function produces ]

(EXAMPLE ( ) )

function name [ input(s) ] [ what the function produces ]

Definition
Write the definition, given variable names to all your input values...

(define ( )

(function name [ variables ]

(cond [ (circle 50 "solid" "red") ]

[ ]

[ ]

[ ]

[ ]

[ ]))

})
# Translating into Algebra

## Value Definitions

<table>
<thead>
<tr>
<th>Racket Code</th>
<th>Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>(define x 10)</code></td>
<td>( x = 10 )</td>
</tr>
<tr>
<td><code>(define y (* x 2))</code></td>
<td>( y = x \cdot 2 )</td>
</tr>
<tr>
<td><code>(define z (+ x y))</code></td>
<td></td>
</tr>
<tr>
<td><code>(define age 14)</code></td>
<td></td>
</tr>
<tr>
<td><code>(define months (* age 12))</code></td>
<td></td>
</tr>
<tr>
<td><code>(define days (* months 30))</code></td>
<td></td>
</tr>
<tr>
<td><code>(define hours (* days 24))</code></td>
<td></td>
</tr>
<tr>
<td><code>(define minutes (* hours 60))</code></td>
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</tr>
</tbody>
</table>

## Function Definitions

<table>
<thead>
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<th>Algebra</th>
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<tbody>
<tr>
<td><code>(define (area length width) (* length width))</code></td>
<td>( \text{area}(\text{length}, \text{width}) = \text{length} \cdot \text{width} )</td>
</tr>
<tr>
<td><code>(define (circle-area radius) (* pi (sqr radius)))</code></td>
<td></td>
</tr>
<tr>
<td><code>(define (distance x1 y1 x2 y2) (sqrt (+ (sqr (- x1 x2)) (sqr (- y1 y2)))))</code></td>
<td></td>
</tr>
</tbody>
</table>
Design Recipe

A rocket is flying from Earth to Mars at 80 miles per second. Write a function that describes the distance \( D \) that the rocket has traveled, as a function of time \( t \).

I. Contract+Purpose Statement
Every contract has three parts:

\[
\begin{array}{ccc}
; & \quad \text{name} & \quad \text{Domain} & \quad \text{Range} \\
; & \quad \text{D} & \quad \text{D} & \\
\end{array}
\]

What does the function do?

II. Give Examples
Write an example of your function for some sample inputs

\[
\begin{align*}
D(1) &= \\
\text{Use the function here} & \quad \text{What should the function produce?} \\
D(2) &= \\
\text{Use the function here} & \quad \text{What should the function produce?} \\
D(\quad) &= \\
\text{Use the function here} & \quad \text{What should the function produce?} \\
\text{Use the function here} & \quad \text{What should the function produce?}
\end{align*}
\]

III. Definition
Write the formula, giving variable names to all your input values.

\[
D(\quad) =
\]
A rocket is traveling from Earth to Mars at 80 miles per second. Write a function that describes the *time* the rocket has been traveling, as a function of *distance*.

I. **Contract+Purpose Statement**

Every contract has three parts:

; name : Domain -> Range

; What does the function do?

II. **Give Examples**

Write an example of your function for some sample inputs

\[
\text{Use the function here} \quad \text{What should the function produce?}
\]

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\text{Use the function here} \quad \text{What should the function produce?}
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\text{Use the function here} \quad \text{What should the function produce?}
\]

III. **Definition**

Write the Formula, giving variable names to all your input values.

\[
\text{Design Recipe}
\]
A rocket leaves Earth, headed for Mars at 80 miles per second. At the exact same time, an asteroid leaves Mars traveling towards Earth, moving at 70 miles per second. If the distance from the Earth to Mars is 50,000,000 miles, how long will it take for them to meet?

I. **Contract+Purpose Statement**
   Every contract has three parts:

   - name: _______________ -> _______________
     Domain Range
   - What does the function do?

II. **Give Examples**
   Write an example of your function for some sample inputs

   =
   Use the function here What should the function produce?

   =
   Use the function here What should the function produce?

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   Use the function here What should the function produce?

III. **Definition**
   Write the Formula, giving variable names to all your input values.

   =
Design Recipe

I. **Contract+Purpose Statement**
Every contract has three parts:

; __________________ : ____________________________________ - > ____________

  name                     Domain              Range

; ____________________________________________________________

  What does the function do?

II. **Give Examples**
Write an example of your function for some sample inputs

= 

Use the function here What should the function produce?

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III. **Definition**
Write the Formula, giving variable names to all your input values.

= 


I. Contract+Purpose Statement

Every contract has three parts:

\[ \text{name} : \text{Domain} \rightarrow \text{Range} \]

What does the function do?

II. Give Examples

Write an example of your function for some sample inputs

\[ \text{Use the function here} \quad \text{What should the function produce?} \]

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III. Definition

Write the Formula, giving variable names to all your input values.

\[ = \]
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