

Name: \_\_\_\_\_



## Student Workbook

Class: \_\_\_\_\_

# Bootstrap Units

**01**    Videogames  
and  
Coordinate  
Planes

**02**    Contracts,  
Strings, and  
Images

**03**    Intro to  
Definitions

**04**    Design Recipe

**05**    Game  
Animation

**06**    Comparing  
Functions

**07**    Conditional  
Branching

**08**    Collision  
Detection

**09**    Prepping for  
Launch

**10**    Additional  
Material

# 01 Videogames and Coordinate Planes



# Lesson 1

## Reverse-Engineering: How does NinjaCat work?

Thing in the game...	What changes about it?	More specifically...
<i>cloud</i>	<i>position</i>	<i>x-coordinate</i>

## Finding Coordinates



The coordinates for the PLAYER (NinjaCat) are:  $( \quad , \quad )$   
x-coordinate y-coordinate

The coordinates for the DANGER (Dog) are:  $( \quad , \quad )$

The coordinates for the TARGET (Ruby) are:  $( \quad , \quad )$

# 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!

Math	Circle of Evaluation	Racket Code
$5 \times 10$		
$8 + (5 \times 10)$		
$(8 + 2) - (5 \times 10)$		
$\frac{5 \times 10}{8 - 2}$		

## 02 Contracts, Strings, and Images





Circles Competition		Time: 5 minutes	
	Math	Round 1 -Circle of Evaluation	Round 2 - Racket Code
Challenge A	$(3 * 7) - (1 + 2)$		
Challenge B	$3 - (1 + 2)$		
Challenge C	$3 - (1 + (5 * 6))$		
Challenge D	$(1 + (5 * 6)) - 3$		

# 03 Intro to Definitions



## Fast Functions

$f$  :  $\mathbb{R} \rightarrow \mathbb{R}$   
 name domain range

(EXAMPLE (  $x$  )  $x^2$  )

(EXAMPLE (  $x$  )  $x^3$  )

(define (  $x$  )  $x^2$  )

$f$  :  $\mathbb{R} \rightarrow \mathbb{R}$   
 name domain range

(EXAMPLE (  $x$  )  $x^2$  )

(EXAMPLE (  $x$  )  $x^3$  )

(define (  $x$  )  $x^2$  )

$f$  :  $\mathbb{R} \rightarrow \mathbb{R}$   
 name domain range

(EXAMPLE (  $x$  )  $x^2$  )

(EXAMPLE (  $x$  )  $x^3$  )

(define (  $x$  )  $x^2$  )

$f$  :  $\mathbb{R} \rightarrow \mathbb{R}$   
 name domain range

(EXAMPLE (  $x$  )  $x^2$  )

(EXAMPLE (  $x$  )  $x^3$  )

(define (  $x$  )  $x^2$  )

## Fast Functions

```

; _____ : _____ -> _____
      name           domain           range

```

range

(EXAMPLE (\_\_\_\_\_) \_\_\_\_\_)

(EXAMPLE (\_\_\_\_\_) \_\_\_\_\_)

```
(define (_____))
```

$;$  \_\_\_\_\_  $:$  \_\_\_\_\_  $\rightarrow$  \_\_\_\_\_  
 name domain range

range

(EXAMPLE (\_\_\_\_\_) \_\_\_\_\_)

(EXAMPLE ( ) )

```
(define (_____))
```

**Syntax:**

```
name : domain -> range
```

range

(EXAMPLE ( ) )

(EXAMPLE ( ) )

```
(define (
```

$;$  \_\_\_\_\_  $:$  \_\_\_\_\_  $\rightarrow$  \_\_\_\_\_  
 name domain range

range

(EXAMPLE ( ))

(EXAMPLE ( ))

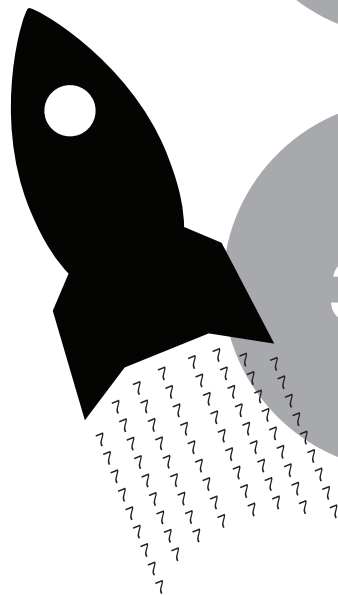
```
(define (
```

# 04 Design Recipe

1 Contract

2 Example

3 Definition



## 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

## Word Problem: lawn-area

**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:  $\text{area} = \text{length} * \text{width}!$ )

## Contract and Purpose Statement

*Every contract has three parts...*

The diagram shows a function notation  $f: \text{domain} \rightarrow \text{range}$ . Below this, a horizontal line is drawn, and underneath it, the text "what does the function do?" is written.

## 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...

$$\begin{array}{ccc} \text{function name} & \text{domain} & \text{range} \\ \hline & & \end{array}$$

what does the function do?

### Examples

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

(EXAMPLE(  $\underline{\hspace{2cm}}$   $\underline{\hspace{2cm}}$  )  
function name input(s)  
 $\underline{\hspace{10cm}}$   
what the function produces

(EXAMPLE(  $\underline{\hspace{2cm}}$   $\underline{\hspace{2cm}}$  )  
function name input(s)  
 $\underline{\hspace{10cm}}$   
what the function produces

### Definition

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

(define(  $\underline{\hspace{2cm}}$   $\underline{\hspace{2cm}}$  )  
function name variables  
 $\underline{\hspace{10cm}}$   
what the function does with those variables



# target



# danger



## 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...

:	:	→
;		
_____	_____	_____
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: 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...*

A diagram illustrating the components of a function signature. It consists of four horizontal lines. The first line is labeled "function name". The second line is labeled "domain". The third line is labeled "range". The fourth line is labeled "what does the function do?". An arrow points from the first line to the second line, and another arrow points from the second line to the third line.

## Examples

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

(EXAMPLE(                      )

<i>function name</i>	<i>input(s)</i>	<i>what the function produces</i>
----------------------	-----------------	-----------------------------------

(EXAMPLE( \_\_\_\_\_ )

<i>function name</i>	<i>input(s)</i>	<i>what the function produces</i>

### Definition

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

(define( \_\_\_\_\_ )  
           \_\_\_\_\_          \_\_\_\_\_  
               *function name*      *variables*

---

*what the function does with those variables*



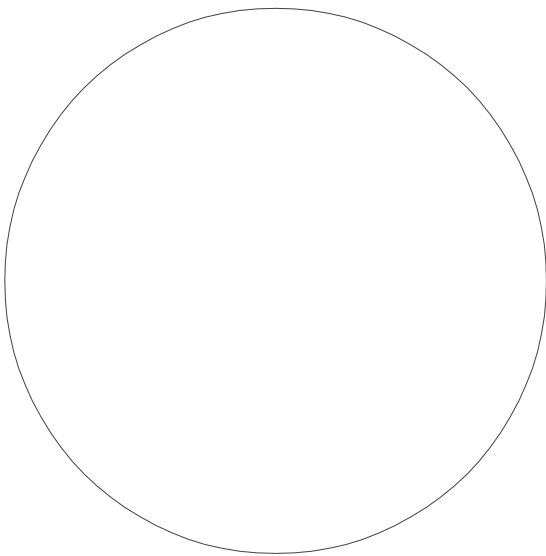
***“safe-left?”***

## **06** Comparing Functions

## Sam the Butterfly

Sam is in a  $640 \times 480$  yard. How far he can 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...  $(> \quad \times \quad -50)$
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...

:	:	→
;		
_____	_____	_____
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: 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...

:	:	→
;		
_____	_____	_____
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

## 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

```

# 07 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...

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

### Examples

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

```
(EXAMPLE(    cost    "cheese"    )  
      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  
    _____  
  
    [ _____ ]  
  
    [ _____ ]  
  
    [ _____ ]  
  
    [ _____ ]  
  
    [else: _____ ]))
```

## 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...

```

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

```

### Examples

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

```

(EXAMPLE(  update-player  320 "up"  )
           function name    input(s)    what the function produces
)

(EXAMPLE(  update-player  100 "up"  )
           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
  (
    _____
  [
    _____
  [
    _____
  [else: _____ ]))

```

# 08 Collision Detection

collision



distance

## Word Problem: line-length

**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...

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

### Examples

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

```
(EXAMPLE( line-length      10 5      ) (- 10 5) )  
          function name    input(s)    what the function produces  
  
(EXAMPLE( line-length      2 8      ) (- 8 2) )  
          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  
    _____  
  
    [ _____ ]  
  
    [ _____ ]))
```

## 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 to code, then label the numbers with (x1,y1) & (y1,y2):

## Word Problem: distance

**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...

```
;  
: _____ → _____  
  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: collide?

**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

Catchy Intro:

---

---

---

Name, Age, Grade:

---

Game Title:

---

Back Story:

---

---

---

---

Characters:

---

---

---

---

---

Explain a piece of your code:

---

---

---

---

[illegible]

## 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!

## Word Problem: red-shape

**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") ]  
    [ _____  
    _____ ]  
    [ _____  
    _____ ]  
    [ _____ ]  
  [else: _____ ]))
```

## Translating into Algebra

### Value Definitions

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

### Function Definitions

Racket Code	Algebra
<code>(define (area length width)   (* length width))</code>	$\text{area}(\text{length}, \text{width}) = \text{length} \cdot \text{width}$
<code>(define (circle-area radius)   (* pi (sqr radius)))</code>	
<code>(define (distance x1 y1 x2 y2)   (sqrt (+ (sqr (- x1 x2))            (sqr (- y1 y2)))))</code>	



# 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:

;  D  : \_\_\_\_\_ -> \_\_\_\_\_  
name Domain Range  
;  
\_\_\_\_\_ *What does the function do?*

## II. Give Examples

Write an example of your function for some sample inputs

  D( 1 )   = \_\_\_\_\_  
Use the function here What should the function produce?

  D( 2 )   = \_\_\_\_\_  
Use the function here What should the function produce?

  D(    )   = \_\_\_\_\_  
Use the function here What should the function produce?

           = \_\_\_\_\_  
Use the function here What should the function produce?

## III. Definition

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

  D(        )   = \_\_\_\_\_

## Design Recipe

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

	=
Use the function here	What should the function produce?

	=
Use the function here	What should the function produce?

	=
Use the function here	What should the function produce?

	=
Use the function here	What should the function produce?

### III. Definition

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

# 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?

=  
Use the function here What should the function produce?

=  
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?

=  
Use the function here What should the function produce?

=  
Use the function here What should the function produce?

=  
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?

=  
Use the function here What should the function produce?

=  
Use the function here What should the function produce?

=  
Use the function here What should the function produce?

## III. Definition

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

=

# Contracts

[illegible]

# Contracts

[illegible]