

## Homework 1, Problem 1: Environment Diagrams with Booleans

In each square, draw an environment diagram as each line of code runs. Put print statements in order on the left side of the code below.

Print Statements:

True  
False  
False  
True  
True

```
line 0    a = 1
line 1    b = 2
line 2    c = a * 2
line 3    print(c == b)
line 4    b = b * 2
line 5    print(c == b)
line 6    b = "two"
line 7    print(c == b)
line 8    print(c == a * 2)
line 9    c = c==b
line 10   print(c == (a == b))
line 11   c = 10
```

<b>0</b> a: 1	<b>4</b> a: 1 b: 4 c: 2	<b>8</b> a: 1 b: "two" c: 2
<b>1</b> a: 1 b: 2	<b>5</b> a: 1 b: 4 c: 2	<b>9</b> a: 1 b: "two" c: False
<b>2</b> a: 1 b: 2 c: 2	<b>6</b> a: 1 b: "two" c: 2	<b>10</b> a: 1 b: "two" c: False
<b>3</b> a: 1 b: 2 c: 2	<b>7</b> a: 1 b: "two" c: 2	<b>11</b> a: 1 b: "two" c: 10

## Homework 1, Problem 2: Logic Practice

You see your instructors at an ice cream store with the following flavors. They tell you their preferences and ask you to order one cone for them. What two scoop combination would satisfy all three? Organize your thoughts using a table like shown below (one example provided), and show at least three combinations you try!

### Preferences

Haley: I want anything with chocolate

Annika: I want sorbet OR gelato flavors, but not together

Kei: I want vanilla and one other scoop, but not vanilla alone

### Flavors

Sorbet: Strawberry, peach, banana, chocolate chip

Gelato: Vanilla, chocolate, oreo, mango

Flavor 1	Flavor 2	Haley?	Kei?	Annika?
Example: Mango	Example: Mango	Example: FALSE	Example: FALSE	Example: TRUE
Chocolate	Peach	TRUE	FALSE	FALSE
Chocolate chip	Vanilla	TRUE	TRUE	FALSE
Chocolate	Vanilla	TRUE	TRUE	TRUE

### Homework 1, Problem 3: Boolean Practice

Goal: Complete the rest of the table below using 1 and 0 to indicate if each boolean is true or false. The first line is completed for you. Pick one more example of variables and work through the solutions yourself – can you find a pair of numbers that make all booleans false?

Boolean 1: True if either variable is larger than 5

Boolean 2: True if either variable is divisible by 5

Boolean 3: True if ONLY one variable is divisible by 5

Boolean 4: True if **at least** one variable is divisible by 2, or their sum is divisible by 2, but not both

Variable 1	Variable 2	Bool 1	Bool 2	Bool 3	Bool 4
Example: 5	Example: 1	0 (False)	1 (True)	1	1
1	1	0	0	0	1
1	10	1	1	1	1
10	10	1	1	0	0
3	7	1	0	0	1
2	2	0	0	0	0

## Homework 1, Problem 4: Logic Challenge 1

You have three jars, one which has oranges, one which has apples, and one which has a mix of both in them. However, all their labels have been swapped! You know that no jar can have its correct label. To relabel them, you can reach in and pull out one fruit at a time. What is the worst case (maximum checks possible) for the number of jars you need to pick from before you can label all three? What is the best (fewest number of checks) you could do?

Try to use an organizer like the one below to work through all possible labels and see what would happen!

Worst case: infinity (or 4 also accepted)

Best case: 1

**Solution:** *All jars must be mis-labeled. This allows the solution of only one pick. Find the jar labeled mix. If you pull out an [orange], you know that this jar must be the [orange] jar, because it cannot be mixed. You now have two jars, one labeled [orange] and one labeled [apple]. You have two labels remaining to place on jars: mix and [apple]. You know the [apple] jar can't contain [apples], so the jar labeled [orange] must contain the [apples]. Finally, you have a mix label and a jar labeled [apples], which is the solution. You can replace orange with apple in the above problem and the solution works either way.*

	real Apple	real Orange	real Mix
label Apple	no	?	?
label Orange	?	no	?
label Mix	?	?	no

### Homework 1, Problem 5: Logic Challenge 2

You visit an island where everyone is a knight or a knave: knights can only say true things, and knaves can only say false things. You approach your instructors and they each say one thing:

Haley: At least one thing is true: Kei is a knave or I am a knight.

Annika: Haley could claim that I am a knave.

Kei: Neither Haley nor Annika are knights.

Can you figure out which instructor is a knight and which is a knave? Test by guessing and following the logic! "If [this instructor] is a knight, what does that tell me?"

Knights: Kei

Knives: Haley, Annika

#### **Solution:**

*If Annika is a knave, it is NOT true that Haley can say Annika is a knave.*

*Using the above sentence, we can replace 'can say Annika is a knave' with 'tells the truth.' – since it is true that Annika is a knave.*

*Meaning it is not true that Haley tells the truth*

*Meaning, it is true that Haley can lie.*

*If Haley can lie, the opposite of at least one being true means that both are false. Therefore, Kei can't be a knave and Haley can't be a knight, which fits in with the logic.*

example of a solution which doesn't work (and how to find mistake):

*Assume Annika is a knight. Then, Annika tells the truth that Haley could claim that Annika is a knave.*

*Which means that Haley has to be a knave, since Annika is a knight. However, this makes Kei's statement unsolvable, because it either has to be all true or all false that Haley and Annika are knights.*

*This suggests that solutions that have Haley and Annika have different identities will not work, giving a hint in what direction to work.*

**Bonus:** You are a wizard and accidentally mixed up all your potions – and you have 1000 of them! You and 9 friends have 24 hours to determine which is the one which makes people fly, but the flying potion takes a whole day to take effect! You don't know which potion it is but you can all take drinks of as many as you want to determine which is the flying potion. How can you divvy up the potions to the 10 people to *\*guarantee\** you find the exact one which is for flying with only one round of testing?

Write up the numbers 1-1000 in binary , where each digit turns into 0 or 1 meaning drink or don't drink. Each person drinks the potions indicated by their digit space (1-10) such that every number is unique. Whoever flies will be 1 and whoever doesn't is 0, so when you line them up the number of the correct potion will be revealed!

Binary Value	Decimal Representation				Decimal Value
	8	4	2	1	
0 0 0 0	0 +	0 +	0 +	0	0
0 0 0 1	0 +	0 +	0 +	1	1
0 0 1 0	0 +	0 +	2 +	0	2
0 0 1 1	0 +	0 +	2 +	1	3
0 1 0 0	0 +	4 +	0 +	0	4
0 1 0 1	0 +	4 +	0 +	1	5
0 1 1 0	0 +	4 +	2 +	0	6
0 1 1 1	0 +	4 +	2 +	1	7
1 0 0 0	8 +	0 +	0 +	0	8
1 0 0 1	8 +	0 +	0 +	1	9
1 0 1 0	8 +	0 +	2 +	0	10