Level 1 Recall

1. Define a set and give an example of a finite set

set any collection of items (nouns) in which the collection has no duplicates and is unordered; could have no items, a finite amount of items, or an infinite amount of items

Reflection

I remembered the properties of sets both from memory of the reading and by remembering the properties of sets in python, since I've used them in python before. I forgot to include that they could be empty, finite, and infinite, and I added that to my definition after checking wikipedia

2. State the difference between a subset and a proper subset

A proper subset cannot be equal to the set it's a subset to. However, a non-proper subset could still be a subset to a set even if the subset and the set are equal.

Reflection

I couldn't immediately recall the difference between the difference within thirty seconds, so I went to my notes that I took while reading Chapter 2 of Brisk Walk. From those notes, I identified the differences.

3. What is a power set and how do we write it?

Given a set of elements, the power set of that set is a set that contains sets that represent all combinations of the original set, including all the elements, all combinations of the elements, and none of the elements (empty set)

Example of Power Set

Given set: $F = \{\text{Dad}, \text{ Mom}\}$

Power set of F is:

$\mathbb{P}(F) = \{\{\text{Dad}, \text{Mom}\}, \{\text{Dad}\}, \{\text{Mom}\}, \emptyset\}$

Reflection

I did remember what I wrote down for power set from memory, but I also double checked my notes for Brisk Walk just to make sure I wasn't forgetting anything. I made up the example based on the example in Brisk Walk that I remembered.

4. What is cardinality and give an example of cardinality of an empty set and an example finite set

Cardinality the size of a set, or the number of elements in a set

Since an empty set by definition has no elements, it's cardinality is 0 (0 elements)

For a finite set like this:

$F = \{\text{Me}, \text{ Dad}, \text{ Mom}\}$

The cardinality (surrounding the set with ||) is 3 because there are three elements in the set

$|F| = 3$

Reflection

I remembered the definition for cardinality from memory of reading Cool Brisk. I double checked my notes just to make sure the notation was correct

Level 2 Skill

1. Use set theory to answer:

Description:
Use set theory to answer Each student in a class of 40 plays at least one game. 18 play LOL, 20 play DOTA, and 27 play D&D. 7 play LOL and D&D, 12 play DOTA and D&D, and 4 play all three. Find the number of students who play LOL and DOTA and the number of students who play LOL and DOTA but not D&D.

Work:
$L = \{k : k \text{ is a student who plays LOL}\}$

$D = \{k : k \text{ is a student who plays DOTA}\}$

$A = \{k : k \text{ is a student who plays D\&D}\}$

$|\Omega| = 40$

$|L| = 18$

$|D| = 20$

$|A| = 27$

$|L \cap A| = 7$

$|D \cap A| = 12$

$|L \cap D \cap A| = 4$

Part 1
Need: Number of students who play LOL and DOTA

Need: $|L \cap D|$

$|L \cup D \cup A| = |L| + |D| + |A| - |L \cap D| - |D \cap A| - |L \cap A| + |L \cup D \cup A|$

$|L \cup D \cup A| = |\Omega|$

$40 = 18 + 20 + 27 - |L \cap D| - 12 - 7 + 4$

$|L \cap D| = 10$

Reflection
I googled: "operations on cardinalities of sets" and got to this page, where I learned about the inclusion-exclusion principle. It had a formula for three sets, so I plugged in my values and used algebra to find the intersection

Part 2
Need: Number of students who play LOL and DOTA but not D&D

Need: $|L \cap D \cap \overline{A}|$

Conceptually: take people who who play L and D and subtract people who play all three to get the ones who only play L and D

$|L \cap D \cap \overline{A}| = |L \cap D| - |L \cap D \cap A|$

$|L \cap D \cap \overline{A}| = 10 - 4$

$|L \cap D \cap \overline{A}| = 6$

Reflection
This one really stumped me. I had to ask [ChatGPT], and although it got a different answer, I understood it's conceptual intention, which I explained above. I'm not confident I got the correct answers for these, so I would appreciate if you verified my answers, and if I got them wrong, provide the correct work.

2. Use set theory to answer:
Question: Given the universal set U = {10,20, 30, 40, 50} and sets A={10, 20}, B = {20, 30}, and C={30, 40} find $(A \cup B) \cap \overline{C}$

First, union of A and B
$D = A \cup B = \{10, 20, 30\}$

Second, complement of C
$\overline{C} = U - C = \{10, 20, 50\}$

Finally, intersection
$D \cap \overline{C} = (A \cup B) \cap \overline{C} = \{10, 20\}$

Reflection
Compared to the first question, this was much easier because we were given all of the elements of the three sets. I just broke the question down bit by bit and did it myself using what I learned about AND and OR from previous units.

3. Determine subsets:
Given the sets P ={x|x is a prime number} and Q = {2,3,5} determine if P is a subset of Q or if Q is a subset of P and justify it.

P is not a subset of Q. For $P \subset Q$ to be true, all elements in P must be found in Q. However, prime numbers above 5 such as 7 are not found in Q, therefore,

$P \not\subset Q$

On the other hand, all elements of Q could be found in P (since 2, 3, and 5 are all prime numbers and would be elements of P). Therefore,

$Q \subset P$

Reflection
I also did this one mostly by myself. I went back to my notes to double check the definition for subset

Level 3 Strategic Thinking

1. Compare and Contrast Set Theory and Logic
Operations in sets are very similar to logical operators.

The union operator between sets is similar to the OR operator in that it results in a set that contains elements from either the first set OR the second set OR both sets.

The intersection operator is similar to the AND operator in that it results in a set that contains only elements found in both the first set AND the second set.

The complement of a set is very similar to the NOT operator in that it gives you everything that was NOT in the original set. Since logic is closely tied to programming, this is a python example of a complement:

```
universe = {10, 20, 30, 40, 50}
b = {10}
b_complement = {elem for elem in universe if elem not in b}
```

Set theory and logic are different in that logic usually deals with propositions, while set theory deals with sets.

In logic, propositions could be true or false. It like you're comparing sets that only have one element that is either true or not true:

Logic Terms

isRaining = true

broughtUmbrella = false

isRaining AND broughtUmbrella = false

Set Terms

$R = \{\text{true}\}$

$U = \{\}$

$R \cap U = \{\}$

Reflection

My answers were my own without external resources. I remembered the textbook creating similarities between union and OR and intersection and AND. I expanded on it and added code examples to connect it to other things I'm learning

2. Give an example of a real-world scenario where the principle of inclusion-exclusion might be applied?

You use the inclusion-exclusion principle when you don't want to double count people. For example, if you wanted to determine the amount of students majoring in either computer science or math, you couldn't just add the total number of computer science students to the total number of math students because some students double major, and you would be counting them twice. In addition to summing these two sets of students, you would have to subtract the students who are taking computer science AND math because you already counted them in one of the sets.

Reflection

I remembered that the Cool Brisk textbook used a similar example, but I recalled and made this example from memory.

Level 4 Extended Thinking

1. Why is set theory important to computing?

A specific aspect of computing, SQL Queries heavily rely on set theory. For example, a company may have a database of users that they partition into different sets such as {Male, Female}, {Minor, Adult}, etc.

If they want to query a specific type of user such as:

WHERE USER * Gender=Male AND Age=Adult

The SQL Query is finding the intersection of the "Male" set and the "Adult" set, and returning the resulting set

Additionally, as stated above, set theory is very closely related to logic (union and OR) (intersection and AND), which computers rely on to make computing decisions.

Reflection

I answered this question on my own. I couldn't immediately think of how it directly tied to computing, so I brought up SQL queries. Then, I remembered I answered how set theory and logic are closely tied, and how logic and computing are closely tied, so I tried to make that connection.