

Discrete Structures II: Combinatorics: Permutations, Rule of Sums, Rule of Products, Rule of Complements

Textbooks: Ensley & Crawley: Chapter 5.2

Johnsonbaugh: Chapter 6.2

Instructions: In-class exercises are meant to introduce you to a new topic and provide some practice with the new topic. **Work in a team of up to 4 people to complete this exercise.** You can work simultaneously on the problems, or work separate and then check your answers with each other. **Turn in one copy of the exercise per group.**

Names:

Combinatorics: Permutations, Rule of Sums, Rule of Products, Rule of Complements

Permutations

Permutation formula

A permutation is a type of structure that describes counting when **order matters** and **repetitions are not allowed**.

A permutation is written as $P(n, r)$ where n is the amount of items we have to choose from, and r is the amount of items we are selecting. The formula for this is:

$$P(n, r) = \frac{n!}{(n - r)!}$$

Where $n!$ is n -factorial. Also note that $0! = 1$.

Question 1

Calculate the following by hand using the formula:

a. $P(5, 2)$

b. $P(5, 5)$

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c. $P(5, 1)$

Question 2

Use www.wolframalpha.com or a graphing calculator to compute the following:

a. $P(26, 3)$

b. $P(52, 6)$

c. $P(26, 2) + P(10, 2)$

The Rule of Sums

The Rule of Sums

In combinatorics, the rule of sum or addition principle is a basic counting principle. Stated simply, **it is the idea that if we have A ways of doing something and B ways of doing another thing and we can not do both at the same time, then there are $A + B$ ways to choose one of the actions.** ^a

^aFrom https://en.wikipedia.org/wiki/Rule_of_sum

Question 3

Uttam wants to read a new book series. He is only going to pick up two books of a series to start with. The serieses he's looking at are "Native Tongue", which has 3 books, or "Seed to Harvest", which has 4 books. How many ways can Uttam select books, if he is choosing 2 Native Tongue books, OR 2 Seed to Harvest books, but not both?

Question 4

Jennifer is trying to set up their class schedule so it won't interfere with work. Jennifer can only take time off work for either mornings, or nights, or weekends. They can fit in the following amount of classes for each schedule:

- Morning classes: 3 per week, or
- Night classes: 3 per week, or
- Weekend classes: 4 per week

The school Jennifer goes to has 12 classes she can take. How many ways are there for her to select either 3 morning classes, or 3 night classes, or 4 weekend classes, out of the 12 available?

When questions are phrased as “can choose **either ... OR ...**”, this usually points to **adding** the size of both sets.

The Rule of Complements

The rule of complements

If there are x objects, and y of those objects have a particular property, then the number of those objects that do **not** have that particular property is $x - y$.^a

^aFrom Discrete Mathematics, Ensley and Crawley, page 390

Question 5

Assume you are rolling two dice.

- a. List out all possible results, assuming order does matter.

	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

- b. How many total outcomes are there?
- c. How many results have 6 show up at least once?
- d. Use the rule of complements to solve how many outcomes there are where 6 does not show up.

The Rule of Products

The rule of products

In combinatorics, the rule of product or multiplication principle is a basic counting principle (a.k.a. the fundamental principle of counting). Stated simply, **it is the idea that if there are a ways of doing something and b ways of doing another thing, then there are $a \cdot b$ ways of performing both actions.** ^a

^aFrom https://en.wikipedia.org/wiki/Rule_of_product

Question 7

On an old arcade machine, the highscore entries allow for 3 letters for a player to sign their name. Many only offer capital letters, so only 26 options, and each letter can be used more than once.

- a. How many options are there for the first letter?

- b. How many options are there for the second letter?

- c. How many options are there for the third letter?

- d. If you're choosing a first letter **and** a second letter **and** a third letter, how many possible combinations are there?