Standards	**PS.SPCR.8** Use permutations and combinations to **solve** mathematical and real-world problems, including **determining** probabilities of compound events. **Justify** the results.
Learning Targets/I Can Statements	I can count how many outcomes an event may have using the fundamental Counting Principle, permutations or combinations.
Essential Question(s)	**How can we base decisions on chance? How can probability be used to simulate events and to predict future happenings?**
Resources	https://www.khanacademy.org/math/statistics-probability/counting-permutations-and-combinations https://www.mathplayground.com/JakeVSAstro_Archive08.html
Learning Activities or Experiences	1st: Recall questions (attached) 2nd: Counting, permutations, and combinations a. Counting Principle and Factorial b. Permutations Alternative: Counting Principle and Factorial 3rd: Interactive Math Playground Counting Principle Activity (link above) 4th: Assignment

How Many Choices Do I Have

Fundamental Counting Principle

When you estimate how likely an event is to occur, you need to know the sample space. The sample space is the set of all possible outcomes in a random experiment. An event is a subset of the sample space. For instance, the outcome of flipping a fair coin once is either Head or Tail, so the sample space is the set {H, T}. There are only two outcomes that are possible.

How can you determine the size of the sample space when the experiment is more complicated and involves more than two outcomes?

Ex: Thomas wanted to purchase a pizza for dinner. He went online to Pizza Hut. Thomas was overwhelmed with all the different choices. Help Thomas determine how many different choices of pizzas are available. The chart is below.

Crust	Sauce	Toppings
Thin	Alfredo	Sausage
Hand-Tossed	Barbecue	Pepperoni
Stuffed	Marinara	Cheese
Pan		Vegetables
Deep-Dished		Chicken
		All Meat

Fundamental Counting: If there are **x** outcomes for one event, followed by **y** outcomes for another event, there are a total of **xy** outcomes.

Simple Terms: Multiply the different events

5 Crust * 3 Sauce * 6 Toppings = 5* 3 * 6 = 90

Your Turn: Determine how many different outfits you can make.

Your Turn: Miss Crawford wants to buy a new car. She is considering either a hybrid or an electric car. She can choose a standard or a luxury model. There are red, silver, black, and white colors available to choose from. How many possible choices does Miss Crawford have if she chooses one item from each group?

a. 8
b. 16
c. 6
d. 12

Permutations

When you set up a numerical password, you can arrange the digits in many different ways, and maybe repeat some of the numbers. The number of ways a general password is generated could be mind boggling depending on how you set it up. The number of digits used, with or without letters, numbers, and characters, with or without repetition, all increase the possible passwords you could create.

Permutation - a possible order or arrangement of objects chosen from a set of objects

Factorial - the product of a sequence of whole numbers from to 1 in descending order

Before you further explore the rules, consider a simple 4-digit password with just the numbers from 0 to 9.

To solve: 10 x 10 x 10 x 10 = 10,000

Explanation: Since there are 10 digits from 0-9 and there is a total of 4 digits for the combination. We have to multiply ten six times.

Your turn: Jack wanted to figure out how many possible lottery numbers they are for the Pick 3. You can only use 0 -9 for each of the 3 digits.

a. 10 x 9 x 8 = 720
b. 10 x 10 x 10 = 1000
c. 10 x 3 = 30
d. 10 + 10 + 10 = 30

Extension for learning: Each digit uses numbers from 0-99. What will be the number of possible outcomes for the Pick 3?