

Fundamental Counting Principle and Permutations

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Algebra II

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Fundamental Counting Principle

- You are going on vacation. You pack one pair of khakis, one pair of jeans, one blue t-shirt and one green t-shirt, one striped buttondown shirt, a pair of tennis shoes and a pair of sandals.
- How many outfits can you make?

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2 Pants	3 Shirts	2 Shoes
Khakis	Blue T-Shirt	Tennis Shoes Sandals
	Green T-Shirt	Tennis Shoes Sandals
	Striped Buttondown	Tennis Shoes Sandals
Jeans	Blue T-Shirt	Tennis Shoes Sandals
	Green T-Shirt	Tennis Shoes Sandals
	Striped Buttondown	Tennis Shoes Sandals

$2 * 3 * 2 = 12 \text{ outfits}$

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Fundamental Counting Principle

- For a few choices, it's easy to draw a diagram. As the choices increase, you should probably change the type of diagram you use.

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Fundamental Counting Principle

- At a restaurant, you have a choice of 8 different entrees, 2 different salads, 12 different drinks, and 6 different desserts. How many different dinners consisting of 1 salad, 1 entrée, 1 drink and 1 dessert can you choose?

$$\frac{2}{\text{salad}} * \frac{8}{\text{entree}} * \frac{12}{\text{drink}} * \frac{6}{\text{dessert}} = 1,152 \text{ different dinners}$$

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F. C. P.

- Police use photographs of various facial features to help witnesses identify suspects.
- One basic identification kit contains 195 hairlines, 99 eyes and eyebrows, 89 noses, 105 mouths, and 74 chins and cheeks. Can this kit produce billions of faces, as the developer claims?

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F. C. P.

- One basic identification kit contains 195 hairlines, 99 eyes and eyebrows, 89 noses, 105 mouths, and 74 chins and cheeks. Can this kit produce billions of faces, as the developer claims?

$$\frac{195}{\text{Hairlines}} * \frac{99}{\text{eyes \& eyebrows}} * \frac{89}{\text{noses}} * \frac{105}{\text{mouths}} * \frac{74}{\text{chins \& cheeks}} = 13,349,986,650$$

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F. C. P.

- One basic identification kit contains 195 hairlines, 99 eyes and eyebrows, 89 noses, 105 mouths, and 74 chins and cheeks.
- If a witness clearly remembers the hairline and eyes and eyebrows of a suspect, how many different faces can be produced?

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Permutations

- An ordering of a certain number of objects is a permutation of the objects.
- For example, there are six permutations of the numbers 1, 2 and 3: 123, 132, 213, 231, 321, and 312.
- The F.C.P. can be used on permutations also.

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Permutations

- If we have six flower pots to put in a row, how many choices do we have for the first position?
- The second position?
- Fill in the rest and multiply. How many permutations are there?

$$6 * 5 * 4 * 3 * 2 * 1 = 720$$

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Permutations

- In general, the number of permutations of n distinct objects is
 - $n!$ (factorial) = $n*(n-1)*(n-2)*...*3*2*1$
- There is a factorial function on your TI83/84 calculator –
 - enter the value for n , press MATH, arrow over to PRB, arrow down to or select 4:!, press ENTER.

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Permutations

- You have homework assignments from 5 different classes to complete this weekend.
- How many ways can you pick the first 2 assignments to work on?
- You can't just do 5! for this one, since you only have 2 positions to fill.

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Permutations

- This is called a permutation of 5 things taken 2 at a time, and the formula is:
 - ${}_5P_2 = \frac{5!}{(5-2)!}$
 - $= 5 * 4 * 3 * 2 * 1 / 3 * 2 * 1$
 - $= 5 * 4$
 - $= 20$

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Permutations

- This is called a permutation of 5 things taken 2 at a time, and the formula is:
 - ${}_5P_2 = \frac{5!}{(5-2)!} = 5 * 4 * 3 * 2 * 1 / 3 * 2 * 1 = 5 * 4 = 20$
- The general format is ${}_nP_r = \frac{n!}{(n-r)!}$, where n is the total number of items, and r is how many you're taking.

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Permutations

- There is a function for permutations on your TI83/84 calculator, also.
 - Enter the value for n, press MATH, arrow over to PRB, arrow down to or select 2:nPr, press ENTER, enter the value for r, press ENTER.

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Permutations with Repetition

- So far we've done permutations of distinct objects (no repetitions). Now let's look at permutations of duplicate objects.

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Permutations with Repetition

- What are the permutations of the letters in DAD?
- DAD ADD DDA
- DAD ADD DDA
- Since each of these sets is identical without the color-coding, there are only 3 distinguishable permutations.

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Permutations with Repetition

- What are the permutations of the letters in DAD?
- DAD ADD DDA
- DAD ADD DDA
- So, instead of $3! = 6$, our permutation is $\frac{3!}{2!} = 3$. The 2! is because we repeated the D twice.

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Permutations with Repetition

- How many distinguishable permutations are there of the letters in OHIO?
- There are 4 letters, and we repeat the O twice, so $\frac{4!}{2!} = 4 * 3 = 12$.
- If more than one item is repeated, just list all the repeats in the denominator.

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Permutations with Repetition

- How many distinguishable permutations are there of the letters in ARKANSAS?

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