Geometry 13.2
Use permutations with probability
Use combinations with probability

outcome - all the ways
sample space
factorial (!) $5! = 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 120$
permutation (order matters) $7! = 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 5040$
combination (non-ordered)
probability How likely is it?

no. of arrangements

pizza

$\frac{\text{Success}}{\text{total}}$ $\frac{1}{6}$

0 ——— | $x!$
0% 50% 100%

## KeyConcept Factorial

**Words** The factorial of a positive integer $n$, written $n!$, is the product of the positive integers less than or equal to $n$.

**Symbols** $n! = n \cdot (n - 1) \cdot (n - 2) \cdot \ldots \cdot 2 \cdot 1$, where $0! = 1$

$= 6$

$3!$

How many ways can A B C stand in a row?

$3 \cdot 2 \cdot 1$

$6$

A B C

A C B

B A C

B C A

C B A

C A B

## Example 1 Probability and Permutations of *n* Objects

**SPORTS** Chanise and Renee are members of the lacrosse team. If the 20 girls on the team are each assigned a jersey number from 1 to 20 at random, what is the probability that Chanise's jersey number will be 1 and Renee's will be 2?

$$\frac{\text{succeed}}{\text{total}} \qquad \frac{1}{20} \cdot \frac{1}{19} = \frac{1}{380}$$

## GuidedPractice

$26 \cdot 26 \cdot 10 \cdot 14 \cdot 50 \cdot 50 \cdot 50 \cdot 50 = 5.9 \times 10^{11}$

$590{,}009{,}006{,}000$

**2.** A student identification card consists of 4 digits selected from 10 possible digits from 0 to 9. Digits cannot be repeated.


**A.** How many possible identification numbers are there?

$10 \cdot 9 \cdot 8 \cdot 7 = 5040$

**B.** Find the probability that a randomly generated card has the exact number 4213.

$\frac{1}{5040}$

probability: #success/# possible

Group photo: Choose 4 from a group of 6


6 Choose 4

permut.

$\frac{6}{} \frac{5}{} \frac{4}{} \frac{3}{} = 360 = 15$

$\frac{}{4} \frac{}{3} \frac{}{2} \frac{}{1}$ $= 24$

FCP

combin

ABCD
ABDC

## Example 2 Probability and ${}_nP_r$

A class is divided into teams each made up of 15 students. Each team is directed to select team members to be officers. If Sam, Valencia, and Deshane are on a team, and the positions are decided at random, what is the probability that they are selected as president, vice president, and secretary, respectively?

PsxPvxPd

${}_{15}P_3$

$\frac{1}{15} \cdot \frac{1}{14} \cdot \frac{1}{13} = \frac{1}{2730}$

Permutations with repetition

CAT

BOO

CAT
CTA
TAC
TCA
ACT
ATR

$3 \cdot 2 \cdot 1$

6

BOO
~~BOO~~
OBO
~~OBO~~
OOB
~~OOB~~

distinguishable ?

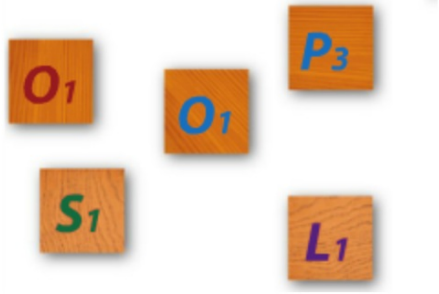
$\frac{3 \cdot 2 \cdot 1}{2 \cdot 1} = 3$

POOLS POOLS SPOOL SPOOL

L!

$\frac{5\ 4\ 3\ 2\ 1}{2\cdot 1} = \frac{120}{2} = 60$

Repeats




Distinguishable permutations #letters/#repeats

**KeyConcept Permutations with Repetition**

The number of distinguishable permutations of $n$ objects in which one object is repeated $r_1$ times, another is repeated $r_2$ times, and so on, is

$$\frac{n!}{r_1! \cdot r_2! \cdot \ldots \cdot r_k!}.$$

## Example 3 Probability and Permutations with Repetition

**GAME SHOW** On a game show, you are given the following letters and asked to unscramble them to name a U.S. river. If you selected a permutation of these letters at random, what is the probability that they would spell the correct answer of MISSISSIPPI?


# letters
# repeats

$$\frac{11!}{4!\,4!\,2!} \qquad \frac{1}{34650}$$

$$\frac{11 \cdot 10 \cdot 9 \cdot 8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{4 \cdot 3 \cdot 2 \cdot 1 \cdot 4 \cdot 3 \cdot 2 \cdot 1 \cdot 2 \cdot 1}$$

How many are there? One will be correct.



$5 \cdot 4 \cdot 3 \cdot 2 \cdot 1$

$120$

Circular


1 4 3 2 1

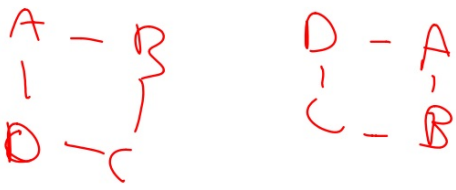
= 24


Is it a different arrangement?
1/5*5*4*3*2*1 Why?

A B C D

1 3 2 1

= 6





Sexhp

1143