Date ______________

Dear Family,

Chapter 11 introduces your child to several topics from the fields of probability and statistics.

When you have several groups of items and you select only one item from each group, the **Fundamental Counting Principle** allows you to multiply the number of items in each group to find the total number of selections. For example, if you have 5 shirts, 3 pants, and 4 jackets, you can create 60 outfits because $5 \cdot 3 \cdot 4 = 60$.

A **permutation** is a selection of items from one group in which order is important. A **combination** is a selection in which order is *not* important. Calculating permutations and combinations require the use of **factorial** (!), the product of the natural numbers less than or equal to the number.

Type	**Formula**	**Example**
Permutation	${}_nP_r = \frac{n!}{(n-r)!}$	How many ways can seven swimmers finish in first, second, and third place? ${}_7P_3 = \frac{7!}{(7-3)!} = \frac{7!}{4!} = \frac{7 \cdot 6 \cdot 5 \cdot \cancel{4 \cdot 3 \cdot 2 \cdot 1}}{\cancel{4 \cdot 3 \cdot 2 \cdot 1}} = 210$
Combination	${}_nC_r = \frac{n!}{r!(n-r)!}$	How many ways can seven coworkers be chosen for a committee of three? ${}_7C_3 = \frac{7!}{3!(7-3)!} = \frac{7!}{3!(4!)} = \frac{7 \cdot \cancel{6} \cdot 5 \cdot \cancel{4 \cdot 3 \cdot 2 \cdot 1}}{\cancel{3 \cdot 2} \cdot 1 \cdot (\cancel{4 \cdot 3 \cdot 2 \cdot 1})} = 35$

Probability is a measure of how likely an event is to occur. To find a **theoretical probability**, you assume all events are equally likely and calculate the ratio of the number of favorable outcomes to the number of all possible outcomes.

To find an **experimental probability**, you use real-world data and calculate the ratio of the number of times an event actually occurs to the number of trials of the experiment.

Probability	**Formula**	**Example**
Theoretical	$P(\text{event}) = \frac{\text{number of favorable outcomes}}{\text{number of all possible outcomes}}$	What is the theoretical probability of rolling a 3 on a number cube? $P(3) = \frac{1}{6}$ ← only one 3 on the cube; ← 6 total sides on the cube
Experimental	$P(\text{event}) = \frac{\text{number of times the event occurs}}{\text{number of trials}}$	A number cube is rolled one-hundred times and comes up 3 forty times. What is the experimental probability? $P(3) = \frac{40}{100} = \frac{2}{5}$ ← 40 favorable rolls; ← 100 total rolls

Events can be **independent** (one event does *not* influence the other), **dependent** (one event *does* influence the other), **mutually exclusive** (the events *cannot* both occur during the same trial), or **inclusive** (the events *can* occur at the same time).

Situation	Formula	Example
Independent Events	$P(A \text{ and } B) = P(A) \cdot P(B)$	Find the probability of rolling a 3 on one number cube and a 3 on another number cube. $P(3 \text{ and } 3) = \frac{1}{6} \cdot \frac{1}{6} = \frac{1}{36}$
Dependent Events	$P(A \text{ and } B) = P(A) \cdot P(B \text{ given } A)$	Find the probability of drawing two aces from a deck of cards without replacement. $P(\text{A and A}) = \frac{4}{52} \cdot \frac{3}{51} = \frac{12}{2652}$
Mutually Exclusive Events	$P(A \text{ or } B) = P(A) + P(B)$	Find the probability of rolling a 3 or a 4 on one number cube. $P(3 \text{ or } 4) = \frac{1}{6} + \frac{1}{6} = \frac{2}{6}$
Inclusive Events	$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$	Find the probability of drawing an ace or a red card from a deck of cards. $P(\text{A or red}) = \frac{4}{52} + \frac{26}{52} - \frac{2}{52} = \frac{28}{52}$

You and your child may already be familiar with the statistical measures of central tendency: **mean** (the average), **median** (the middle), and **mode** (the most often). Chapter 11 also uses measures of variation, including the **range** (the difference between the maximum and minimum), the **interquartile range** (the “length” of the middle 50% of data), and the **standard deviation** (a complex average of how much each data value differs from the mean).

When a binomial of the form $(p + q)$ is raised to a power and expanded, the terms of the polynomial are given by the **Binomial Theorem**:

$$(p+q)^n = {}_nC_0 p^n q^0 + {}_nC_1 p^{n-1} q^1 + {}_nC_2 p^{n-2} q^2 + \cdots + {}_nC_{n-1} p^1 q^{n-1} + {}_nC_n p^0 q^n$$

Surprisingly, the terms also correspond to the probabilities of events in a situation in which each trial has two possible outcomes, success or failure. If p and q are the probabilities of success or failure, respectively, then the **binomial probability** of r successes is $P(r) = {}_nC_r p^r q^{n-r}$. For example, if each item on a multiple-choice test has four options, then the probability of guessing 8 out of 10 correctly is $P(8) = {}_{10}C_8 \left(\frac{1}{4}\right)^8 \left(\frac{3}{4}\right)^2 = \frac{405}{1{,}048{,}576} \approx 0.0004$.

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