

# THE HUNGER GAMES

## PROBABILITY



### TOPICS COVERED:

- Basic probability
- Simple Events and Expected Outcomes
- Experimental and Theoretical Probability
- Tree Diagrams
- The Counting Principle
- Independent Events
- Dependent Events
- Permutations
- Factorials
- Combinations
- Odds

A PROBABILITY UNIT BASED ON THE BEST-SELLING BOOK SERIES

## 74<sup>th</sup> Annual Hunger Games Tributes

District	Name	Gender	Age	Train. Scores	Days Survived	Eliminated by
District 1 – Luxury	Marvel	Male	17	9	9	Katniss
District 1 - Luxury	Glimmer	Female	17	10	5	Katniss
District 2 - Masonry	Cato	Male	18	10	17	Mutts
District 2 - Masonry	Clove	Female	15	10	12	Thresh
District 3 – Technology		Male	14	10	8	Cato
District 3 - Technology		Female	13	4	1	5 Male
District 4 – Fishing		Male	12	9	1	Cato
District 4 - Fishing		Female	16	8	5	Katniss
District 5 – Power		Male	15	3	1	8 Male
District 5 - Power	Foxface	Female	15	5	15	Nightlock
District 6 – Transportation	Jason	Male	16	7	1	Cato
District 6 - Transportation		Female	17	4	1	Glimmer
District 7 – Lumber		Male	17	5	1	Clove
District 7 - Lumber		Female	16	4	1	Marvel
District 8 – Textiles		Male	14	3	1	Thresh
District 8 - Textiles		Female	13	5	2	Careers
District 9 – Grain		Male	14	4	1	Clove
District 9 - Grain		Female	14	5	1	Marvel
District 10 – Livestock		Male	18	4	8	Careers
District 10 - Livestock		Female	16	7	1	Glimmer
District 11 - Agriculture	Thresh	Male	18	10	14	Mutts
District 11 - Agriculture	Rue	Female	12	7	9	Marvel
District 12 – Mining	Peeta	Male	16	8	20	Winner
District 12 - Mining	Katniss	Female	16	11	20	Winner

**HEADLINES – “DISTRICT 12 REAPING BEING HELD TODAY”**

*May the odds be ever in your favor...will they be today????*

In the book *The Hunger Games*, 24 contestants compete for the title of Hunger Games Champion. The contestants are from age 12 to age 18. In their country of Panem there are 12 districts. One boy and one girl from each district are chosen to attend the Hunger Games. They are called tributes.

Below is a summary of the tributes.

DISTRICT											
1	2	3	4	5	6	7	8	9	10	11	12
BOY	BOY	BOY	BOY	BOY	BOY	BOY	BOY	BOY	BOY	BOY	BOY
GIRL	GIRL	GIRL	GIRL	GIRL	GIRL	GIRL	GIRL	GIRL	GIRL	GIRL	GIRL

Use the table above to answer the following questions. Write probabilities as simplified fractions.

**For #1-10, you choose one of the 24 contestants at random.**

1.	P(boy) [What is the probability you will choose a boy?]	
2.	P(a person from district 12)	
3.	P(a girl from district 11)	
4.	P(a person not from district 2)	
5.	P(either a boy or a girl)	
6.	P(a person from district 13)	
7.	P(a person from a prime numbered district)	
8.	P(a boy from a composite numbered district)	
9.	P(a girl from district 4, 5, or 6)	
10.	P(a person from a district that is a multiple of 3)	

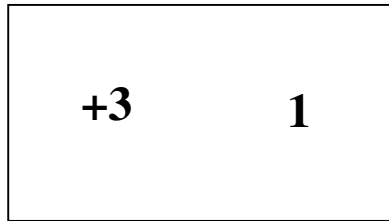
11.	Assume each contestant has an equal chance of winning. What is the probability the girl from district 12 will win?	
12.	If the Hunger Games were played 96 times, how many times would expect a boy from district 6 to win?	
13.	The final four contestants are the boys and girls from districts 3 and 4. Use a tree diagram to list all the possible orders the next two contestants may be eliminated.	

+1 0	+1 1	+1 0
+1 1	+1 0	+1 1
+1 0	+1 1	+2 0
+2 0	+2 0	+2 1
+2 0	+2 1	+2 0
+2 1	+3 0	+3 0

+3 0	+3 1	+3 0
+3 1	+4 0	+4 1
+4 0	+4 1	+5 0
+5 0	+5 0	+5 1
+6 0	+6 0	+6 0
+6 1		

**The Hunger Games Reaping Simulation**

You received a piece of paper when you walked in to class today.



The **first number** (+1 to +6) represents how many years you are going to add to your current age for today's lesson.

My current age: \_\_\_\_\_ + my first number \_\_\_\_\_ = my age for this project \_\_\_\_\_

Members of my family: \_\_\_\_\_ (current members living in your house, including yourself)

The **second number** represents whether you received tesserae or not. In the Hunger Games, tesserae represents additional food resources for families in need.

0 = you are not starving and you did not receive tesserae

1 = you are starving and your family has received tesserae each year since you were 12

**Directions for determining your entries into the reaping****PART 1: AGE**

Age 12 = 1, Age 13 = 2, Age 14 = 3, Age 15 = 4, Age 16 = 5, Age 17 = 6, Age 18 = 7

**PART 2: TESSERAE**

You must add 1 extra entry for every family member (including yourself) that received tesserae. These extra entries are cumulative.

For example, if you are 14 years old, your baseline number of entries would be 3 (for age). Added to this number would be your tesserae. For example, if you have 5 members in your family, the entries for tesserae at age 14 would be  $5 \times 3 = 15$ .

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**Portions of this first project taken from: *Hunger Games: What Are the Chances?*, Sarah B. Bush and Karen S. Karp, *Mathematics Teaching in the Middle School*, Vol. 17, No. 7 (March 2012), pp. 426-**

1.	On the basis of your age and your tesserae status, determine the number of entries you will have in the reaping lottery this year. Show all work here:
2.	Place your entries in the boy drawing or girl drawing using the small pieces of paper. Then write your number of entries in the correct column on the board.
3.	Given the grand total number of entries in our district (class) and for your gender, what is the probability that your name will be selected? Express your answer as both a fraction and a percentage round to the nearest hundredth (ex. 5.82%). <b>Calculator</b>
4.	Suppose you were a student in another class period. Would your chances (or probability) of being selected for the Hunger Games be the same? Why or why not?
5.	Write an algebraic equation representing a person's total number of entries, E, for a given year if you did not receive tesserae. Define your variables and write your equation below.
6.	Write an algebraic equation representing a person's total number of entries, E, for a given year if you did receive tesserae each year, starting at age 12, for all family members. Define your variables and write your equation below.

7.	Katniss had 20 entries in the reaping, Peeta 5, Gale 42, and Prim 1. If there were 4,144 boy entries and 4,060 girl entries in District 12, what is the probability that each name would be drawn for the Hunger Games? (percentage, round to the nearest hundredth) <b>Calculator</b>
8.	What is the probability that both Peeta and Prim are drawn at the reaping? To determine to probability of both of these two events happening, you multiply each individual probability together. Show your expression and answer below. <b>Calculator</b>
9.	How many entries would you have if you were 18 years old, had 9 family members, and received tesserae for each of them every year since you were 12?
10.	Suppose you were in a math class of 24 students and each student randomly draws the name of a contestant from the Hunger Games. If your contestant wins the Hunger Games, you win a prize. Is this a fair game? Why or why not? Can you determine the probability of your contestant winning the Hunger Games? If so, write it as a fraction.
11.	How many orders are possible for the first, second, and third person eliminated?
12.	During the Hunger Games in the book, 24 contestants compete until one person is declared the winner. How many orders are possible in which the contestants could have been eliminated (assuming 1 contestant eliminated at a time)? <b>Calculator</b>
13.	Suppose as the Hunger Games tributes arrive at the capitol they each greet every other contestant one time. How many total greetings would there be? Use drawings or lists to help organize your thoughts. Show all your work.



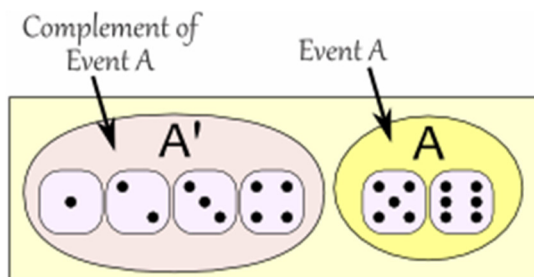
Determine something has a probability of...

<b>0%</b>		<b>50%</b>	
<b>10%</b>		<b>75%</b>	
<b>25%</b>		<b>100%</b>	

<b>Probability</b>	the chance that some event will happen
<b>Outcome</b>	one possible result of a probability event For example, 4 is an outcome when a die is rolled.
<b>Sample space</b>	the set of all possible outcomes For example, rolling a die the sample space is {1, 2, 3, 4, 5, 6}
<b>Theoretical Probability</b>	the ratio of the number of ways an event can occur to the number of possible outcomes (You are solving it mathematically.)
<b>Experimental Probability</b>	an estimated probability based on the relative frequency of positive outcomes occurring during an experiment (You are conducting an experiment.)
<b>Random</b>	outcomes occur at random if each outcome is equally likely to occur
<b>Simple</b>	A simple experiment consists of one action.
<b>Composite</b>	A composite experiment consists of more than one action.

The probability of an event is the ratio of the number of ways the event can occur to the number of possible outcomes.

$$P(\text{event}) = \frac{\text{number of ways an event can occur}}{\text{number of possible outcomes}}$$



The probability of rolling a 5 or 6 above is  $\frac{2}{6}$ .  $P(A) = \frac{2}{6}$

The **complement** of an event is all the outcomes that are not the event. It is represented with the prime symbol.  $P(A') = \frac{4}{6}$  because rolling a 1, 2, 3, or 4 is the complement of rolling a 5 or a 6.

$$P(A) + P(A') = 1 \text{ always.}$$

## HUNGER GAMES COMPETITION

The chart below shows how many tributes were left at the end of each day of the 74<sup>th</sup> Annual Hunger Games.

	Tributes remaining		Tributes remaining		Tributes remaining
<b>Start</b>	24	<b>Day 6</b>	10	<b>Day 12</b>	5
<b>End of Day 1</b>	13	<b>Day 7</b>	10	<b>Day 13</b>	5
<b>Day 2</b>	12	<b>Day 8</b>	8	<b>Day 14</b>	4
<b>Day 3</b>	12	<b>Day 9</b>	6	<b>Day 15</b>	3
<b>Day 4</b>	12	<b>Day 10</b>	6	<b>Day 16</b>	3
<b>Day 5</b>	10	<b>Day 11</b>	6	<b>Day 17</b>	2

Assume that all of the contestants have equal abilities to win the Hunger Games. Use the table above to answer the following questions.

	Name	Fraction	Percent (nearest whole percent)
1.	Before the Hunger Games begin what is the probability that Katniss will win?		
2.	Before the Hunger Games begin what is the probability that Katniss won't win?		
3.	After day one, what is the probability that Katniss will win?		
4.	After day one, what is the probability that Katniss won't win?		
5.	At the end of day 5 what is the probability that Katniss will win?		
6.	At the end of day 8 what is the probability that Katniss will win?		
7.	At the end of day 14 what is the probability that Katniss will win?		
8.	At the end of day 16 what is the probability that Katniss will win?		
9.	At the end of day 16 what is the probability that Katniss won't win?		
10.	<i>Why does Katniss' probability become greater as she gets farther into the Hunger Games?</i>		

If the Hunger Games were played 84 times, about how many times would you expect a tribute from District 11 would win? [Assume equal chances for all districts.]

To figure out about how many times without doing the experiment, you can just multiply. First, you must determine the probability District 11 will win. That would be  $\frac{1}{12}$ . Multiply the probability times the number of events.

$$\frac{1}{12} \cdot 84 = 7$$

Therefore, you would expect District 11 to win 7 times.

**Suppose 24 tributes compete in a Hunger Games simulation.**

1.	How many equally likely outcomes are there?	
2.	If there is one simulation, what is the probability of a tribute from District 12 winning?	
3.	If you run the simulation 96 times, about how many times would you expect the boy from District 1 to win?	
4.	If you run the simulation 120 times, about how many times would you expect a tribute from a prime district to win?	
5.	If you run the simulation 80 times, about how many times would you expect a girl tribute from district 4, 5, or 6 to win?	

**In the Hunger Games simulation the final four tributes consist of two from District 12, one from District 2, and one from District 5.**

6.	If there is one simulation, what is the probability that district 12 will win?	
7.	If you run the simulation 92 times, about how many times will district 2 win?	
8.	If you run the simulation 144 times, about how many times will district 5 not win?	
9.	If you run the simulation 80 times, about how many times will a person from a composite district win?	

**Cinna puts the following color cards (in equal quantities) in a bag for Katniss to choose one for her next dress: green, yellow, orange, red, purple.**

10.	If Katniss draws 65 times, about how many draws would be green?	
11.	If Katniss draws 180 times, about how many draws would not be orange or red?	
12.	If Katniss draws 640 times, about how many draws would be green, red, or purple?	
13.	If Katniss draws 36 green and yellow cards, about how many total cards are there?	

**Make a prediction based on the probability.**

1.	President Snow loves to bowl. He knocks down at least 6 pins 70 percent of the time. Out of 200 rolls, how many times can you predict President Snow will knock down at least 6 pins?													
2.	In the Hunger Games arena it rains about 16 percent of the time. On how many days out of 400 can the tributes predict they will get rain?													
3.	In The Capitol Effie notices that 55 percent of the people leaving the supermarket choose plastic bags instead of paper bags. Out of 600 people, how many can Effie predict will carry plastic bags?													
4.	Haymitch loves to play baseball. He reaches base 35 percent of the time. How many times can he expect to reach base in 850 at-bats?													
5.	Katniss loves to play basketball and she can make 65 percent of her shots from the free-throw line. If she shoots 75 times, how many shots can she expect to make?													
6.	<p>A professor in The Capitol predicted that at least 78 percent of residents prefer getting their news from a digital source rather than from a print source. He polled 3 different groups. The results are shown in the table below.</p> <table border="1" data-bbox="418 947 1053 1115"> <thead> <tr> <th></th> <th>Group 1</th> <th>Group 2</th> <th>Group 3</th> </tr> </thead> <tbody> <tr> <th>Digital</th> <td>20</td> <td>14</td> <td>30</td> </tr> <tr> <th>Print</th> <td>5</td> <td>10</td> <td>7</td> </tr> </tbody> </table> <p>In which group(s) did his prediction hold true? Explain.</p>		Group 1	Group 2	Group 3	Digital	20	14	30	Print	5	10	7	
	Group 1	Group 2	Group 3											
Digital	20	14	30											
Print	5	10	7											
7.	Cato flips the coin 64 times. How many times can Cato expect the coin to land on heads?													
8.	A spinner is divided into five equal sections labeled 1 to 5. What is the probability that the spinner will land on 3? If the spinner is spun 60 times, how many times can you expect the spinner to land on 3?													
9.	If Rue rolls the number cube 39 times, how many times can she expect to roll a 3 or 4?													
10.	A bag contains 6 red and 10 black marbles. If Foxface picks a marble, records its color, and returns it to the bag 200 times, how many times can she expect to pick a black marble?													
11.	Glimmer rolls a number cube 78 times. How many times can she expect to roll an odd number greater than 1?													
12.	A shoebox holds different color disks: 5 red, 6 white, and 7 blue disks. You pick out a disk, record its color, and return it to the box. If you repeat this process 250 times, how many times can you expect to pick either a red or white disk?													
13.	Clove flips two pennies 105 times. How many times can she expect both coins to come up heads?													

**Theoretical probability** – determined mathematically

**Experimental probability** – determined by conducting an experiment

### CELEBRITY HUNGER GAMES EXPERIMENT

Based on the book, a tribute has a bit more than a 50% chance of advancing to Day 2. After the first day a tribute's chance of advancing any given day rises to about 85-90%.

ROLL TWO DICE	<i>Eliminated</i>	<i>Survived</i>
Day 1	8, 9, 10, 11, 12	2, 3, 4, 5, 6, 7
After Day 1	3, 11, 12	2, 4, 5, 6, 7, 8, 9, 10

If the final tributes are eliminated on the same day, re-roll for that day.

Simulate the 12 person Celebrity Hunger Games five times.

Player	Example	1 <sup>st</sup> Simulation	2 <sup>nd</sup> Simulation	3 <sup>rd</sup> Simulation	4 <sup>th</sup> Simulation	5 <sup>th</sup> Simulation
Justin Bieber	Day 1					
Taylor Swift	Day 4					
Katniss Everdeen	Day 7					
Harry Potter	Day 1					
Batman	Day 1					
Darth Vader	Day 5					
LeBron James	Day 2					
Michael Jordan	Day 1					
Mrs. Loewen	Day 10					
Mrs. Bailey	Day 1					
Olaf	WON					
Nemo	Day 2					
<b>WINNER</b>	Olaf					

1.	What was the theoretical probability Nemo would win?	
2.	What was the experimental probability Nemo would win?	
3.	What was the theoretical probability Darth Vader would not win?	
4.	What was the experimental probability Darth Vader would not win?	
5.	What was the theoretical probability a two-name character would win?	
6.	What was the experimental probability a two-name character would win?	
7.	Why are theoretical and experimental probabilities not necessarily the same?	

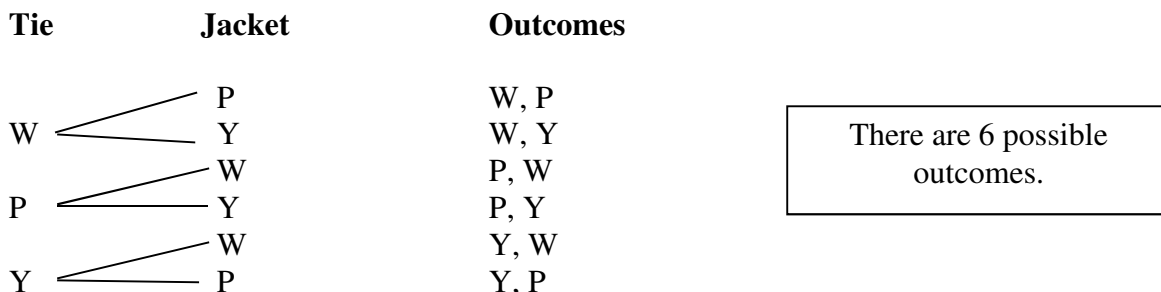
Record all answers as both fractions and percentages. Round to the nearest whole percent.

**Solve.**

1.	Katniss is playing basketball. She scored 11 baskets in 15 free throws. What is the experimental probability that she will score a basket on her next free throw?													
2.	Gale has gone to work for 60 days. On 39 of those days, he arrived at work before 8:30 A.M. On the rest of the days he arrived after 8:30 A.M. What is the experimental probability he will arrive after 8:30 A.M. on the next day he goes to work?													
3.	For the past four weeks, Prim has been recording the daily high temperature. During that time, the high temperature has been greater than 45°F on 20 out of 28 days. What is the experimental probability that the high temperature will be below 45°F on the twenty-ninth day?													
4.	After the movie <i>The Hunger Games</i> , 99 out of 130 people surveyed said they liked the movie. What is the experimental probability that the next person surveyed will say he or she liked the movie? He or she did not like the movie?													
5.	For the past 40 days, Katniss has been recording the number of customers at The Hob between 10:00 A.M. and 11:00 A.M. During that hour, there have been fewer than 20 customers on 25 out of the 40 days. What is the experimental probability there will be fewer than 20 customers on the forty-first day? 20 or more customers on the forty-first day?													
6.	<p>Peeta was bored so he tossed a coin and spun a spinner with 3 equal sections. The results are shown in the table.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>Heads</th> <th>Tails</th> </tr> </thead> <tbody> <tr> <th>1</th> <td>53</td> <td>65</td> </tr> <tr> <th>2</th> <td>49</td> <td>71</td> </tr> <tr> <th>3</th> <td>54</td> <td>62</td> </tr> </tbody> </table> <p>What is the experimental probability that the next toss and spin will result in Tails and a 3?</p>		Heads	Tails	1	53	65	2	49	71	3	54	62	
	Heads	Tails												
1	53	65												
2	49	71												
3	54	62												
7.	<p>The tributes stopped at the Sandwich Shop for lunch. They can choose the bread and meat they want. The table shows the sandwiches that were sold on a given day.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>White Bread</th> <th>Wheat Bread</th> </tr> </thead> <tbody> <tr> <th>Ham</th> <td>22</td> <td>24</td> </tr> <tr> <th>Turkey</th> <td>21</td> <td>22</td> </tr> <tr> <th>Tuna</th> <td>25</td> <td>23</td> </tr> </tbody> </table> <p>What is the experimental probability that the next sandwich sold will be tuna on wheat bread?</p>		White Bread	Wheat Bread	Ham	22	24	Turkey	21	22	Tuna	25	23	
	White Bread	Wheat Bread												
Ham	22	24												
Turkey	21	22												
Tuna	25	23												

You can draw a tree diagram to find the number of possible combinations or outcomes.

**Example** Haymitch will wear either a white, purple, or yellow tie with a white, purple, or yellow jacket. The tie and jacket cannot be the same color. How many different choices does Haymitch have?



**Create a tree diagram with titles or create an organized list/table of the outcomes possible. Then give the total number of outcomes.**

1.	Katniss bought 3 pins: one with a star, a butterfly, and a mockingjay. She has a blue dress and a green dress. How many dress/pins combinations are possible?
2.	Cinna is trying to figure out what Katniss should wear for the interview. She can wear a blue, pink, purple, or red dress. Then she can either wear gold, silver, black, or white high heels. What are all the different combinations?
3.	The Final Four tributes in the Hunger Games were: Foxface, Cato, Peeta, and Katniss. What are all the possible combinations of the top 2?
4.	Katniss and Gale take a quick trip to the Hob. Katniss has a choice to buy a rabbit, a leg of a wild dog, or a bowl of meat soup. She also has a choice of a free item with the meat: a district 12 token, an arrow, or a knife. What are all the combinations?
5.	Caesar Flickerman is making his yearly Hunger Games interview with the tributes. Caesar can dye his eyebrows mockingjay blue, amber red, or mockingjay pin gold. He can dye his hair President Snow white or Capitol rainbow. What are the combinations for Caesar?
6.	Katniss is at the cornucopia. She can get a square of plastic, a backpack, some bows and arrows, or a tent. Then she can either run the opposite direction of either Cato, Thresh, or Peeta. Next, she can be allies with the Careers or Rue. List all the possible outcomes.
7.	Katniss wanted to get rid of the Careers by throwing a tracker-jacker nest on them, destroying their food supply, or singing for them and damaging their ears. After this she is going to either leave them, throw them in a river, or go find Peeta. List the outcomes.
8.	The people who live in the Capitol are betting on who will win the Hunger Games. The tributes are Beth and Liz. After one wins, she will either be famous and rich, become known as the greatest person in the world, or be forgotten in a week. During the Games she would have run away, tried to fight, or lived in the trees. What is the probability of Liz winning, being known as the greatest person in the world, and living in the trees?





**The Counting Principle** uses multiplication to find the number of possible outcomes.

Event M followed by N can occur in  $m \cdot n$  ways.

**Example: The Capitol's Best Pizza serves 11 different kinds of pizza with 3 choices of crust and in 4 different sizes. How many different selections are possible?**

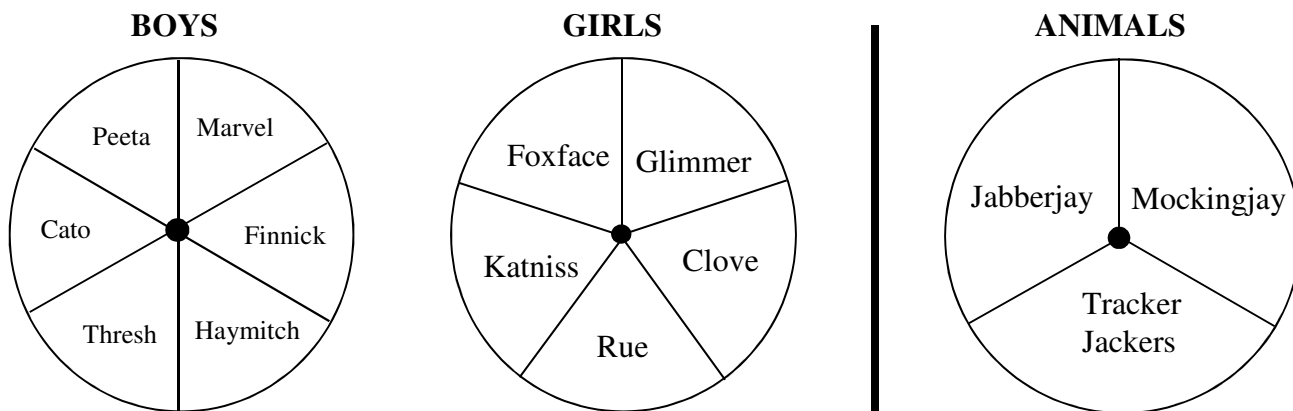
Apply the Counting Principle:  $11 \cdot 3 \cdot 4 = 132$       132 pizza selections

**Use the Counting Principle to find the total number of outcomes in each situation.**

1.	The Hob nursery has 14 different colored tulip bulbs. Each color comes in dwarf, average, or giant size. How many different kinds of bulbs are there?	
2.	The type of bicycle Prim wants comes in 12 different colors of trim. There is also a choice of curved or straight handlebars. How many possible selections are there?	
3.	At a tribute banquet, guests were given a choice of 4 entrees, 3 vegetables, soup or salad, 4 beverages, and 4 desserts. How many different selections were possible?	
4.	Gale is setting the combination lock on his briefcase. If he can choose any digit 0-9 for each of the 6 digits in the combination, how many possible combinations are there?	
5.	Mrs. Everdeen choosing a paint color from among 6 color choices, and choosing a wallpaper pattern from among 5 choices	
6.	Clove flipping a penny, a nickel, and a dime	
7.	Marvel choosing the last three digits in a five-digit zip code if the first digit is 6, the second digit is 1, and no digit is used more than once	
8.	Glimmer choosing one of three science courses, one of five math courses, one of two English courses, and one of four social studies courses	
9.	Rue choosing from one of three appetizers, one of four main dishes, one of six desserts, and one of four soft drinks	
10.	Cashmere choosing a book with a mystery, science-fiction, romance, or adventure theme, choosing one of five different authors for each theme, and choosing paperback or hardcover for the type of book	
11.	Brutus is choosing a 7 digit phone number if the first three-digit combination can be one of 8 choices and if the last four digits can be any combination of digits from 1 to 9 without any repeated digits	
12.	In the 1980's telephone area codes in the US contain three digits, they did not begin with a 1 or 0, and the middle digit was always a 0 or a 1. Mags said, "If that is true, each state in the USA could have less than 5 area codes and yet all the area codes could be used up." Is Mags correct?	

## HUNGER GAMES INDEPENDENT EVENTS

If the outcome of one event does not affect the outcome of a second event, the two events are **independent**. The probability of two independent events, A and B, is equal to the probability of event A times the probability of event B.  $P(A, B) = P(A) \cdot P(B)$



1.	How many outcomes are possible when you spin all three spinners (hint: Counting Principle)	
2.	If you made a tree diagram showing all these outcomes, how many branches would show landing on Peeta, Foxface, and Mockingjay?	

For #3-10, the first two spinners above are spun. **Find the probability of each event.**

3.	P(Peeta, Katniss)		4.	P(Cato, Clove)	
5.	P(boy, girl)		6.	P(contains an E, starts with R)	
7.	P(ends with H, has exactly 2 vowels)		8.	P(double letters, double letters)	
9.	P(ends with consonant, Rue)		10.	P(not Cato, not Foxface)	

A third spinner is now added. **Write the expression and find the probability of each event.**

11.	P(Peeta, Katniss, Mockingjay)		
12.	P(Marvel, Glimmer, ends with "jay")		
13.	P(not Thresh, not Rue, not tracker jackers)		
14.	P(boy, girl, animal)		
15.	P(contains H, contains E, contains Y)		
16.	P(contains E, contains A, contains R)		
17.	P(not Marvel, Clove, not jabberjay)		

18.	If a 4 <sup>th</sup> spinner was added above, would the probabilities of the four events happening increase or decrease? Why?	
-----	---	--

*Show work on a separate sheet of paper.*

A quarter and a dime are tossed. **Find the probability of each event.**

1.	P(T, H)		2.	P(both the same)	
3.	P(T, T)		4.	P(at least one head)	

Suppose you write each letter of “Effie Trinket” on a separate index card and select one letter from each name without looking. **Find the probability of each event.**

5.	P(vowel, vowel)		6.	P(consonant, vowel)	
7.	P(F, E)		8.	P(T, K)	

Peeta’s bakery offers 5 kinds of muffins, one of which is blueberry. The bakery also offers 5 kinds of beverages, one of which is orange juice. **Find the probability of each event.**

9.	P(blueberry muffin)		10.	P(orange juice)	
11.	P(blueberry muffin and orange juice)		12.	P(blueberry muffin, some beverage other than orange juice)	

Suppose you toss a coin and pick a card from a pile of 16 cards, each printed with a letter from the name “Caesar Flickerman” **Find the probability of each of the following.**

13.	P(heads, M)		14.	P(tails, A)	
15.	P(tails, E)		16.	P(heads, vowel)	
17.	P(tails, consonant)		18.	P(heads, a letter in “wiress”)	

President Snow spins a spinner with 4 equally likely outcomes: blue, red, yellow, and red. He will also roll a die. **Find the probability of each of the following.**

19.	P(blue, 2)		20.	P(blue, not 2)	
21.	P(yellow, even)		22.	P(red, even)	
23.	P(not blue, 5)		24.	P(not blue, odd)	

A bag contains 6 marbles: one black, 2 white, and 3 striped. Seeder picks one marble, replaces it, and then picks a second marble. **Find the probability of the following.**

25.	P(white, striped)		26.	P(not white, striped)	
27.	P(black, black)		28.	P(striped, striped)	
29.	P(white, not white)		30.	P(not white, not white)	

If the outcome of one event affects the outcome of a second event, the events are dependent.

The probability of two dependent events, A and B, is equal to the probability of event A times the probability of event B. However, the probability of event B now depends on event A.

$$P(A, B) = P(A) \cdot P(B)$$

Example: There are 6 black pens and 8 blue pens in a jar. Plutarch takes a pen without looking and then takes another pen without replacing the first, what is the probability he will get 2 black pens?

$$P(\text{black first}) = \frac{6}{14} \text{ or } \frac{3}{7} \qquad P(\text{black second}) = \frac{5}{13}$$

$$P(\text{black, black}) = \frac{3}{7} \cdot \frac{5}{13} \text{ or } \frac{15}{91}$$

**Tell whether each event is independent or dependent.**

1.	Haymitch (not good at fashion) selecting a sweater, selecting a shirt	
2.	Madge choosing one card from a deck then choosing a second card without replacing the first	
3.	Gale's wallet contains two \$5 bills, two \$10 bills, and three \$20 bills. Two bills are selected without the first being replaced.	
4.	Alma Coin rolls two dice.	
5.	Annie choosing two cards from a deck so that they make a "pair".	
6.	Beetee selecting a DVD from a storage case and then selecting a second DVD after replacing the first	
7.	There are 20 letter tiles face down on the table. Prim knows that there is one X-tile and one J-tile. Prim picks two tiles at the same time. What is the probability that she will pick the X-tile and then the J-tile?	
8.	Squad 451 has 12 CD's in their car. They select one of the CD's while also selecting a beverage to drink at Starbucks.	

86% of Texas' 12<sup>th</sup> graders missed this STAAR problem.

9.	Winners from the math club fund-raiser randomly select a gift-certificate from Box A and from Box B. The boxes are shown below.		What is the probability that the first winner will randomly select a DVD certificate and an amusement certificate?	
	<div style="border: 1px solid black; padding: 5px; width: fit-content;"> <p><b>BOX A</b> 5 dinner certificates 4 DVD certificates 3 movie certificates 5 T-shirts certificates</p> </div>	<div style="border: 1px solid black; padding: 5px; width: fit-content;"> <p><b>BOX B</b> 4 CD certificates 3 camera certificates 5 amusement certificates 5 TV certificates</p> </div>		
	A $\frac{20}{289}$	B $\frac{9}{17}$	C $\frac{9}{289}$	D $\frac{1}{19}$

F	I	N	N	I	C	K
---	---	---	---	---	---	---

Mags places the seven cards above into a box. She draws one card, does not replace it, and then draws another card. **Write both the expression and the answer.**

1.	P(N, N)		2.	P(C, F)	
3.	P(I, K)		4.	P(N, I)	
5.	P(C, D)		6.	P(N, not K)	

Wiress draws three cards and does not replace them. **Write both the expression and the answer.**

7.	P(F, I, N)		8.	P(N, I, N)	
9.	P(K, C, F)		10.	P(N, I, not F)	
11.	P(vowel, vowel, consonant)		12.	P(N, N, N)	

Beetee draws four cards and does not replace them. **Write both the expression and the answer.**

13.	P(F, I, N, N)		14.	P(N, I, C, K)	
15.	P(N, N, I, not I)		16.	P(K, C, F, I)	

Annie draws five cards and does not replace them. **Write both the expression and the answer.**

17.	P(F, I, N, N, I)		18.	P(K, C, F, I, not N)	
-----	------------------	--	-----	----------------------	--

**Find the missing probability.**

19.	P(A) = 0.5 P(B) = 0.6 P(A and B) = ?		20.	P(A) = 0.31 P(B given A) = 0.8 P(A and B) = ?	
21.	P(A) = 0.3 P(B) = ? P(A and B) = 0.27		22.	P(A) = 0.7 P(B given A) = ? P(A and B) = 0.7	
23.	P(A) = ? P(B) = 0.06 P(A and B) = 0.03		24.	P(A) = ? P(B given A) = 0.6 P(A and B) = 0.27	

Peeta and Katniss are both very hungry and could use a little snack. Use the table of probabilities to answer questions 1–3.

	<b>Burrito</b>	<b>Taco</b>	<b>Wrap</b>
<b>Cheese</b>	$P = \frac{1}{9}$	$P = \frac{1}{9}$	$P = \frac{1}{9}$
<b>Salsa</b>	$P = \frac{1}{9}$	$P = \frac{1}{9}$	$P = \frac{1}{9}$
<b>Veggie</b>	$P = \frac{1}{9}$	$P = \frac{1}{9}$	$P = \frac{1}{9}$

1.	List the members of the sample space that include a taco. Use parentheses.	
2.	List the members of the sample space that include cheese. Use parentheses.	
3.	What is the probability of choosing a burrito with cheese or a taco or a wrap with salsa? Explain.	

Based on historical records of the Hunger Games, the chance of getting a gift from your mentor any day is 20 percent. The simulation below models the experimental probability of getting a gift from a mentor in at least one of the next 5 days. The numbers 1 and 2 represent getting a gift. The numbers 3–10 represent not getting a gift.

Here is the table created. Fill in the missing data.

<b>Trial</b>	<b>Numbers Generated</b>	<b>Gifts Caught</b>	<b>Trial</b>	<b>Numbers Generated</b>	<b>Gifts Caught</b>
1	7, 3, 2, 7, 10		6	8, 4, 7, 6, 5	
2	2, 4, 5, 3, 10		7	6, 10, 1, 7, 6	
3	9, 9, 7, 6, 6		8	7, 9, 8, 3, 8	
4	7, 9, 6, 6, 4		9	1, 4, 4, 8, 9	
5	10, 6, 4, 6, 4		10	7, 8, 9, 5, 3	

4.	According to the simulation above, what is the experimental probability that a tribute will be receive a gift in at least one of the next 5 catches?	
----	--	--

**Katniss, Rue, Peeta, Thresh, Foxface, Cato, Clove, Glimmer, Marvel**

<b>Total number of people</b>	<b>People picked to put in order</b>	<b>Written mathematically</b> ${}_n P_r$	<b>Number of ways to order them</b>	<b>How to solve mathematically</b>
1	1			
2	1			
2	2			
3	1			
3	2			
3	3			
4	1			
4	2			
4	3			
4	4			
5	1			
5	2			
5	3			
5	4			
5	5			

1.	Say that we had 10 people to pick from in the front of the room. How many people would we select to give us the least number of permutations?	
2.	Say that we had 10 people to pick from in the front of the room. How many people would we select to give us the most number of permutations?	

An arrangement or listing in which order is important is called a **permutation**.

Example: Prizes – 3<sup>rd</sup> place: a Gale doll, 2<sup>nd</sup> place: a Rue doll, and 1<sup>st</sup> place: a Katniss doll. There are 7 different students from which Mr. Mangham will draw. How many possible ways can Mr. Mangham pick the winners for each prize?

Using the Counting Principle, there are  $7 \cdot 6 \cdot 5 = 210$  possible ways.

${}_7P_3$  represents the number of permutations of 7 students taken 3 at a time.

$${}_7P_3 = 7 \cdot 6 \cdot 5 = 210$$

$${}_nP_r = n \cdot (n-1) \cdot (n-2) \cdot \dots \cdot (n-r+1)$$

${}_4P_4$  would be calculated by:  ${}_4P_4 = 4 \cdot 3 \cdot 2 \cdot 1 = 24$ . The mathematical notation  $4!$  is read “four **factorial**”.  $n!$  means the product of all counting numbers beginning with  $n$  and counting backward to 1.  $0!$  is defined as 1.

**Find each value.**

1.	${}_6P_2$		2.	${}_8P_3$		3.	$4!$	
4.	$8!$		5.	$0!$		6.	${}_7P_4$	
7.	${}_4P_2$		8.	$\frac{6!3!}{4!2!}$		9.	$\frac{8!4!}{5!2!}$	
10.	${}_3P_2$		11.	${}_9P_9$		12.	$9!$	

**How many different ways can the letters of each word be arranged? Write both the factorial and the answer.**

13.	RUE		14.	FLICKERMAN	
15.	CLOVE		16.	MARVEL	

17.	How many odd four-digit numbers can be formed from the digits 1, 2, 3, and 4? Write the possible odd numbers.	
18.	How many even four-digit numbers can be formed from the digits 1, 2, 3, and 5? Write the possible even numbers.	
19.	With the digits 1, 2, 3, 4, and 5, how many five-digit positive integers can be formed if no digits can be repeated	
20.	In how many different ways can you arrange the letters in the word JOURNALISM if you take six at a time?	Permutation
		Answer
21.	Write your own interesting word problem which can be solved by a permutation.	



**Katniss, Rue, Peeta, Thresh, Foxface, Cato, Clove, Glimmer, Marvel**

<b>Total number of people</b>	<b>People picked</b>	<b>Written mathematically</b> ${}_n C_r$	<b>Number of ways to pick them</b>	<b>How to solve mathematically</b>
1	1			
2	1			
2	2			
3	1			
3	2			
3	3			
4	1			
4	2			
4	3			
4	4			
5	1			
5	2			
5	3			
5	4			
5	5			

1.	Say that we had 10 people to pick from in the front of the room. How many people would we select to give us the least number of combinations?	
2.	From #1, how many people would we select to give us the most number of combinations?	

An arrangement or listing in which order is not important is called a **combination**.

Example: Mr. Mangham is giving away 3 movie tickets. There are 7 different students with Mangham's Most Wanted slips from which Mr. Mangham will draw. How many possible ways can Mr. Mangham pick the 3 winners for the prizes?

A quick way to find the number of combinations is to divide the number of permutations,  ${}_7P_3$ , by the number of orders 3 students can be drawn,  $3!$ .

$$\text{Number of ways} = \frac{7 \cdot 6 \cdot 5}{3 \cdot 2 \cdot 1} = \frac{210}{6} = 35 \text{ ways}$$

${}_n C_r$  means the number of combinations of  $n$  things taken  $r$  at a time.

$${}_n C_r = \frac{{}_n P_r}{r!}$$

**Find each value.**

1.	${}_4 C_2$		2.	${}_5 C_3$		3.	${}_6 C_2$	
4.	${}_8 C_3$		5.	${}_6 C_4$		6.	${}_7 C_7$	
7.	${}_{15} C_6$		8.	${}_{15} C_7$		9.	${}_{15} C_8$	

**Determine whether each situation is a permutation or a combination.**

10.	Annie taking 2 drinking glasses from 6 on a shelf	
11.	Finnick placing 6 different drinking glasses on a shelf	
12.	President Snow taking 4 cards from a 52-card deck	
13.	A mutt choosing 3 numbers from 1 to 9	
14.	A mockingjay making a 3 digit number with each digit between 1 and 9 and each digit only used once	

**Solve.**

15.	How many ways can you choose four toy soldiers from a collection of sixteen toy soldiers?	
16.	How many different five-card hands are possible using a 52-card deck?	
17.	How many combinations of four textbooks can be chosen from eight textbooks in a locker?	
18.	How many different "double features" (two-film showings) can be chosen from a collection of twelve films?	
19.	How many ways can 5 children line up to get on the school bus if Jenny always gets third?	
20.	Write your own interesting word problem which can be solved by a combination.	

Write the appropriate permutation or combination expression and then solve. You may use a calculator.

1.	How many ways can 6 students' desks be arranged in a row?		
2.	How many ways can 2 students choose one baseball card each from 18 baseball cards that are a reward for their hard work?		
3.	How many ways can 10 students line up for lunch?		
4.	How many ways can you choose 4 CDs from a stack of 8 CDs?		
5.	How many ways can 3 pairs of shoes be chosen from 8 pairs?		
6.	How many ways can 9 runners be arranged on a 4-person relay team?		
7.	The Ft. Worth Zoo has 23 animals it can take on visits to schools. How many ways can the zoo choose 9 animals for a trip to Durham Intermediate?		
8.	There are 15 dancers in a championship competition. How many ways can the top 3 finishers be arranged?		
9.	In the Daytona 500 the cars start in 11 rows of 3. How many ways can the front row be made from the field of 33 race cars?		
10.	How many ways can you make a sandwich by choosing 4 of 10 ingredients?		
11.	How many ways can 11 photographs be arranged on the wall?		
12.	How many ways can you make a batting order in baseball (9 players) from a team of 16?		
13.	How many ways can 3 cookie batches be chosen out of 6 prize-winning batches?		
14.	Which situation represents a permutation? A. Selecting six marbles from a jar                      C. Putting three coins in a purse B. Awarding first and second place                      D. Selecting two candidates from a group of 16		
15.	Which situation represents a combination? A. Five people in line to buy tickets                      C. First and second place in a race B. 7 people running for chair and vice-chair                      D. Choosing team of 3 people from a group of 10		

## HUNGER GAMES ODDS

Based on past results, one can make an educated guess at the odds the boys and girls coming from each district have of winning. Boys tend to win more than girls and Districts 1, 2, and 4 win the most often.

### Odds against winning the Hunger Games

[Odds against = number of failures to number of successes]

District Number	Male Odds	Female Odds	District Number	Male Odds	Female Odds
1	7-1	18-1	7	25-1	50-1
2	8-1	15-1	8	30-1	45-1
3	25-1	70-1	9	40-1	60-1
4	7-1	14-1	10	35-1	50-1
5	20-1	40-1	11	25-1	60-1
6	24-1	70-1	12	37-1	74-1

1.	Which tribute(s) has the best odds of winning?	
2.	As a fraction, what is the probability this tribute will win?	
3.	As a decimal, what is the probability this tribute will win?	
4.	Which tribute has the worst odds of winning?	
5.	As a fraction, what is the probability this tribute will win?	
6.	As a decimal (nearest thousandth), what is the probability this tribute will win?	
7.	Write your answer to #6 as a percentage.	
8.	Which tribute has a probability of winning of $\frac{1}{15}$ ?	
9.	Which female tribute has the best odds of winning?	
10.	Which tribute(s) has about a 5% chance of winning?	
11.	Which tribute is closest to a 2% chance of winning, without going under 2%?	
12.	Which tribute has a probability of losing of $\frac{35}{36}$ ?	
13.	List all of the tributes in order from most likely to win to least likely to win.	

## PROBABILITY PROJECT

Mr. Mangham needs a probability project/assignment/activity for his future math classes to complete when they are finishing up their probability unit. Below are the requirements. Please read them carefully.

- You may work individually or in a team of up to 4 people (the bigger the team, the better your final product should be).
- What you create will be a concluding probability project/assignment/activity so you do not need to teach any of the concepts. The students just have to use the concepts they already know in some way.
- Your creation must relate to one of our themes:
 

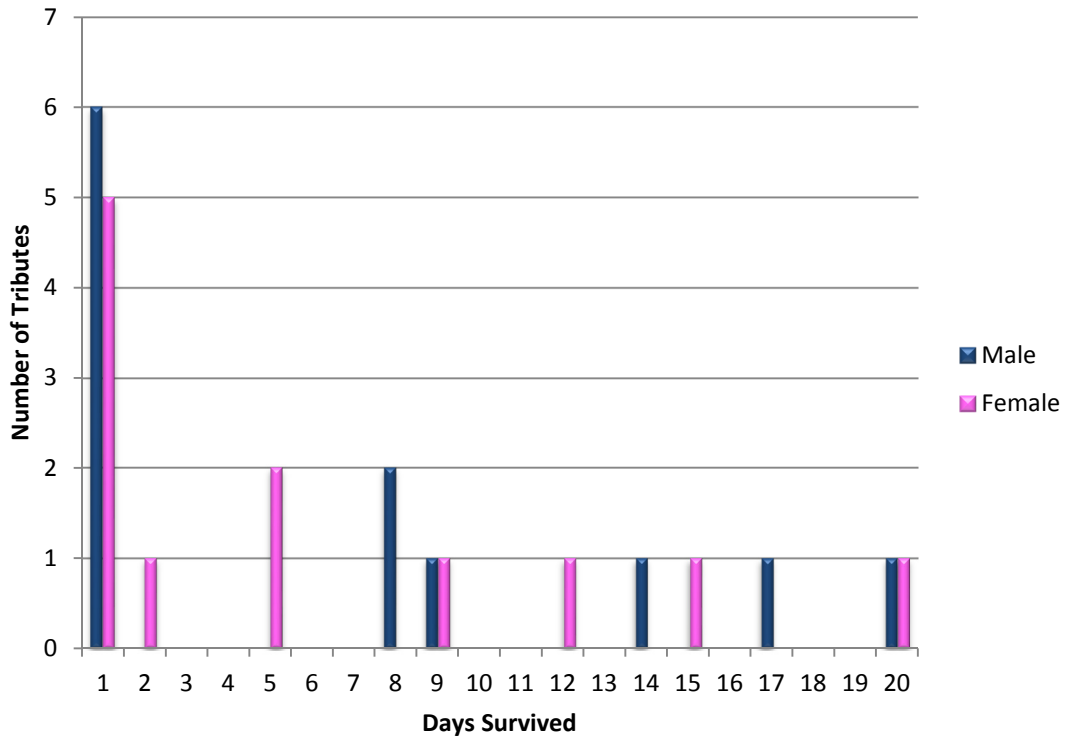
The Hunger Games	Star Wars
Food & Restaurants	Titanic
Architecture	Fantasy Football
Animal Sizes and Shapes	
The Stock Market	
Design the Zoo of the Future	

- You must address **one probability concept in each column** in some way.

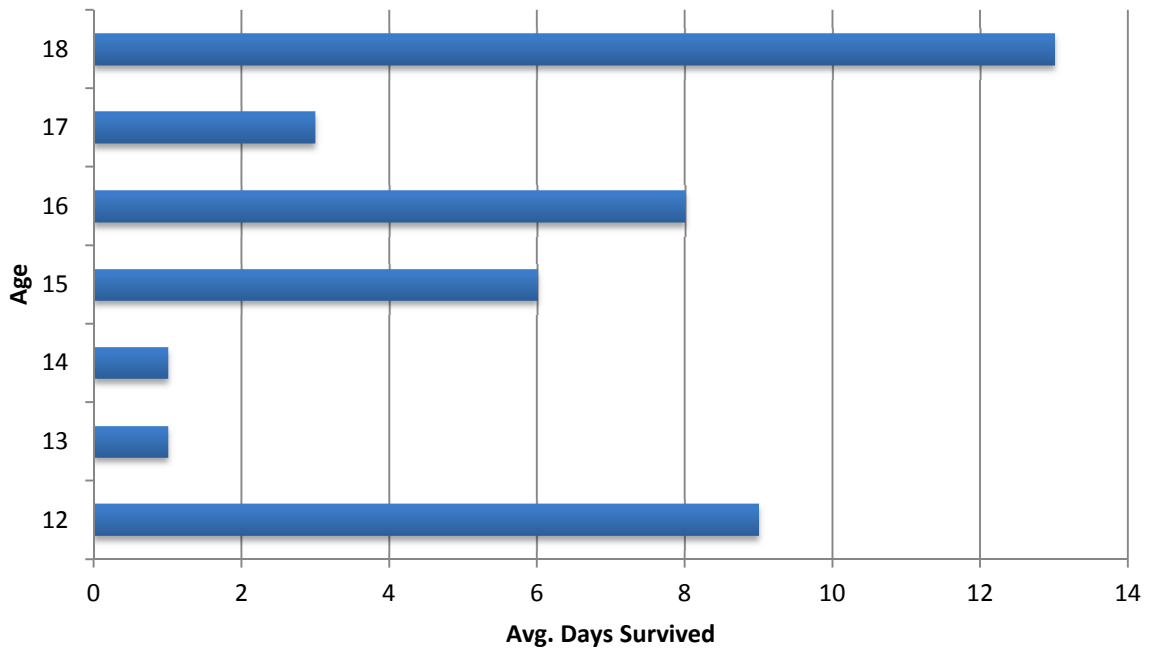
Theoretical Probability	Independent Events	Permutations
Experimental Probability	Dependent Events	Combinations
Tree Diagrams		Factorials
Counting Principle		Odds

- What you create is totally up to you.
- You must work at a good pace. You have this class period to get the majority of the project completed. This assignment will be turned in Tuesday. You are going to want to keep things relatively simple. I understand it will not look like you spent 10 hours completing this assignment. It may look more like a rough copy than final copy.
- Your grade is based on:
  - Did you address the 3 probability concepts you chose at an accelerated math level?
  - Will students find your activity fun, interesting, and educational?
  - Do you believe Mr. Mangham can actually use your project in his class

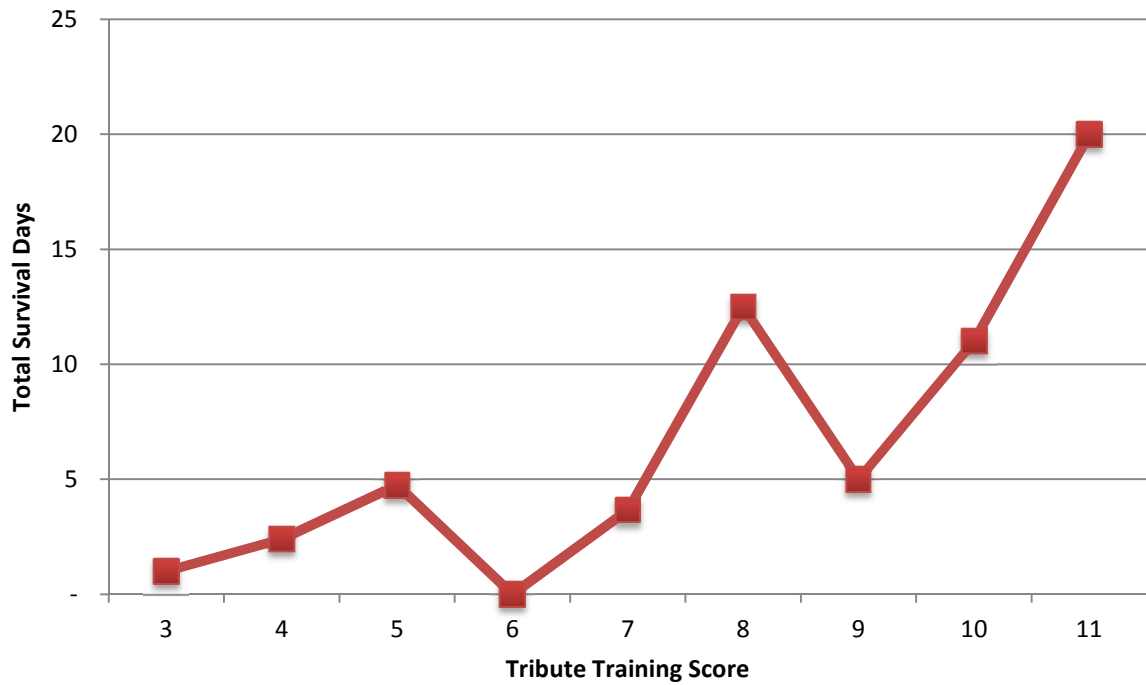
## Hunger Games - Days Survived by Gender



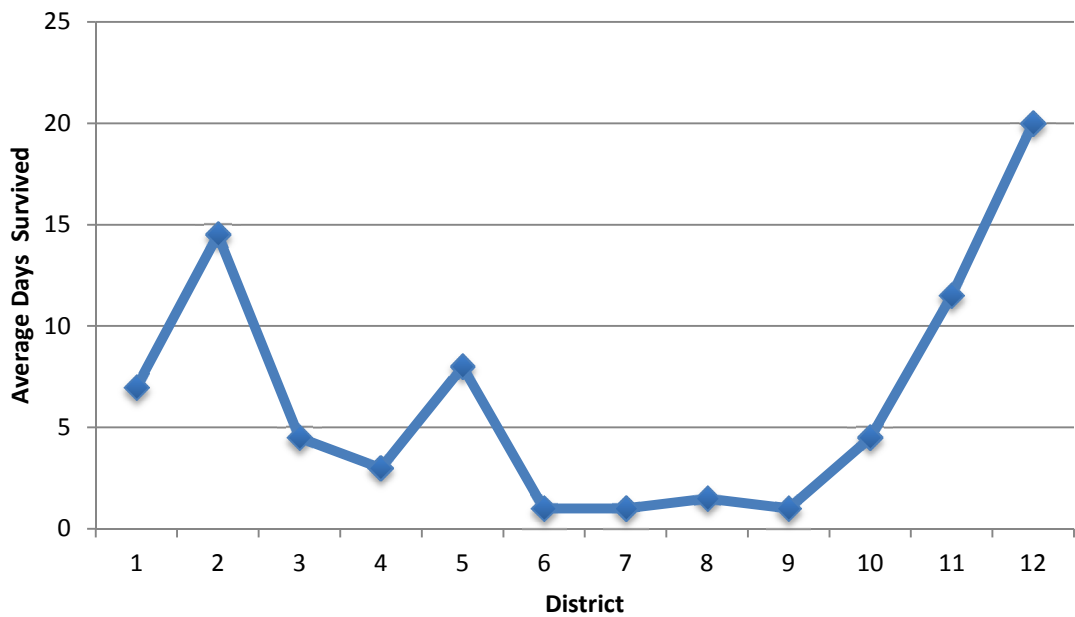
## Average Days Survived by Age



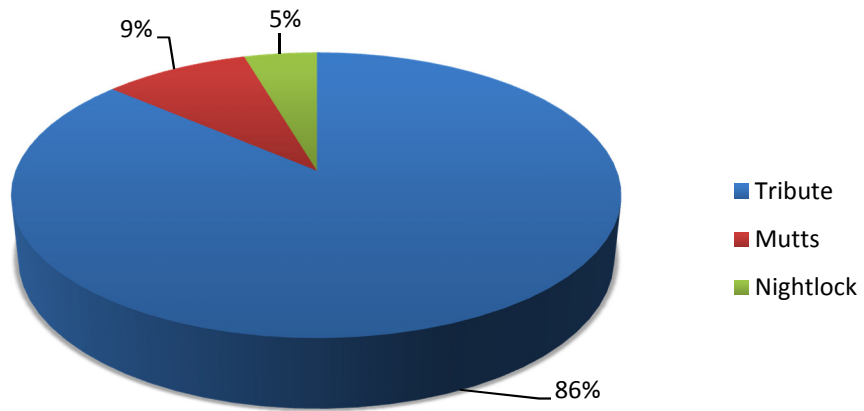
### Average Days Survived vs Training Score



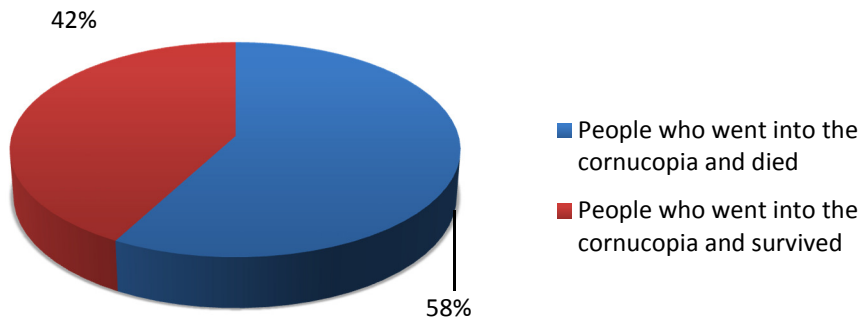
### Average Days Survived by District



### Source of Death



### Cornucopia Chance of Survival





## The Hunger Games

N B R I R K P E E T A M E L L A R K N C Z Y Z P K  
 A B Q E T U H C A R A P R E V L I S N J H W O M O  
 K B T V B J E A C A M O U F L A G E K T L I G S A  
 J U A E V L E W T T C I R T S I D K A H S M T L C  
 H D U Z H L T S T A B B E D X Y J N G O N P M L S  
 T G H F R O S T I N G Z H R A T R X N N E Y Q A M  
 I G S S O G F Z H V O S L R J E B B P I V T R B A  
 M O S N O N H H I S R S S C B L E G N E E Z C E T  
 S B C T E D O G Q C E N L A H R W G E R L M M R M  
 E F A L W E U I B S S R H T R F N V E I E G Y I P  
 L C Z B O I D D T V F C H I B I S E D F T O Y F R  
 P I B O J V K R P C T P E T W Q C X R N C Z Y Q G  
 M J H W I O E P E I E S P O C C A F E O I O N J G  
 E P A A D Y M V M V C F R V B I A J V L R D Y Z M  
 T F M N B H X Y Y B E H N A O F U V E R T L T H E  
 S W R D C H A B W C T S Z I T H S G E I S Q P X H  
 U R N A F H W Z Z E C R S W R Z T G S G I O E U T  
 I E G R D F T E F C V E D I F J L T O F D L N O N  
 D S S R K Y O I M E D K Q F N C X J R E A T A W A  
 U T O O H H N G V R T A H E C T X C M G I F D U G  
 A L K W P K Z Z V Z V B X A C W A E I G Y W M A R  
 L I O S D G N N G I B N X S Z J P K R S Q A E Z O  
 C N U E U H E G N I R Y S T O Z W K P O T L N P C  
 L G S Q X V O O M S V C O R N U C O P I A D A B K  
 U U U Y V C W I W F K P X O T K L O M D E S P H I

ANTHEM	FEAST	POISON BERRIES
BAKER	FIREBALLS	PRIMROSE EVERDEEN
BOW AND ARROWS	FROSTING	ROCK
CAMOUFLAGE	GALE	RUE
CATO	GIRL ON FIRE	SILVER PARACHUTE
CAVE	HAYMITCH ABERNATHY	STABBED
CLAUDIUS TEMPLESMITH	INFECTION	SYRINGE
CLOVE	KATNISS EVERDEEN	THRESH
CORNUCOPIA	KNIFE THROWING	WRESTLING
DISTRICT ELEVEN	PANEM	
DISTRICT TWELVE	PEETA MELLARK	

## Catching Fire Probability

You will interview 20 people. Ask them what district they would want to live in, and who their favorite character is.

Name	District	Character

Then write 10 probability questions that can be solved based on someone reading the results of your survey. Include an answer key.

## How many entries are in the District 12 reaping?

Basic assumptions: 8000 residents in Panem and 30% of the population is under the age of 18

Therefore 2400 children and 931 would be age 12-18

About 133 would be in each age category: 68 boys, 65 girls (slightly more boys are born than girls in the general population)

Assume 75% the children (all of the Seam, none of the Merchant class) are from tesserae taking families and an average tesserae family size of 4

Assume that the eldest child will take the tesserae for their family and that 40% of the children are the oldest in their family still under age 18.

### EXAMPLES

#### 12 Year Old Boys

17 Merchant Children (No Tesserae; +1 Age Entry): 17 Entries

20 Seam Children- Oldest Sibling (+4 Tesserae; +1 Age Entry): 100 Entries

31 Seam Children- Younger Sibling (No Tesserae; +1 Age Entry): 31 Entries

**Total (12-13) Entries: 148**

#### 12 Year Old Girls

16 Merchant Children (No Tesserae; +1 Age Entry): 16 Entries

20 Seam Children- Oldest Sibling (+4 Tesserae; +1 Age Entry): 100 Entries

29 Seam Children- Younger Sibling (No Tesserae; +1 Age Entry): 29 Entries

**Total (12-13) Entries: 145**

## BOYS

Age	Boys	Name slips	Age Name Slips	Additional Tessarae Slips	Total Slips	Percent chance of being drawn
12	68	1	68	80	148	3.6%
13	68	2	136	160	296	7.1%
14	68	3	204	240	444	10.7%
15	68	4	272	320	592	14.3%
16	68	5	340	400	740	17.9%
17	68	6	408	480	888	21.4%
18	68	7	476	560	1036	25.0%
Total					4144	

## GIRLS

Age	Girls	Name slips	Age Name Slips	Additional Tessarae Slips	Total Slips	Percent chance of being drawn
12	65	1	65	80	145	3.6%
13	65	2	130	160	290	7.1%
14	65	3	195	240	435	10.7%
15	65	4	260	320	580	14.3%
16	65	5	325	400	725	17.9%
17	65	6	390	480	870	21.4%
18	65	7	455	560	1015	25.0%
Total					4060	

What is the probability a brother age 14 and a sister age 12 (living in a 4 person family with mom and dad in the Seam) are both chosen the same year?

Based on your answer it would occur about once every \_\_\_\_ years.

## ***FUTURE MATERIALS***

Katniss – 1 out of 24 players = 4.16% chance of winning

District 12 has 1.35% of the district winners

Males are 5.2% likelier to live

$.052/1.35 = .04$  female disadvantage

$1.35 - 0.04 = 1.31\%$  that Katniss will win

Since  $1.31x=100$   $x=76$

It is as if there are 76 players in the games.

### **Simple event design**

### **Independent event design**

### **Dependent event design**

### **Design a map of the arena, cornucopia, % probability of living in certain areas**

**20% forest, 30% desert, 10% water, etc.**

Design a target with certain percentages in each section

What is safe to eat in the wild

### **Construct a tourist brochure for District 12, the Capitol, or the Arena**

Your objective is to encourage people to visit this place. Be as accurate as possible (though you may add details that may not have been disclosed in the novel, as long as it doesn't take away from the facts in the story). Make sure to include:

- illustrations that accurately depict what this location looks like
- description of what the location is like
- reasons why people should choose your location as a travel destination

### **Compare/Contrast 74<sup>th</sup> and 75<sup>th</sup> Hunger Games**

Include arenas, tributes, opening ceremonies, and outcomes. Presentation should be in the form of a power point or some other presentation tool.

### **Interview Tributes**

The tributes have been selected and it's now time to interview them. You are a news anchor on E News and you must come up with questions that your audience will want to know about the Tributes. Come up with 7-10 questions and provide answers that would match the voice of the tribute. Any of the tributes can be used in this activity, but it might be easier to use Katniss, Peeta, Finnick, Mags, Beetee, Johanna, Gloss, Cashmere. Make sure to be creative with your questions and use the proper voice to answer the questions. This can be in the form of a video, or it can be done live.

### **Arena Map**

Create a map of the Arena for the 75<sup>th</sup> Hunger Games. This map should be three dimensional or it could be done on the computer. Make sure you label all the areas, geographical features, location of tribute deaths, and the cornucopia.

An arena is a large, enclosed, outdoor area where the Hunger Games are held each year. Arenas are designed by the Gamemakers and a new one is built every year. It could be a dense forest or a freezing wasteland. The Gamemakers plant traps and cunning ideas into the arena, to entertain the people of Panem. All arenas have a Cornucopia, where the tributes launch into the arena to begin the Games. Also all the arenas have force fields around the arenas that bounces back anything that hits it. Over the years a few tributes have used it as a weapon. The arenas were considered important historical landmarks, and were preserved after the conclusion of the Games. The arenas were also a popular tourist destination for many Capitol citizens, who would spend a month's vacation visiting the arena from their favorite games, where they would be able to rewatch the Games, visit the sites of the deaths and even take part in reenactments. After the end of the war, all the arenas were destroyed, and memorials to the hundreds of teenagers killed within their confines were constructed in their place.

### **50th Hunger Games**

The 50th Hunger Games' arena was spectacular. It had a big, beautiful meadow, with flowers, streams, pools, birds and a picturesque mountain and sharp, jagged rocks. But everything was lethal. The tributes of these Games had to face harmless-looking squirrels which were in fact carnivorous; the picturesque mountain that was actually a volcano; flowers that squirted poison into their faces; pink birds with skewer-like beaks that killed Maysilee Donner, and dehydration, due to the fact that the only sources of water that weren't toxic were from the bounty at the Cornucopia or rainfall. Haymitch Abernathy used the force field around the arena to stay alive and win the second Quarter Quell. When only he and the female tribute from District 1 were left, she threw an axe at him but hit the forcefield instead, causing it to bounce back and hit her in the head. This made Haymitch the victor.

### **70th Hunger Games**

The 70th Hunger Games' arena included a dam that was broken during the games by an earthquake to wipe out many of the tributes. The arena was flooded because the Gamemakers believed that the Games were getting too "boring". Most of the tributes drowned, but Annie Cresta, the strongest swimmer, survived and won the Hunger Games. It is unknown whether the dam was broken in part by the Gamemakers to liven things up, or if it was a occurrence caused by a natural earthquake outside of the arena.

### **74th Hunger Games**

The 74th Hunger Games' arena was a large expanse of various terrains. In the center, around the Cornucopia where the tributes launch was a plain of hard packed dirt. In one direction, there was a wheat field, which was not visible from the Cornucopia, there was a steep downward slope and this area was a lot lower down than the rest of the arena; Thresh was hiding out in this part of the arena; the only time he left it was to go to the feast. In another direction there was a large lake, the Careers set up camp next to this and it was their main source of water.

In the other two directions there was a wood which makes up most of the arena, this is where Katniss Everdeen and most of the other tributes set up camp. This wood contained a stream that lead to the lake, several ponds, a variety of different trees, a marshy area, and a rocky area with numerous caves that was next to the stream. Several mutations such as tracker jackers and mockingjays in addition to natural animals such as rabbits, squirrels, deer and groosling, and water birds inhabited the arena. The stream was evaporated by the high daytime temperatures, as Katniss later describes a flat expanse of dry mud as what used to be the stream. The wood was also rigged with Gamemaker traps such as devices that create fireballs. The Gamemakers changed the temperatures in the arena so that it was hot during the day and freezing during the night, this was another annoyance the Gamemakers created.

In the movie, the arena is mostly wooded forest, with mountainous higher areas to the south flat plains to the west. A single large river runs through the east of the arena that feeds the large lake by the Cornucopia.

### **75th Hunger Games**

The 75th Hunger Games' arena was set up like a clock. The 12 to 1 wedge consisted of the tall tree that was periodically struck by lightning during the 12th hour, which proved to be a very important factor later on in the novel. The other sections of the "clock" each had a tall tree identical to the 12 to 1 tree to throw tributes off, and were made up of different "horrors" that were unleashed by the hour. The horrors consisted of an acid fog, blood rain, an unknown beast, a tidal wave, carnivorous monkeys, jabberjays that repeat the sounds of loved ones screaming in terror, unknown species of insects that emit loud clicking noises, and more which are not mentioned.

This arena was very small, and circular in shape, which tipped Wiress off to the set-up of the clock mechanism. A powerful force-field surrounded it, and the Cornucopia lied in the middle of the arena, its tail pointing in the direction of the 12th hour, and was surrounded by water and spokes that held the tributes as they are first raised into the arena. The trees contained in the arena were full of the only water that can be consumed safely, which had to be extracted by a spile, or by hacking at the bark.

Hour 1-2: Blood Rain

Hour 2-3: Poisonous Fog

Hour 3-4: Monkey Muttations

Hour 4-5: Jabberjays (who imitate screams of tributes' loved ones)

Hour 5-6: Unknown

Hour 6-7: The Beast (assumed to be some sort of mutation jungle cat)

Hour 7-8: Unknown

Hour 8-9: Unknown

Hour 9-10: Unknown

Hour 10-11: Saltwater Tsunami

Hour 11-12: Carnivorous Insects (assumed)

Hour 12-1: Electric Storm (A lightning bolt strikes a tree during this hour)