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

Created by Lance Mangham, 6th grade teacher, Carroll ISD

Activity 13-1: **Probability Introduction** Name:

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

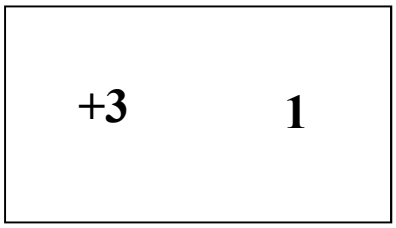
Use the table above to answer the following questions. Write probabilities as simplified fractions.
For #1-10, you choose one of the 24 contestants at random.

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.	

The Hunger Games 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 5x3=15.

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. 426-435

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%). **Calculator**
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) **Calculator**
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. **Calculator**
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)? **Calculator**
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.

See the end of this unit for cards to hand out for the initial project.

Activity 13-4: **Probability Vocabulary** Name:

Determine something has a probability of…

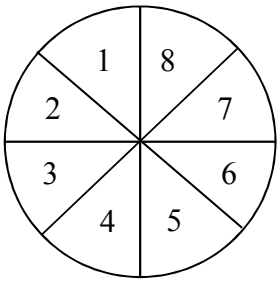
0%	
10%	
25%	
50%	
75%	
100%	

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

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

Example #1: On the spinner there are eight equally likely outcomes. Find the probability of spinning a number less than 3.



$P(\text{less than } 3) = \frac{2}{8}$ or $\frac{1}{4}$

Example #2: Find $P(\text{greater than } 10)$. $P(\text{greater than } 10) = \frac{0}{8}$ or 0

Example #3: Find $P(\text{less than } 9)$. $P(\text{less than } 9) = \frac{8}{8}$ or 1

Activity 13-5: **Basic Probability** Name:

HUNGER GAMES COMPETITION

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

	Tributes remaining		Tributes remaining		Tributes remaining
Start	24	**Day 6**	10	**Day 12**	5
End of Day 1	13	**Day 7**	10	**Day 13**	5
Day 2	12	**Day 8**	8	**Day 14**	4
Day 3	12	**Day 9**	6	**Day 15**	3
Day 4	12	**Day 10**	6	**Day 16**	3
Day 5	10	**Day 11**	6	**Day 17**	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.	***Why does Katniss' probability become greater as she gets farther into the Hunger Games?***		

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.

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

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?	

Activity 13-7: **Theoretical vs. Experimental Probability** Name:

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 the next day. After the first day a tributes chance of advancing any given day rises to about 85-90%.

Day 1: Roll two die. If you roll a 8, 9, 10, 11, or 12 the tribute is eliminated.
After day 1: Roll two dice. If you roll a 3, 11, or 12 the tribute is eliminated. If the final tributes are eliminated on the same day, re-roll for that day.

Simulate the 12 person Celebrity Hunger Games five times. In each column record the day the tribute was eliminated.

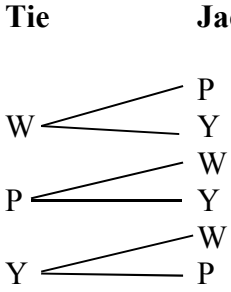
Player	1st Simulation	2nd Simulation	3rd Simulation	4th Simulation	5th Simulation
Lady Gaga					
Justin Bieber					
Selena Gomez					
Harry Potter					
Kermit the Frog					
Luke Skywalker					
Tony Romo					
Michael Jordan					
Shrek					
Mrs. Buckmaster					
Taylor Swift					
Katniss Everdeen					
WINNER					

1.	What was the theoretical probability Taylor Swift would win?	
2.	What was the experimental probability Taylor Swift would win?	
3.	What was the theoretical probability Kermit the Frog would not win?	
4.	What was the experimental probability Kermit the Frog would not win?	
5.	What was the theoretical probability a male (human) would win?	
6.	What was the experimental probability a male (human) would win?	
7.	Why are theoretical and experimental probabilities not necessarily the same?	

Activity 13-8: **Tree Diagrams** Name:

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?



There are 6 possible outcomes.

Create a tree diagram with titles, create a list of the outcomes possible, and 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. 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 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?

Activity 13-9: **Tree Diagrams and Outcomes** Name: _____

Create a tree diagram with titles, create a list of the outcomes possible, and give the total number of outcomes.

1. Katniss has 3 bows to choose from: bronze, silver, and gold. She also has 3 arrows: sharp, pointy, and dull. How many different combinations can she make?

2. Katniss Everdeen is in the Hunger Games and needs to choose an ally and a bow. She's decided either Peeta, Rue, Foxface, or Thresh will be her ally. She will use either a longbow, crossbow, or a recurve bow. How many different combinations can she make?

3. Katniss and Peeta are at the training center for the Hunger Games. They can visit archery, knot tying, or camouflage before lunch break. Afterwards, they can go to spear throwing, knife throwing, or weight lifting. How many different ways can they visit the stations?

4. Katniss has to choose between marigolds, zinnias, roses, and tulips to adorn Rue. She also has to choose if she wants red, white, black, or gold. If she chooses zinnias she can't choose black or gold. She can't choose roses with gold. How many choices does she have?

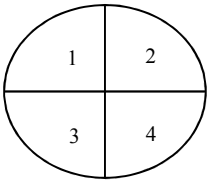
5. In the Hunger Games Katniss has 3 possible sponsors: a rich man, a Capitol woman, or anonymous. They can buy either a knife, a lamp, bread, or an exploding pineapple. What is the probability Katniss' first gift is an exploding pineapple given from an anonymous person?

6. Peeta Mellark has three different types of icing that are chocolate, cream cheese, and butter crème. He needs cake batter to go with the icing. His choices are red velvet, birthday cake, and strawberry. How many possible icing-batter outcomes are there?

7. If a coin is tossed three times to help determine which animal to unleash in the arena, which lists all the possible outcomes?

A. HT, TH, HH, TT
B. HHT, HTH, HTT, THH, THT, TTH
C. HHH, TTT, HHT, HTT
D. HHH, HHT, HTH, HTT, THH, THT, TTH, TTT

8. Cinna spins the spinner below to choose which dress for Katniss to wear. He will then flip a coin to determine which pair of shoes to go with it.



Which shows all the possible outcomes that could result?

A.

Spinner	1	2	3	4	1	2	3	4
Coin	H	T	H	T	H	T	H	T

B.

Spinner	1	2	3	4
Coin	H	T	H	T

C.

Spinner	1	2	3	4	1	2	3	4
Coin	H	H	H	H	T	T	T	T

D.

Spinner	1	2	3	4	1	2	3	4
Coin	H	H	T	T	H	H	T	T

Activity 13-10: **The Counting Principle** Name:

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

> If event M can occur in *m* ways and is followed by event N that can occur in *n* ways, then the event M followed by N can occur in $m \bullet n$ 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: $11 \bullet 3 \bullet 4 = 132$ 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?	

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

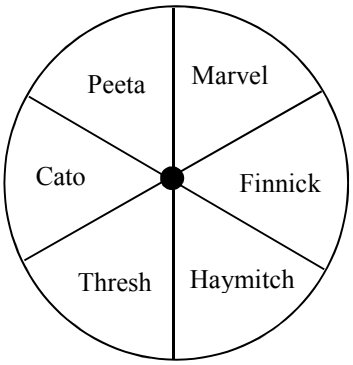
5.	Mrs. Everdeen choosing a paint color from among 6 color choices, and choosing a wallpaper pattern from among 5 choices	
6.	Clove flipping a penny, a nickel, and a dime	
7.	Marvel choosing the last three digits in a five-digit zip code if the first digit is 6, the second digit is 1, and no digit is 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?	

Activity 13-11: **Independent Events** Name:

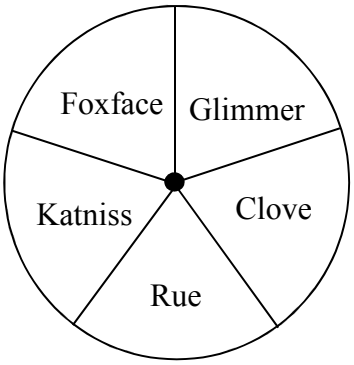
HUNGER GAMES INDEPENDENT EVENTS

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. $P(A, B) = P(A) \bullet P(B)$

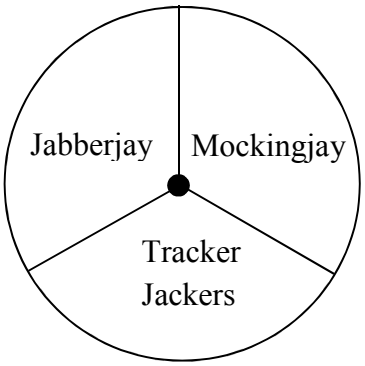
BOYS



GIRLS



ANIMALS



1.	How many possible 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 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 4th spinner was added above, would the probabilities of the four events happening increase or decrease? Why?	

Created by Lance Mangham, 6th grade teacher, Carroll ISD

Activity 13-12: **Independent Events** Name: _____

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 "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(black, white)		26.	P(black, striped)	
27.	P(white, striped)		28.	P(not white, striped)	
29.	P(black, black)		30.	P(striped, striped)	
31.	P(white, not white)		32.	P(not white, not white)	

Activity 13-13: **Independent and Dependent Events** Name:

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.

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

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?**

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

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

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' 12th graders missed this TAKS 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. BOX A 5 dinner certificates 4 DVD certificates 3 movie certificates 5 T-shirts certificates BOX B 4 CD certificates 3 camera certificates 5 amusement certificates 5 TV certificates What is the probability that the first winner will randomly select a DVD certificate and an amusement certificate? A. $\frac{20}{289}$ B. $\frac{9}{17}$ C. $\frac{9}{289}$ D. $\frac{1}{19}$

Activity 13-14: **Independent and Dependent Events** Name:

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) = ?		22.	P(A) = 0.31 P(B given A) = 0.8 P(A and B) = ?	
20.	P(A) = 0.3 P(B) = ? P (A and B) = 0.27		23.	P(A) = 0.7 P(B given A) = ? P (A and B) = 0.7	
21.	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	

Activity 13-15: **Permutations** Name:

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

Total number of people	**People picked to put in order**	**Written mathematically** ${}_nP_r$	**Number of ways to order them**	**How to solve mathematically**
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?	

Activity 13-16: **Permutations and Factorials** Name:

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

Example: Prizes – 3rd place: a Gale doll, 2nd place: a Rue doll, and 1st 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 $7 \bullet 6 \bullet 5 = 210$ possible ways.

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

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

${}_nP_r = n \bullet (n-1) \bullet (n-2) \bullet \ldots \bullet (n-r+1)$

${}_4P_4$ would be calculated by: ${}_4P_4 = 4 \bullet 3 \bullet 2 \bullet 1 = 24$. 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.	

Activity 13-17: **Combinations** Name:

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

Total number of people	**People picked**	**Written mathematically** ${}_nC_r$	**Number of ways to pick them**	**How to solve mathematically**
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?	

Activity 13-18: **Combinations** Name:

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!.

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

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

$$_{\text{n}}\text{C}_{\text{r}} = \frac{_{\text{n}}P_r}{\text{r!}}$$

Find each value.

1.	${}_4C_2$		2.	${}_5C_3$		3.	${}_6C_2$	
4.	${}_8C_3$		5.	${}_6C_4$		6.	${}_7C_7$	
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.	

Activity 13-19: **Permutations and Combinations** Name:

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?		

Activity 13-20: **Odds** Name:

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 (nearest thousandth), 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 (taking place in May)
  The Stock Market (being added next year)
  Design the Zoo of the Future (being added next year)

- 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?

74TH ANNUAL HUNGER GAMES FACTS

District 1 – Luxury
Male: Marvel – Spear
Female: Glimmer – Unknown

District 2 – Masonry
Male: Cato – Sword, Machete
Female: Clove – Throwing Knives

District 5 – Power
Female: Foxface – Stealth

District 11 – Agriculture
Male: Thresh – Rock
Female: Rue – Slingshot

District 12 – Mining
Female: Katniss – Bow/Arrow
Male: Peeta – Spear/Camouflage

HUNGER GAMES DISTRICT GROUPS

Food Supply Districts
District 4 – Fishing
District 9 – Grain
District 10 – Livestock
District 11 – Agriculture

Special Skills Districts
District 2 – Masonry
District 8 – Textiles

Limited Resource Districts
District 7 – Lumber
District 12 – Mining

Extra Benefits Districts
District 1 – Luxury
District 3 – Technology
District 5 – Power
District 6 – Transportation

Created by Lance Mangham, 6th grade teacher, Carroll ISD

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

Created by Lance Mangham, 6th grade teacher, Carroll ISD

+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		

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 tessarae taking families and an average tessarae family size of 4

Assume that the eldest child will take the tessarae 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

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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.

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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

75th Annual Hunger Games

District	Female Tribute	Male Tribute
District 1	Cashmere	Gloss
District 2	Enobaria	Brutus
District 3	Wiress	Beetee
District 4	Mags	Finnick Odair
District 5	Unnamed Tribute	Unnamed Tribute
District 6	"Female Morphling"	"Male Morphling"
District 7	Johanna Mason	Blight
District 8	Cecelia	Woof
District 9	Unnamed Tribute	Unnamed Tribute
District 10	Unnamed Tribute	Unnamed Tribute
District 11	Seeder	Chaff
District 12	Katniss Everdeen	Peeta Mellark

Activity: **Roulette Wheel Probability** Name:

Roulette Wheel – 50 spaces

Space	Number on wheel	Money won	Space	Number on wheel	Money won
1	22	$3,000	Flag	1	$50,000
2	14	$4,500	Joker	1	$50,000
5	7	$9,000	Not a 1	28	$2,300
10	3	$20,000	Not a Flag or a Joker	48	$1,400
20	2	$30,000			

Spin #	My bet	Actual spin	Money won	Total $
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

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