**PROBABILITY PROJECT #4 – COUNTING**

**NAME:**

**CLASS:**

**DATE**: June 8, 2019

**PART A** **– COUNTING BASICS – THE FUNDAMENTAL PRINCIPLE OF COUNTING AND FACTORIALS**

A1 Counting with respect to probability is not just 1, 2, 3, . . . It is a little more complicated than that and it can be tricky. Search the web using key words “fundamental principle of counting”. Define the principle in your own words.

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Website URL(s):

How does your definition compare with mine, “To determine the total number of ways an event can happen, multiply the number of ways the sub-events can happen.”?

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Luckily the fundamental principle of counting is easier to use than to define.

A2 Examples. Let’s say you are going on a weekend trip and bring 3 tops (tank top, short sleeve shirt, and long sleeve shirt) and 2 bottoms (skirt and shorts). Assuming you wear one top and one bottom, how many outfits could you assemble?

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If your answer is not 6, rethink the problem.



Let’s say you take your 4-year-old niece to Baskin Robbins. You tell them they can have 1 scoop of ice cream and 1 topping on any cone they want.

How many types of ice cream are there?

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What is your favorite ice cream?

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How many types of toppings are there? (okay to approximate)

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What is your favorite topping?

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How many types of cones are there? (okay to approximate)

>

What is your favorite cone?

>

Now, how many choices does your niece have?

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It’s an overwhelming decision if you don’t have your favorites going in.

A3 Factorials. A factorial is a mathematical operation represented by the exclamation point “!”. When you see 3! in a mathematical context, it doesn’t mean to shout 3, rather it means 3 factorial.

5! = 5\*4\*3\*2\*1 = 120

4! = 4\*3\*2\*1 = 24

3! = 3\*2\*1 = 6

2! = 2\*1 = 2

1! =1

Go to <https://www.mathsisfun.com/numbers/factorial.html> and review.

What is the rule for n!

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What is 0! and why?

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A4 Factorial Practice. Calculate the following showing all work and simplifying as much as possible.

|  |  |
| --- | --- |
|  |  |
|  |  |

A5 Factorial Example. Let’s say you are at a horse race with 8 horses. How many ways could the horses finish? Using the fundamental principle of counting, there would be 8 horses that could finish 1st, then 7 horses that could finish 2nd, then 6 horses that could finish 3rd, etc. Represent the number of ways that the horses could finish using factorial notation and simplify.

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**PART B – PERMUTATIONS (ORDER MATTERS!)**

B1 Permutations are often used to count the number of ways an event can occur when order matters. Key words include rank, race and position. Go to <https://www.mathplanet.com/education/algebra-2/discrete-mathematics-and-probability/permutations-and-combinations> and review. What is the formula for the number of permutations of n objects taken r at a time?

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Note that you can write P(n,r) as nPr which you will see on many calculators.

B2 Permutation Practice. Calculate the following showing all work and simplifying as much as possible.

|  |  |
| --- | --- |
| P(6,2) | P(5,5) |
| 3P2 | 4P4 |

B3 Permutation Practice. In horse racing, there is a wager called a “trifecta” where you bet on the first 3 horses. In an 8-horse race, this can be calculated using the permutation P(8,3). Calculate that showing your work.

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In practice, we often do not use the formula for permutations, rather we use the Fundamental Principle of Counting and think of the three places. There are 8 horses that could finish 1st, then 7 horses that could finish 2nd, then 6 horses that could finish 3rd. Thus, we would calculate 8\*7\*6 = 336. Explain mathematically why this approach gives the same answer as using the formula.

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B4 An “exacta” is similar to a trifecta but for only the top 2 horses. In a 12-horse race, calculate the number of ways the top 2 horses could finish using the formula and the Fundamental Principle of Counting.

Formula:

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Fundamental Principle of Counting:

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Which method do you prefer and why?

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**PART C – COMBINATIONS (ORDER DOES NOT MATTER!)**

C1 Combinations are often used to count the number of ways an event can occur when order does not matter. Key words choose and committee. Go back to <https://www.mathplanet.com/education/algebra-2/discrete-mathematics-and-probability/permutations-and-combinations> and review. What is the formula for the number of combinations of n objects taken r at a time?

>

Note that you can write C(n,r) as or nC r which you will see on many calculators.

C2 Combination Practice. Calculate the following showing all work and simplifying as much as possible.

|  |  |
| --- | --- |
| C(6,2) | C(5,5) |
| 3C2 | 4C0 |
|  |  |

C3 Combination Practice. In horse racing, a “quinella” is similar to an exacta but order doesn’t matter. You pick the top two horses and they could finish in any order. In a 12-horse race, calculate the number of ways the top 2 horses could finish using the formula.

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C4 Based on what you saw in C3 and B4 above, which is larger: P(n,r) or C(n,r)? Explain.

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**PART D – PUTTING IT INTO CONTEXT**

D1 Mrs. Moss is a special education teacher in a self-contained classroom and has 7 students – 3 girls and 4 boys.

|  |  |  |
| --- | --- | --- |
| **Girls** | **Condition** | **Boys** |
| Rachel | Asperger’s | Juan |
|  | High-Functioning Autism | John |
| Maria | ADHD |  |
|  | ADD | Mohammed |
| Tamika | Conduct Disorder | Dwayne |

Research the web to find out the difference between Asperger’s and High-Functioning Autism. Explain.

>

Website URL:

Research the web to find out the difference between ADHD and ADD. Explain.

>

Website URL:

Research the web and describe what Conduct Disorder refers to?

>

Website URL:

D2 Mrs. Moss wants to line up the kids in a row. How many ways could she do this with the following restrictions. Show all work. Note that some of these are harder than they seem.

How many ways with no restrictions?

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How many ways with the Boys together?

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How many ways with the Girls together?

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How many ways with both the Boys together and the Girls together?

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How many ways if the Boys and Girls alternate?

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D3 The principal has asked Mrs. Moss to send two of her students to a district event. One will be the class representative and the other will be a backup. How many possibilities are there? Show your work.

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D4 Mrs. Moss is choosing 2 of her students to visit the other special education class. How many possibilities are there? Show your work.

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D5 If Mrs. Moss picks 3 students to form a group, how many ways are there to have 1 student with Conduct Disorder in the group?

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D6 If Mrs. Moss picks 4 students to form a group, how many ways are there to have 2 students with ADHD or ADD in the group?

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D7 If Mrs. Moss picks 3 students to form a group, how many ways are there to have at least 2 students with some form of ASD in the group?

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D8 If Mrs. Moss picks 5 students to form a group, how many ways are there to have no students with ASD in the group?

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D9 Save this Word document as firstname.lastname.counting and email to me.