

Names: _____

M and Ms Probability Lab

Student Learning Outcomes:

- The student will calculate theoretical and empirical probabilities.
- The student will appraise the differences between the two types of probabilities.
- The student will demonstrate an understanding of long-term probabilities.

Theoretical Table

Color	Quantity
Yellow Y	
Green G	
Blue BL	
Brown B	
Orange O	
Red R	

Empirical Table

With Replacement Table	Without Replacement Table
(,) (,)	(,) (,)
(,) (,)	(,) (,)
(,) (,)	(,) (,)
(,) (,)	(,) (,)
(,) (,)	(,) (,)
(,) (,)	(,) (,)
(,) (,)	(,) (,)
(,) (,)	(,) (,)
(,) (,)	(,) (,)
(,) (,)	(,) (,)
(,) (,)	(,) (,)
(,) (,)	(,) (,)
(,) (,)	(,) (,)
(,) (,)	(,) (,)
(,) (,)	(,) (,)

Directions:

- Count out 40 mixed-color M&M's[®]
- **Record the number of each color in the Theoretical Table.** Use the information from this table to complete the theoretical probability questions after you have done the experiment (explained in the steps below).
- Next, put the M&M's in a cup.
- The experiment is to pick 2 M&M's, one at a time. Do NOT look at them as you pick them.
- The first time through, replace the first M&M before picking the second one. Record the results in the **“With Replacement”** column of the **empirical table**. Do this 24 times.
- The second time through, after picking the first M&M, do NOT replace it before picking the second one. Then, pick the second one. Record the results in the **“Without Replacement”** column section of the **empirical table**. After you record the pick, put BOTH M&M's back. Do this a total of 24 times.
- Use the data from the empirical table to calculate the empirical probability questions. **Leave your answers in unreduced fractional form. Do NOT multiply out any fractions.**

Probability Trees: Create two trees from the Theoretical Table. One tree is a “With Replacement” tree and the other is a “Without Replacement” tree. Use the trees to fill in the Theoretical Probabilities. **Hint:** On the first pick for each tree, you have 6 colors to choose from. Hand in your trees stapled to the rest of the lab.

Theoretical Probabilities: Use the Theoretical Table to calculate the following:

	With replacement	Without replacement
P(2 reds):		
P(R₁B₂ or B₁R₂):		
P(R₁ and G₂):		
P(G₂ R₁):		
P(no yellows):		
P(doubles):		
P(no doubles):		

Note: G₂ = green on second pick; R₁ = red on first pick; doubles = both picks are the same color. B₁ = brown on first pick; B₂ = brown on second pick.

Formulas: C and D are events.

- Multiplication Rule: $P(C \text{ AND } D) = P(C) \cdot P(D | C)$.
If C and D are independent events, then $P(C \text{ AND } D) = P(C) \cdot P(D)$. Using algebra, $P(D | C) = P(C \text{ AND } D) \div P(C)$.
- Addition Rule: $P(C \text{ OR } D) = P(C) + P(D) - P(C \text{ AND } D)$.
If C and D are mutually exclusive events, then $P(C \text{ OR } D) = P(C) + P(D)$.
- C' and C are complementary events. $P(C) + P(C') = 1$.

Empirical Probabilities: Use the Theoretical Table to calculate the following:

	With replacement	Without replacement
P(2 reds):		
P(R_1B_2 or B_1R_2):		
P(R_1 and G_2):		
P(G_2 R_1):		
P(no yellows):		
P(doubles):		
P(no doubles):		

Note: G_2 = green on second pick; R_1 = red on first pick; doubles = both picks are the same color. B_1 = brown on first pick; B_2 = brown on second pick.

Questions (ANSWER IN COMPLETE SENTENCES AND WRITE OR PRINT CLEARLY):

1. Why are the “With Replacement” and “Without Replacement” probabilities different?
2. If you increased the number of times you picked 2 M&M’s to 240 times, why would empirical probability values change? (Read #3 before you answer this question. They are different questions).
3. Would this change (See #2 above) cause the empirical probabilities and theoretical probabilities to be closer together or farther apart? How do you know?
4. Explain the differences in what $P(R_1 \text{ and } G_2)$ and $P(G_2 | R_1)$ represent. **Hint:** Think about the sample space for each probability.