

## 10.7: Probability Topics (Worksheet)

Name: \_\_\_\_\_

Section: \_\_\_\_\_

Student ID#: \_\_\_\_\_

*Work in groups on these problems. You should try to answer the questions without referring to your textbook. If you get stuck, try asking another group for help.*

### Student Learning Outcomes

- The student will use theoretical and empirical methods to estimate probabilities.
- The student will appraise the differences between the two estimates.
- The student will demonstrate an understanding of long-term relative frequencies.

### Do the Experiment

Count out 40 mixed-color M&Ms® which is approximately one small bag's worth. Record the number of each color in [Table](#). Use the information from this table to complete [Table](#). Next, put the M&Ms in a cup. The experiment is to pick two M&Ms, 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 [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 [Table](#). After you record the pick, put **both** M&Ms back. Do this a total of 24 times, also. Use the data from [Table](#) to calculate the empirical probability questions. Leave your answers in unreduced fractional form. Do **not** multiply out any fractions.

Population

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

Theoretical Probabilities

	With Replacement	Without Replacement
$P(2 \text{ reds})$		
$P(R_1 B_2 \text{ OR } B_1 R_2)$		
$P(R_1 \text{ AND } G_2)$		
$P(G_2   R_1)$		
$P(\text{no yellows})$		
$P(\text{doubles})$		
$P(\text{no doubles})$		

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

### Empirical Results

With Replacement	Without Replacement
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )
( __ , __ ) ( __ , __ )	( __ , __ ) ( __ , __ )

### Empirical Probabilities

With Replacement	Without Replacement
$P(2 \text{ reds})$	
$P(R_1 B_2 \text{ OR } B_1 R_2)$	
$P(R_1 \text{ AND } G_2)$	
$P(G_2   R_1)$	
$P(\text{no yellows})$	
$P(\text{doubles})$	
$P(\text{no doubles})$	

### Discussion Questions

- Why are the “With Replacement” and “Without Replacement” probabilities different?
- Convert  $P(\text{no yellows})$  to decimal format for both Theoretical “With Replacement” and for Empirical “With Replacement”. Round to four decimal places.
  - Theoretical “With Replacement”:  $P(\text{no yellows}) = \underline{\hspace{2cm}}$
  - Empirical “With Replacement”:  $P(\text{no yellows}) = \underline{\hspace{2cm}}$
  - Are the decimal values “close”? Did you expect them to be closer together or farther apart? Why?
- If you increased the number of times you picked two M&Ms to 240 times, why would empirical probability values change?
- Would this change (see part 3) cause the empirical probabilities and theoretical probabilities to be closer together or farther apart? How do you know?
- Explain the differences in what  $P(G_1 \text{ AND } R_2)$  and  $P(R_1 | G_2)$  represent. Hint: Think about the sample space for each probability.

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