4.2: Theoretical Probability - SOLUTIONS

Group Activity

Coin Toss. In the video we looked at the theoretical probabilities for flipping a quarter, dime and nickel. Now we will do a class experiment to find empirical probabilities.

1. Empirical Probability . Get a quarter, nickel and dime for your group. Take turns tossing them for a total of 10 trials. Record H or T for each coin in each trial.

Trial	1	2	3	4	5	6	7	8	9	10
Quarter										
Nickel										
Dime										

2. From your 10 trials, count the number of times you got 0 heads, 1 head, 2 heads and 3 heads. Write the number in each column. They should add up to 10 trials.

Number of Heads	0	1	2	3
Group Count				

3. Combining the Class Data. Record your totals on the class sheet on the document camera. Once all the data is added, write the totals in the next table. Number of trials____

Number of Heads	0	1	2	3
Total Class Count				

4. Empirical Probability Model. Using the class totals, calculate the empirical probability of each outcome.

Number of Heads	0	1	2	3
Empirical Probability				

5. Compare these numbers to the theoretical outcomes on your notes. How do they compare?

6. What would you expect if we repeated this experiment for 1000 trials?
We would expect the empirical probabilities to be close to the theoretical probabilities. The more trials we do, the closer they should get.

Theoretical Probability

7. Using the prize wheel below, make a theoretical probability model and then use it to find the probabilities below.

	Sub	Drink	Cookies	Chips	BOGO	Mystery Prize
Probability	$\frac{2}{13}$	$\frac{2}{13}$	$\frac{2}{13}$	$\frac{4}{13}$	$\frac{2}{13}$	$\frac{1}{13}$

8. If you spin the wheel once, what's the probability that you get

a. chips or a drink?

$$P(\text{chips or drink}) = \frac{4}{13} + \frac{2}{13} = \frac{6}{13}$$

b. not the mystery prize?

$$P(\text{not mystery}) = 1 - P(\text{mystery}) = 1 - \frac{1}{13} = \frac{12}{13}$$

c. a drink or not BOGO?

$$P(\text{drink or not BOGO}) = \frac{2}{13} + \frac{9}{13} = \frac{11}{13}$$

Be careful not to double count the drinks!

9. Find the following odds:

a. The odds of winning the mystery prize.

The odds of winning the mystery prize are 1:12

b. The odds against winning the mystery prize.

The odds against winning the mystery prize are 12:1

c. The odds on winning a sandwich.

The odds against winning a sandwich are 11:2

10. If you get to spin the wheel repeatedly, would that be like drawing with or without replacement? **With replacement because the wheel is the same every time. That makes the spins independent.**

a. If you get to spin 3 times, what is the chance you would get 3 bags of chips?

$$P(\text{chips and chips and chips}) = \frac{4}{13} \cdot \frac{4}{13} \cdot \frac{4}{13} = \frac{64}{2197}$$

b. If you get to spin twice, what is the chance you will get two BOGO's?

$$P(\text{BOGO and BOGO}) = \frac{2}{13} \cdot \frac{2}{13} = \frac{4}{169}$$

11. The t-shirts for your school group just arrived: 5 red small, 5 orange small, 10 red medium, 10 orange medium, 15 red large, 15 orange large, 10 red extra large, 10 orange extra large.

If you grab one t-shirt at random, what is the probability that

a. it is a small or an extra large

Disjoint

$$P(\text{small or xlarge}) = \frac{10}{80} + \frac{20}{80} = \frac{30}{80} = \frac{3}{8}$$

b. it is extra large or orange?

Overlapping

$$P(\text{xlarge or orange}) = \frac{20}{80} + \frac{30}{80} = \frac{50}{80} = \frac{5}{8}$$

Be careful not to double count orange XL's

c. it is not small or medium?

Disjoint

$$P\left(\text{not}\left(\text{small or medium}\right)\right)$$
$$= 1 - \frac{30}{80} = \frac{50}{80} = \frac{5}{8}$$

d. it is not small or red? (not small & not red)

Overlapping

$$P\left(\text{not}\left(\text{small or red}\right)\right) = \frac{35}{80}$$

Be careful not to double count

12. If five people come up and you draw 5 shirts at random, what is the probability that

a. they are all red larges? **Drawing without replacement**

$$\frac{15}{80} \cdot \frac{14}{79} \cdot \frac{13}{78} \cdot \frac{12}{77} \cdot \frac{11}{76} = \frac{3}{24,016} \approx 0.00013$$

b. there is at least one orange extra large? **At least one is the complement of none**

$$1 - P(\text{no orange XL}) = 1 - \frac{70}{80} \cdot \frac{69}{79} \cdot \frac{68}{78} \cdot \frac{67}{77} \cdot \frac{66}{76} \approx 1 - 0.5035 \approx 0.4965$$

Class Recording Sheet
Tossing a Quarter, Nickel and Dime

Number of Heads	**0**	**1**	**2**	**3**
Count for Group 1				
Count for Group 2				
Count for Group 3				
Count for Group 4				
Count for Group 5				
Count for Group 6				
Count for Group 7				
Count for Group 8				
Totals				

Use the total row to calculate the empirical probabilities