LESSON 10-6

Practice A

Theoretical Probability

Find the theoretical probability of each outcome.

1. flipping one coin and having it land tails up — 50%
2. randomly choosing a yellow marble from a bag of 3 yellow marbles and 7 blue marbles — 30%
3. rolling a 1 on a number cube — $16\frac{2}{3}\%$
4. randomly choosing the letter A from the letters in MATH — 25%
5. The probability it will rain is 10%. What is the probability it will not rain? — 90%
6. The probability of choosing a red marble from a bag is $\frac{3}{4}$. What is the probability of not choosing a red marble? — $\frac{1}{4}$
7. A spinner has red, green, and blue. The probability of spinning red is 0.2 and the probability of spinning blue is 0.3. What is the probability of spinning a green? — 0.5
8. The probability of winning first place in a contest is 5%. What is the probability of not winning first place? — 95%
9. The odds in favor of winning a contest are 1:4.
   - **a.** What is the total number of possible outcomes? — 5
   - **b.** How many ways can a person win? — 1
   - **c.** What is the probability that a person wins? — probability = $\frac{1}{5}$
10. The odds against a spinner landing on green are 7:2.
    - **a.** What is the total number of possible outcomes? — 9
    - **b.** How many ways can the spinner not land on green? — 7
    - **c.** What is the probability of the spinner not landing on green? — probability = $\frac{7}{9}$
11. The probability of choosing a green marble from a bag is $\frac{3}{5}$.
    - **a.** How many ways can green be chosen? — 3
    - **b.** How many ways can green not be chosen? — 2
    - **c.** What are the odds in favor of choosing a green marble? — odds = $\frac{3}{2}$ or 3:2
12. The table shows how many of each letter are in a bag. Find the following.
    - **a.** P(A) — $\frac{2}{5}$
    - **b.** P(not B) — $\frac{11}{15}$
    - **c.** odds in favor of C — 1:2

Letter	How Many in Bag
A	6
B	4
C	5

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LESSON 10-6

Practice B

Theoretical Probability

Find the theoretical probability of each outcome.

1. rolling a number less than 4 on a standard number cube — 50%
2. randomly choosing a day of the week and it is a weekend — $28\frac{4}{7}\%$
3. spinning red on a spinner with equal sections of red, blue, and green — $33\frac{1}{3}\%$
4. randomly choosing the letter N from the letters in NUMBER — $16\frac{2}{3}\%$
5. The probability it will snow is 60%. What is the probability it will not snow? — 40%
6. The probability of tossing two coins and having them land heads up is $\frac{1}{4}$. What is the probability the coins will not land heads up? — $\frac{3}{4}$
7. A spinner has red, green, blue, and yellow. The probability of spinning a red is 0.4, the probability of spinning a blue is 0.05 and the probability of spinning a yellow is 0.25. What is the probability of spinning a green? — 0.3
8. Miguel entered a contest offering prizes to the top 3 finishers. The probability of winning 1st is 12%, the probability of winning 2nd is 18% and probability of winning 3rd is 20%. What is the probability that Miguel will not win any prize? — 50%
9. The odds of winning a contest are 1:50. What is the probability of winning the contest? — $\frac{1}{51}$
10. The odds against a spinner landing on yellow are 3:1. What is the probability the spinner will not land on yellow? — $\frac{3}{4}$
11. The probability of a thunderstorm is 80%. What are the odds that there will be a thunderstorm? — 4:1
12. The odds of selecting a red card from a box of cards are 2:5. What is the probability of not selecting a red card from a box? — $\frac{5}{7}$

The table shows how many of each letter are in a bag. Use the table for 13–16. Find the following.

13. P(A) — 20%
14. P(B) — 16%
15. odds in favor of C — 6:19
16. odds against E — 17:8

Letter	How Many in Bag
A	5
B	4
C	6
D	2
E	8

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LESSON 10-6

Practice C

Theoretical Probability

Find the theoretical probability of each outcome.

1. selecting a month with a name containing the letter "r" — $66\frac{2}{3}\%$
2. flipping 3 coins and having any one land heads up and the other two land tails up — 37.5%
3. throwing a dart in a 3×3 yellow square that is centered inside a 6×6 blue square — 25%
4. randomly choosing the letter B from the letters in PROBABILITY — $\frac{2}{11} \approx 18.2\%$
5. The probability a computer program will work is 98.9%. What is the probability the program will not work? — 1.1%
6. A jar has green, red and blue marbles. The probability of selecting a green marble is $\frac{1}{4}$. The probability of selecting a blue marble is $\frac{1}{5}$. What is the probability of selecting a red marble? — $\frac{11}{20}$
7. The probability of winning a contest is 0.003. What is the probability of not winning the contest? — 0.997
8. The probability of winning first prize is 0.05%, second prize is 0.075%, and third prize is 0.125%. What is the probability of not winning any prize? — 99.75%
9. The odds in favor of being selected to represent the students are 4:1. What is the probability of not being selected? — 20%
10. The odds against winning a contest are 74:1. What is the probability of winning the contest? — $\frac{1}{75} \approx 1.3\%$
11. The odds in favor of a person being struck by lightning in their lifetime are 1:3000. What is the probability a person will be struck by lightning? Write the answer as a percent rounded to the nearest hundredths. — 0.03%
12. The odds against winning a lottery game are 5,245,786 to 1. What is the probability of not winning this lottery game? Write the answer as a percent rounded to the nearest millionths. — 99.999981%

The table shows how many of each colored stone are in a bag.

13. P(red or white or blue) — 64%
14. P(not yellow or red) — $50\frac{2}{3}\%$
15. odds in favor of yellow — 1:4
16. odds against white — 21:4

Color	Number
red	22
white	12
blue	14
green	12
yellow	15

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LESSON 10-6

Reteach

Theoretical Probability

When the outcomes in the sample space of an experiment have the same chance of occurring, the outcomes are **equally likely**.

$$\text{theoretical probability} = \frac{\text{number of ways the event can occur}}{\text{total number of equally likely outcomes}}$$

A bag of marbles contains 8 yellow, 2 red, and 10 green marbles. An experiment consists of selecting one marble at random from the bag. Find the theoretical probability of each outcome.

A. selecting a yellow marble

Step 1: Determine total number of outcomes.

$8 + 2 + 10 = 20$

Step 2: Determine the number of ways the event can occur.

The event occurs if a yellow marble is selected. Thus, the number of ways the event can occur is 8.

Step 3: Find theoretical probability.

$P(\text{yellow}) = \frac{8}{20} = 0.4 = 40\%$

B. selecting a red or yellow marble

Step 1: Determine total number of outcomes.

$8 + 2 + 10 = 20$

Step 2: Determine the number of ways the event can occur.

The event occurs if a red or yellow marble is chosen. Thus the number of ways the event can occur is $2 + 8 = 10$.

Step 3: Find theoretical probability.

$P(\text{red or yellow}) = \frac{10}{20} = 0.5 = 50\%$

The sum of the probabilities of an event and its complement is 100%, because the event will either happen or not happen.

Use the information above to find the probability of NOT selecting a yellow marble.

$$P(\text{yellow}) + P(\text{not yellow}) = 100\%$$
$$40\% + P(\text{not yellow}) = 100\%$$
$$-40\% \quad\quad -40\%$$
$$P(\text{not yellow}) = 60\%$$

Find the theoretical probability of each outcome.

1. rolling an odd number on a number cube — $\frac{1}{2}$
2. randomly choosing a red marble from a bag of 6 red, 6 blue and 8 green marbles — $\frac{3}{10}$
3. rolling a number less than or equal to 2 on a number cube — $\frac{1}{3}$
4. not rolling a 6 on a number cube — $\frac{5}{6}$
5. There is a 12% probability of winning a game. Find the probability of not winning the game. — 88%

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LESSON 10-6 Reteach

Theoretical Probability (continued)

Odds are another way to discuss the likelihood of an event.

Odds in favor of an event describe the likelihood the event will occur.

$$\text{odds in favor} = \frac{\text{number of ways event can happen } (a)}{\text{number of ways event can fail to happen } (b)} \text{ or } a{:}b$$

Odds against an event describe the likelihood that the event will not occur.

$$\text{odds against} = \frac{\text{number of ways event can fail to happen } (b)}{\text{number of ways event can happen } (a)} \text{ or } b{:}a$$

Convert from odds to probability:

The odds of winning a game are 3:7. What is the probability of winning the game?

Step 1: Determine the number of ways to win and not win.

If the odds of winning a game are 3:7, there are 3 ways to win and 7 ways to not win.

Step 2: Find total number of outcomes.

Add the ways to win and the ways to not win to get the total number of outcomes.

$3 + 7 = 10$

Step 3: Find the probability.

Because the ways to win equals 3, and total outcomes is 10, the probability is $\frac{3}{10}$ or 30%.

Convert from probability to odds.

The probability of winning a game is 10%. What are the odds in favor of winning the game?

Step 1: Write the probability as a fraction.

$10\% = \frac{1}{10}$

Step 2: Find the number of ways to win and not win.

The numerator is the number of ways to win: 1. The number of ways to not win is the total number of outcomes minus the number of ways to win: $10 - 1 = 9$.

Step 3: Find the odds.

The odds in favor are $\frac{1}{9}$ or 1:9.

6. The probability of a spinner landing on green is 20%. What are the odds in favor of the spinner landing on green? 1:4

7. The odds in favor of getting tickets to a concert are 4:5. What is the probability of getting the tickets? $\frac{4}{9}$

8. The odds against winning a contest are 98:1. What is the probability of not winning the contest? $\frac{98}{99}$

9. The probability of choosing a blue marble is 60%. What are the odds in favor of choosing a blue marble? 3:2

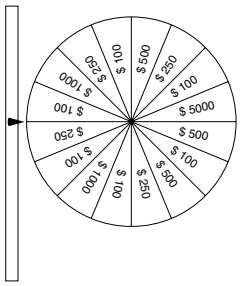
10. The odds in favor of winning a game are 1:20. What is the probability of winning the game? $\frac{1}{21}$

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LESSON 10-6 Challenge

A Probability Function

The wheel shown at right is similar to those used on game shows.
Consider a game-show function that has as its domain the dollar amounts that you could win with one spin of the wheel.



1. Write the domain of the function.

{100, 250, 500, 1000, 5000}

This game-show function will assign a number to the probability of landing on each dollar amount. For example, since 6 out of 16 spins are labeled with $100, the theoretical probability of landing on a space marked with $100 is $\frac{6}{16}$ or $\frac{3}{8}$. Thus, $P(100) = \frac{3}{8}$.

Complete each of the following.

2. $P(250) = \frac{1}{4}$ **3.** $P(500) = \frac{3}{16}$ **4.** $P(1000) = \frac{1}{8}$ **5.** $P(5000) = \frac{1}{16}$

6. What is the range of this function? $\left\{\frac{1}{16}, \frac{1}{8}, \frac{3}{16}, \frac{1}{4}, \frac{3}{8}\right\}$

This function has a special property.

7. What is the sum of all the range elements for this function? 1

8. Why does the sum have to be the number that you found in Exercise 7?

The total of the probabilities for all possible events must be 1.

9. Is the sum of the range elements for any function always this number? Explain your response.

No; the range of functions can vary widely. A sum of 1 is only required for a probability function such as the one used here.

For this game-show function, find each of the following probabilities.

10. P(100 or 500) $\frac{9}{16}$

11. P(500 or 1000) $\frac{5}{16}$

12. P(more than 500) $\frac{3}{16}$

13. P(at least 500) $\frac{3}{8}$

14. P(less than 500) $\frac{5}{8}$

15. P(10,000) 0

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LESSON 10-6 Problem Solving

Theoretical Probability

Mahjong is a classic Chinese game frequently played with tiles. Each tile has numbers, pictures, or characters on them. Similar to a deck of playing cards, most of the tiles can be grouped into suits. From a certain set of mahjong tiles, the odds *in favor* of selecting a tile from the bamboo suit is 1:3.

1. What is the probability of selecting a tile from the bamboo suit? $\frac{1}{4}$

2. What is the probability of selecting a tile that is *not* from the bamboo suit? $\frac{3}{4}$

3. Any set of mahjong tiles has 36 tiles in the bamboo suit. How many tiles are in the entirety of this set? (*Hint:* Set up a proportion using your answer from question 1.)

144 tiles

4. This set of mahjong tiles also has 8 special tiles that represent flowers or seasons. What are the odds *against* selecting a tile that represents a flower or a season?

17:1

At a carnival game, you drop a ball into the top of the machine shown below. As the ball falls, it goes either left or right as it hits each peg. In total, the ball can follow 16 different paths. (See if you can find all 16 paths.) The ball eventually lands in one of the bins at the bottom and you win that amount of money. (One path to $0 is shown.) Select the best answer.

5. What is the probability of wining $2?

A $\frac{1}{16}$ C $\frac{1}{4}$

(B) $\frac{1}{8}$ D $\frac{1}{2}$

6. What is the probability of wining $1?

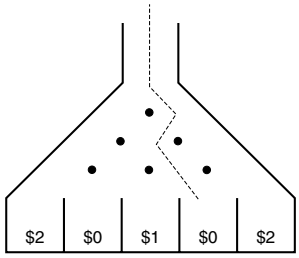
F $\frac{1}{8}$ H $\frac{1}{4}$

G $\frac{3}{16}$ (J) $\frac{3}{8}$

7. What are the odds in favor of winning nothing ($0)?

(A) 1:1 C 1:3

B 1:2 D 1:4



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LESSON 10-6 Reading Strategies

Using a Model

Use the model below as a guide to finding probabilities and odds.

Experiment: Choose a letter at random from the word MODEL.

Probability of choosing a vowel:	**Probability of not choosing a vowel:**
$P(\text{vowel}) = \frac{\text{\# of vowels}}{\text{total \# of letters}}$	$P(\text{not vowel}) = \frac{\text{\# of non-vowels}}{\text{total \# of letters}}$
$\frac{\{O, E\}}{\{M, O, D, E, L\}}$	$\frac{\{M, D, L\}}{\{M, O, D, E, L\}}$
$\frac{2}{5}$	$\frac{3}{5}$

MODEL

Odds in favor of choosing a vowel:	**Odds against choosing a vowel:**
# of vowels : # of non-vowels	# of non-vowels : # of vowels
{O, E} : {M, D, L}	{M, D, L} : {O, E}
2:3	3:2

Use the information above to complete the following.

1. Look at the probability of choosing a vowel and the probability of not choosing a vowel.

a. What is true about the denominators? they are the same

b. How are the numerators related to the denominator?

The sum of the numerators equals the denominator: $2 + 3 = 5$.

2. Compare the probability of choosing a vowel and the odds in favor of choosing a vowel.

The numerator in the probability is the same as the first number in the odds ratio. The numbers in the odds ratio sum to the denominator in the probability.

There is a prize in 1 cereal box out of every 5 cereal boxes. You buy 1 box. Find each of the following.

3. P(prize) $\frac{1}{5}$ **4.** P(no prize) $\frac{4}{5}$

5. odds in favor of prize 1:4 **6.** odds against prize 4:1

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