

Lesson 2

Audio Tutor 2/21 Listen and Understand

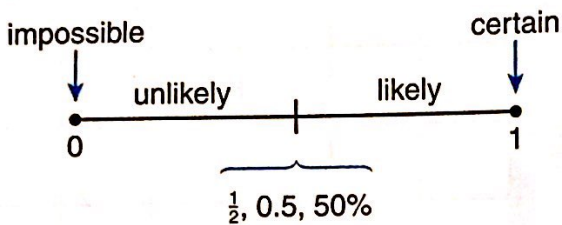
Theoretical Probability

Objective Find probabilities if each outcome of an experiment has the same chance of occurring.

Vocabulary
event
probability
theoretical probability

Learn About It

An **event** is one or more outcomes of an experiment. The **probability** of an event is a measure of the likelihood that the event will occur. A probability can be expressed as a ratio between 0 and 1. It can also be expressed as a decimal or as a percent.



Suppose a game piece is only four spaces from the last space on the board. What is the probability that a player will toss a 1–6 number cube and get at least a 4 to win the game?

If each outcome is equally likely, the **theoretical probability** P of an event A is the ratio of the number of possible outcomes in the event to the total number of possible outcomes.

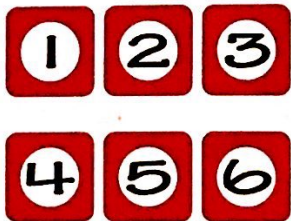
$$P(A) = \frac{\text{number of outcomes in the event}}{\text{total number of possible outcomes}}$$

To read P(A), say "The probability of event A."

Find P(4 or higher).

STEP 1 Find the sample space.

1



There are 6 equally likely possible outcomes: 1, 2, 3, 4, 5, and 6.

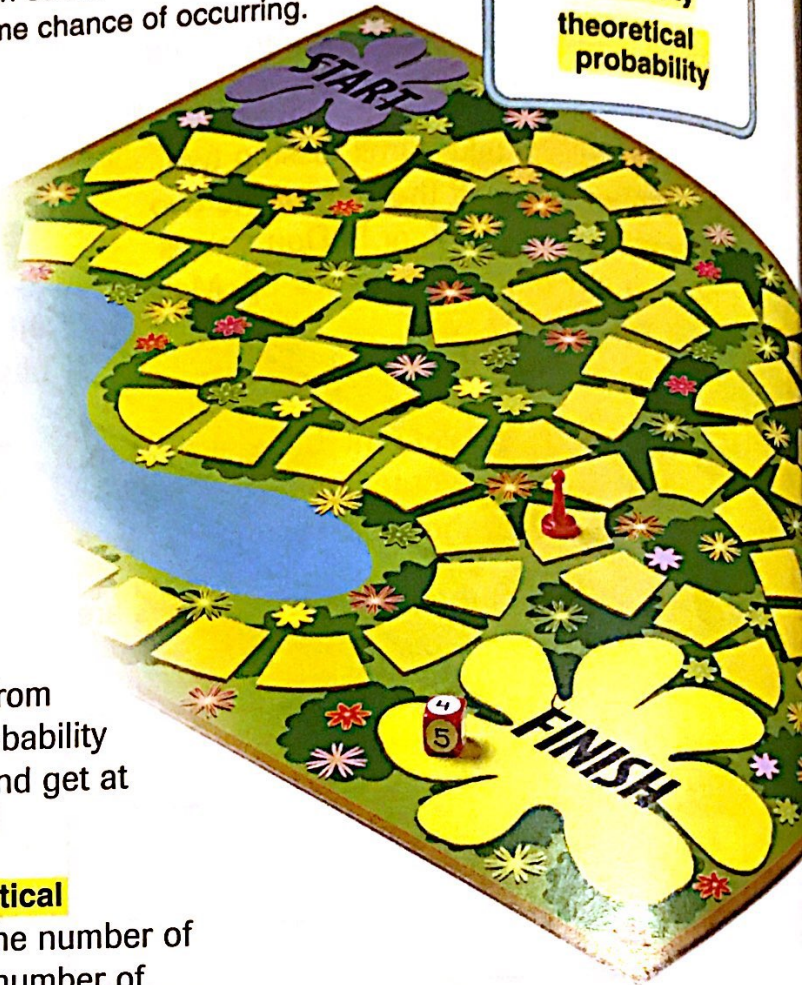
STEP 2

Count the number of outcomes in the event 4 or higher. Write the probability as a ratio.

There are three outcomes of 4 or higher: 4, 5, or 6

$$P(4 \text{ or higher}) = \frac{\text{outcomes in event}}{\text{possible outcomes}}$$

$$= \frac{3}{6} = \frac{1}{2}$$



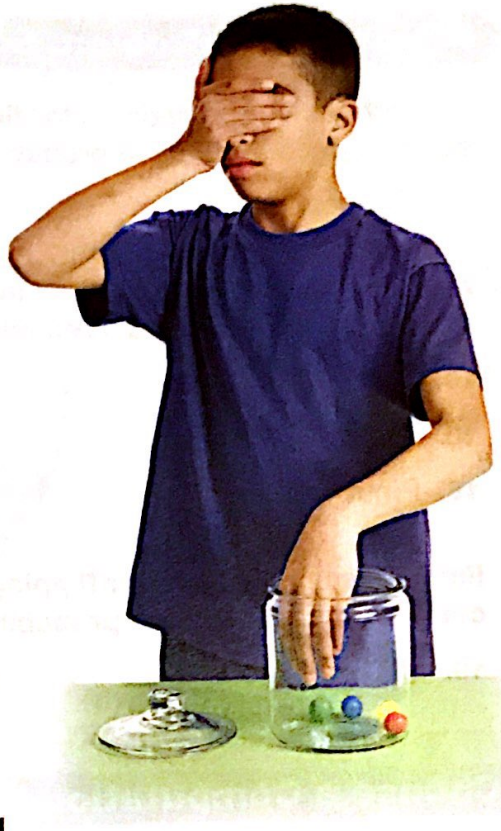
► Sometimes you need to find the probability that an event will not occur.

Suppose that there are 4 marbles of identical size—1 red, 1 blue, 1 green, and 1 yellow. Bill picks one marble without looking. What is the probability that he does not pick a blue marble?

If $P(A)$ is the probability of an event A occurring, then the probability that the event A will not occur is $1 - P(A)$.

$$\begin{aligned} P(\text{not blue}) &= 1 - P(\text{blue}) \\ &= 1 - \frac{1}{4} = \frac{3}{4} \end{aligned}$$

The probability that Bill will not pick a blue marble is $\frac{3}{4} = 0.75 = 75\%$.



Other Examples

A. Probability of 0

In the example above, what is the probability that Bill will pick a purple marble?

$$P(\text{purple}) = \frac{0}{4} \leftarrow \begin{array}{l} \text{outcomes in event} \\ \text{possible outcomes} \end{array}$$

$$P(\text{purple}) = 0$$

B. Probability of 1

In the example above, what is the probability that Bill will pick a marble that is either red, blue, green, or yellow?

$$P(\text{red, blue, green, or yellow}) = \frac{4}{4} \leftarrow \begin{array}{l} \text{outcomes in event} \\ \text{possible outcomes} \end{array}$$

$$P(\text{red, blue, green, or yellow}) = 1$$

Guided Practice

Use the following data for Problems 1–6. Find each probability.

There are 20 pennies in a jar. Two were minted in 2002, 4 in 2003, 5 in 2004, 8 in 2005, and 1 in 2006. A penny is drawn at random and its date checked.

- | | | |
|--------------|--------------|--------------------------|
| 1. $P(2002)$ | 2. $P(1995)$ | 3. $P(\text{not } 2004)$ |
| 4. $P(2006)$ | 5. $P(2003)$ | 6. $P(\text{not } 2002)$ |

Ask Yourself

- How many outcomes are there in the event?
- How many possible outcomes are there?

Explain Your Thinking ► What is the mathematical relationship between the probability that an event will happen and the probability that the event will not happen?



Theoretical Probability

Find all possible outcomes for three identical spinners. Each spinner is divided into 4 equal sectors, numbered 1 through 4. Use your list to find each probability.

1. P(three 4s)

2. P(no 4s)

3. P(1, 2, and 3)

A jar contains 50 marbles that are the same size. There are 15 blue, 8 yellow, and 27 red marbles. Find each probability.

4. P(blue)

5. P(yellow)

6. P(red)

7. P(green)

8. P(not blue)

9. P(not yellow)

10. P(not red)

11. P(red or yellow)

12. P(not green)

Find the sample space for flipping four identical coins at once. Use your list to find each probability.

13. P(4 heads)

14. P(1 head, 3 tails)

15. P(2 tails, 2 heads)



Test Prep

16. If you toss four coins, what is the probability that all four coins will land on heads?

A 0

B $\frac{1}{8}$

C $\frac{1}{16}$

D 1

17. You roll a 1-6 number cube. What is the probability of rolling an odd number? Explain how you found your answer.

Theoretical Probability

Find the probability that a 1–6 number cube will land on an even number.

Step 1: Find the sample space.
There are six equally likely outcomes:
1, 2, 3, 4, 5, and 6

Step 2: Count the number of outcomes in the event. Write the probability as a ratio.

$$\frac{\text{(Outcomes in the event)}}{\text{(Possible outcomes)}} = \frac{3}{6}$$

A jar contains 18 marbles that are all the same size. It contains 7 purple, 3 green, and 8 orange marbles. Without looking, Marge picks 1 marble. What is the probability of each of the following outcomes?

1. P(green)

2. P(purple)

3. P(orange)

4. P(not green)

5. P(not black)

6. P(blue)

Find the sample space for spinning two identical spinners, each divided equally into the following colors: red, blue, green, and purple. Use your list to find each probability.

7. P(2 purple)

8. P(blue, not green)

9. P(red, yellow)

10. P(not red, not purple)

11. P(gray, green)

12. P(green, not blue or purple)

Problem Solving

Show Your Work

13. What is the probability of rolling a number less than three on a 1–6 number cube?
