

SIMPLE PROBABILITY

Outcome: Any possible or actual result of the action considered, such as rolling a 5 on a standard number cube or getting tails when flipping a coin.

Event: A desired (or successful) outcome or group of outcomes from an experiment, such as rolling an even number on a standard number cube.

Sample space: All possible outcomes of a situation. For example, the sample space for flipping a coin is heads and tails; rolling a standard number cube has six possible outcomes (1, 2, 3, 4, 5, and 6).

Probability: The likelihood that an event will occur. Probabilities may be written as fractions, decimals, or percents. An event that is guaranteed to happen has a probability of 1, or 100%. An event that has no chance of happening has a probability of 0, or 0%. Events that “might happen” have probabilities between 0 and 1 or between 0% and 100%. In general, the more likely an event is to happen, the greater its probability.

Experimental probability: The probability based on data collected in experiments.

$$\text{Experimental probability} = \frac{\text{number of successful outcomes in the experiment}}{\text{total number of outcomes in the experiment}}$$

Theoretical probability is a calculated probability based on the possible outcomes when they all have the same chance of occurring.

$$\text{Theoretical probability} = \frac{\text{number of successful outcomes (events)}}{\text{total number of possible outcomes}}$$

In the context of probability, “successful” usually means a desired or specified outcome (event), such as rolling a 2 on a number cube (probability of $\frac{1}{6}$). To calculate the probability of rolling a 2, first figure out how many possible outcomes there are. Since there are six faces on the number cube, the number of possible outcomes is 6. Of the six faces, only one of the faces has a 2 on it. Thus, to find the probability of rolling a 2, you would write:

$$P(2) = \frac{\text{number of ways to roll 2}}{\text{number of possible outcomes}} = \frac{1}{6} \text{ or } 0.\overline{16} \text{ or approximately } 16.7\%$$

Example 1

If you roll a fair, 6-sided number cube, what is $P(3)$, that is, the probability that you will roll a 3?

Because the six sides are equally likely to come up, and there is only one 3, $P(3) = \frac{1}{6}$.

Example 2

There are 12 marbles in a bag: 2 clear, 4 green, 5 yellow, and 1 blue. If one marble is chosen randomly from the bag, what is the probability that it will be yellow?

$$P(\text{yellow}) = \frac{5 \text{ (yellow)}}{12 \text{ (outcomes)}} = \frac{5}{12}$$

Example 3

Joe flipped a coin 50 times. When he recorded his tosses, his result was 30 heads and 20 tails. Joe's activity provided data to calculate experimental probability for flipping a coin.

- a. What is the theoretical probability of Joe flipping heads?

The theoretical probability is 50% or $\frac{1}{2}$, because there are only two possibilities (heads and tails), and each is equally likely to occur.

- b. What was the experimental probability of flipping a coin and getting heads based on Joe's activity?

The experimental probability is $\frac{30}{50}$, $\frac{3}{5}$, or 60%. These are the results Joe actually got when he flipped the coin.

Example 4

Decide whether these statements describe theoretical or experimental probabilities.

- a. The chance of rolling a 6 on a fair die is $\frac{1}{6}$.

This statement is theoretical.

- b. I rolled the die 12 times and 5 came up three times.

This statement is experimental.

- c. There are 15 marbles in a bag; 5 blue, 6 yellow, and 4 green. The probability of getting a blue marble is $\frac{1}{3}$.

This statement is theoretical.

- d. When Veronika pulled three marbles out of the bag she got 2 yellow and 1 blue, or $\frac{2}{3}$ yellow, $\frac{1}{3}$ blue.

This statement is experimental.

Problems

1. There are 24 crayons in a box: 5 black, 3 white, 7 red, 2 yellow, 3 blue, and 4 green. What is the probability of randomly choosing a green? Did you respond with an experimental or theoretical probability?
2. A spinner is divided into four equal sections numbered 2, 4, 6, and 8. What is the probability of spinning an 8?
3. A fair number cube marked 1, 2, 3, 4, 5, and 6 is rolled. Tyler tossed the cube 40 times, and noted that 26 times an even number showed. What is the experimental probability that an even number will be rolled? What is the theoretical probability?
4. Sara is at a picnic and reaches into an ice chest, without looking, to grab a can of soda. If there are 14 cans of orange, 12 cans of fruit punch, and 10 cans of cola, what is the probability that she takes a can of fruit punch? Did you respond with an experimental probability or a theoretical one?
5. A baseball batting average is the probability a baseball player hits the ball when batting. If a baseball player has a batting average of .266, it means the player's probability of getting a hit is 0.266. Is a batting average an experimental probability or theoretical?
6. In 2011, 39 people died by being struck by lightning, and 241 people were injured. There were 310,000,000 people in the United States. What is the probability of being one of the people struck by lightning?
7. In a medical study, 107 people were given a new vitamin pill. If a participant got sick, they were removed from the study. Ten of the participants caught a common cold, 2 came down with the flu, 18 got sick to their stomach, and 77 never got sick. What was the probability of getting sick if you participated in this study? Did you respond with an experimental probability or a theoretical one?
8. Insurance companies use probabilities to determine the rate they will charge for an insurance policy. In a study of 300 people that had life insurance policies, an insurance company found that 111 people were over 80 years old when they died, 82 people died when they were between 70 and 80 years old, 52 died between 60 and 70 years old, and 55 died when they were younger than 60 years old. In this study what was the probability of dying younger than 70 years old? Did you respond with an experimental probability or a theoretical one?

Answers

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|--------------------------------|--|---|---|
| 1. $\frac{1}{6}$; theoretical | 2. $\frac{1}{4}$ | 3. $\frac{26}{40}$; $\frac{3}{6}$ | 4. $\frac{1}{3}$; theoretical |
| 5. experimental | 6. $\frac{39+241}{310,000,000}$
$\approx 0.000\ 000\ 903$ | 7. $\frac{10+2+18}{107} \approx 0.28$
experimental | 8. $\frac{55+52}{300} \approx 35.7\%$
experimental |