Introduction to Probability

Introduction to Probability: Apply, Compare, and Design

Name _____ **Date** _____ **Score** _____ / 6

QUICK REVIEW

For equally likely outcomes, probability is favorable outcomes divided by all outcomes. A fair six-sided number cube has three even outcomes $(2, 4, 6)$, so $P(\text{even}) = \frac{3}{6} = \frac{1}{2}$. Impossible events have probability 0; certain events have probability 1.

Worked example

A bag holds 3 red, 1 blue, and 4 green counters. Draw one counter uniformly at random. Find the probability of red.

1. All counters are equally likely; total outcomes: $3 + 1 + 4 = 8$.
2. Red outcomes: 3, so $P(\text{red}) = \frac{3}{8} = \frac{3}{8}$.
Answer: $\frac{3}{8}$.

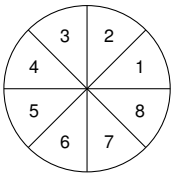
Practice Problems

Show your thinking.

1. Design a 12-counter bag with 4 blue counters so a uniform random draw of one counter has red probability $\frac{1}{2}$. Give the red, blue, and green counts.

2. A bag has 2 red and 6 blue counters. Add only red until the colors are equally likely when one counter is drawn uniformly at random. How many do you add, and what is the new red probability?

3. Each game uses one spin of the same fair spinner. A wins on $1, 2, 3$; B wins on even numbers. Which is more likely to win, and by what probability difference?



4. Design a winning rule for one roll of a fair 1-through-6 number cube. Win chance must be $\frac{1}{3}$, and neither 1 nor 6 may win. Give one possible set of winning outcomes.

5. Choose a bag for one uniformly random counter draw. A has 4 red and 6 blue counters; B has 5 red and 10 blue. Which has the higher chance of red, and by how much?

6. In each of 20 trials, one counter was drawn uniformly at random from the same bag and then returned. Red appeared 9 times. Give the observed red fraction. Does it guarantee red on the next draw?

Answer Key

1. 6 red, 4 blue, 2 green.
2. Add 4 red counters; new probability $\frac{1}{2}$.
3. B; difference $\frac{1}{8}$.
4. For example, win on 2 or 5.
5. A by $\frac{1}{15}$.
6. $\frac{9}{20}$; no guarantee.

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. Red needs half the 12 counters: $12 \div 2 = 6$.
2. With 4 blue, green is $12 - 6 - 4 = 2$. Check $\frac{6}{12} = \frac{1}{2}$.

Problem 2

1. Equal chances need equal counts. Blue stays at 6, so add $6 - 2 = 4$ red counters.
2. The new bag has $6 + 6 = 12$ counters; red chance is $\frac{6}{12} = \frac{1}{2}$.

Problem 3

1. A has 3 winning sectors, so $P(A) = \frac{3}{8}$.
2. B has 4 winning sectors, so $P(B) = \frac{4}{8} = \frac{1}{2}$. The difference is $\frac{4}{8} - \frac{3}{8} = \frac{1}{8}$.

Problem 4

1. $6 \times \frac{1}{3} = 2$ winning outcomes are needed.
2. Choose $2, 5$; probability $\frac{2}{6} = \frac{1}{3}$. Neither excluded face wins.

Problem 5

1. A: $\frac{4}{10} = \frac{2}{5} = \frac{6}{15}$. B: $\frac{5}{15} = \frac{1}{3}$.
2. A has the greater fraction despite fewer red counters. The gap is $\frac{6}{15} - \frac{5}{15} = \frac{1}{15}$.

Problem 6

1. Observed relative frequency is $9 \div 20 = \frac{9}{20}$.
2. 11 of the 20 draws were not red. Returning the counter keeps the bag the same; the observed fraction does not guarantee the next color.

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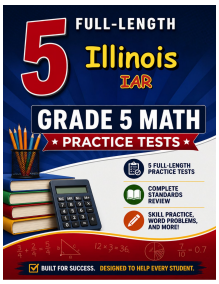

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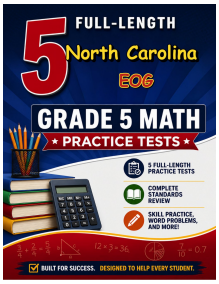

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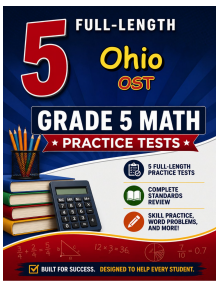

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