What Is Probability?

Apply the skill to decisions and designs

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QUICK REVIEW

Probability describes chance from 0 (impossible) to 1 (certain). In bag questions, assume one counter is drawn uniformly at random. For equally likely outcomes, divide the favorable count by the total count. The chance an event does not occur is 1 minus its chance.

Worked example

An equally likely spinner has six sections: one silver and five green. Find the silver and not-silver probabilities.

1. The spinner has 6 equal sections and exactly 1 silver section.
2. Divide favorable by total: $P(\text{silver}) = 1/6$.
3. The complement is $1 - 1/6 = 5/6$; together the probabilities make 1.
Answer: Silver $1/6$; not silver $5/6$.

Practice Problems

Show your thinking.

1. A game bag has 4 winning and 4 nonwinning counters, each equally likely. Add only nonwinning counters so the win chance is exactly $1/3$. How many must you add?

2. A machine always issues exactly one of codes A, B, C. Find the probability that a code is in this list, regardless of how often each code occurs.

3. A prize bag has 2 winning and 8 nonwinning counters. Find winning chance and decide if winning is more likely than not.

4. Design a four-counter bag with winning probability $1/2$. State winning and nonwinning counts and verify.

5. A weather model assigns rain probability $3/10$. Find no-rain probability and choose the more likely outcome under the model.

6. A poster advertises a probability of 125%. Convert it to a fraction and explain why no single-event probability can equal it.

7. Game A wins on 5 of 20 equally likely counters. Game B wins with probability $3/10$. Compare chances and find the gap.

8. A model gives success probability $3/8$. For 32 trials, estimate successes and nonsuccesses so the counts total 32.

9. A bag has 8 red and 4 other counters. Enlarge it to 15 counters while preserving red chance $2/3$. Find how many of each type to add.

10. A vendor promises a 140% winning chance. Convert it to a fraction and quantify why the claim is impossible.

Answer Key

1. Add 4 nonwinning counters.
2. 1; certain.
3. $1/5$; winning is less likely.
4. 2 winning, 2 nonwinning.
5. No rain $7/10$; no rain is more likely.
6. $5/4$; invalid, $1/4$ above certainty.
7. B is more likely by $1/20$.
8. Expected successes 12; nonsuccesses 20, not guaranteed counts.
9. Add 2 red and 1 other.
10. Invalid; distance outside $[0, 1]$ is $\frac{2}{5}$.

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. The 4 winning counters must be one third of the new total.
2. The new total must be $3(4) = 12$ counters. It currently has $4 + 4 = 8$.
3. Add $12 - 8 = 4$ nonwinning counters; the new chance is $4/12 = 1/3$.

Problem 2

1. The listed codes exhaust all possible outputs.
2. Probability of any listed code is $P(A) + P(B) + P(C) = 1$.
3. The complement is empty, with probability $1 - 1 = 0$.

Problem 3

1. Total $= 2 + 8 = 10$.
2. Winning probability $= 2/10 = 1/5$.
3. Nonwinning probability $= 8/10 = 4/5 > 1/5$.

Problem 4

1. Winning count $= 4(1/2) = 2$.
2. Other count $= 4 - 2 = 2$.
3. Check $2/4 = 1/2$.

Problem 5

1. Total probability $= 10/10$.
2. No rain $= 10/10 - 3/10 = 7/10$.
3. $7/10 > 3/10$, so no rain is more likely, not guaranteed.

Problem 6

1. $125\% = 125/100 = 5/4$.
2. The greatest valid probability is $1 = 4/4$.
3. Excess $= 5/4 - 4/4 = 1/4$.

Problem 7

1. Total counters $5 + 15 = 20$; win probability $5/20 = 1/4$.
2. Nonwinning probability $15/20 = 3/4$; sum 1.
3. B minus A chance $3/10 - 1/4 = 1/20 > 0$, so B is more likely.

Problem 8

1. Complement $1 - 3/8 = 5/8$.
2. Success allocation $32(3/8) = 12$; other allocation $32(5/8) = 20$.
3. Check $12 + 20 = 32$ and $3/8 + 5/8 = 1$.

Problem 9

1. Original red count $12(2/3) = 8$; other count $12 - 8 = 4$.
2. At size 15, red count $15(2/3) = 10$; other count $15 - 10 = 5$.
3. Additions are $10 - 8 = 2$ red and $5 - 4 = 1$ other; check $10/15 = 2/3$.

Problem 10

1. Valid single-event probabilities satisfy $0 \le P \le 1$.
2. The claim is $\frac{7}{5}$ because $140/100 = 7/5$.
3. Excess $\frac{7}{5} - 1 = \frac{2}{5}$.

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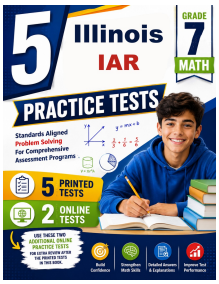

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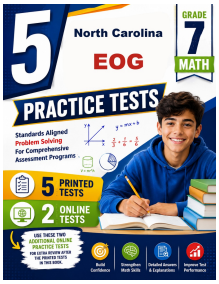

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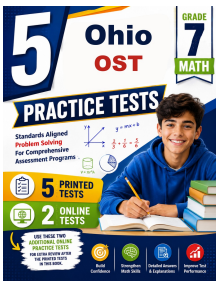

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