Introduction to Probability

Introduction to probability: Applications and decisions

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QUICK REVIEW

For equally likely outcomes, probability = favorable outcomes/total outcomes. A bag with 3 red and 5 blue has $P(\text{red}) = 3/8$, while $P(\text{not red}) = 5/8 = 1 - 3/8$. Impossible events have probability 0; certain events have probability 1. Random does not mean every color is equally likely when color counts differ.

Worked example

Find the probability of one red draw. A bag contains 3 red, 5 blue, and 0 green counters; draw one at random. Find $P(\text{red})$.

1. Total equally likely counters $= 3 + 5 + 0 = 8$.
2. The event has 3 favorable counters, so probability $= 3/8 = \frac{3}{8}$.
3. Complement probability $= 1 - \frac{3}{8} = \frac{5}{8}$; together they total 1.
Answer: $\frac{3}{8}$.

Practice Problems

Show your thinking.

1. Each game draws one ticket at random from its own box. Both give the same prize for a win. Which game gives the better chance, and by how much?

Game	Winning tickets	All tickets
A	6	14
B	8	21

2. A bag holds 3 gold and 9 plain counters. Each exchange replaces one plain counter with a gold counter. What is the fewest exchanges that make gold more likely than plain in one random draw? Give the new gold probability.

3. One round scores a whole number from 0 to 3. The table shows the chances of reaching each cutoff. Find the chances of scoring exactly 0, 1, and 2 points.

Score at least	Chance
1	$5/6$
2	$1/2$
3	$1/6$

4. A bag starts with 2 gold and 3 silver counters. The first counter drawn is silver. Compare the chances of gold on a second random draw if that silver counter is returned or kept out. Give the difference.

5. Design an equal-sector spinner with only red, green, and blue sectors. Red must have chance $1/2$ and green chance $1/3$. What is the smallest total number of sectors? Give the count of each color.

6. An unbiased spinner has one red sector covering half the circle. Blue, green, and yellow each occupy an equal share of the other half. A student says red and blue are equally likely since each has one sector. Correct both chances and explain.

Answer Key

1. Game A by $1/21$.
2. 4 exchanges; gold probability $7/12$.
3. $P(0) = 1/6$, $P(1) = 1/3$, $P(2) = 1/3$.
4. Returned: $2/5$. Kept out: $1/2$, higher by $1/10$.
5. 6 sectors: 3 red, 2 green, 1 blue.
6. Red: $1/2$. Blue: $1/6$. The sectors have different sizes.

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. Game A wins on $6/14 = 3/7 = 9/21$ of its tickets.

2. Game B wins on $8/21$ of its tickets. It has more winning tickets, but also more tickets in all.

3. Since $9/21 > 8/21$, choose A. The difference is $9/21 - 8/21 = 1/21$.

Problem 2

1. The total stays 12. With $12/2 = 6$ gold, the chances would tie.

2. Gold must outnumber plain, so the smallest winning gold count is $6 + 1 = 7$. That takes $7 - 3 = 4$ exchanges.

3. The new bag has $12 - 7 = 5$ plain counters; $7/12 > 5/12$.

Problem 3

1. Only 0 is below the first cutoff: $P(0) = 1 - 5/6 = 1/6$.

2. Scores at least 1 but not at least 2 are exactly 1: $P(1) = 5/6 - 1/2 = 1/3$.

3. Likewise $P(2) = 1/2 - 1/6 = 1/3$. Since the maximum is 3, the last row gives $P(3) = 1/6$.

4. Check that $1/6 + 1/3 + 1/3 + 1/6 = 1$.

Problem 4

1. Returning the silver counter restores all $2 + 3 = 5$ counters, so the gold chance is $2/5$.

2. Keeping it out leaves $5 - 1 = 4$ counters, still with 2 gold. The gold chance is $2/4 = 1/2$.

3. Keeping the silver out raises the chance by $1/2 - 2/5 = 5/10 - 4/10 = 1/10$.

Problem 5

1. Red needs half the sectors and green a third. The total must be a multiple of both 2 and 3; the first positive one is 6.

2. With 6 sectors, use $6/2 = 3$ red and $6/3 = 2$ green. Blue fills the remaining $6 - 3 - 2 = 1$ sector.

3. Check: $3/6 = 1/2$ and $2/6 = 1/3$. The counts add to $3 + 2 + 1 = 6$.

Problem 6

1. Chance is the fraction of the full circle a sector covers. The red sector covers $1/2$.

2. The other $1 - 1/2 = 1/2$ is split into 3 equal shares. Blue has one of them: $(1/2) \div 3 = 1/6$.

3. Although red and blue each have 1 sector, $1/2 > 1/6$, so red is more likely.

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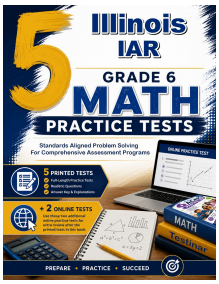

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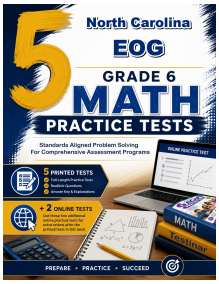

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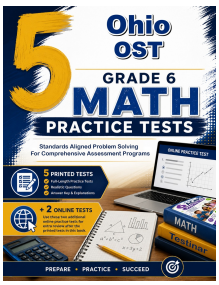

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