Probability Models

Apply the skill to decisions and designs

Name _____ **Date** _____ **Score** _____ / 8

QUICK REVIEW

List every outcome once. Probabilities must be nonnegative and total 1; for instance $0.2 + 0.3 + 0.5 = 1$. Group repeated labels before reporting the model. For trial data, divide each count by the total number of trials.

Worked example

Five equally likely slips are labeled X, X, Y, Z, Z. Build the label model.

1. One slip has probability $1/5$.
2. X and Z each use 2 slips: $P(X) = P(Z) = 2/5$. Y uses one: $P(Y) = 1/5$.
3. Check the total: $2/5 + 1/5 + 2/5 = 1$.
Answer: X: $2/5$, Y: $1/5$, Z: $2/5$.

Practice Problems

Show your thinking.

1. A booth offers red, blue, or no prize. Red chance is $1/5$ and blue is twice that. Build the model and estimate counts for 50 plays.

2. Design an eight-equal-sector spinner with exactly two green sectors and twice as many red as blue. Give all color counts and probabilities.

3. Use the tally to build an experimental model. For 120 future plays, will 50 B prizes cover the forecast? Find any shortfall.

Prize	Test count
A	12
B	18
C	10

4. A, B, C are the only modes, with $P(A) = 1/4$ and $P(B) = 3/8$. A bonus requires C chance at least $2/5$. Does C qualify? Find its exact margin or shortfall.

5. A bag starts with 4 red and 6 blue counters. Only red counters may be added. One counter will then be drawn uniformly from the bag. How many red counters must be added to make the red chance exactly $1/2$?

6. Booth A wins with chance $3/10$ over 80 plays. Booth B wins with chance $1/4$ over 120. Which should stock more prizes by expected count, and by how many?

7. Use either 20 or 30 equally likely counters to model A 0.15, B 0.35, C 0.50 exactly. Which kit works? Give label counts.

8. Design a 12-equal-sector spinner with red chance $1/2$, blue $1/3$, and green $1/6$. Give counts. Then how many blue sectors must change to green to equalize blue and green?

Answer Key

1. Red $1/5$, blue $2/5$, none $2/5$; expect $10, 20, 20$.
2. Red 4 $(1/2)$, blue 2 $(1/4)$, green 2 $(1/4)$.
3. A: $3/10$, B: $9/20$, C: $1/4$. Forecast is 54 B prizes; short 4.
4. No. C is $3/8$, short by $1/40$.
5. Add 2 red counters.
6. B: 30 expected versus A: 24, so 6 more.
7. Use 20: A 3, B 7, C 10.
8. Start red 6, blue 4, green 2. Recolor 1 blue to green.

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. Blue has chance $2(1/5) = 2/5$.
2. No prize has chance $1 - 1/5 - 2/5 = 2/5$.
3. In 50 plays, multiply by each chance: 10 red, 20 blue, and 20 none are estimates.

Problem 2

1. After green, $8 - 2 = 6$ sectors remain.
2. If blue has b, then red has $2b$. Solve $b + 2b = 6$ to get $b = 2$ and red 4.
3. Divide by 8: red $4/8 = 1/2$, blue and green $2/8 = 1/4$ each.

Problem 3

1. There were $12 + 18 + 10 = 40$ trials.
2. Rates for A, B, C are $12/40 = 3/10$, $18/40 = 9/20$, and $10/40 = 1/4$.
3. Expected B count is $120(9/20) = 54$; the stock is short of the estimate by $54 - 50 = 4$.

Problem 4

1. A and B total $1/4 + 3/8 = 5/8$.
2. C has the remaining probability $1 - 5/8 = 3/8$.
3. Compare $3/8 = 15/40$ to $2/5 = 16/40$: shortfall $1/40$.

Problem 5

1. Half red means the red and blue counts are equal.
2. Blue stays at 6, so add $6 - 4 = 2$ red.
3. Then red chance is $6/(6 + 6) = 1/2$.

Problem 6

1. A expects $80(3/10) = 24$ prizes.
2. B expects $120(1/4) = 30$ prizes.
3. B needs $30 - 24 = 6$ more by the model, despite its lower win chance.

Problem 7

1. A 30-counter kit would need $30(0.15) = 4.5$ counters labeled A, which is impossible.
2. With 20: $20(0.15) = 3$, $20(0.35) = 7$, $20(0.50) = 10$.
3. All are whole counts and total $3 + 7 + 10 = 20$.

Problem 8

1. Multiply by 12: red $12(1/2) = 6$, blue $12(1/3) = 4$, and green $12(1/6) = 2$.
2. Blue and green share $4 + 2 = 6$ sectors, so equal chances require $6/2 = 3$ each.
3. Change $4 - 3 = 1$ blue sector to green. Red stays at 6.

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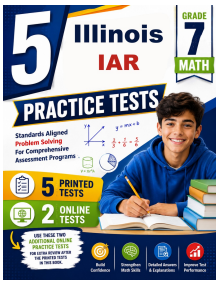

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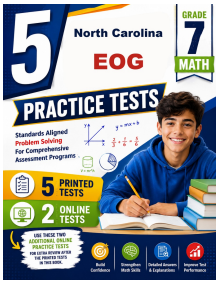

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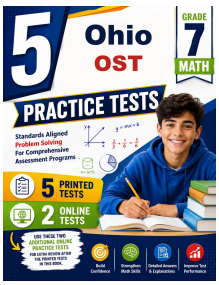

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