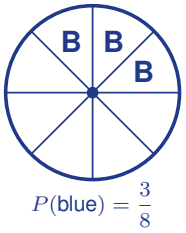
Probability Models

Name: _____	Date: _____	Score: _____ / 18

Probability is not just about single events—you can also use it to **predict** what will happen over many trials! If you know the probability of an event and the number of trials, you can estimate how many times that event should occur. The result is an *expected count*, not a guarantee, because randomness is always in play. But over many trials, expected values become incredibly useful for planning and making smart decisions!

Spinner ($n = 400$ spins)



$P(\text{blue}) = \frac{3}{8}$

expected count →

Predicted blue outcomes

$$400 \times \frac{3}{8} = \frac{1200}{8} = 150 \textbf{ times}$$

Key Concepts & Quick Review

Expected count $= n \times P(\text{event})$ where n = number of trials and $P(\text{event})$ = probability of the event.

Note: Expected count is a *prediction*, not a guarantee. The more trials performed, the closer the actual count will be to the expected count.

Examples

① A bag contains 3 red marbles and 7 blue marbles. One marble is drawn and replaced each time. In 200 draws, how many times is a red marble expected?

Think It Through: Expected count uses the formula $n \times P(\text{event})$. Here the probability of red is $\frac{3}{10}$ because 3 of the 10 marbles are red. Multiply by the number of draws: $200 \times \frac{3}{10} = 60$. This does not mean red will appear exactly 60 times, but 60 is the long-run average prediction.

Answer: 60 *red marbles expected*

② A survey shows that 2 out of every 5 students prefer science as their favorite subject. A school has 800 students. Predict how many students prefer science.

Think It Through: Turn the survey result into a probability first: $P(\text{science}) = \frac{2}{5}$. Then multiply by the total number of students: $800 \times \frac{2}{5} = 320$. Expected count is just probability scaled up to the full group.

Answer: 320 *students predicted*

Practice Problems

Compute the expected count using Expected count $= n \times P(\text{event})$.

1. Probability $= \frac{1}{2}$ over 80 trials. Expected count? _____
2. Probability $= \frac{1}{4}$ over 120 trials. Expected count? _____
3. Probability $= \frac{3}{5}$ over 100 trials. Expected count? _____
4. Probability $= 0.3$ over 200 trials. Expected count? _____
5. Probability $= 0.75$ over 400 trials. Expected count? _____
6. A spinner has 2 red sections out of 5. Expected reds in 150 spins? _____
7. A fair six-sided die is rolled 300 times. Expected number of 4s? _____
8. A bag has 4 green and 6 white counters. Expected greens in 250 draws? _____
9. Chance of rain is 40%. Expected rainy days over 25 days? _____
10. A fair coin is flipped 500 times. Expected heads? _____
11. Probability of blue is $\frac{3}{8}$. Expected blues in 400 spins? _____
12. Probability of drawing an ace is $\frac{1}{13}$. Expected aces in 260 draws? _____
13. Chance of a goal is 0.2. Expected goals in 45 shots? _____
14. Chance of a win is $\frac{3}{10}$. Expected wins in 70 games? _____
15. A bag has 7 red and 3 blue counters. Expected blues in 90 draws? _____

Study Tips

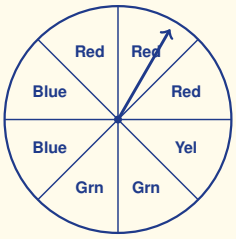
- Convert percentages to decimals or fractions before using the formula: $40\% = 0.40 = \frac{2}{5}$.
- Expected count is a **long-run average**. In any single experiment the actual count may differ, but over many repetitions the average converges to the expected value.
- To predict how many will *not* occur, first find $P(\text{not } A) = 1 - P(A)$, then multiply by n.

Word Problems

16. A factory machine produces a defective part with probability $\frac{1}{25}$. The machine produces $1{,}500$ parts during one shift. (a) How many defective parts are predicted? (b) How many non-defective parts are predicted? (c) The actual number of defective parts was 72. Was the result close to the prediction? _____

17. A weather forecast says there is a 35% chance of rain on any day in April. April has 30 days. (a) Predict how many rainy days there will be in April. (b) A gardener waters the garden only on non-rainy days. Predict how many times she will water. (c) She actually watered 22 times. Was April rainier or drier than predicted? _____

18. This spinner has 8 equal sectors. Use it to find (a) $P(\text{Red})$ as a fraction, (b) the expected number of Red outcomes in 200 spins, and (c) the expected number of *non*-Red outcomes in 200 spins.



Answer Keys

1) 40
2) 30
3) 60
4) 60
5) 300
6) 60
7) 50
8) 100
9) 10
10) 250
11) 150
12) 20
13) 9
14) 21
15) 27
16) (a) 60; (b) 1440; (c) 72 actual vs. 60 predicted, slightly above prediction
17) (a) about 10–11 rainy days; (b) about 19–20 watering days; (c) about 8 rainy days, drier than predicted
18) (a) $\frac{3}{8}$; (b) 75 Reds; (c) 125 non-Reds

Step-by-Step Explanations

Strategy: For Histograms and Stem-and-Leaf Plots, read the display by intervals or stems before calculating totals, centers, or frequencies. Always answer in the language of the display: interval, stem, leaf, frequency, or total.

Practice 1: A histogram has interval 0–9 with frequency 4, interval 10–19 with frequency 8, and interval 20–29 with frequency 6. How many data values are shown? **Answer:** 18
In the opening example, read the display by bins or stems first, then answer the question from the organized data.

Practice 15: Can you find the exact median from a histogram alone? Explain why or why not. **Answer:** no; only estimate
For the end-of-set item, read the display by bins or stems first, then answer the question from the organized data.

Word-problem notes:

16. Answer: Stems 7|2 5 8, 8|0 2 5 8, 9|0 3 5. Median $= \frac{82+85}{2} = 83.5$.
Start by building the stem-and-leaf plot—the stems are 7, 8, and 9. Once the data is laid out, finding the median is straightforward. With 10 values, positions 5 and 6 share the center when the data is listed in order. Those two values are 82 and 85: $(82 + 85) \div 2 = 83.5$. The stem-and-leaf plot makes it easy to spot the middle values at a glance!

17. Answer: $12 + 5 = 17$ students.
"At least $30\ min$" means 30 or more, so we need the bars for 30–44 and 45–59. Read the heights: 12 students and 5 students. Add them: $12 + 5 = 17$. So 17 students read for at least $30\ min$.

18. Answer: (a) $4 + 7 + 12 + 5 + 2 = 30$ students; (b) modal interval is 80–89; (c) at least 80: $12 + 5 + 2 = 19$ students.
Read each bar height: $4, 7, 12, 5, 2$. (a) Total students $= 4 + 7 + 12 + 5 + 2 = 30$. (b) The tallest bar is at the 80–89 interval, so that is the modal interval. (c) "At least 80" means the 80–89, 90–99, and 100 bars combined, giving $12 + 5 + 2 = 19$ students.

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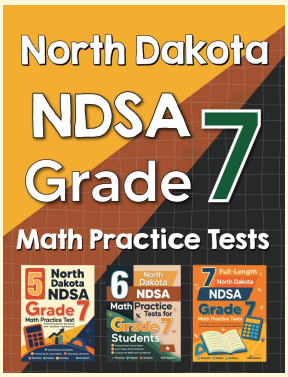

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