

Experimental Probability

Name: _____ Date: _____ Score: _____ / 34

Q Quick Review

Experimental probability is what actually happens when you run the experiment. Count up the favorable outcomes from your trials and divide by the total number of trials: $P_{\text{exp}}(E) = \frac{\text{successes observed}}{\text{total trials}}$.

Theoretical vs. experimental. Theoretical probability comes from a clean math model – “a fair coin lands heads $\frac{1}{2}$ of the time.” Experimental probability comes from data – “I flipped this coin 100 times and got heads 54 times, so my experimental estimate is 0.54.” Both are useful; they answer slightly different questions.

Law of Large Numbers. As the number of trials grows, the experimental probability tends to settle near the true probability. Small samples bounce around a lot. A coin flipped 10 times can easily land 7 heads even if it's perfectly fair.

Reliability ~ sample size. A bigger experiment gives a more trustworthy estimate. 100 trials beat 10. 1000 beats 100. Quadrupling the sample roughly halves the random wobble.

When experimental matters most. When no theoretical model exists – weather, sports outcomes, manufacturing defects – data is the only honest probability you've got.

Common slips. Confusing experimental with theoretical and writing the wrong fraction. Treating 10 flips of 7 heads as proof that the coin is biased (sample size too small). Comparing two experiments with different sample sizes as if they're equally reliable.

PRACTICE

Compute or interpret each experimental probability.

1. A coin was flipped 50 times with the tally below. Find $P_{\text{exp}}(\text{heads})$. _____

Outcome	Count
Heads	28
Tails	22
Total	50

2. Coin flipped 100 times, 56 heads. $P_{\text{exp}}(\text{heads})$ _____

3. A die rolled 300 times gave the tally below. Find $P_{\text{exp}}(4)$. _____

face	1	2	3	4	5	6
count	52	49	51	48	50	50

4. Rain on 24 of 40 days. $P_{\text{exp}}(\text{rain})$ _____

5. A bag was sampled 200 times (with replacement); results are below. Find $P_{\text{exp}}(\text{R})$. _____

Red	Blue	Green	Total
80	60	60	200

6. Same draws as above. $P_{\text{exp}}(\text{B})$ _____

7. Larger sample size usually means estimate is ... _____

8. Coin: 10 flips, all heads. Estimate reliable? _____

9. Spinner: 45 red of 150. $P_{\text{exp}}(\text{red})$ _____

10. Free throws: 34 of 40 made. $P_{\text{exp}}(\text{make})$ _____

11. Defective parts: 12 of 400. $P_{\text{exp}}(\text{defect})$ _____

12. Coin: 54 heads in 100. $P_{\text{exp}}(\text{tails})$ _____

13. Survey: 45 “yes” of 180. $P_{\text{exp}}(\text{yes})$ _____



- 14. Class A: 26/50 heads. Class B: 23/50. Which is more reliable? _____
- 15. Two flips, 2 heads in 2. Is $P_{\text{exp}}(\text{heads}) = 1$ reliable? _____
- 16. Six-sided die rolled 600 times, ones came up 120. $P_{\text{exp}}(1)$ _____
- 17. Web visits: 240 purchases of 4000. $P_{\text{exp}}(\text{buy})$ _____
- 18. As $n \rightarrow \infty$, $P_{\text{exp}} \rightarrow P_{\text{theoretical}}$ describes ... _____
- 19. Coin: 500 flips, 260 heads. $P_{\text{exp}}(\text{heads})$ _____
- 20. Die rolled 120 times, sixes 18. $P_{\text{exp}}(6)$ _____

◆ Word Problems

- 21. A bag contains red, blue, and green marbles. After 200 draws with replacement, the results are 80 red, 60 blue, and 60 green. Find the experimental probability of drawing each color. _____
- 22. In a quality-control sample of 400 parts, 12 are defective. Use this data to estimate the probability that a randomly selected part from the production line is defective. Then estimate how many defective parts you'd expect in a batch of 5000. _____
- 23. Two classes each flip a coin 50 times. Class A gets 26 heads (52%), Class B gets 23 heads (46%). Which class has the better estimate of the true probability of heads? _____
- 24. A weather station records rain on 24 of 40 days that share similar conditions. Based on this data, what is the experimental probability of rain on a similar day? How many rainy days would you predict in the next 30 similar days? _____

Additional Practice

- 25. Probability of rolling an even number on a fair die. _____
- 26. Probability of drawing a heart from a standard deck. _____
- 27. Complement of $P(A) = 0.37$. _____
- 28. If events are independent, $P(A) = 0.4$, $P(B) = 0.5$, find $P(A \cap B)$. _____
- 29. Find $P(A \cup B)$ if $P(A) = 0.6$, $P(B) = 0.3$, $P(A \cap B) = 0.1$. _____
- 30. Choose 3 from 8. _____
- 31. Arrange 4 distinct books. _____
- 32. Find 7P_2 . _____
- 33. Find 7C_2 . _____
- 34. Probability of two heads in two coin flips. _____



Answer Keys

1. 0.56
 2. 0.56
 3. $\frac{4}{25}$
 4. $\frac{3}{5}$
 5. 0.4
 6. 0.3
 7. more reliable
 8. No
 9. 0.3
 10. 0.85
 11. 0.03
 12. 0.46
 13. 0.25
 14. Equally reliable
 15. No
 16. 0.2
 17. 0.06
 18. Law of Large Numbers
 19. 0.52
 20. 0.15
 21. $P(R) = 0.4, P(B) = 0.3, P(G) = 0.3$
 22. $P_{\text{exp}} = 0.03$; expect 150 defective
 23. Equally valid (same sample size)
 24. $P_{\text{exp}} = 0.6$; predict 18 rainy days

Additional Practice Answers

25. $\frac{1}{2}$
 26. $\frac{1}{4}$
 27. 0.63
 28. 0.20
 29. 0.8
 30. 56
 31. 24
 32. 42
 33. 21
 34. $\frac{1}{4}$

Additional Practice: Answers for all numbered items, including the added practice, are shown in the grid above.

Step-by-Step Explanations

1. A careful way to see it: $\frac{28}{50} = 0.56$. Just observed successes over observed trials. That gives a quick check on the answer.
2. Experimental probability is observed successes over total trials: $\frac{56}{100} = 0.56$. This is data-based – a fair coin's theoretical 0.5 won't match exactly in a finite run.
3. One steady path is: $\frac{48}{300} = \frac{4}{25} = 0.16$. (Theoretical would be $\frac{1}{6} \approx 0.167$ – close, but not the same value.) That gives a quick check on the answer.
4. Rainy days over total days observed: $\frac{24}{40}$. Reduce by dividing both by 8: $\frac{3}{5} = 0.6$.
5. Count of reds over total draws: $\frac{80}{200} = 0.4 = 40\%$. Each draw was replaced, so the 200 is a clean total.
6. Blue draws over total: $\frac{60}{200} = 0.3$. Same total as the red calculation – only the favorable count changes.
7. Law of Large Numbers: more trials shrink the random variation. The estimate tightens around the true probability.
8. Only 10 trials – way too few. A fair coin can land 10 heads in a row with probability about $\frac{1}{1024}$. Unusual, but not proof of bias.
9. A careful way to see it: Observed reds over total spins: $\frac{45}{150} = 0.3$ (divide top and bottom by 15). That gives a quick check on the answer.
10. Makes over attempts: $\frac{34}{40} = 0.85 = 85\%$. That's the experimental free-throw rate – pretty hot shooting.
11. Defectives over total inspected: $\frac{12}{400} = 0.03 = 3\%$. This empirical rate is the best estimate of the true defect probability.
12. Start with the key idea: $\frac{100 - 54}{100} = \frac{46}{100} = 0.46$. Or use the complement: $1 - 0.54 = 0.46$. That gives a quick check on the answer.
13. "Yes" responses over total surveyed: $\frac{45}{180}$. Divide both by 45 to reduce: $\frac{1}{4} = 0.25$.
14. Same sample size means same inherent reliability. Both are plausible estimates from fair coins – the small difference is random variation.
15. Sample size is laughably small. The estimate of 1.0 from 2 trials says basically nothing about the true probability.
16. Observed ones over total rolls: $\frac{120}{600} = 0.2$. That's a bit above the theoretical $\frac{1}{6} \approx 0.167$, which is normal random variation, not proof of a loaded die.
17. Purchases over total visits: $\frac{240}{4000} = 0.06 = 6\%$. With 4000 visits this is a large, fairly reliable estimate of the conversion rate.
18. That's the formal name: experimental probability converges to theoretical probability as the number of trials grows.
19. One steady path is: $\frac{260}{500} = 0.52$. Closer to the theoretical 0.5 than a 50-flip experiment would likely get. That gives a quick check on the answer.
20. Start with the key idea: $\frac{18}{120} = 0.15$. Below the theoretical $\frac{1}{6} \approx 0.167$, but plausible noise. That gives a quick check on the answer.
21. Just divide each color count by the total trials. $P_{\text{exp}}(R) = \frac{80}{200} = 0.4$. $P_{\text{exp}}(B) = \frac{60}{200} = 0.3$. $P_{\text{exp}}(G) = \frac{60}{200} = 0.3$. The three add to 1, as they must – every draw produced one of the three colors. Red is the empirical favorite.
22. Experimental probability: $\frac{12}{400} = 0.03 = 3\%$. For the batch of 5000: multiply the rate by the batch size. $0.03 \times 5000 = 150$ defective parts expected. (That's an estimate – the actual number will vary, but 150 is the reasonable midpoint.)
23. Both classes used the same number of trials, so both estimates have the same inherent reliability. The small 52% vs. 46% difference is sampling noise, not a difference in estimate quality. A common trap: thinking "52 is closer to 50, so Class A is better." That confuses proximity to a theoretical value with the validity of the experiment itself.



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24. Start with the key idea: $P_{\text{exp}}(\text{rain}) = \frac{24}{40} = \frac{3}{5} = 0.6$. For 30 similar days: $0.6 \times 30 = 18$ rainy days expected. (This is a forecast, not a guarantee – weather varies, but 18 is the midpoint a forecaster would quote.) That gives a quick check on the answer.



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