

Experiments, Simulation and Smart Decisions

Grade 11 – Algebra 2 math · Worksheet · Standards: S-IC.A.2, S-IC.B.5, S-IC.B.6, S-MD.B.6, S-MD.B.7

Name: _____ Date: _____ Class: _____

These problems train using simulation to test models, comparing treatments in randomized experiments, evaluating reports, and making decisions with probability, matching standards S-IC.A.2, S-IC.B.5, S-IC.B.6, S-MD.B.6 and S-MD.B.7.

Early problems build simulations and read counts. Later ones judge significance and compare expected values.

Standards: S-IC.A.2, S-IC.B.5, S-IC.B.6, S-MD.B.6, S-MD.B.7 · **Level:** Grade 11 Algebra 2

Problem 1 Assign random digits (easy)

A volleyball server lands 60% of her serves in bounds. Describe how to use random digits 0-9 to simulate one serve.

Problem 2 Run a simulation by hand (easy)

Use the rule digits 0-6 = make and 7-9 = miss on this list of random digits to simulate ten shots. Count the makes.

Shot	1	2	3	4	5	6	7	8	9	
Digit	3	7	1	0	8	6	2	9	4	

Random digits for ten shots.

Problem 3 Estimate a probability from trials (easy)

In 200 trials of a simulation, at least 3 successes occurred 46 times. Estimate the probability of at least 3 successes.

Problem 4 Compare a simulation with theory (medium)

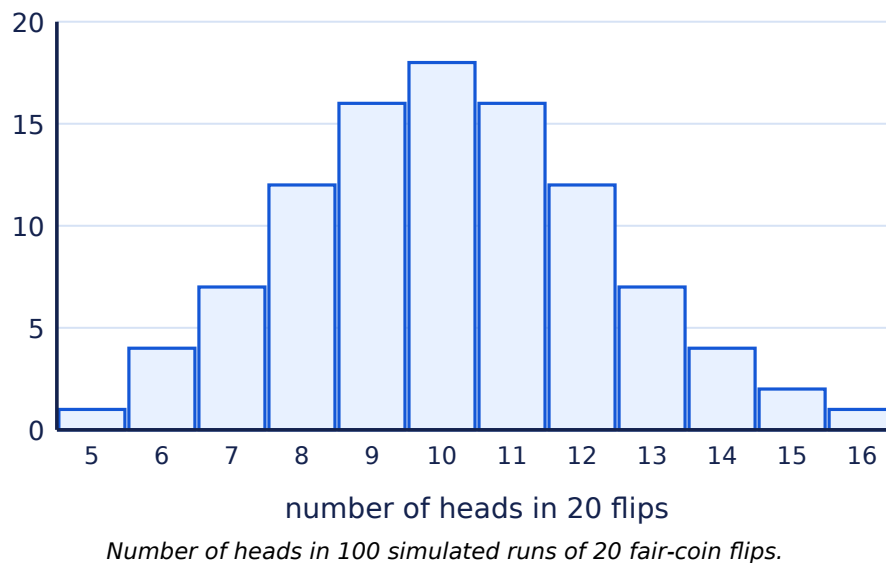
To model three-child families, a class flips a fair coin three times per family (heads = girl). In 50 simulated families, 7 had all girls. Find the experimental probability, and compare it with the theoretical probability of three girls.

Problem 5 Is the coin fair? (14 heads) (medium)

A coin lands heads 14 times in 20 flips. The histogram shows the number of heads in 100 simulated runs of 20 flips of a fair coin. How many runs had 14 or more heads, and is a fair coin

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plausible?



Problem 6 Is the coin fair? (18 heads) (medium)

Using the same simulation of 100 runs, how many runs had 18 or more heads? If a coin gave 18 heads in 20 flips, what would you conclude?

Problem 7 Parts of an experiment (medium)

Forty volunteers are randomly assigned to drink either an energy drink or plain water, and their reaction times are measured an hour later. Identify the treatments, the response variable, and the purpose of random assignment.

Problem 8 Correlation and causation (medium)

A school finds that students who eat breakfast have a higher mean GPA. Can the school conclude that breakfast raises GPA? Explain.

Problem 9 Evaluate a poll (medium)

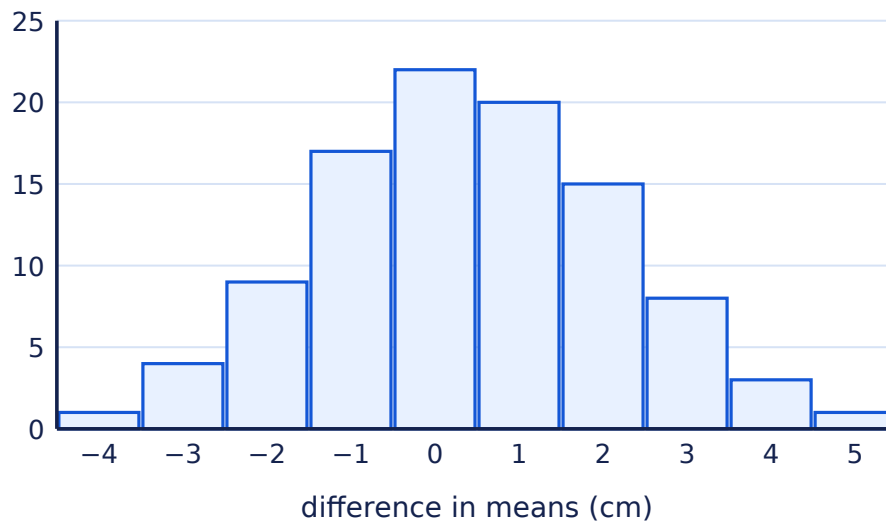
A website asks visitors, “Do you agree that our food is the best in town?” and reports that 85% of the 400 who clicked a button said yes. Give two reasons the report may be misleading.

Problem 10 Sample size and margin of error (medium)

A poll's margin of error is about $1/\sqrt{n}$. Find it for $n = 100$ and $n = 1000$, and compare.

Problem 11 Re-randomization for two fertilizers (medium)

Thirty plants were randomly split into two groups of 15 and given fertilizer A or B. Fertilizer A's group grew 4 cm more on average. The histogram shows the difference in means from 100 random re-assignments of the same plants. How often was a difference of 4 cm or more seen?



Differences in mean growth (cm) from 100 random re-assignments of the 30 plants.

Problem 12 Draw a conclusion from the simulation (medium)

Using the 4% from the previous problem and a 5% cutoff, is the difference between the fertilizers statistically significant? State your conclusion in context.

Problem 13 Choose fairly among three options (hard)

Three friends want to decide fairly who washes the car. Describe a method using one die, and give each friend's probability.

Problem 14 Is the game fair? (hard)

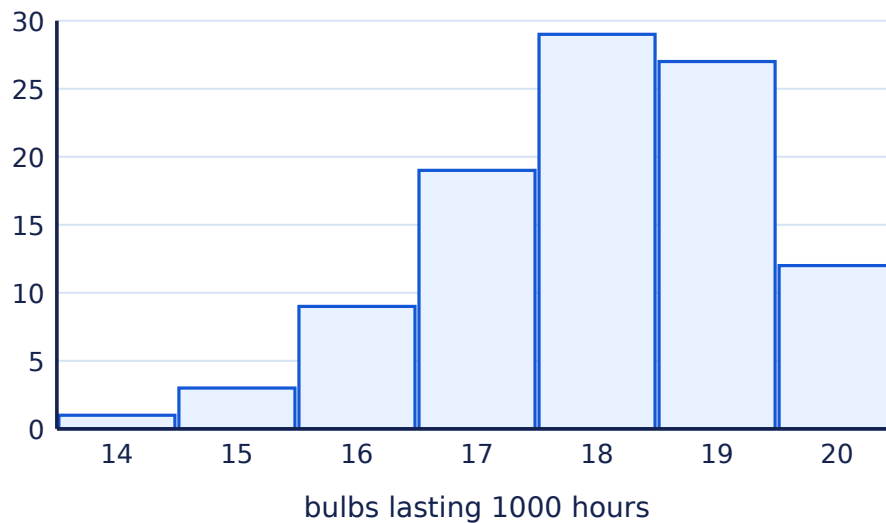
A game costs \$2 to play. You roll one die and win \$9 if it shows a 1, and nothing otherwise. Find the expected value of your winnings, the expected net value, and decide whether the game is fair.

Problem 15 Raffle expected value (hard)

A raffle sells 500 tickets at \$5 each. The prizes are one \$200 prize, two \$50 prizes and five \$20 prizes. Find the expected prize value of one ticket and the expected net value.

Problem 16 Test a manufacturer's claim (hard)

A manufacturer claims that 90% of its bulbs last 1000 hours. In a sample of 20 bulbs, only 15 lasted that long. The histogram shows the number of long-lasting bulbs in 100 simulated samples of 20 when the claim is true. Is the claim believable?



Number of bulbs lasting 1000 hours in 100 simulated samples of 20 when the true rate is 90%.

Problem 17 Warranty decision (hard)

A \$60 extended warranty covers repair costs. The chance the device needs a \$450 repair is 8%. Compare the expected repair cost with the warranty price and recommend a decision.

Problem 18 Evaluate a tutoring report (hard)

A report says a tutoring program caused scores to rise from a mean of 71 to a mean of 76, based on 12 students who chose to enroll. List three questions to ask about the study.

Problem 19 Sure thing versus gamble (hard)

Plan A pays \$550 for sure. Plan B pays \$1,000 with probability 0.6 and \$0 otherwise. Find the expected value of each and decide which has the higher expected value.

Problem 20 Compare two machines (hard)

Machine X makes a good item 92% of the time (profit \$3) and a defective item 8% of the time (loss \$5). Machine Y makes a good item 97% of the time (profit \$2.50) and a defective item 3% of the time (loss \$4). Which machine has the higher expected profit per item?