Simulating Compound Events

Explore ideas and representations

Name _____ **Date** _____ **Score** _____ / 6

QUICK REVIEW

Each practice entry is an ordered pair of independent uniform digits from 0 to 9. Match each chance with the right number of digit labels; for $1/10$, use one label. Count whole trials, not separate digits.

Worked example

Model independent stage chances $1/2$ and $1/5$. Using separate digits, how can both stages pass? Find the model chance.

1. Use 5 of 10 labels for the first chance: $5/10 = 1/2$.
2. Use 2 of 10 labels for the second chance: $2/10 = 1/5$.
3. With independent digits, both pass with chance $(5/10)(2/10) = 1/10$.

Answer: First 0 to 4, second 0 to 1; both $1/10$.

Practice Problems

Show your thinking.

1. A trial wins when its first digit is 0 to 2 and its second is 0 to 5. List winning trial numbers and find the observed rate.

Trial number: (first digit, second digit)				
$1:(6,4)$	$2:(1,9)$	$3:(2,6)$	$4:(7,4)$	$5:(5,7)$
$6:(6,6)$	$7:(7,9)$	$8:(9,1)$	$9:(8,1)$	$10:(4,6)$
$11:(1,5)$	$12:(9,1)$	$13:(0,6)$	$14:(8,7)$	$15:(8,4)$
$16:(4,6)$	$17:(6,9)$	$18:(2,0)$	$19:(5,9)$	$20:(0,4)$

2. The first check passes on an even first digit; the second passes on 7, 8, or 9. Find each check chance, the model chance both pass, and the observed both-pass rate.

Trial number: (first digit, second digit)				
$1:(4,6)$	$2:(7,1)$	$3:(9,2)$	$4:(8,9)$	$5:(3,8)$
$6:(2,8)$	$7:(4,5)$	$8:(9,9)$	$9:(7,4)$	$10:(8,2)$
$11:(2,9)$	$12:(4,6)$	$13:(4,5)$	$14:(3,6)$	$15:(4,2)$
$16:(0,0)$	$17:(7,7)$	$18:(2,7)$	$19:(6,4)$	$20:(9,9)$

3. A trial wins if exactly one digit is in 0 to 3. Explain why $(2,3)$ would fail, list winning trials, and find the observed rate.

Trial number: (first digit, second digit)				
$1:(0,1)$	$2:(4,7)$	$3:(2,8)$	$4:(3,3)$	$5:(6,6)$
$6:(1,9)$	$7:(3,4)$	$8:(7,5)$	$9:(1,1)$	$10:(5,7)$
$11:(4,4)$	$12:(0,4)$	$13:(1,6)$	$14:(7,2)$	$15:(8,8)$
$16:(6,3)$	$17:(2,5)$	$18:(3,6)$	$19:(8,6)$	$20:(5,3)$

4. A buzzer sounds if either digit is 0, including when both are 0. Find the model probability by using the complement. Then find the observed rate.

Trial number: (first digit, second digit)				
$1:(9,4)$	$2:(8,6)$	$3:(9,0)$	$4:(6,7)$	$5:(8,0)$
$6:(7,1)$	$7:(6,0)$	$8:(7,2)$	$9:(5,7)$	$10:(7,7)$
$11:(7,2)$	$12:(4,4)$	$13:(0,3)$	$14:(9,9)$	$15:(3,1)$
$16:(0,0)$	$17:(0,3)$	$18:(9,1)$	$19:(6,0)$	$20:(9,0)$

5. A trial wins if its digit sum is at least 15. Find the exact model probability, observed rate, and absolute gap.

Trial number: (first digit, second digit)				
$1:(5,5)$	$2:(8,7)$	$3:(9,0)$	$4:(2,6)$	$5:(2,9)$
$6:(0,8)$	$7:(6,5)$	$8:(6,1)$	$9:(9,9)$	$10:(1,8)$
$11:(9,7)$	$12:(1,0)$	$13:(8,1)$	$14:(0,3)$	$15:(2,0)$
$16:(4,4)$	$17:(6,1)$	$18:(1,5)$	$19:(4,8)$	$20:(6,9)$

6. A trial wins when the two digits match. Use this run to estimate the number of matches in 60 new trials. Is the estimate guaranteed?

Trial number: (first digit, second digit)				
$1:(0,4)$	$2:(9,5)$	$3:(1,4)$	$4:(4,6)$	$5:(5,7)$
$6:(5,8)$	$7:(6,2)$	$8:(5,2)$	$9:(1,8)$	$10:(0,3)$
$11:(7,7)$	$12:(6,7)$	$13:(4,1)$	$14:(8,0)$	$15:(0,7)$
$16:(9,1)$	$17:(1,0)$	$18:(1,8)$	$19:(7,7)$	$20:(4,0)$

Answer Key

1. Trials $11, 18, 20$; observed rate $\frac{3}{20}$.
2. Checks: $1/2$ and $3/10$. Both: model $\frac{3}{20}$, observed $\frac{1}{5}$.
3. $(2, 3)$ has two qualifying digits. Wins: $3, 6, 7, 12, 13, 14, 16, 17, 18, 20$; rate $\frac{1}{2}$.
4. Model $\frac{19}{100}$; observed $\frac{2}{5}$.
5. Model $\frac{1}{10}$; observed $\frac{1}{5}$; gap $\frac{1}{10}$.
6. About 6 matches, not guaranteed.

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. Keep only pairs in which both the first digit is at most 2 and the second is at most 5.
2. Winning trials: $11, 18, 20$; count 3 of 20.
3. Observed rate: $3/20 = \frac{3}{20}$.

Problem 2

1. Five even digits out of 10 give $5/10 = 1/2$. The second check uses $3/10$.
2. Multiply the independent chances: $(5/10)(3/10) = \frac{3}{20}$.
3. Winning trials: $4, 6, 11, 18$; count 4 of 20.
4. Observed rate: $4/20 = \frac{1}{5}$.

Problem 3

1. Both 2 and 3 qualify individually, so $(2, 3)$ fails the exactly-one rule.
2. Winning trials: $3, 6, 7, 12, 13, 14, 16, 17, 18, 20$; count 10 of 20.
3. Observed rate: $10/20 = \frac{1}{2}$.

Problem 4

1. No zero has chance $(9/10)(9/10) = 81/100$.
2. The buzzer probability is $1 - 81/100 = \frac{19}{100}$.
3. Winning trials: $3, 5, 7, 13, 16, 17, 19, 20$; count 8 of 20.
4. Observed rate: $8/20 = \frac{2}{5}$.

Problem 5

1. Sums $15, 16, 17, 18$ have $4, 3, 2, 1$ ordered pairs, respectively.
2. Model probability: $(4 + 3 + 2 + 1)/100 = \frac{1}{10}$.
3. Winning trials: $2, 9, 11, 20$; count 4 of 20.
4. Observed rate: $4/20 = \frac{1}{5}$.
5. Absolute gap: $|\frac{1}{5} - (\frac{1}{10})| = \frac{1}{10}$.

Problem 6

1. Keep only pairs with equal digits, such as $(4, 4)$, not $(4, 5)$.
2. Winning trials: $11, 19$; count 2 of 20.
3. Observed rate: $2/20 = \frac{1}{10}$.
4. Forecast $60(\frac{1}{10}) = 6$ matches. New random trials can differ.

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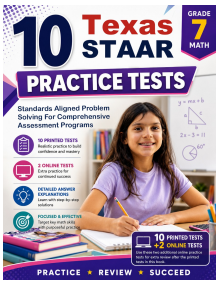

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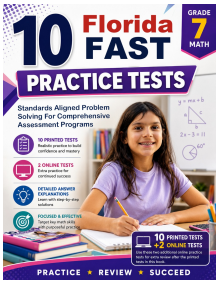

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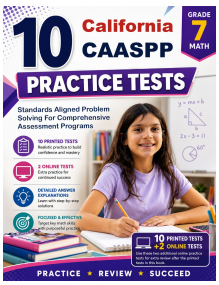

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