Compound Events

Name: _____ Date: _____ Score: _____ / 35

Quick Review

A **compound event** is built from two or more simple events. "Roll an even number on a die" is compound – it's the bundle $\{2, 4, 6\}$, not a single outcome.

Union (OR). $P(A \cup B)$ counts outcomes in A, in B, or in both. The general formula is the **inclusion-exclusion principle**: $P(A \cup B) = P(A) + P(B) - P(A \cap B)$. Subtract the overlap because it was counted once for A and once for B – twice total.

Mutually exclusive shortcut. If A and B can't both happen, $P(A \cap B) = 0$ and the formula collapses to $P(A \cup B) = P(A) + P(B)$. Drawing a single card and asking "heart or spade?" is mutually exclusive – no card is both.

Intersection (AND). $P(A \cap B)$ is the chance both happen. If A, B are independent, multiply: $P(A \cap B) = P(A)P(B)$. Otherwise use the conditional form $P(A \cap B) = P(A) \cdot P(B \mid A)$.

Complement. $P(A^c) = 1 - P(A)$. The complement of "at least one" is "none" – often the cleanest path.

Three-set inclusion-exclusion. Add singles, subtract pairs, add the triple: $P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(A \cap B) - P(A \cap C) - P(B \cap C) + P(A \cap B \cap C)$.

Common slips. Adding two probabilities that overlap (you double-count the overlap). Reporting a probability above 1 (that's the tip-off you forgot the subtraction). Treating mutually exclusive and independent as the same idea – they're opposite when both probabilities are positive.

PRACTICE

Apply the union, intersection, or complement rule as needed.

1. Mutually exclusive: $P(A) = 0.3, P(B) = 0.2$. $P(A \cup B)$ _____
2. $P(A) = 0.5, P(B) = 0.4, P(A \cap B) = 0.2$. $P(A \cup B)$ _____
3. From the survey of 30 students below, find $P(\text{math or science})$. _____

Group	Students
Like math	18
Like science	15
Like both	10
Total	30

4. $P(A) = 0.6, P(B) = 0.5,$ independent. $P(A \cap B)$ _____
5. Using the bag of marbles below, find $P(\text{red or blue})$. _____

Red	Blue	Green	Total
4	3	2	9

6. Mutually exclusive A, B, C: $P(A) = 0.4, P(B) = 0.3, P(C) = 0.2$. $P(A \cup B \cup C)$ _____
7. $P(\text{football}) = 0.6, P(\text{basketball}) = 0.45, P(\text{both}) = 0.20$. $P(\text{at least one})$ _____
8. $P(A) = 0.7$. $P(A^c)$ _____
9. Card draw. $P(\text{heart or } 7)$ _____
10. Two fair dice. $P(\text{sum} \geq 10 \text{ or doubles})$ _____
11. $P(A \cap B)$ when $P(A) = 0.5, P(B \mid A) = 0.4$ _____

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12. A fair 5-section spinner has the equal probabilities shown. Find $P(\text{odd or } > 3)$. _____

$outcome$	1	2	3	4	5
P	$\frac{1}{5}$	$\frac{1}{5}$	$\frac{1}{5}$	$\frac{1}{5}$	$\frac{1}{5}$

13. Card draw. $P(\text{face card or red})$ _____

14. $P(A) = 0.55, P(B) = 0.45, P(A \cup B) = 0.85$. $P(A \cap B)$ _____

15. Independent A, B with $P(A) = 0.5, P(B) = 0.4$. $P(A \cup B)$ _____

16. Three independent events each $p = 0.5$. $P(\text{at least one})$ _____

17. Card draw. $P(\text{ace or king})$ _____

18. $P(A \cup B) = 0.9, P(A) = 0.6, P(B) = 0.5$. $P(A \cap B)$ _____

19. Roll a die. $P(\text{even or } > 4)$ _____

20. Card draw. $P(\text{neither heart nor spade})$ _____

♦ Word Problems

21. In a class of 30 students, 18 like mathematics, 15 like science, and 10 like both. What's the probability a randomly selected student likes mathematics *or* science? ____

22. At a school, 60% of students play football, 45% play basketball, and 20% play both. What's the probability a student plays football *or* basketball? ____

23. A bag contains 4 red, 3 blue, and 2 green marbles. You draw a single marble. What's the probability the marble is red *or* blue? ____

24. A six-sided die is rolled and a fair coin is flipped. What's the probability of rolling an even number *or* flipping heads? ____

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 $7P2$. _____

33. Find $7C2$. _____

34. Probability of two heads in two coin flips. _____

35. Expected wins in 80 trials with $p = 0.25$. _____

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Answer Keys

1. $\boxed{0.5}$
2. $\boxed{0.7}$
3. $\boxed{\frac{23}{30}}$
4. $\boxed{0.30}$
5. $\boxed{\frac{7}{9}}$
6. $\boxed{0.9}$
7. $\boxed{0.85}$
8. $\boxed{0.3}$
9. $\boxed{\frac{4}{13}}$
10. $\boxed{\frac{5}{18}}$
11. $\boxed{0.20}$
12. $\boxed{\frac{4}{5}}$
13. $\boxed{\frac{8}{13}}$
14. $\boxed{0.15}$
15. $\boxed{0.70}$
16. $\boxed{\frac{7}{8}}$
17. $\boxed{\frac{2}{13}}$
18. $\boxed{0.2}$
19. $\boxed{\frac{2}{3}}$
20. $\boxed{\frac{1}{2}}$
21. $\boxed{\frac{23}{30}}$
22. $\boxed{0.85}$
23. $\boxed{\frac{7}{9}}$
24. $\boxed{\frac{3}{4}}$

Additional Practice Answers

25. $\boxed{\frac{1}{2}}$
26. $\boxed{\frac{1}{4}}$
27. $\boxed{0.63}$
28. $\boxed{0.20}$
29. $\boxed{0.8}$
30. $\boxed{56}$
31. $\boxed{24}$
32. $\boxed{42}$
33. $\boxed{21}$
34. $\boxed{\frac{1}{4}}$
35. $\boxed{20}$

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

Step-by-Step Explanations

1. Mutually exclusive means the events can't happen together, so $P(A \cap B) = 0$ and there's no overlap to remove. The union rule collapses to plain addition: $0.3 + 0.2 = 0.5$.

2. Inclusion-exclusion: $0.5 + 0.4 - 0.2 = 0.7$. The overlap of 0.2 came in twice, so subtract once.

3. Math or science count: $18+15-10 = 23$. Divide by total: $\frac{23}{30}$. The 10 students who like both got double-counted before we subtracted.

4. "And" with independent events means multiply: $P(A \cap B) = P(A)P(B) = 0.6 \times 0.5 = 0.30$. Don't add – addition is for "or" questions, not "and".

5. Colors are mutually exclusive (one marble, one color). Total marbles $4+3+2 = 9$. Red or blue: $4 + 3 = 7$. So $\frac{7}{9}$.

6. No overlaps, so add: $0.4 + 0.3 + 0.2 = 0.9$. (If any pair could co-occur, we'd subtract.)

7. One steady path is: $0.60 + 0.45 - 0.20 = 0.85$. Watch the trap: adding without subtracting gives 1.05 – a probability can't exceed 1, so that's a red flag. That gives a quick check on the answer.

8. The complement A^c is "A does not happen," and the two together cover everything, so they sum to 1. Subtract: $P(A^c) = 1 - 0.7 = 0.3$.

9. A careful way to see it: $P(\text{heart}) = \frac{13}{52}$, $P(7) = \frac{4}{52}$, overlap is the 7 of hearts $= \frac{1}{52}$. Sum: $\frac{13+4-1}{52} = \frac{16}{52} = \frac{4}{13}$. That gives a quick check on the answer.

10. Sums ≥ 10: $10, 11, 12$ give $3 + 2 + 1 = 6$ outcomes. Doubles: 6 outcomes. Overlap $(5,5)$, $(6,6)$ is 2. By inclusion-exclusion: $\frac{6+6-2}{36} = \frac{10}{36} = \frac{5}{18}$.

11. Here the events aren't independent, so use the general multiplication rule with the conditional: $P(A \cap B) = P(A) \cdot P(B \mid A) = 0.5 \times 0.4 = 0.20$. The $P(B \mid A)$ already accounts for A having happened.

12. Odd: $\{1, 3, 5\}$. Greater than 3: $\{4, 5\}$. Overlap: $\{5\}$. Count of union: $3 + 2 - 1 = 4$, out of 5. So $\frac{4}{5}$.

13. Face cards: 12. Red: 26. Overlap (red face cards): 6. $\frac{12+26-6}{52} = \frac{32}{52} = \frac{8}{13}$.

14. Rearrange the union rule $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ to solve for the overlap: $P(A \cap B) = P(A) + P(B) - P(A \cup B) = 0.55 + 0.45 - 0.85 = 0.15$. The overlap is exactly the amount the singles overcount the union.

15. One steady path is: $P(A \cap B) = 0.5 \times 0.4 = 0.20$. Then $P(A \cup B) = 0.5 + 0.4 - 0.20 = 0.70$. This is the part to check before moving on, because it keeps the answer tied to the original question.

16. Complement is cleaner: $P(\text{none}) = (0.5)^3 = \frac{1}{8}$. So $P(\text{at least one}) = 1 - \frac{1}{8} = \frac{7}{8}$.

17. A careful way to see it: Mutually exclusive (one card can't be both). $\frac{4}{52} + \frac{4}{52} = \frac{8}{52} = \frac{2}{13}$. That gives a quick check on the answer.

18. Plug into the union rule and solve for the missing overlap: $0.6 + 0.5 - P(A \cap B) = 0.9$, so $P(A \cap B) = 1.1 - 0.9 = 0.2$. The overlap is what keeps the union from exceeding 1.

19. Even $\{2, 4, 6\}$, greater than 4 $\{5, 6\}$, overlap $\{6\}$. Union $= \{2, 4, 5, 6\}$, 4 outcomes out of 6: $\frac{4}{6} = \frac{2}{3}$.

20. Neither heart nor spade leaves diamonds and clubs: 26 cards out of 52. So $\frac{26}{52} = \frac{1}{2}$. (Or use complement of "heart or spade": $1 - \frac{26}{52} = \frac{1}{2}$.)

21. Count using inclusion-exclusion: students who like math or science $= 18 +$

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$15 - 10 = 23$. The 10 students who like both were in the math count *and* the science count, so we subtract them once. Probability: $\frac{23}{30} \approx 0.767$. (A common slip: adding $18 + 15 = 33$ then writing $\frac{33}{30}$, which is bigger than 1 – a dead giveaway you forgot to subtract.)

22. Inclusion-exclusion: $P(F \cup B) = 0.60 + 0.45 - 0.20 = 0.85$. The 20% who play both got counted in both groups, so subtract once. So 85% of students play at least one of the two sports. (And 15% play neither – the complement of 0.85.)

23. The colors are mutually exclusive – one marble can't be two colors at once – so just add. Total: $4 + 3 + 2 = 9$ marbles. Red or blue: $4 + 3 = 7$. So $P(\text{red} \cup \text{blue}) = \frac{7}{9}$. Sanity check via the complement: green has probability $\frac{2}{9}$, and $1 - \frac{2}{9} = \frac{7}{9}$. Matches.

24. Start with the key idea: $P(\text{even}) = \frac{3}{6} = \frac{1}{2}$, $P(\text{heads}) = \frac{1}{2}$. The die and the coin are independent, so the overlap is $\frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$. Then $P(\text{even} \cup \text{heads}) = \frac{1}{2} + \frac{1}{2} - \frac{1}{4} = \frac{3}{4}$. (Quick check: of the 12 equally-likely die-coin outcomes, 9 have either an even number or heads – $\frac{9}{12} = \frac{3}{4}$.) That gives a quick check on the answer.

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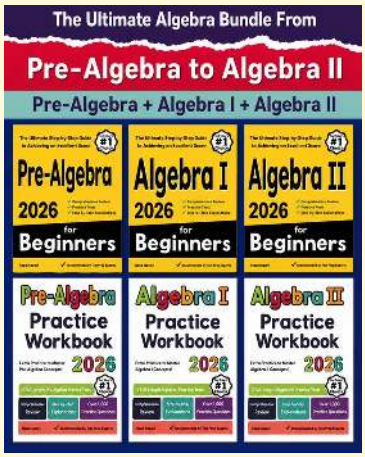

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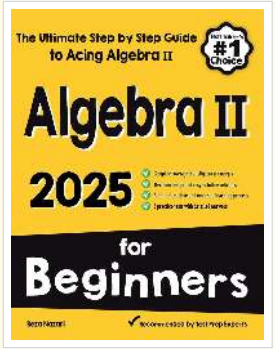

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