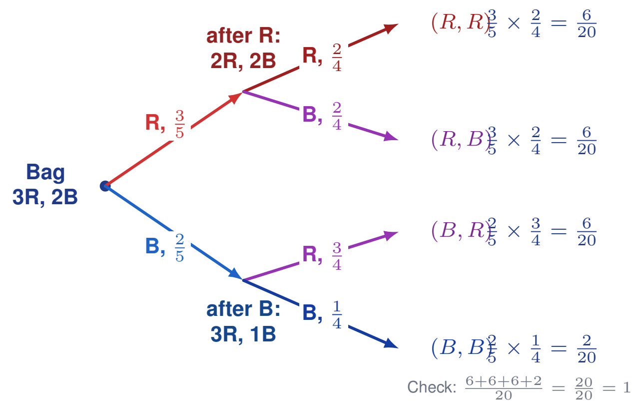
Compound Events (Dependent)

Name: ____________________	Date: ____________	Score: _____ / 17

Dependent events happen when the first outcome changes what can happen next—and this usually occurs in "without replacement" situations, because the total number of items *and* the mix of items both change after each draw. That means you must update the second probability before you multiply. Learning to notice this shift is the key to solving dependent probability problems correctly. Once you spot the dependency, the rest of the calculation is straightforward!



Key Concepts & Quick Review

Dependent events: $P(A \text{ then } B) = P(A) \times P(B \mid A)$

After the first draw (without replacement): **total decreases by 1** and the **count of the drawn color decreases by 1**. Always update both numerator and denominator before the second draw.

Examples

① A bag has 4 green and 6 yellow candies. Two are drawn without replacement. Find $P(\text{both green})$.

Think It Through: Without replacement means the second draw depends on the first, so update the bag after one green is taken. The probability of a green first is $\frac{4}{10} = \frac{2}{5}$. Then only 3 green remain out of 9 candies, so the second probability becomes $\frac{3}{9} = \frac{1}{3}$. Multiply the two stages to get $\frac{2}{5} \times \frac{1}{3} = \frac{2}{15}$.

Answer: $\frac{2}{15}$

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② Two cards are drawn from a standard deck without replacement. Find $P(\text{both aces})$ and $P(\text{ace then king})$.

Think It Through: For both aces, the first draw has probability $\frac{4}{52}$ and the second has probability $\frac{3}{51}$ because one ace has already been removed. Multiply to get $\frac{1}{221}$. For ace then king, drawing an ace first does not change the number of kings, so the second probability is still $\frac{4}{51}$. Multiplying gives $\frac{4}{663}$.

Answer: $P(AA) = \frac{1}{221}$; $P(AK) = \frac{4}{663}$

Practice Problems

All draws are WITHOUT replacement (dependent). Find each probability.

1. A bag has 3 red and 5 blue marbles. Draw twice without replacement. Find P(red, then red). __________
2. A bag has 3 red and 5 blue marbles. Draw twice without replacement. Find P(blue, then blue). __________
3. A bag has 3 red and 5 blue marbles. Draw twice without replacement. Find P(red, then blue). __________
4. A bag has 3 red and 5 blue marbles. Draw twice without replacement. Find P(blue, then red). __________
5. A bag has 4 green and 6 yellow marbles. Draw twice without replacement. Find P(green, then green). __________
6. Using the same green/yellow bag, find P(green, then yellow). __________
7. From a standard deck, draw two cards without replacement. Find P(two hearts). __________
8. From a standard deck, draw two cards without replacement. Find P(spade, then club). __________
9. From a standard deck, draw two cards without replacement. Find P(two face cards). __________
10. From a standard deck, draw two cards without replacement. Find P(two black cards). __________
11. A bag has 5 red, 3 white, and 2 blue marbles. Draw twice without replacement. Find P(red, then red). __________
12. Using that bag, find P(white, then blue). __________
13. Using that bag, find P(red, then white). __________
14. A box has 2 A tiles, 3 B tiles, and 5 C tiles. Draw twice without replacement. Find $P(A$, then $A)$. __________
15. Using that tile box, find $P(A$, then $C)$. __________

Study Tips

- **Without replacement $=$ dependent.** After each draw, *subtract 1 from the total* and *subtract 1 from the drawn category's count.*
- Draw the tree and write the updated fractions at each branch — this prevents the most common mistake (forgetting to update the denominator).
- **Check:** all final-branch probabilities must sum to exactly 1. If not, you made an arithmetic error.

Word Problems

16. A class has 12 students who want to present projects: 7 finished on time and 5 did not. The teacher randomly selects 2 students to present first. (a) What is the probability both selected students finished on time? (b) What is the probability neither finished on time? (c) What is the probability at least one finished on time? ________

17. A bag contains 4 chocolate, 3 vanilla, and 2 strawberry truffles. Nia randomly picks and eats two truffles one at a time. (a) Find $P(\text{both chocolate})$. (b) Find $P(\text{one chocolate and one vanilla, in either order})$. (c) If Nia is desperately hoping for strawberry both times, is this even possible? What is the probability? ________

Answer Keys

1) $\frac{3}{28}$
2) $\frac{5}{14}$
3) $\frac{15}{56}$
4) $\frac{15}{56}$
5) $\frac{2}{15}$
6) $\frac{4}{15}$
7) $\frac{1}{17}$
8) $\frac{13}{204}$
9) $\frac{11}{221}$
10) $\frac{25}{102}$
11) $\frac{2}{9}$
12) $\frac{1}{15}$
13) $\frac{1}{6}$
14) $\frac{1}{45}$
15) $\frac{1}{9}$
16) (a) $\frac{7}{22}$; (b) $\frac{5}{33}$; (c) $\frac{28}{33}$
17) (a) $\frac{1}{6}$; (b) $\frac{1}{3}$; (c) yes, $\frac{1}{36}$

Step-by-Step Explanations

Strategy: For Box Plots and Measures of Spread, read the five-number summary and compare IQRs before making a statement about consistency. For box plots, name the five-number summary first, then compare the spread.

Practice 1: For the data set $2, 5, 7, 8, 10, 11$, find the five-number summary and the IQR. **Answer:** min 2, Q1 5, med $\frac{15}{2}$, Q3 10, max 11, IQR 5

For the first sample, use the five-number summary and compare spread by looking at the intervals.

Practice 15: A box plot has minimum 5, $Q1 = 15$, median 25, $Q3 = 40$, and maximum 60. Find the IQR. **Answer:** 25

Late in the set, use the five-number summary and compare spread by looking at the intervals.

Word-problem notes:

16. Answer: Min 0; Q1 2; Med 4.5; Q3 6.5; Max 12; IQR $= 4.5$; range $= 12$; outlier threshold: $6.5 + 6.75 = 13.25$; 12 is NOT an outlier; right-skewed (long right whisker).

The data are already ordered. The minimum is 0 and the maximum is 12. With 12 data values, the middle sits between positions 6 and 7, so $\frac{4+5}{2} = 4.5$. The lower half is $0, 1, 2, 2, 3, 4$, so Q1 is 2. The upper half is $5, 5, 6, 7, 8, 12$, so Q3 is $\frac{6+7}{2} = 6.5$. That gives an IQR of $6.5 - 2 = 4.5$ and a range of $12 - 0 = 12$. The upper outlier fence is $6.5 + 1.5(4.5) = 13.25$, so 12 is not an outlier. The long upper side suggests the box plot is right-skewed.

17. Answer: A: min25,Q1$35$,med45,Q3$60$,max80,IQR$=25$; B: min30,Q1$32$,med38,Q3$42$,max45,IQR$=10$; A more variable.

For Stadium A, the middle value is 45, the lower-half median is 35, and the upper-half median is 60, so the IQR is $60 - 35 = 25$. For Stadium B, the five-number summary gives Q1 $= 32$, median $= 38$, and Q3 $= 42$, so the IQR is 10. Since the IQR measures the spread of the middle half of the data, the larger IQR for Stadium A means its prices are more variable.

18. Answer: Min 20, Q1 35, Med 45, Q3 60, Max 70; IQR $= 25$; range $= 50$; upper fence $= 60+1.5(25) = 97.5$, so 80 is *not* an outlier.

Read each marked location off the box plot: minimum at 20, Q_1 at 35, median at 45, Q_3 at 60, maximum at 70. So IQR $= Q_3 - Q_1 = 60 - 35 = 25$ and range $= 70 - 20 = 50$. The upper outlier fence is $Q_3 + 1.5 \times$ IQR $= 60 + 37.5 = 97.5$. Because $80 < 97.5$, the value 80 is not an upper outlier.

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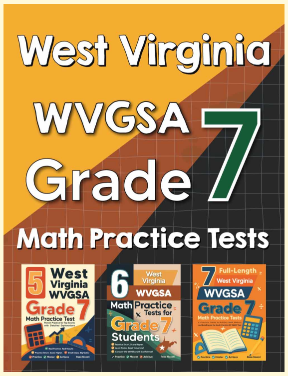

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