SELECTION OF QUICK AND BASIC PROBABILITY WORKSHEETS (With Answers)

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14-1 Counting Outcomes *(Pages 754–758)*

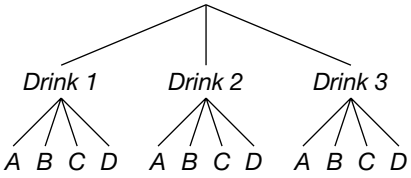
Tree diagrams and the Fundamental Counting Principle are two methods of calculating the total number of possible outcomes for any situation. A **tree diagram** is a picture that creates a list of every possible outcome. This list is called a **sample space** and each individual element of the sample space is called an **event**. The **Fundamental Counting Principle** uses multiplication to find the total number of outcomes.

Fundamental Counting Principle	If an event M can occur in m ways and is followed by event N that can occur in n ways, then the event M followed by event N can occur in $m \cdot n$ ways.

A **factorial** may be used to find the total number of outcomes of a scenario with descending amounts of choices. The factorial of n, written as $n!$, is calculated by $n \cdot (n - 1) \cdot (n - 2) \cdot \ldots \cdot 3 \cdot 2 \cdot 1$.

Examples

a. How many lunches can you choose from 3 different drinks and 4 different sandwiches?



Letter the different sandwiches A, B, C, and D.

A tree diagram shows 12 as the number of outcomes.

You could also use the Fundamental Counting Principle.

$$\underset{3}{\text{number of types of drinks}} \times \underset{4}{\text{number of types of sandwiches}} = \underset{12}{\text{number of possible outcomes}}$$

There are 12 possible outcomes.

b. Find the value of 5!.

$5! = 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1$

$5! = 120$

c. How many ways can you place 8 books on a shelf?

$8! = 8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1$

$8! = 40{,}320$

Practice

Use a tree diagram or the Fundamental Counting Principle to find the total number of outcomes.

1. A restaurant menu has a special where you can select from 3 meats, 2 vegetables and 2 drinks.

2. A soccer team's kit consists of 2 jerseys, 2 pairs of shorts, and 2 pairs of socks.

3. A pizza shop offers 10-inch, 12-inch, and 16-inch sizes with thin, thick, deep dish, or garlic crust. Also, the customer can choose a topping from extra cheese, pepperoni, sausage, mushroom, and green pepper.

4. **Standardized Test Practice** In how many ways can a group of 10 people form a line for an amusement park ride?

A 100,000 **B** 3,628,800 **C** 1,814,400 **D** 403,200

Answers: 1. 12 2. 8 3. 60 4. B

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14-2 Permutations and Combinations

(Pages 760–767)

An arrangement in which order is important is called a **permutation**. Arrangements or listings where the order is not important are called **combinations**. Working with these arrangements, you will use **factorial** notation. The symbol 5!, or 5 factorial, means $5 \cdot 4 \cdot 3 \cdot 2 \cdot 1$. The expression $n!$ means the product of all counting numbers beginning with n and counting backwards to 1. The definition of 0! is 1.

Working with Permutations and Combinations	The symbol ${}_7P_3$ means the number of permutations of 7 things taken 3 at a time. To find ${}_7P_3$ use the formula ${}_nP_r = \frac{n!}{(n-r)!}$, or $\frac{7!}{(7-3)!} \cdot \frac{5040}{24} = 210$. The symbol ${}_7C_3$ means the number of combinations of 7 things taken 3 at a time. To find ${}_7C_3$ use the formula ${}_nC_r = \frac{n!}{(n-r)!r!}$, or $\frac{7!}{(7-3)!3!} \cdot \frac{5040}{144} = 35$.

Examples

a. Find ${}_5P_3$

${}_5P_3 = 5 \cdot 4 \cdot 3$ or 60

${}_5P_3 = \frac{5!}{(5-3)!} = \frac{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{2 \cdot 1} = 60$

b. Find ${}_5C_3$

First find the value of ${}_5P_3$ or $\frac{5!}{(5-3)!3!}$.

From Example A, you know that ${}_5P_3$ is 60.

Divide 60 by 3!. This is $\frac{60}{6}$ or 10.

c. Fred plans to buy 4 tropical fish from a tank at a pet shop. Does this situation represent a permutation or a combination? Explain.

This situation represents a combination. The only thing that matters is which fish he selects. The order in which he selects them is irrelevant.

Practice

Tell whether each situation represents a permutation or combination.

1. a stack of 18 tests

2. two flavors of ice cream out of 31 flavors

3. 1st-, 2nd-, and 3rd-place winners

4. 20 students in a single file line

How many ways can the letters of each word be arranged?

5. RANGE

6. QUARTILE

7. MEDIAN

Find each value.

8. ${}_5P_2$

9. ${}_{10}P_3$

10. 7!

11. 9!

12. ${}_7C_2$

13. ${}_{12}C_3$

14. $\frac{5!2!}{3!}$

15. $\frac{8!4!}{7!3!}$

16. **Standardized Test Practice** If there are 40 clarinet players competing for places in the district band, how many ways can the 1st and 2nd chairs be filled?

A 40!

B $40 \cdot 39$

C $\frac{40 \cdot 39}{2!}$

D 2

Answers: **1.** permutation **2.** combination **3.** permutation **4.** permutation **5.** 120 ways **6.** 40,320 ways **7.** 720 ways **8.** 20 **9.** 720 **10.** 5040 **11.** 362,880 **12.** 21 **13.** 220 **14.** 40 **15.** 32 **16.** B

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14-3 Probability of Compound Events *(Pages 769–776)*

A **compound event** consists of two or more simple events. When one event *does not* affect the others, we say that these are **independent events**. If the outcome of an event *does* affect the outcome of another event, we say that these are **dependent events**.

Examples **A bag contains 4 red marbles, 5 blue marbles, and 3 green marbles. Two marbles are picked at random. Find each probability.**

a. 2 red marbles if the first marble is returned before the second is chosen

Since the first marble is returned before the second one is chosen, the events are independent.

$P(\text{red}) = \frac{4}{12}$ or $\frac{1}{3}$

$P(\text{red, then red}) = \frac{1}{3} \cdot \frac{1}{3}$ or $\frac{1}{9}$

b. 2 red marbles if the first marble is *not* returned before the second is chosen

Since the first marble is not *returned before the second one is chosen, the events are dependent.*

$P(\text{red}) = \frac{4}{12}$ or $\frac{1}{3}$

$P(\text{red after one red is selected}) = \frac{3}{11}$

$P(\text{red, then red}) = \frac{1}{3} \cdot \frac{3}{11}$ or $\frac{1}{11}$

Practice

1. **School** Eva forgot to study one of the chapters for her history test so she had to guess on two multiple-choice questions which each had four answer choices. What is the probability that she got both questions correct?

2. During a magic trick, a magician randomly selects two cards from a standard deck of cards.
   a. Find the probability both cards are clubs if the first card is returned to the deck before the second card is selected.
   b. Find the probability both cards are clubs if the first card is not returned to the deck before the second card is selected.

3. **Gift Wrapping** A gift-wrapping service offers the following choices.
   Paper: Sunflowers, Stripes, Spirals, Silver, Plaid
   Ribbon: White, Silver, Yellow, Gold
   a. What is the probability that a customer who chooses at random will choose sunflower paper and yellow ribbon?
   b. If you choose at random, what is the probability of selecting paper with either stripes or spirals with white ribbon?

4. **Standardized Test Practice** The probability that Tara will make a free throw is $\frac{3}{4}$. What is the probability that Tara will make her next two free throws?

   A $\frac{3}{4}$ **B** $\frac{1}{2}$ **C** $\frac{9}{16}$ **D** $\frac{3}{8}$

Answers: 1. $\frac{1}{16}$ 2a. $\frac{1}{16}$ 2b. $\frac{1}{17}$ 3a. $\frac{1}{20}$ 3b. $\frac{1}{10}$ 4. C

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14-5 Probability Simulations *(Pages 782–788)*

The type of probability that you have used so far is **theoretical probability**, which is calculated by dividing the number of favorable outcomes by the number of total possible outcomes. Probability can also apply to the actual data that is collected by conducting an experiment. This type of probability is called **experimental probability**. Experimental probability is a ratio that compares the **relative frequency**, or the number of times a favorable outcome occurred, with the total number of times the experiment was conducted. Performing an experiment many times, recording data, and analyzing results is called an **empirical study**. When conducting an empirical study with an event that may be unrealistic to perform, you can use a **simulation**, or similar experiment with the same probability as the desired experiment.

Calculating Theoretical Probability	$P(\text{event}) = \frac{\text{the number of favorable outcomes}}{\text{the number of possible outcomes}}$
Calculating Experimental Probability	$P(\text{event}) = \frac{\text{the relative frequency of favorable events}}{\text{total number of events}}$

Examples

A Number Cube is Rolled 20 Times	
Number Rolled	**Frequency**
1	2
2	5
3	3
4	8
5	1
6	1

a. What is the theoretical probability of rolling a 6 on a number cube?

$P(6) = \frac{1}{6}$

$P(6) = 16.\overline{6}\%$

b. According to the data, what is the experimental probability of rolling a 6 on a number cube?

$P(6) = \frac{1}{20}$

$P(6) = 5\%$

Practice

A card is drawn from a standard deck of 52 playing cards. This process is repeated a total of 100 times. The results have been recorded in the table. Use this information for Exercises 1–3.

Clubs	22
Diamonds	17
Hearts	31
Spades	30

1. What is the experimental probability of drawing a club?

2. What is the experimental probability of drawing a diamond or a spade?

3. **Standardized Test Practice** What is the theoretical and experimental probability of drawing a heart or a club?

A 50%, 53% **B** 25%, 31% **C** 25%, 22% **D** 50%, 48%

Answers: 1. 22% 2. 47% 3. A

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14

Chapter Review

Hidden Picture

Find each value.

1. 5!

2. 8!

3. ${}_{10}P_4$

4. ${}_7P_2$

5. ${}_5C_3$

6. ${}_8C_5$

7. the number of sandwiches that can be made if a person must choose one out of 3 different types of meat, one out of 2 different types of cheese, and one out of 4 different types of bread

8. the number of outfits that can be worn if a person must choose one out of 5 pairs of slacks, one out of 6 shirts, and one out of 2 jackets

9. the number of ways 6 children can form a line

10. the number of ways to choose the first 3 batters from 9 baseball players

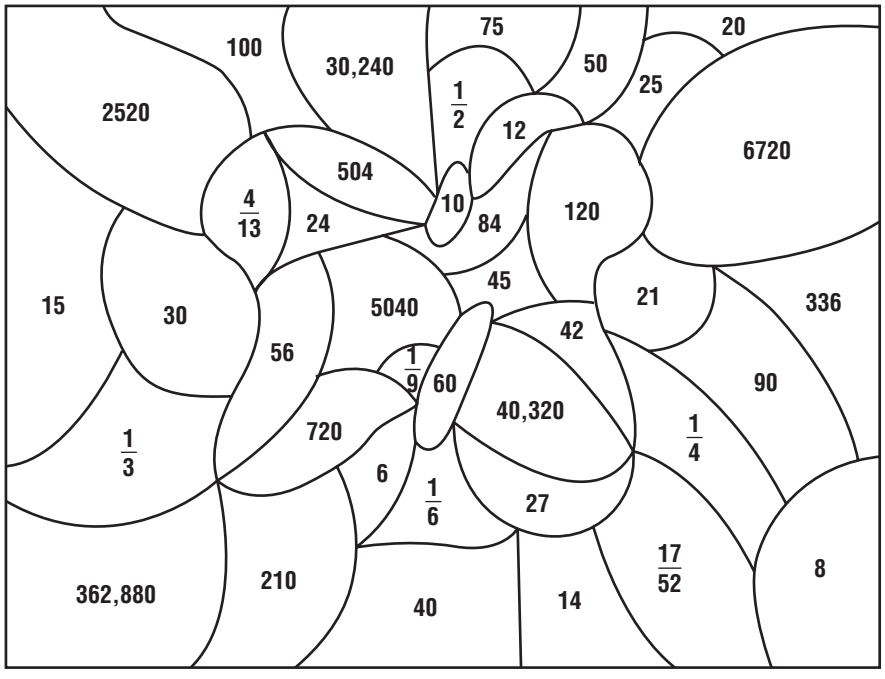
11. the number of ways to choose 2 committee members from 10 students

12. the number of ways to choose 3 types of candy bars out of 9 types of candy bars to sell for the band fundraiser

13. the probability that a card chosen at random from a standard deck of cards is either an ace or a club

14. the probability that a die is rolled twice and both times the number is less than 3

Shade in each region containing an answer to the Exercises 1–14. What do you see?



Answers are located in the Answer Key.