

Here are the choices for each of the ten groups of items:

Area Code

8	10	10
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Local Telephone Number

8	10	10	10	10	10	10	10
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We use the Fundamental Counting Principle to determine the number of different telephone numbers that are possible. The total number of telephone numbers possible is

$$8 \cdot 10 \cdot 10 \cdot 8 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 = 6,400,000,000.$$

There are six billion four hundred million different telephone numbers that are possible.



6 An electronic gate can be opened by entering five digits on a keypad containing the digits 0, 1, 2, 3, ..., 8, 9. How many different keypad sequences are possible if the digit 0 cannot be used as the first digit?

EXERCISE SET 11.1 ●●●●●●

• Practice and Application Exercises

Solve Exercises 1–6 using the Fundamental Counting Principle with two groups of items.

- A restaurant offers 8 appetizers and 10 main courses. In how many ways can a person order a two-course meal?
- The model of the car you are thinking of buying is available in nine different colors and three different styles (hatchback, sedan, or station wagon). In how many ways can you order the car?
- A popular brand of pen is available in three colors (red, green, or blue) and four writing tips (bold, medium, fine, or micro). How many different choices of pens do you have with this brand?
- In how many ways can a casting director choose a female lead and a male lead, from five female actors and six male actors?
- A student is planning a two-part trip. The first leg of the trip is from San Francisco to New York, and the second leg is from New York to Paris. From San Francisco to New York, travel options include airplane, train, or bus. From New York to Paris, the options are limited to airplane or ship. In how many ways can the two-part trip be made?
- For a temporary job between semesters, you are painting the parking spaces for a new shopping mall with a letter of the alphabet and a single digit from 1 to 9. The first parking space is A1 and the last parking space is Z9. How many parking spaces can you paint with distinct labels?

Solve Exercises 7–22 using the Fundamental Counting Principle with three or more groups of items.

- An ice cream store sells two drinks (sodas or milk shakes), in four sizes (small, medium, large, or jumbo), and five flavors (vanilla, strawberry, chocolate, coffee, or pistachio). In how many ways can a customer order a drink?
- A pizza can be ordered with three choices of size (small, medium, or large), four choices of crust (thin, thick, crispy, or regular), and six choices of toppings (ground beef, sausage, pepperoni, bacon, mushrooms, or onions). How many one-topping pizzas can be ordered?

- A restaurant offers the following limited lunch menu.

Main Course	Vegetables	Beverages	Desserts
Ham	Potatoes	Coffee	Cake
Chicken	Peas	Tea	Pie
Fish	Green beans	Milk	Ice cream
Beef		Soda	

If one item is selected from each of the four groups, in how many ways can a meal be ordered? Describe two such orders.

- An apartment complex offers apartments with four different options, designated by A through D.

A	B	C	D
one bedroom	one bathroom	first floor	lake view
two bedrooms	two bathrooms	second floor	golf course view
three bedrooms			no special view

How many apartment options are available? Describe two such options.

- Shoppers in a large shopping mall are categorized as male or female, over 30 or 30 and under, and cash or credit card shoppers. In how many ways can the shoppers be categorized?
- There are three highways from city A to city B, two highways from city B to city C, and four highways from city C to city D. How many different highway routes are there from city A to city D?
- A person can order a new car with a choice of six possible colors, with or without air conditioning, with or without automatic transmission, with or without power windows, and with or without a CD player. In how many different ways can a new car be ordered with regard to these options?
- A car model comes in nine colors, with or without air conditioning, with or without a sun roof, with or without automatic transmission, and with or without antilock brakes. In how many ways can the car be ordered with regard to these options?

15. You are taking a multiple-choice test that has five questions. Each of the questions has three answer choices, with one correct answer per question. If you select one of these three choices for each question and leave nothing blank, in how many ways can you answer the questions?
16. You are taking a multiple-choice test that has eight questions. Each of the questions has three answer choices, with one correct answer per question. If you select one of these three choices for each question and leave nothing blank, in how many ways can you answer the questions?
17. In the original plan for area codes in 1945, the first digit could be any number from 2 through 9, the second digit was either 0 or 1, and the third digit could be any number except 0. With this plan, how many different area codes are possible?
18. The local seven-digit telephone numbers in Inverness, California, have 669 as the first three digits. How many different telephone numbers are possible in Inverness?
19. License plates in a particular state display two letters followed by three numbers, such as AT-887 or BB-013. How many different license plates can be manufactured for this state?
20. How many different four-letter radio station call letters can be formed if the first letter must be W or K?
21. A stock can go up, go down, or stay unchanged. How many possibilities are there if you own seven stocks?
22. A social security number contains nine digits, such as 074-66-7795. How many different social security numbers can be formed?

• Writing in Mathematics

23. Explain the Fundamental Counting Principle.
24. Figure 11.2 on page 609 shows that a tree diagram can be used to find the total number of outfits. Describe one

advantage of using the Fundamental Counting Principle rather than a tree diagram.

25. Write an original problem that can be solved using the Fundamental Counting Principle. Then solve the problem.

• Critical Thinking Exercises

26. How many four-digit odd numbers are there? Assume that the digit on the left cannot be 0.
27. In order to develop a more appealing hamburger, a franchise used taste tests with 12 different buns, 30 sauces, 4 types of lettuce, and 3 types of tomatoes. If the taste test was done at one restaurant by one tester who took 10 minutes to eat each hamburger, approximately how long would it take the tester to eat all possible hamburgers?

• Group Exercise

28. The group should select real-world situations where the Fundamental Counting Principle can be applied. These can involve the number of possible student ID numbers on your campus, the number of possible phone numbers in your community, the number of meal options at a local restaurant, the number of ways a person in the group can select outfits for class, the number of ways a condominium can be purchased in a nearby community, and so on. Once situations have been selected, group members should determine in how many ways each part of the task can be done. Group members will need to obtain menus, find out about telephone-digit requirements in the community, count shirts, pants, shoes in closets, visit condominium sales offices, and so on. Once the group reassembles, apply the Fundamental Counting Principle to determine the number of available options in each situation. Because these numbers may be quite large, use a calculator.

SECTION 11.2 • PERMUTATIONS

OBJECTIVES

1. Use the Fundamental Counting Principle to count permutations.
2. Evaluate factorial expressions.
3. Use the permutations formula.
4. Find the number of permutations of duplicate items.



Ladies and gentlemen: Please give a huge round of applause for

U2! Bruce Springsteen and the E Street Band!
Aerosmith! The Rolling Stones!

You are in charge of planning one of the most anticipated concert tours of the decade. All four of these groups will appear in concert, which will be seen in a pay-per-view cable special by millions of people throughout the world. One of your jobs is to determine the order in which the groups will perform. Each group will perform once. How many different ways can you put together this four-group concert?

You are familiar with the work of all these musicians *and* you know the Fundamental Counting Principle! (Who could be better qualified for this job?) You can choose any of the four groups as the first performer. Once you've chosen the first

1 Use the Fundamental Counting Principle to count permutations.