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Using Counting Principles



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The Multiplication Counting Principle

- If one event occur in m ways and another event can occur in n ways, then the number of ways that both events can occur is $m \cdot n$. This principle can be extended to three or more events



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- Skateboards

At a sporting goods store, skateboards are available in 8 different deck designs. Each deck design is available with 4 different wheel assemblies. How many skate boards choices does the store offer?

- You can use the multiplication counting principle to find the number of skateboard choices. Multiply the number of deck designs (8) and the number of wheel assemblies (4).
- The store offers $8 * 4 = 32$ skateboard choices



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The Addition Counting Principle

- If the possibilities being counted can be divided into groups with no possibilities in common, then the total number of possibilities is the sum of the numbers of possibilities in each group.



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- Codes
- Every purchase made on a company's website is given a randomly generated confirmation code. The code consist of 3 symbols (letters and digits). How many codes can be generated if at least one letter is used in each?

- To find the number of codes, find the sum of the number of possibilities for the 1 letter codes, 2 letter codes, and 3 letter codes.



James Madison HIGH SCHOOL 1 letter

- There are 26 choices for each letter and 10 choices for each digit. So there are $26 * 10 * 10 = 2600$ letter-digit-digit possibilities. The letters can be in any of the three positions, so there are $3 * 2600 = 7800$ possibilities



James Madison HIGH SCHOOL 2 letters

- There are $26 * 26 * 10 = 6760$ letter-letter-digit possibilities. The letters can be in any of the three positions, so there are $3 * 6760 = 20,280$ possibilities



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3 letters

- There are $26 * 26 * 26 = 17,576$ letter-letter-letter possibilities.



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- So there are $7800 + 20,280 + 17576 = 45656$ possibilities.



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Fundamental Counting Principle

- The ***fundamental counting principle*** states that if one event can occur in m ways and a
- second event can occur in n ways, then the number of ways that both events can occur is
- mn ways. If there is a third event that can occur in p ways, then the number of ways that
- all three events can occur is mnp ways. The fundamental counting principle can be
- extended to any number of events. It can also be used in a situation with or without
- replacement.



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Example:

- You are asked to type a pass code in order to gain access to an Internet site. You can use
- the digits 0 to 9 and the letters A to Z. To find the number of different possible pass codes
- of 1 digit followed by 3 letters when you can use a letter more than one time,
- multiply $10 \times 26 \times 26 \times 26 = 175,560$.
- There are 10 different digits for the first position and 26 different letters for the second,
- third, and fourth positions.



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Example:

- You are asked to type a pass code in order to gain access to an Internet site. You can use
- the digits 0 to 9 and the letters A to Z. To find the number of different possible pass codes
- of 1 digit followed by 3 letters when you can NOT use a letter more than once, multiply
- $10 \times 26 \times 25 \times 24 = 156,000$.
- There are 10 different digits for the first position, 26 different letters for the second
- position, 25 different letters for the third position, and 24 different letters for the fourth
- position.



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On your Own

- Drake can choose from 31 flavors of ice cream. He wants to get a bowl with four scoops of ice cream.
- Each of the four scoops of ice cream will be a different flavor.
- How many different bowls of four scoops of ice cream are possible?



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- The event of selecting a flavor of ice cream after the first selection is dependent on the
- previous event, since each scoop of ice cream will be a different flavor.
- • Scoop 1 has 31 options.
- • Scoop 2 has $31 - 1 = 30$ options.
- • Scoop 3 has $30 - 1 = 29$ options.
- • Scoop 4 has $29 - 1 = 28$ options.
- Multiply $31 \times 30 \times 29 \times 28 = 755,160$ different bowls of four scoops of ice cream.



James Madison HIGH SCHOOL On Your Own

- There are 14 students in a mathematics competition. Each student will earn points during the competition. The student with the greatest number of points will be the first place winner, and the student with the second greatest number of points will be the second place winner.
- How many different ways can the 14 students finish in first place and second place?
- A. 27
- B. 91
- C. 182
- D. 196