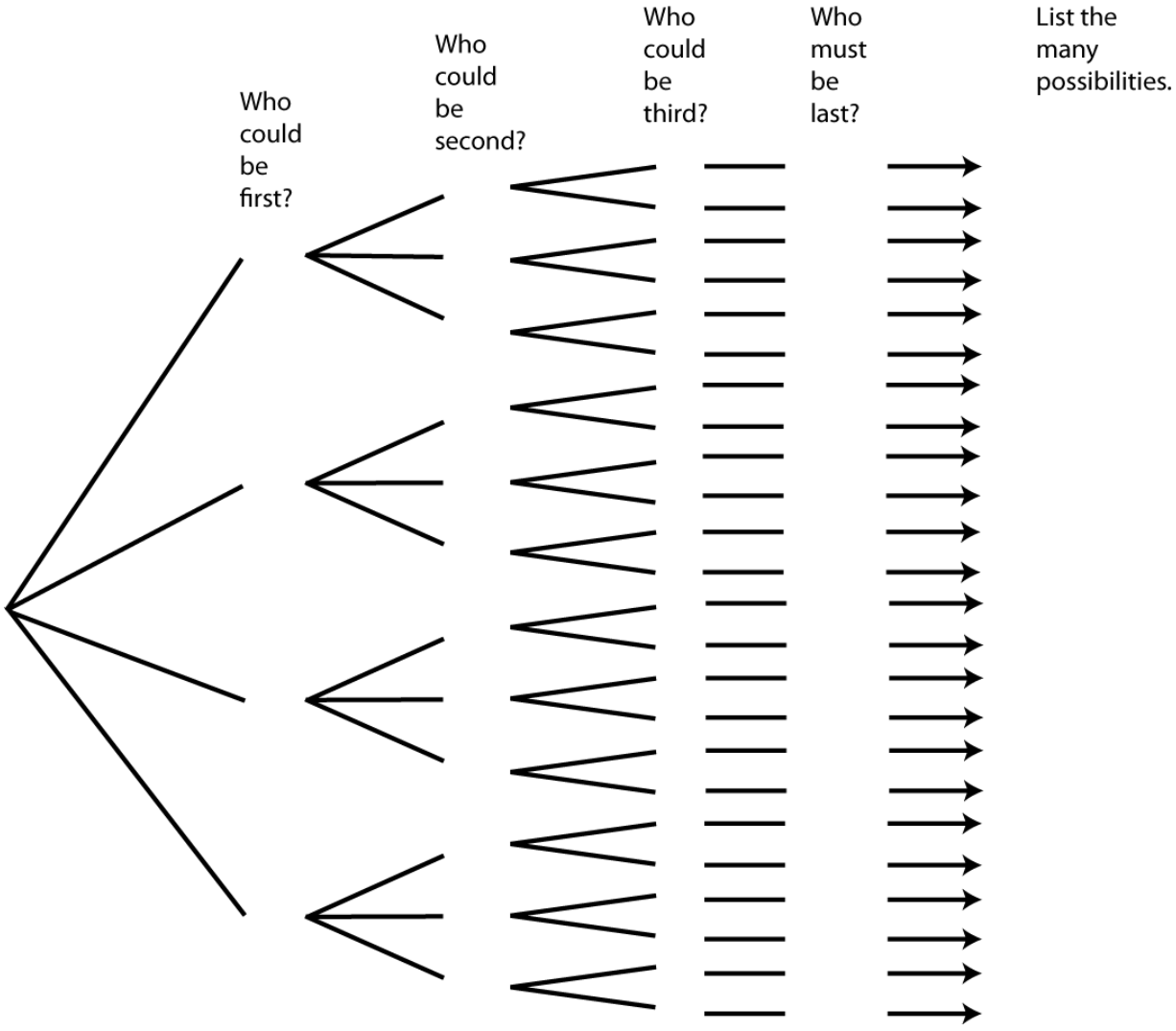
The Fundamental Counting Principle NAME:

Abby, Bob, Cathy, and Doug are lining up outside of a theatre to buy tickets to a show. How many ways can this happen? We will investigate the many possibilities for the order of this line.

1. Write down one possible order for these four people to buy tickets.

2. Fill in the tree diagram to draw out and organize the possibilities for the $1^{st}$, $2^{nd}$, $3^{rd}$, and $4^{th}$ places in line at the theatre. The first branching should represent the first person in line; the second branching should represent the second person in line, and so on.




3. Use your tree diagram to write out the many possibilities (of all four places) to the far right. How many possibilities are there?

4. **The Fundamental Counting Principle tells us how many possibilities we should have.** It states that if you have a task (like lining people up outside a theatre) that takes $k$ parts (like $k$ places in line), and the first part can be done in $n_1$ ways, the second part can be done in $n_2$ ways, … the $k^{th}$ part can be done in $n_k$ ways, then the number of ways you can do the task is $n_1 * n_2 * n_3 * ..... * n_k$ .

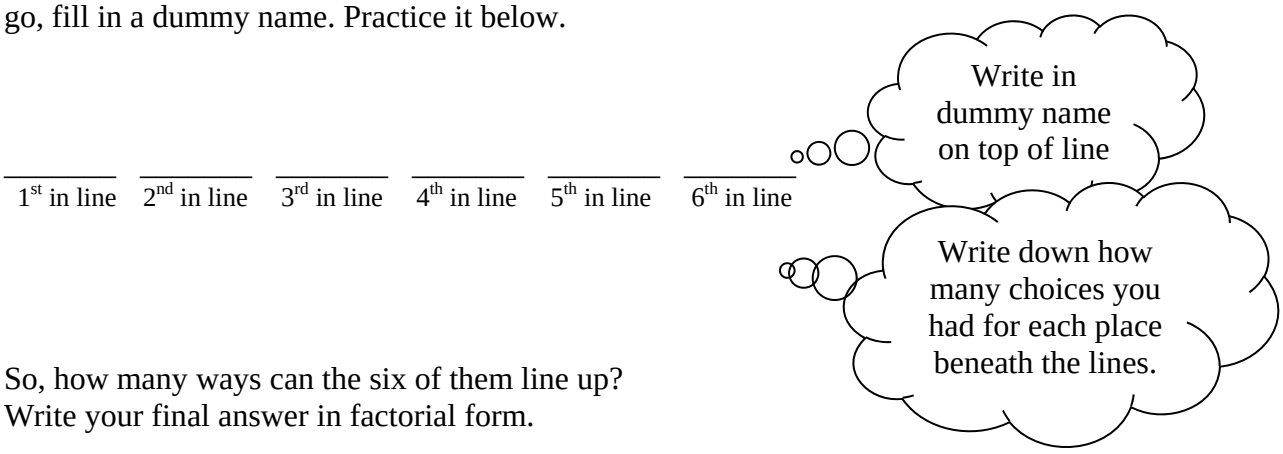
Now, in our problem, $k$ is 4, the number of places in line. When you place the first person in line, there are 4 people to choose from. When you place the second person in line, there are only 3 people to choose from, since the first person is already standing in line. When you place the third person, there are 2 people to choose from. When you place the fourth person in line, there is only 1 person to choose from.

Show that the Fundamental Counting Principle finds the number of possibilities you found in question 3.

Notice this answer could be thought of as 4! ("four factorial")

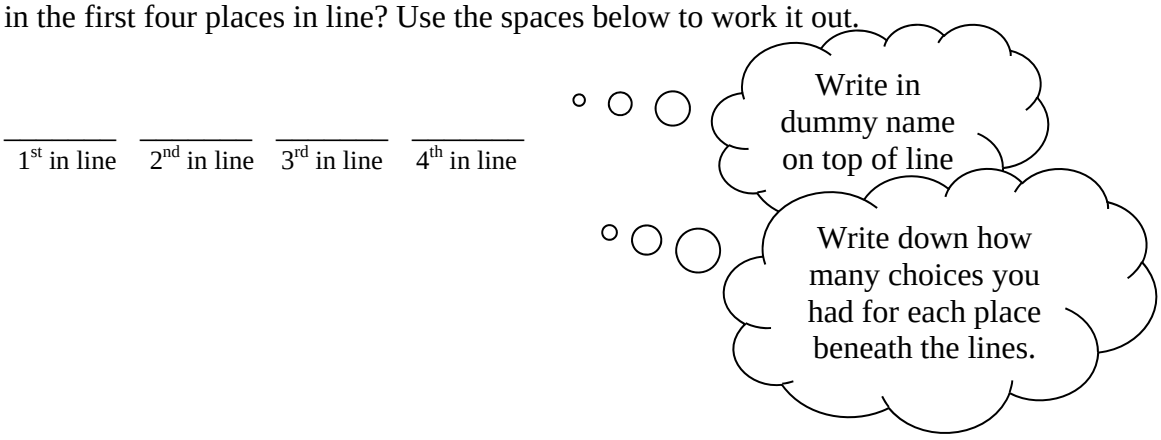
5. Let's mix up the problem a bit. What if Edgar and Fred come by and stand in line with them? How many ways can the six of them line up? Let's think about it together.

A good way to think through these problems is to draw spaces for each part of the task (like the six places in line) and ask yourself how many ways can each be filled? As you go, fill in a dummy name. Practice it below.

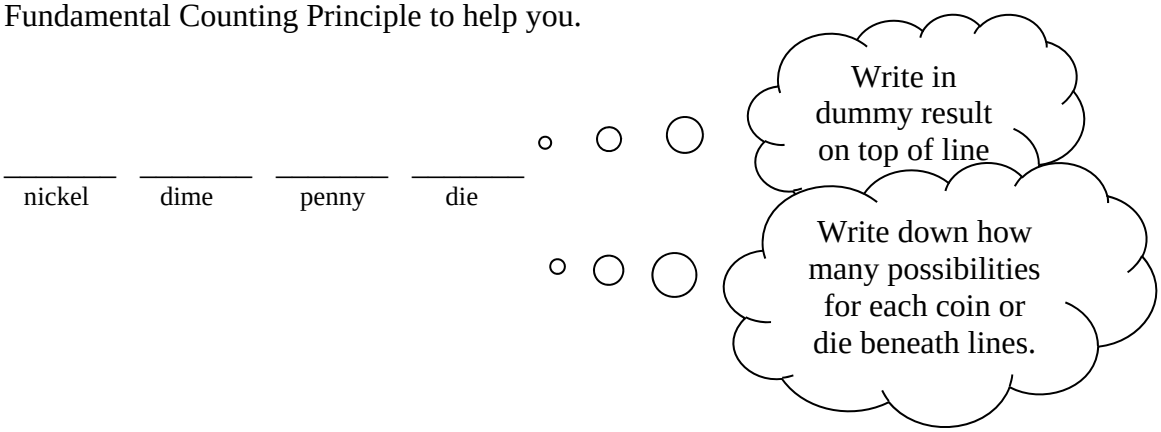



So, how many ways can the six of them line up?
Write your final answer in factorial form.

6. Suppose only the first four places will be able to buy tickets. If the six people (Abby, Bob, Cathy, Doug, Edgar, and Fred) show up, how many ways can four of them line up in the first four places in line? Use the spaces below to work it out.




7. Three coins (a nickel, a dime, and a penny) and a fair, six-sided die are tossed into the air. Whether a heads or tails shows on each coin and the number on the die will be recorded. How many different results are possible? Use the spaces below and the Fundamental Counting Principle to help you.




8. A menu is reproduced below. A special is underway where a customer can order one appetizer, one entree, and one dessert for the low, low price of $12.95. How many different ways can this be done?

| **Appetizers** | **Entrees** | **Desserts** |
|---|---|---|
| Clam sampler | Fried Calamari | Chocolate cake |
| Shrimp cocktail | Lemon Zested Salmon | Cherry pie |
| Mozzarella sticks | Curried Chicken | |
| | Beef a la Teriyaki | |
| | Vegetarian Delight | |

9. An algebra test has four multiple-choice questions with five answers each followed by three true-false questions. How many answer sheets are possible? Write down a dummy answer sheet. Use it to explain your answer.

10. Ten people are competing in a dance competition. How many ways could the top three positions be chosen? Explain your answer.