

**Math Domain**

- |  |   |   |
|--|---|---|
| <input type="checkbox"/> Number/Quantity | <input type="checkbox"/> Shape/Space            | <input type="checkbox"/> Function/Pattern |
| <input type="checkbox"/> Chance/Data     | <input checked="" type="checkbox"/> Arrangement |   |

**Math Actions** (possible weights: 0 through 4)

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|--|--|
| <input type="checkbox"/> 2 Modeling/Formulating          | <input type="checkbox"/> 2 Manipulating/Transforming |
| <input type="checkbox"/> 3 Inferring/Drawing Conclusions | <input type="checkbox"/> 2 Communicating             |

**Math Big Ideas**

- |  |   |  |
|--|---|--|
| <input type="checkbox"/> Scale         | <input type="checkbox"/> Reference Frame    | <input checked="" type="checkbox"/> Representation |
| <input type="checkbox"/> Continuity    | <input type="checkbox"/> Boundedness        | <input type="checkbox"/> Invariance/Symmetry       |
| <input type="checkbox"/> Equivalence   | <input type="checkbox"/> General/Particular | <input type="checkbox"/> Contradiction             |
| <input type="checkbox"/> Use of Limits | <input type="checkbox"/> Approximation      | <input type="checkbox"/> Other                     |

The intent of this task is to have students demonstrate their ability to organize information and to enumerate arrangements determined by Cartesian products.

All of the questions are subject to interpretation of what choices of garnish are available: 1) either one of the garnishes is available for each sandwich, 2) both garnishes could be combined on a sandwich, or 3) a sandwich can have no garnish.

1. The answer to this question will depend entirely on the choice made about available garnish; either 2 kinds (with lettuce or tomato), 3 kinds (with lettuce, or tomato, or lettuce and tomato), or 4 kinds (lettuce, or tomato, or lettuce and tomato, or no garnish).
2. For each choice of bread there are 2, 3, or 4 choices of garnish. Since there are 3 possible breads, there are 6, 9 or 12 possible combinations.
3. This question gets directly at the idea of how the garnishes are counted

According to Aunt Millie there can be 4 (salmon, roast beef, ham, tuna) x 3 (rye, white, French) x 2 (lettuce, tomato) = 24 kinds of sandwich.

According to Uncle Mel there can be 4 (salmon, roast beef, ham, tuna) x 3(rye, white, French) x 3 (lettuce, tomato, nothing added **or** lettuce & tomato) = 36 kinds of sandwich.

According to the customer there can be 4 (salmon, roast beef, ham, tuna) x 3 (rye, white, French) x 4 (lettuce, tomato, lettuce & tomato, no garnish) = 48 kinds of sandwich.

**Extension:**

Assuming that the 3 garnishes are counted as yielding 7 possibilities, there will be 8 fillings x 5 breads x 7 garnishes or 280 different sandwiches. It would take a little over a year to eat a different sandwich every weekday.

	<b>partial level</b>	<b>full level</b>
<b>Modeling/ Formulating (weight: 2)</b>	Attempt to make an exhaustive list of kinds of sandwiches, with no evidence of systematic organization.	Come up with a consistent and systematic counting scheme, (most probably a Cartesian product of bread x garnish x filling).
<b>Transforming/ Manipulating (weight: 2)</b>	Correctly compute some of the results.	Correctly compute all of the results, and have all answers consistent with respect to choice of garnish possibilities.
<b>Inferring/ Drawing Conclusions (weight: 3)</b>	Perform a complete, consistent analysis of either the two or the three possibilities for garnish	Perform a clear, consistent analysis of the four possibilities for garnish.
<b>Communicating (weight: 2)</b>	List results but present no explanation or defense for any of the answers.	Present a reasoned argument in defense of any one of the positions, and clearly communicate that the choice of garnish is the key element in the different answers.