## **Review of the Fundamental Counting Principle**

### **Example 1:**

Determine how many possible ways we can arrange the letter A, B and C using the Fundamental Counting Principle.



### Example 2:

(A) In how many different ways can a set of 5 distinct books be arranged on a shelf?

$$\# possibilities: \underline{S} \times \underline{4} \times \underline{3} \times \underline{2} \times \underline{1} \\ = 120$$

(B) In how many different orders can 15 different people stand in a line?

Notice that in each of the previous examples, we ended up taking the total numbers of tasks, and multiplied it by each of the natural numbers below it.

 $5 \times 4 \times 3 \times 2 \times 1 = 120$ 

Since this often happens in counting problems, it is useful to use something called **Factorial Notation** to speed up the calculations.

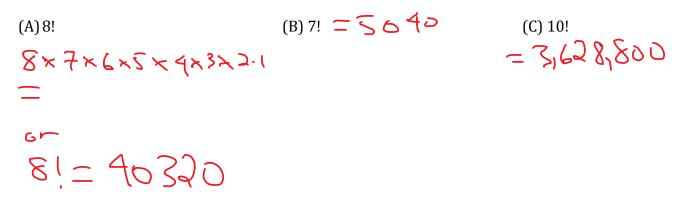
The symbol for factorial is *n*!, where *n* is a natural number. When we take the factorial of a number, we are multiplying the number by all of the natural numbers below it.

$$4! = 4 \times 3 \times 2 \times 1 = 24$$

In general:

$$n! = n(n-1)(n-2)(n-3) \dots (3)(2)(1), n \in \mathbb{N}$$
  
ic  $l \supseteq = l \supseteq (9)(8) \dots (3)(2)(1)$ 

**Example 3:** Evaluate the following:



Instead of us writing all of this out and doing the multiplication by hand, we can use the factorial button on our calculators. Find it now and redo Example 3.

# **Simplifying Expressions Using Factorials**

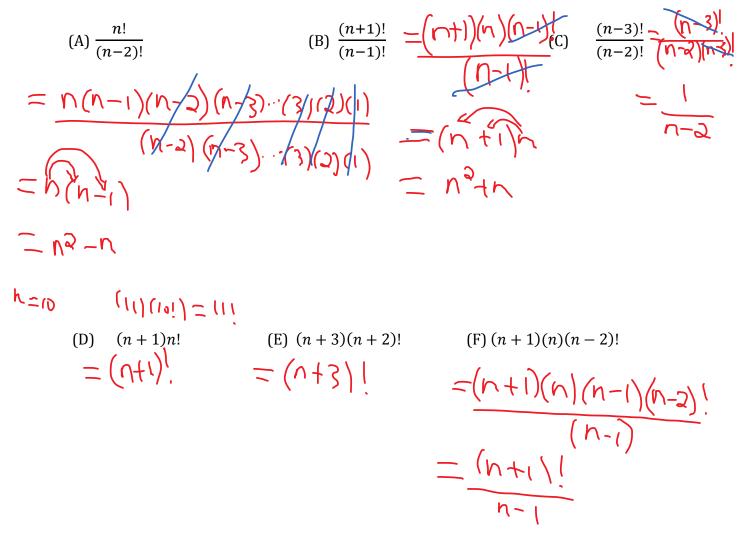
### Example 1:

Simplify the following:

$$(A) \frac{8!}{5!} = \frac{40320}{120} \qquad (B) \frac{9!}{6!} = \frac{9\cdot8\cdot7\cdot6!}{9\cdot8\cdot7\cdot6!} \qquad (C) \frac{12!}{9!3!} = \frac{12\cdot11\cdot10}{9!3!} = \frac{12\cdot11\cdot10}{3\cdot3!} = \frac{12\cdot11\cdot10}{3\cdot3!} = \frac{12\cdot11\cdot10}{3\cdot3\cdot1} = \frac{12\cdot11\cdot10}{3\cdot1} = \frac{12\cdot10}{3\cdot1} = \frac{12\cdot10}{3\cdot$$

### **Example 2:**

Simplify the following, where  $n \in I$ :



**Textbook Questions:** pages 81, 82; 1, 3, 4, 5, 6