

TOPIC: FACTORIALS

Factorials

- ◆ **Factorials** are just another operation, where you multiply all numbers from a specific number down to 1.
- Sequences, series, combinatorics, & probability all use factorials, represented with

$4! = 4 \cdot \underline{\hspace{1cm}} \cdot \underline{\hspace{1cm}} \cdot 1$

EXAMPLE Calculate the factorials in the table below.

Factorials	
Number	Factorial
0	$0! = \rule{1.5cm}{0.4pt} \rightarrow \rule{0.5cm}{0.4pt}$
1	$1! = \rule{1.5cm}{0.4pt} \rightarrow \rule{0.5cm}{0.4pt}$
2	$2! = \rule{1.5cm}{0.4pt} \rightarrow \rule{0.5cm}{0.4pt} \cdot \rule{0.5cm}{0.4pt} = \rule{0.5cm}{0.4pt}$
3	$3! = \rule{1.5cm}{0.4pt} \rightarrow \rule{0.5cm}{0.4pt} \cdot \rule{0.5cm}{0.4pt} \cdot \rule{0.5cm}{0.4pt} = \rule{0.5cm}{0.4pt}$
4	$4! = \rule{1.5cm}{0.4pt} \rightarrow \rule{0.5cm}{0.4pt} \cdot 3 \cdot 2 \cdot 1 = \rule{0.5cm}{0.4pt}$
5	$5! = \rule{1.5cm}{0.4pt} \cdot 4 \cdot 3 \cdot 2 \cdot 1 = \rule{0.5cm}{0.4pt}$
6	$6! = \rule{1.5cm}{0.4pt} \cdot \rule{1.5cm}{0.4pt} = \rule{0.5cm}{0.4pt}$

- ◆ Each factorial = factorial multiplied by new number:
- This can be used to easily simplify factorial expressions.

New
$$n! = n \cdot (\rule{1cm}{0.4pt})!$$

EXAMPLE Evaluate the expression. Hint: *Use the formula above.*

(A)
$$4 \cdot 3!$$

(B)
$$\frac{100!}{99!}$$

(C)
$$(1 - 1)!$$

PRACTICE Evaluate each expression.

(A)
$$\frac{12}{4!}$$

(B)
$$\frac{9!}{7!}$$

(C)
$$\frac{16!}{12! \cdot 4!}$$

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PRACTICE

Write the first 4 terms of the sequence $a_n = n^2 \cdot (n - 1)!$