# Math Journal

Andrew Ha

## Combinatorial Proof

**Proposition 1.** *For positive integers $n$ and $k$ with $n = 2k$, $\frac{n!}{2!^k}$ is an integer.*

*Proof.* Consider the $n$ symbols: $x_1, x_1, x_2, x_2, \cdots, x_k, x_k$. The number of arrangements of all these $n = 2k$ symbols is an integer that equals

$$\frac{n!}{\underbrace{2!2!\cdots 2!}_{\text{k factors of 2!}}} = \frac{n!}{2!^k}$$

I learned this from the first day of class in MACM 101. This is an example of proving that a value is an integer by obtaining that value from counting something. You can also use combinatorics in proof by double counting:

**Identity 1.**

$$2^n = \sum_{k=0}^{n} \binom{n}{k}$$

This can be proved by counting the number of subsets of a set with $n$ elements.
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