Preliminary problems. These problems should be completed before discussion on Thursday.

(P1) Take the derivative of both sides of the equality in the binomial theorem with respect to x (treat z as a constant). You may assume that $n \geq 1$.

Hint: write the original sum using "$\cdots$" instead of a "$\sum$" before taking the derivative.

(P2) Given the following information, use the Sieve formula to compute $|A_1 \cup A_2 \cup A_3 \cup A_4|$.

$$
\begin{array}{llllllll}
|A_1| &=& 15 & |A_1 \cap A_2| &=& 5 & |A_1 \cap A_2 \cap A_3| &=& 1 & |A_1 \cap A_2 \cap A_3 \cap A_4| &=& 1 \\
|A_2| &=& 10 & |A_1 \cap A_3| &=& 3 & |A_1 \cap A_2 \cap A_4| &=& 5 \\
|A_3| &=& 6 & |A_1 \cap A_4| &=& 5 & |A_1 \cap A_3 \cap A_4| &=& 1 \\
|A_4| &=& 5 & |A_2 \cap A_3| &=& 2 & |A_2 \cap A_3 \cap A_4| &=& 1 \\
& & & |A_2 \cap A_4| &=& 5 \\
& & & |A_3 \cap A_4| &=& 1
\end{array}
$$

$|A_1 \cup A_2 \cup A_3 \cup A_4| =$