The Multiplication Rule

(1) If A and B are two events with $P(B) \neq 0$, then $P(A \cap B) = P(B) \cdot P(A|B)$.

(2) If A and B are two events with $P(A) \neq 0$, then $P(A \cap B) = P(A) \cdot P(B|A)$.

If $P(A) \neq 0$ and $P(B) \neq 0$, then equations (1) and (2) above both hold.

When two events are independent, then $P(A|B) = P(A)$ and $P(B|A) = P(B)$ and we have the following:

If A and B are independent events, then $P(A \cap B) = P(A) \cdot P(B)$.

This result can be extended to any number of events. If $A_1, A_2, \dots, A_n$ are independent events, then for each collection $A_{j1}, \dots, A_{jm}$ of events

$$P\left(A_{j1} \cap A_{j2} \cap \cdots \cap A_{jm}\right) = P\left(A_{j1}\right) P\left(A_{j2}\right) \cdots P\left(A_{jm}\right)$$

In particular,

$$P(A_1 \cap A_2 \cap \cdots \cap A_n) = P(A_1)\, P(A_2) \cdots P(A_n)$$