Example: Suppose we draw cards from a deck until the 2 of spades appears for the 5th time. We replace cards and shuffle in between. Let X be the number of draws required. Notice we have an independent collection of trials, each with the probability of success being $1/52$.

$$p_X(x) = P(X = x) = \binom{x-1}{4} p^4 q^{x-1-4} \cdot p = \boxed{\binom{x-1}{4} p^5 q^{x-5}}$$

$\binom{x-1}{4}$: within first $x-1$ trials, need 4 successes and $x-1-4$ failures

p: xth trial needs to be a success

" in this case

$$\boxed{\binom{x-1}{4}\left(\frac{1}{52}\right)^5\left(\frac{51}{52}\right)^{x-5}}$$

Roll a die until the 10th value of 3 appears. Let X be the number of rolls required. Notice the trials (rolls) are independent, each with probability of success $p = 1/6$

$$p_X(x) = P(X = x) = \binom{x-1}{9}\left(\frac{1}{6}\right)^9\left(\frac{5}{6}\right)^{x-1-9} \cdot \left(\frac{1}{6}\right) = \boxed{\binom{x-1}{9}\left(\frac{1}{6}\right)^{10}\left(\frac{5}{6}\right)^{x-10}}$$

$\binom{x-1}{9}$: first $x-1$ rolls need 9 occurrences of 3 and $x-1-9$ non-3's

$\frac{1}{6}$: xth trial to succeed