P: $\lim_{k\to\infty} \|\nabla f(x_k)\|^2 = 0$

$\forall K$: $\underbrace{2L(f(x_0) - f(x^*))}_{\text{bounded}} \geq \sum_{k=1}^{K-1} \|\nabla f(x_k)\|^2$ $\quad K \xrightarrow{\forall K} \infty$

$$2L(f(x_0) - f(x^*)) \geq \sum_{k=1}^{\infty} \|\nabla f(x_k)\|^2$$

bounded

$\sum_{k=1}^{\infty} \|\nabla f(x_k)\|^2$ is bounded $\Rightarrow \lim_{k\to\infty} \|\nabla f(x_k)\|^2 = 0$