12) $(p - \lambda q) \cdot (p - \lambda q) \geq 0$

$$\boxed{\lambda = \frac{p \cdot q}{|q|^2}}$$

$$\cancel{p^2 - 2\lambda(p \cdot q) + \lambda^2(q \cdot q) \geq 0}$$

$$|p|^2 - 2\lambda(p \cdot q) + \lambda^2 |q|^2 \geq 0$$

$$|p|^2 - 2\left(\frac{p \cdot q}{|q|^2}\right)(p \cdot q) + \left(\frac{p \cdot q}{|q|^2}\right)^2 \cdot |q|^2 \geq 0$$

$$|p|^2 - 2 \cdot \frac{(p \cdot q)^2}{|q|^2} + \frac{(p \cdot q)^2}{|q|^2} \geq 0$$

$$|p|^2 - \frac{(p \cdot q)^2}{|q|^2} \geq 0$$

$$|p|^2 \cdot |q|^2 \geq (p \cdot q)^2$$

$|p| \cdot |q| \geq (p \cdot q)$ → Cauch-Schwarz Inequality

Two vectors can never be more "aligned" than the length of each one multiplied together