TPC

$$U(q) = \langle q, Aq \rangle$$

$$A^T = A$$

$$\implies \nabla U = 2Aq$$

Se $q = (x, y)$ e $A = \begin{pmatrix} a & b \\ b & c \end{pmatrix}$

Então:

$$\langle q, Aq \rangle = \begin{pmatrix} x & y \end{pmatrix} \begin{pmatrix} a & b \\ b & c \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

$$(x, y) \cdot (ax + by, bx + cy) = ax^2 + 2bxy + cy^2$$

$$\nabla U = (U_x, U_y) = (2ax + 2by, 2bx + 2cy)$$

$$= 2(ax + by, bx + cy) = 2Aq$$