Algebra   Everything is Handwavy! A, a, b, c

are constants

$$x^T A x \qquad\qquad \underset{\sim}{} \quad A x^2$$

Think:
$\sim \quad A x^2$

$$x^T x \qquad\qquad \sim \quad x^2$$

$$\underbrace{A x}_{\text{vector}} \cdot \underbrace{(b - A x)}_{\text{vector}} = x^T A^T (b - A x)$$

Derivatives

$$\partial A = 0$$

$$\partial (a X) = a \partial X$$

$$\partial (X + Y) = \partial X + \partial Y$$

$$\sim \frac{d\, ax}{dx}$$

$$\frac{\partial x^T a}{\partial x} = \frac{\partial a^T x}{\partial x} = a \qquad \sim \frac{\partial (ax)}{\partial x}$$

$$\frac{\partial a^T X b}{\partial x} = a b^T \qquad \sim \frac{\partial ((ab) x)}{dx}$$

$$\frac{\partial a^T X^T b}{\partial X} = b a^T$$

Think:

$$\frac{\partial \|x\|_2^2}{\partial x} = \frac{\partial \|x^T x\|_2}{\partial x} = 2x$$

with Symmetric Matrix S

$$\frac{\partial}{\partial x} (b - Ax)^T S (b - Ax) = -2 A^T S (b - Ax)$$

$$\frac{\partial}{\partial x} S y(x)^2 = \overset{\text{Think} \sim}{2 S y(x) \cdot y'(x)}$$

Try: $\frac{\partial}{\partial x} (b - x)^T W (b - x)$:

if not symmetric more weird but don't think you'll need