The Henderson - Hasselbalch Equation

$$HA + H_2O \rightleftharpoons H_3O^{\oplus} + A^{\ominus}$$

$$K_{eq} = \frac{[H_3O^{\oplus}]\,[A^{\ominus}]}{[HA]\,[H_2O]}$$

$$K_a = K_{eq}\,[H_2O] = \frac{[H_3O^{\oplus}]\,[A^{\ominus}]}{[HA]}$$

Definition: -log X = pX

$$-\log K_a = -\log\left(\frac{[H_3O^{\oplus}]\,[A^{\ominus}]}{[HA]}\right)$$

$$-\log K_a = -\log [H_3O^{\oplus}] - \log\left(\frac{[A^{\ominus}]}{[HA]}\right)$$

$$pK_a = pH - \log\left(\frac{[A^{\ominus}]}{[HA]}\right)$$