

- The physiological properties of chromium depend on its oxidation state. Consider the half reaction in which Cr(VI) is reduced to Cr(III).



Calculate the potential for this half reaction at 25 °C, where pH = 7.40 and  $[\text{CrO}_4^{2-}(\text{aq})] = 1.0 \times 10^{-6} \text{ M}$ .

As  $\text{pH} + \text{pOH} = 14.00$  and  $\text{pOH} = -\log_{10}([\text{OH}^-(\text{aq})])$ , at  $\text{pH} = 7.40$ ,

$$\text{pOH} = 14.00 - 7.40 = 6.60 = -\log_{10}([\text{OH}^-(\text{aq})])$$

$$[\text{OH}^-(\text{aq})] = 10^{-6.60}$$

The reaction quotient for the half-cell reaction is,

$$Q = \frac{[\text{OH}^-(\text{aq})]^5}{[\text{CrO}_4^{2-}(\text{aq})]} = \frac{(10^{-6.60})^5}{(1.0 \times 10^{-6})} = 1.0 \times 10^{-27}$$

Using the Nernst equation for this three electron process,

$$E = E^\circ - \frac{RT}{nF} \ln Q = (-0.13) - \frac{8.314 \times (25+273)}{3 \times 96485} \ln(1.0 \times 10^{-27}) = +0.40 \text{ V}$$

Answer:  $E = +0.40 \text{ V}$