Chromium Chemistry: Option Analysis

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Response: The correct statement is **(3)**.

Analysis of Options

- **(1) Incorrect:** When an aqueous solution of potassium chromate ($\mathrm{K_2CrO_4}$, **yellow**) is acidified with dilute $\mathrm{H_2SO_4}$, it converts to dichromate ions ($\mathrm{Cr_2O_7^{2-}}$, **orange**):

  $$2\mathrm{CrO_4^{2-}} + 2\mathrm{H^+} \rightleftharpoons \mathrm{Cr_2O_7^{2-}} + \mathrm{H_2O}$$

  A clear color change from **yellow to orange** is observed.

- **(2) Incorrect:** Electronegativity generally increases across a period from left to right across the 3d transition series. Cobalt (Co, atomic number 27) has a higher electronegativity (≈ 1.88 on the Pauling scale) than Chromium (Cr, atomic number 24, ≈ 1.66).

- **(3) Correct:** Hexaaquachromium(II) ions, $[\mathrm{Cr(H_2O)_6}]^{2+}$, are oxidized by atmospheric oxygen/reagents to $\mathrm{Cr^{3+}}$. When treated with excess NaOH, chromium forms the tetrahydroxochromate(III) complex, $[\mathrm{Cr(OH)_4}]^-$. Upon oxidation with hydrogen peroxide ($\mathrm{H_2O_2}$), chromium(III) is oxidized to chromate ($\mathrm{CrO_4^{2-}}$), which gives a **yellow-colored solution**:

  $$2[\mathrm{Cr(OH)_4}]^- + 3\mathrm{H_2O_2} + 2\mathrm{OH^-} \longrightarrow 2\mathrm{CrO_4^{2-}} + 8\mathrm{H_2O}$$

- **(4) Incorrect:** Chromium(III) oxide ($\mathrm{Cr_2O_3}$) is **amphoteric** (reacts with both acids and bases), not purely basic. (Note: CrO is basic, $\mathrm{Cr_2O_3}$ is amphoteric, and $\mathrm{CrO_3}$ is acidic).

- **(5) Incorrect:** When $\mathrm{H_2S}$ gas is passed into an acidic solution of $\mathrm{K_2Cr\_2O\_7}$, the dichromate oxidizes $\mathrm{H_2S}$ to elemental sulfur (S):

  $$\mathrm{Cr_2O_7^{2-}} + 3\mathrm{H_2S} + 8\mathrm{H^+} \longrightarrow 2\mathrm{Cr^{3+}} + 3\mathrm{S}\downarrow + 7\mathrm{H_2O}$$

  While $\mathrm{Cr^{3+}}$ gives a green color, the precipitate of colloidal sulfur makes the solution **turbid/cloudy green**, not a clear solution.
