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Aim: To investigate the influence of pH on an equilibrium system.

Investigative question:

What is the effect of a change in pH on the $\text{CrO}_4^{2-}(\text{aq}) \rightleftharpoons \text{Cr}_2\text{O}_7^{2-}(\text{aq})$ equilibrium if the temperature remains constant?

Hypothesis:

If the pH is decreased by adding an acid to a $\text{CrO}_4^{2-}(\text{aq}) \rightleftharpoons \text{Cr}_2\text{O}_7^{2-}(\text{aq})$ equilibrium system, the forming of $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$ will be favoured, while the forming of $\text{CrO}_4^{2-}(\text{aq})$ will be favoured if the pH is increased by adding a strong base to the equilibrium system at constant temperature.

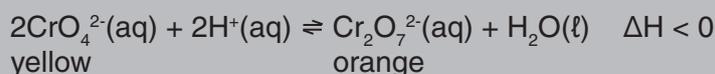
Variables:

Independent variable (Which is changed.)	Dependent variable (Which is measured.)	Controlled variable(s) (Which remain(s) the same.)
Solution added to K_2CrO_4 .	Colour	Initial temperature Quantity of K_2CrO_4 Concentration of K_2CrO_4

Observations:

	Test tube A $\text{K}_2\text{CrO}_4(\text{aq})$	Test tube B $\text{K}_2\text{CrO}_4(\text{aq})$	Test tube C $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$	Test tube D $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$
Initial colour	Yellow	Yellow	Orange	Orange
Colour after $\text{HCl}(\text{aq})$ is added.	Orange	Brighter yellow	Orange	Brighter orange
Colour after $\text{NaOH}(\text{aq})$ is added.	Brighter yellow	Yellow	Brighter orange	Yellow

Results:



Forward reaction is exothermic.

$\text{HCl}(\text{aq})$ with the solutions in test tubes A and C:

- When $\text{HCl}(\text{aq})$ is added to the solutions in test tubes A and C, the $[\text{H}^+(\text{aq})]$ increases.
- If the $[\text{H}^+(\text{aq})]$ increases, the reaction which decreases the $[\text{H}^+(\text{aq})]$ again, is favoured. The forward reaction is favoured and the $[\text{CrO}_4^{2-}(\text{aq})]$ decreases. The $[\text{Cr}_2\text{O}_7^{2-}(\text{aq})]$ increases; therefore the solution changes from yellow to orange.



NaOH(aq) with the solutions in test tubes B and D:

- When NaOH(aq) is added to the solutions in test tubes B and D, the $\text{H}^+(\text{aq})$ reacts with the $\text{OH}^-(\text{aq})$ to form $\text{H}_2\text{O}(\ell)$; \therefore the $[\text{H}^+(\text{aq})]$ decreases.
- If the $[\text{H}^+(\text{aq})]$ decreases, the reaction that increases the $[\text{H}^+(\text{aq})]$ again, is favoured \therefore the reverse reaction is favoured and the $[\text{CrO}_4^{2-}(\text{aq})]$ increases and the $[\text{Cr}_2\text{O}_7^{2-}(\text{aq})]$ decreases; \therefore the solution changes from orange to yellow.

Conclusions:

The initial hypothesis is correct, if the pH is decreased at constant temperature by adding an acid to a $\text{CrO}_4^{2-}(\text{aq}) \rightleftharpoons \text{Cr}_2\text{O}_7^{2-}(\text{aq})$ equilibrium system, the forming of $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$ will be favoured, while the forming of $\text{CrO}_4^{2-}(\text{aq})$ will be favoured if the pH is increased by adding a strong base to the equilibrium system at constant temperature.

Experiment 19: Page 294

Aim: To investigate the factors that influence the $\text{CoCl}_4^{2-}(\text{aq})$ and $\text{Co}(\text{H}_2\text{O})_6^{2+}$ equilibrium system.

Investigative question:

- What effect does a change in the concentration of the ions in a solution have on the equilibrium?
- What effect does a change in temperature have on an equilibrium system of ions in solution?

Hypothesis:

- If the concentration of one of the ions in an equilibrium solution changes, the change can be predicted by Le Chatelier's principle.
- If the temperature of a solution in equilibrium increases, the endothermic reaction will be favoured, and if the temperature of a solution in equilibrium decreases, the exothermic reaction will be favoured.

Variables:

Independent variable (Which is changed.)	Dependent variable (Which is measured.)	Controlled variable(s) (Which remain(s) the same.)
a) Concentration b) Temperature	Colour	a) Temperature b) Concentration