1. $Co(H_2O)_6^{2+}(aq) + 4\ Cl^-(aq) <=> CoCl_4^{2-}(aq) + 6\ H_2O(l)$

Pink **Blue**

The $Co(H_2O)_6^{2+}$ complex is pink, and the $CoCl_4^{2-}$ complex is blue.

This reaction is endothermic. <u>The equilibrium mixture colour is Pink</u>

Change	Imposed change	Prediction using LCP	$[Co(H_2O)_6^{2}]$	$[Cl^-]$	$[CoCl_4^{2-}]$	Amount of H_2O	Colour change
Adding HCl							
<u>Explanation using Collision theory:</u>							
Adding $CoCl_4^{2-}$							
<u>Explanation using Collision theory:</u>							
Adding $AgNO_{3\ aq}$							
<u>Explanation using Collision theory:</u>							

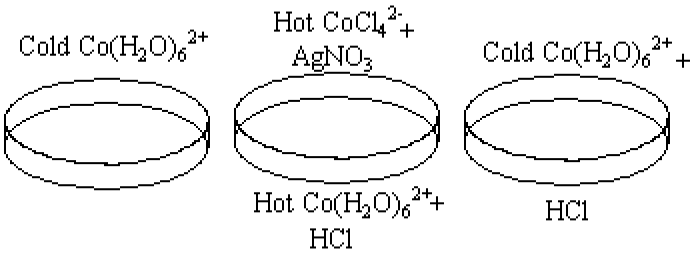
Draw the Graph of the following changes.

Concentration-Time Graph

Chemical Concepts Demonstrated: Equilibrium constants relative to temperature, color changes in transition metal complexes, LeChatelier's principle

Demonstration:
$Co(H_2O)_6^{2+}$ is formed by dissolving $CoCl_2*H_2O$ in water.

1. The first sample of the solution is heated to boiling.
2. The first sample now contains a hot $CoCl_4^{2-}$ solution. $AgNO_3$ is added to produce $Co(H_2O)_6^{2+}$ again. A second sample is used as a reference.
3. HCl is added to a third sample at room temperature.



Observations:

When the solution is heated to boiling, it turns from pink to blue. This blue solution shifts back to pink as the $AgNO_3$ is added. When HCl is added to a pink solution, it turns blue.

Explanations (including important chemical equation):

The following equilibrium is observed:

$Co(H_2O)_6^{2+}(aq) + 4\ Cl^-(aq) <=> CoCl_4^{2-}(aq) + 6\ H_2O(g)$

The $Co(H_2O)_6^{2+}$ complex is pink, and the $CoCl_4^{2-}$ complex is blue.

This reaction is endothermic as written, so adding heat causes the equilibrium constant to shift to the right. This, correspondingly, makes the solution blue.

When the $AgNO_3$ is added, Cl^- is removed from solution. This shifts the equation back to the left, and the solution turns pink again.

When HCl is added, there is more Cl^- in solution, so the equilibrium is shifted to the right, and the solution turns blue.

All of the above effects are variations of LeChatelier's principle.

2. Consider the following system at equilibrium at a constant temperature:

$$Fe^{3+}(aq) + SCN^{-}(aq) \rightleftharpoons FeSCN^{2+}(aq)$$
$$\text{(colourless)} \qquad\qquad \text{(red)}$$

Answer the following-

(a) Increasing the Concentration of a **SCN^-** (at Constant Temperature)

(b) Removing $FeSCN^{2+}$ (at Constant Temperature)

(c) adding NaOH aq

(d) Adding K_2CO_3 aq

Change	Imposed change	Prediction using LCP	[Fe^{3+}]	[SCN^-]	[$FeSCN^{2+}$]	Colour change

Consider the following gaseous system at equilibrium:

$$\underset{\text{(red-brown)}}{2NO_2(g)} \rightleftharpoons \underset{\text{(colourless)}}{N_2O_4(g)}$$

(a) Reducing the Volume of the Reaction Vessel (at constant temperature)

(b) Increasing the Volume of the Reaction Vessel (at constant temperature)

(c) Increasing the Concentration of a Gaseous Reactant (at Constant Temperature and Volume)

(d) Decreasing the Concentration of a Gaseous Reactant (at Constant Temperature and Volume)

(e) Increasing the partial pressure of a Product (at Constant Temperature and Volume)

(d) Addition of an Inert Gas (at Constant Temperature and Volume)

Change	Imposed change	Prediction using LCP/Shift in equlb/reaction favoured	[R]	[P]	Colour change