Examples: Strong acids and bases

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Step 1. Calculate dilutions. First add the volumes

Total volume = 25 mL + 35 mL = 60 mL

Calculate concentrations in the solution

$$[HCl] = [0.30]\left(\frac{25}{60}\right) = 0.125\ M$$

$$[NaOH] = [0.20]\left(\frac{35}{60}\right) = 0.117\ M$$

Examples: Strong acids and bases

What is the pH when 25 mL of 0.30 M HCl are added to 35 mL of 0.20 M NaOH?

Step 2. Write a balanced chemical reaction for the limiting reaction and the excess reaction.

Limiting reaction

$$HCl + NaOH \leftrightarrow Na^{+} + Cl^{-} + H_2O$$

Species	HCl	NaOH	Na^+	Cl^-
Initial	0.125	0.117	0.0	0.0
Difference	-x	-x	x	x
Final	0.125-x	0.117-x	x	x

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Limiting reaction

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Species	HCl	NaOH	Na^+	Cl^-
Initial	0.125	0.117	0.0	0.0
Difference	-0.117	-0.117	0.117	0.117
Final	0.008	0.0	0.117	0.117

Excess reaction $$HCl \leftrightarrow H^+ + Cl^-$$

Species	HCl	H^+	Cl^-
Initial	0.008	0.0	0.0
Final	0.0	0.008	0.008

Examples: Strong acids and bases

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Recognize that both HCl and NaOH are strong acid/base, respectively. Therefore, rather than find the equilibrium constant, we assume that the reaction goes to completion. In this case we find the limiting reagent which is NaOH.

In the general case we could include both H^+ and OH^- on the right hand side. We may not know initially which one is going to dominate, since we must first calculate the limiting reagent.

$$pH = -\log_{10}(0.008) = 2.09$$

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Short cut method:

Step 1. calculate number of moles of each reagent

$$n_{HCl} = [0.30\ M](0.025L) = 7.5\ x\ 10^{-3}\ mol$$

$$n_{NaOH} = [0.20\ M](0.035L) = 7.0\ x\ 10^{-3}\ mol$$

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Step 2. calculate the total volume (0.025 + 0.035 = 0.060 L)

Step 3. make a table considering only H^+ and OH^-

Species	H^+	OH^-	H2O
Initial	7.5	7.0	0.0
Difference	-7.0	-7.0	+7.0
Final	0.5	0.0	7.0

Examples: Strong acids and bases

What is the pH when 25 mL of 0.30 M HCl are added to 35 mL of 0.20 M NaOH?

Short cut method:
Step 4. calculate the final concentration of [H^+]

$$[H^+] = \frac{n_{H^+}}{V_{tot}} = \frac{5x10^{-4}}{0.06} = 0.008$$

Step 5. calculate the pH

$$pH = -\log_{10}(0.008) = 2.09$$