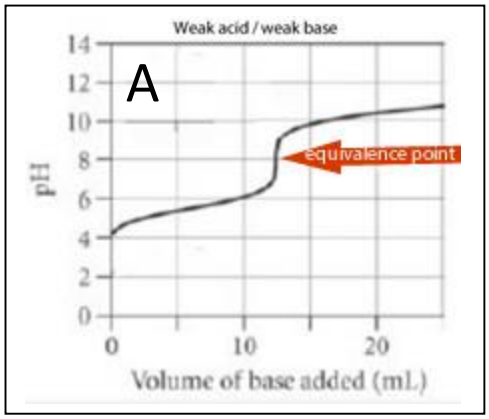
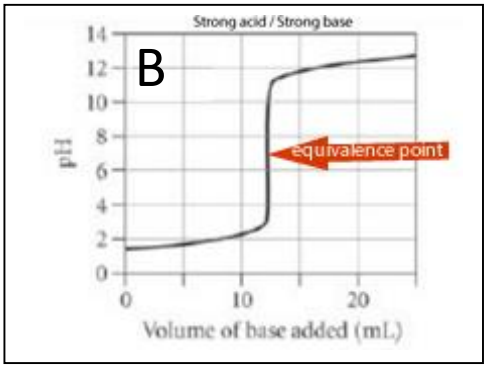
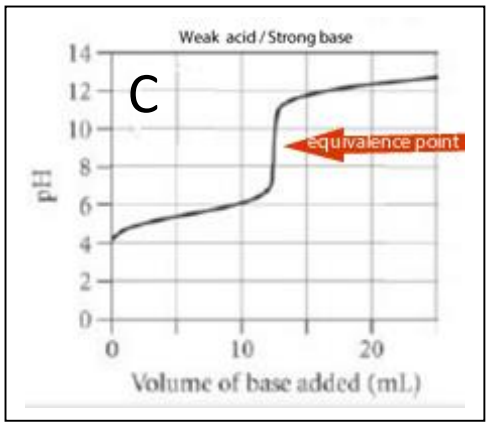
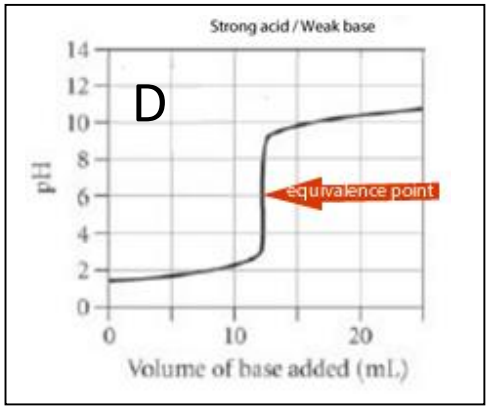
Lesson - indicators

An **acid-base titration** is when an unknown acid solution is neutralised with a base solution of known concentration and volume in order to determine the unknown's concentration. Unknown concentration of base solution can also be determined by the reaction with an acid solution of known concentration and volume. During an acid-base titration the pH of the solution in the conical flask changes. The shape of the pH curve varies depending on the strength of both the acid and base. Shown on the right are four examples. It is the shape of the curve that will determine the indicator of choice.









An indicator of choice should change colour either directly below or above the equivalence point. Equivalence point is the point at which enough titre is added to completely neutralise the sample in the conical flask.

Name of indicator	Color at lower pH	pH range	Color at higher pH
methyl violet	yellow	0.0 - 1.6	blue
thymol blue	red	1.2 - 2.8	yellow
methyl orange	red	3.2 - 4.4	yellow
bromophenol blue	yellow	2.8 - 4.6	blue
bromocresol green	yellow	3.8 - 5.4	blue
methyl red	red	4.2 - 6.3	yellow
bromothymol blue	yellow	6.0 - 7.6	blue
thymol blue	yellow	8.0 - 9.6	blue
phenolphthalein	colorless	8.2 - 10.0	pink/violet
alizarin yellow	yellow	10.1 - 13.0	orange/red

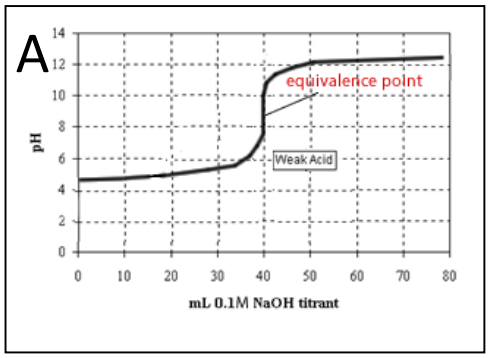
1. From the table above select an appropriate indicator for the four titration A
   thymol blue (yellow to blue) or phenolphthalein (clear to pink)
2. Which indicators are not ideal for titration B?
   methyl violet, thymol blue, alizarin yellow
3. From the table above select the indicator that is ideal to use in both titrations C and D.
   Thymol blue (8.0 - 9.6) *this range still sits in the steep part of both pH curves*.

Name of indicator	pH range
methyl orange	3.1-4.4
methyl red	4.4-6.2
bromothymol blue	6.0-7.6
phenolphthalein	8.3-10.0

4. Selecting an appropriate indicator for a titration is very important. Consider the two pH curves shown on the right of a weak and strong acid.
   The pH ranges of four indicators is also shown.

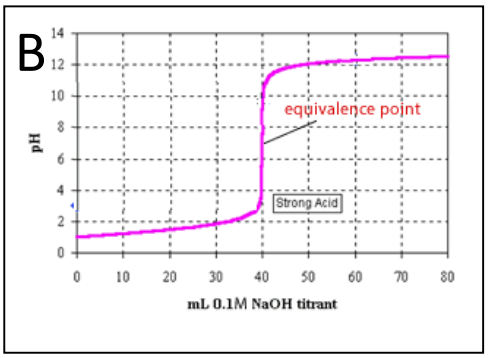
a. What is the appropriate indicator to use when titrating an unknown HCl solution with NaOH? Explain your answer

Since HCl is a strong acid the pH curve of titration B is relevant. Methyl red, bromothymol blue and phenolphthalein are possible indicators to use. Their pH ranges are clearly within the steep part of the titration curve.

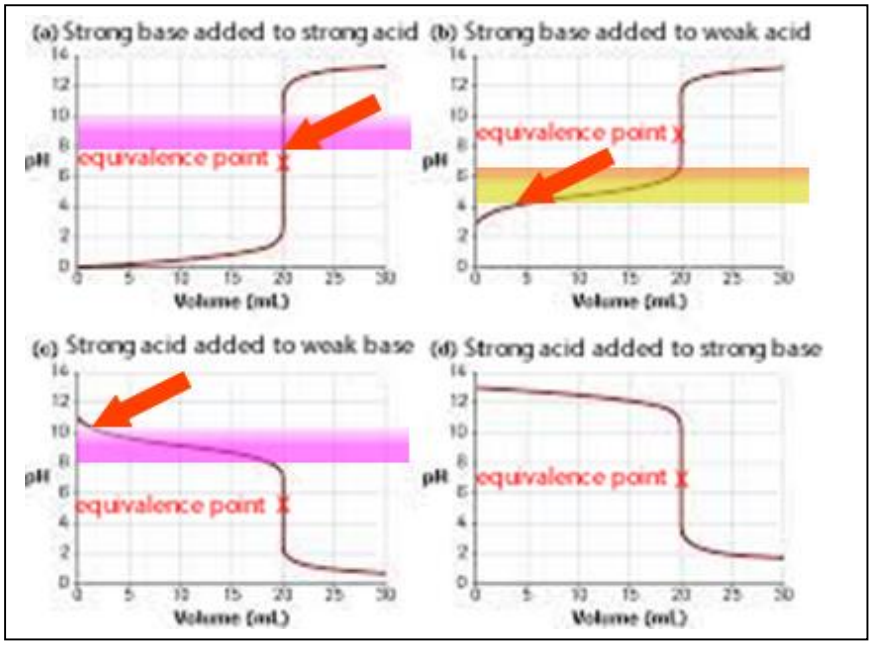


b. What is the appropriate indicator to use when titrating an unknown H_2CO_3 solution with NaOH? Explain your answer

Since H_2CO_3 is a weak acid the pH curve of titration A is relevant. Phenolphthalein is the only indicator possible. The colour will change at ph 8.3 which is on the steep part of the pH curve for the titration.



c. Consider the 4 pH curves shown below.



Name of indicator	pH range
methyl orange	3.1-4.4
methyl red	4.4-6.2
bromothymol blue	6.0-7.6
phenolphthalein	8.3-10.0

If the correct average titre is 20.00 mL what would be the impact of the average titre if:

i. Phenolphthalein was used as the indicator in a). Explain

No impact. The end point, as indicated by the arrow, and equivalence point both are on the steep part of the curve and there is no difference in volume of titrant between the two points.

ii. Phenolphthalein was used as the indicator in c). Explain

An under estimation of the equivalence point will result. The phenolphthalein indicator would change colour in the ph range 8.3-10 resulting in an end point equal to roughly 1-2 mL as indicated by the arrow.

Methyl red was used as the indicator in b). Explain

An under estimation of the equivalence point will result. The methyl red indicator would change colour in the ph range 4.4-6.2 resulting in an end point equal to roughly 5 mL as indicated by the arrow.

d. Explain how the calculated concentrations of the unknown solution would be impacted using the indicators stated in c. above.

Underestimation of the end point will result in a final calculation of the concentration of the unknown sample that is clearly below the true value of its concentration.