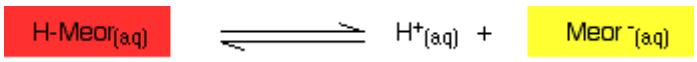
INDICATORS

1. Methyl orange is an indicator commonly used in certain acid-base titrations. It exists in two forms, one red and one yellow, which are in equilibrium with each other.



H-Meor represents one form, and $Meor^-$ the other.

a) Explain why methyl orange turns yellow when you add it to an alkaline solution.

b) Explain why methyl orange turns red when you add it to a sufficiently acidic solution.

c) The pK_{ind} for methyl orange is 3.7, and its pH range is 3.1 - 4.4. What does this information tell you about the indicator?

d) What colour would methyl orange be in a solution with a pH of 7.0? Explain your answer.

e) What colour would methyl orange be in a solution with a pH of 5.0? Explain your answer.

f) What colour would methyl orange be in a solution with a pH of 3.4? Explain your answer.

2. The table shows pK_{ind}, the pH range, and the colour changes of three indicators.

Indicator	pK_{ind}	pH range	colour at lower pH	colour at higher pH
bromophenol blue	4.0	3.0 - 4.6	yellow	blue
methyl red	5.1	4.2 - 6.3	red	yellow
phenolphthalein	9.3	8.3 - 10.0	colourless	red

What colours would each of these indicators be in solutions with the following pHs?

a) 2.0

b) 3.0

c) 4.0

d) 5.0

e) 6.0

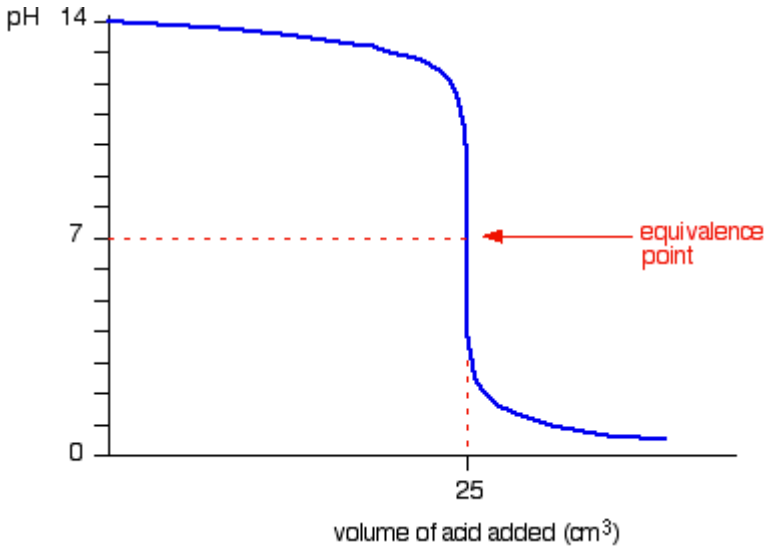
f) 7.0

g) 8.0

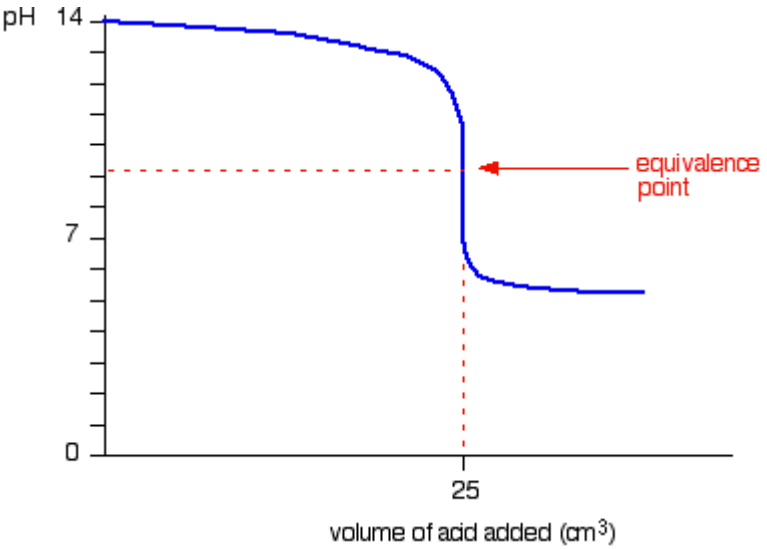
h) 9.0

3. This question is about the use of indicators in various titrations. In each case, I have given you a pH curve for the reaction. Use these curves to help you to explain whether you could use methyl orange, phenolphthalein, both, or neither, as the indicator for the titration.

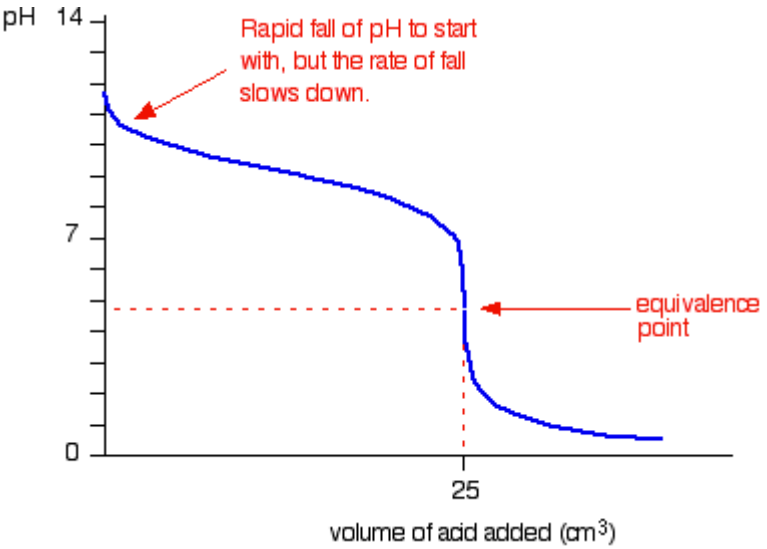
a) Titrating a strong base with a strong acid:



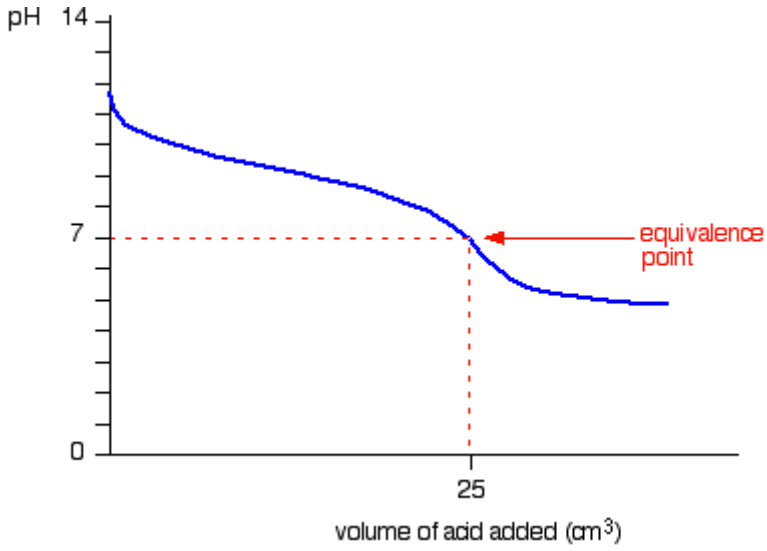
b) Titrating a strong base with a weak acid:



c) Titrating a weak base with a strong acid:

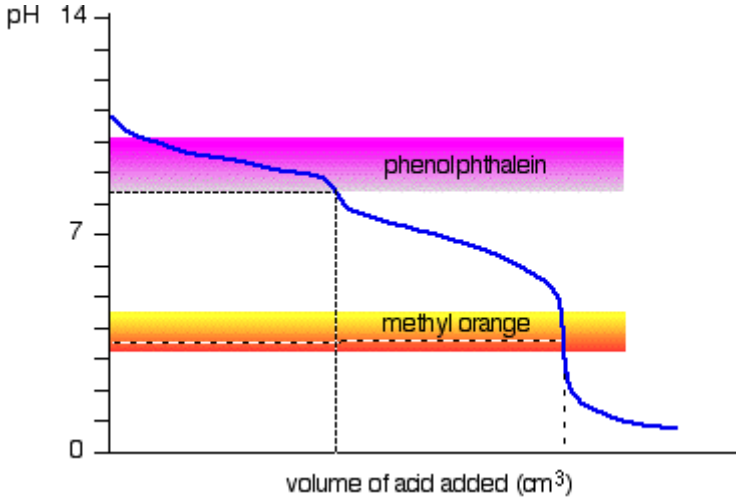


d) Titrating a weak base with a weak acid:



e) In the last case, the equivalence point is at a pH of approximately 7.0. Bromothymol blue has a pK_{ind} of 7.0, and a pH range of 6.0 - 7.6. Explain why you couldn't use this as the indicator to give you an accurate titration result.

4. The pH curve below is for the titration of sodium carbonate solution with dilute hydrochloric acid with the pH ranges of phenolphthalein superimposed on it.



a) Write the equation for the reaction which phenolphthalein detects the end point of.

b) The point of inflexion which the phenolphthalein detects isn't very different from the one with a weak acid / weak base in the graph in the last question. What two features of phenolphthalein allow you to be able to use it successfully in this sodium carbonate case?

c) Could you use bromophenol blue or methyl red (see Q2) to detect the second end point of this reaction? Explain your answer. If you could use either or both of these indicators, what colour(s) would you look for to get the most accurate reading for the second end point?