4.3 Exercise 4 - Titrations and indicators

1. 20 cm^3 of methanoic acid (K_a = 1.8 x 10^{-4} $moldm^{-3}$) of concentration 0.10 $moldm^{-3}$ is titrated against sodium hydroxide of concentration 0.05 $moldm^{-3}$.
   a) Calculate the pH of the solution:
      i) initially
      ii) after 10 cm^3 of the alkali has been added
      iii) after 20 cm^3 of the alkali has been added
      iv) after 30 cm^3 of the alkali has been added
      v) after 50 cm^3 of the alkali has been added
   b) Sketch a pH titration curve to show this reaction
   c) Explain why the pH at the end-point is greater than 7.

2. Calculate the pH after the following solutions are mixed together:
   a) 15 cm^3 of 0.1 $moldm^{-3}$ HCl and 10 cm^3 of 0.1 $moldm^{-3}$ NaOH
   b) 10 cm^3 0.1 $moldm^{-3}$ HCl and 15 cm^3 of 0.1 $moldm^{-3}$ NaOH

3. Sketch pH curves for the following titrations:
   a) 20 cm^3 0.10 $moldm^{-3}$ NH_3 against 0.1 $moldm^{-3}$ HCl
   b) 20 cm^3 0.10 $moldm^{-3}$ NaOH against 0.2 $moldm^{-3}$ HCl
   c) 20 cm^3 0.10 $moldm^{-3}$ CH_3COOH against 0.06 $moldm^{-3}$ NaOH
   d) 20 cm^3 0.10 $moldm^{-3}$ CH_3COOH against 0.15 $moldm^{-3}$ NH_3

4. Given the following pK_{In} values:

Indicator	pK_{In}
Methyl red	5.1
Phenolphthalein	9.3

State, with a reason, which of the indicators would be suitable for each of the titrations in question 3.