- Calculate the pH of a solution that is prepared by mixing 750 mL of 1.0 M potassium dihydrogenphosphate with 250 mL of 1.0 M potassium hydrogenphosphate.

  For H_3PO_4, pK_{a1} = 2.15, pK_{a2} = 7.20, pK_{a3} = 12.38

Marks 2

The hydrogenphosphate anion is the conjugate base of dihydrogenphosphate, corresponding to the second ionization of phosphoric acid (K_{a2}). K_{a1} is much larger than K_{a2} so the equilibrium will not be greatly affected by protonation of dihydrogenphosphate. K_{a3} is much smaller than K_{a2} so the equilibrium will also not be greatly affected by deprotonation of hydrogenphosphate. The solution is a buffer and the pH can be calculated using the Henderson-Hasselbalch equation:

$$\mathbf{pH = pK_a + \log_{10}\left(\frac{[base]}{[acid]}\right) = pK_{a2} + \log_{10}\left(\frac{[hydrogenphosphate]}{[dihydrogenphosphate]}\right)}$$

After mixing, a 1.00 L solution is formed that contains 0.750 mol of dihydrogenphosphate and 0.250 mol of hydrogenphosphate. Thus:

$$\mathbf{pH = 7.20 + \log_{10}\left(\frac{0.250}{0.750}\right) = 6.72}$$

Answer: **pH = 6.72**