18.1 Further Aspects of Acids & Bases

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Course	DP IB Chemistry
Section	18. Acids & Bases (HL only)
Topic	18.1 Further Aspects of Acids & Bases
Difficulty	Medium

To be used by all students preparing for DP IB Chemistry HL
Students of other boards may also find this useful

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The correct answer is **D** because:

- Definitions that you must know are:
  - A Lewis acid is an electron pair acceptor
  - A Lewis base is an electron pair donor
  - A Brønsted-Lowry acid is a proton (H^+) donor
  - A Brønsted-Lowry base is a proton (H^+) acceptor
- A hydroxide ion can act as a Lewis base and a Brønsted-Lowry base because it can donate a pair of electrons as there are three lone pairs present and it can accept a proton (H^+) to form H_2O

A, **B** & **C** are incorrect as	these are correct statements

2

The correct answer is **D** because:

- The half equivalence point is the stage of the titration at which exactly half the amount of weak acid has been neutralised
  - $[CH_3CH_2COOH (aq)] = [CH_3CH_2COO^- (aq)]$
  - At this point the pK_a of the acid is equal to the pH
  - pK_a = pH at half equivalence

A is incorrect as	for a weak acid - strong base titration, the equivalence point will be greater than pH 7 (> pH 7)
B is incorrect as	the salt formed for a weak acid - strong base titration will be alkaline by hydrolysis because of the $CH_3CH_2COO^-$ reacts with water to release OH^- ions $CH_3CH_2COO^-(aq) + H_2O(l) \rightarrow CH_3CH_2COOH(aq) + OH^-(aq)$
C is incorrect as	the salt will be CH_3CH_2COOK, not CH_3COOK This salt is for potassium ethanoate, not potassium propanoate

3

The correct answer is **D** because:

- Statements I, II and III are correct
- As the pH of a solution changes, the equilibrium of the dissociation of the indicator will shift to the left or right hand side

$$HIn(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + In^-(aq)$$

$$\text{colour 1} \rightleftharpoons \text{colour 2}$$

- If the solution is acidic, the equilibrium will shift to the left hand side and colour 1 will be observed
- If the solution is alkaline, the equilibrium will shift to the right hand side and colour 2 will be observed
- The pH at which these transitions will occur depends on the K_a of the indicator

$$K_a = \frac{[H^+][In^-]}{[HIn]} = [H^+]$$

- The endpoint of the reaction is where [HIn] = [In$^-$]
- At this point these two concentrations are equal and if we take the negative log of both sides
  - pK_a = pH

A, **B** & **C** are incorrect as	all statements are correct

4

The correct answer is **A** because:

- A buffer solution is a solution which resists changes in pH when **small amounts of acid or base are added**
- The statement written in option A does not match this, though it could be easy to confuse them

B, C & **D** are incorrect as	these statements are correct

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The correct answer is **A** because:

- Remember: for an indicator the endpoint of the reaction is where $[HIn] = [In^-]$
- At this point these two concentrations are equal and if we take the negative log of both sides
  - $pK_a = pH$
- This titration would be an example involving a strong acid (hydrochloric acid) and a weak base (ammonia)
- The equivalence point in this type of titration will be below pH 7.00
- So the best indicator will be methyl orange which changes colour in the range of 3.2–4.4, so with a pK_a value within this range

B is incorrect as	phenolphthalein will change colour when the pH is close to 9.6 which is above pH 7.0
C is incorrect as	phenol red will change colour when the pH is close to 7.9, which is too high for the strong acid - weak base titration
D is incorrect as	bromothymol blue changes colour when the pH is close to 7.0 which is still too high for a strong acid - weak base titration