Exemplar exam questions – Chapter 8

1   **a**   Explain, using an example, what is meant by a **Lewis acid**.   [2]

   b   Explain, using examples, the difference between a strong acid and a weak acid.   [2]

Higher Level only

   c   **i**   Explain what is meant by a **buffer solution**.   [2]

   ii   40.0 cm^3 of 0.100 mol dm^{-3} ethanoic acid (pK_a = 4.76) is added to 20.0 cm^3 of 0.100 mol dm^{-3} sodium ethanoate. What is the pH of the resulting buffer solution?   [3]
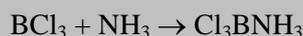

Commentary

a   Possible answer:

   A Lewis acid is an electron acceptor. An example would be BCl$_3$.

The word **pair** is missing from the first part of the answer. A Lewis acid is an **electron pair** acceptor.

The example is correct, but a bit more explanation could be given, for example:

   In the reaction

   $$BCl_3 + NH_3 \rightarrow Cl_3BNH_3$$

   BCl$_3$ is a Lewis acid because it accepts a lone pair of electrons from NH$_3$.

b   Model answer:

   A strong acid fully dissociates in aqueous solution, for example:

   $$HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$$ [1]

   A weak acid is only partially dissociated in aqueous solution, for example:

   $$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$$ [1]

The equilibrium symbol is essential in the second equation.

When choosing examples, there are no extra marks for choosing more complicated examples.

c   **i**   Model answer:

   A buffer solution is one that resists changes in pH when small amounts of acid or alkali are added. It consists of a mixture of a weak acid and its salt or a weak base and its salt.   [2]

The word **small** is essential. It is not clear whether the second sentence is necessary because the first sentence, which contains two points, may be sufficient to gain the marks. The second sentence, however, is correct and improves the quality of the answer.

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ii The calculation can be simplified if it is realised that the number of moles of acid is twice the number of moles of the salt. The question can either be worked out using the Henderson–Hasselbalch equation or by using K_a.

Although most mark schemes for calculation questions award full marks to the final correct answer, even with no working shown, sufficient working should be shown to make sure that as many marks as possible are gained if a mistake is made.

The number of moles of ethanoic acid is twice the number of moles of sodium ethanoate, therefore $\dfrac{[\text{salt}]}{[\text{acid}]} = 0.5$ [1]

using the equation: $pH = pK_a + \log \dfrac{[\text{salt}]}{[\text{acid}]}$ [1]

$pH = 4.76 + \log (0.5)$

$pH = 4.46$ [1]

The final answer should be given to 3 significant figures as the data in the question is given to 3 significant figures.