**1.** Phenol, C6H5OH, is a powerful disinfectant and antiseptic. Phenol is a weak Brønsted–Lowry acid.

C6H5OH(aq) ⇌ H+(aq) + C6H5O-(aq) *K*a = 1.3 × 10–10 mol dm–3

1. Define the following terms: **(i)** A *Brønsted*–*Lowry* acid **[1] (ii)** A *weak* acid. **[1]**

**(b)** When phenol is mixed with aqueous sodium hydroxide, an acid*–*base reaction takes place.

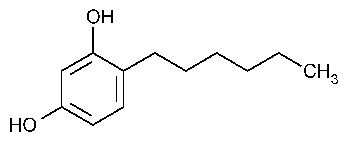
C6H5OH(aq) + OH–(aq) ⇌ C6H5O–(aq) + H2O(l)

Label one conjugate acid*–*base pair as **acid 1** and **base 1**, and label the other as **acid 2** and **base 2**. **[1]**

**(c)** A solution of phenol in water has a concentration of 4.7 g dm–3.

1. Write an expression for the acid dissociation constant, *K*a, of phenol. **[1]**

**(ii)** Calculate the pH of this solution of phenol. **[5]**

**(d)** As part of an investigation, a student needed to prepare a buffer solution with a pH value of 8.71. From the *K*a value of phenol, the student thought that a mixture of phenol and sodium phenoxide could be used to prepare this buffer solution. The student decided to use a 0.200 mol dm–3 solution of phenol, mixed with an equal volume of sodium phenoxide. Use your knowledge of buffer solutions to determine the concentration of sodium phenoxide solution that the student needs to mix with the 0.200 mol dm–3 phenol solution. **[3]**

**(e)** Hexylresorcinol is an antiseptic used in solutions for cleansing wounds and in mouthwashes and throat lozenges. The structure of hexylresorcinol is shown. Identify a chemical that could be added to hexylresorcinol to make a buffer. Explain your answer. **[1]**

**2.** This question is about propanoic acid, CH3CH2COOH. Propanoic acid is a weak acid which dissociates: CH3CH2COOH(aq) + H2O(l)  ⇌ CH3CH2COO–(aq) + H3O+(aq)

1. Label one conjugate acid*–*base pair as **acid 1** and **base 1**, and the other as **acid 2** and **base 2**. **[1]**

Explain what is meant by the term **weak acid**.  **(2)**

1. The acid dissociation constant, *K*a, for propanoic acid is 1.30 × 10–5 mol dm–3 at 298 K.
2. Write the expression for the acid dissociation constant, *K*a, for propanoic acid. **(1)**

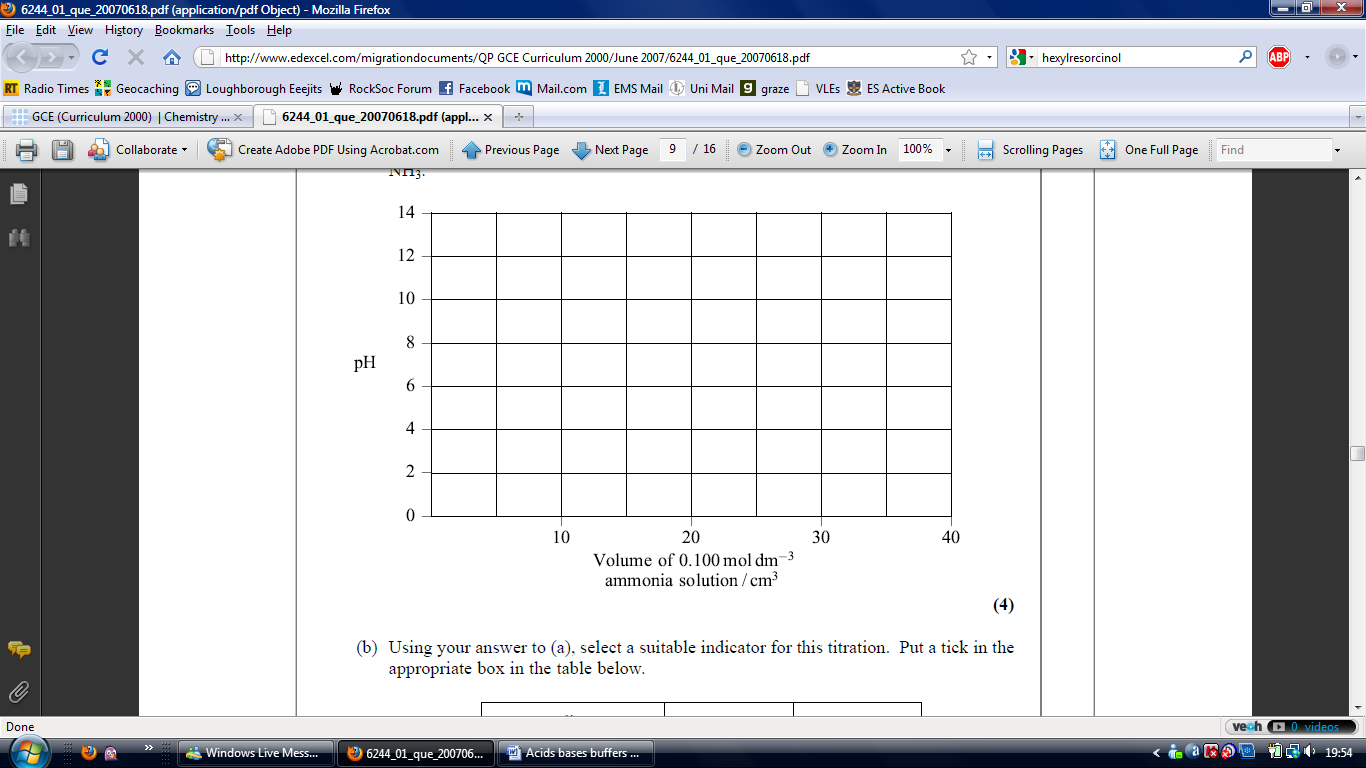
(ii) A solution of propanoic acid has a pH of 3.44 at a temperature of 298 K. Calculate the concentration, in mol dm–3, of the propanoic acid solution. Show clearly **two** assumptions you have made. **(5)**

(c) An aqueous solution of propanoic acid was titrated with sodium hydroxide. At the equivalence point, the resulting solution of sodium propanoate had a pH greater than 7. Explain, with the aid of a suitable equation, why this is **(2)**

(d) A mixture of sodium propanoate and propanoic acid acts as a buffer. What is meant by a **buffer solution**?  **(2)**

(e) Calculate the pH of a buffer made by mixing 100 cm3 of 0.0100 mol dm–3 propanoic acid solution with 300 cm3 of 0.00500 mol dm–3 sodium propanoate solution at 298K. [*K*a for propanoic acid: 1.30 × 10–5 mol dm–3 at 298K] **(3)**

**3.** Sketch the titration curve that you would expect if 25.0 cm3 of 0.100 mol dm–3 hydrochloric acid, HCl, is titrated with 40.0 cm3 of 0.100 mol dm–3 ammonia solution, NH3.



1. Using your answer to (a), select a suitable indicator for this titration. Put a tick in the appropriate box in the table.

|  |  |  |
| --- | --- | --- |
| Indicator | p*K*Ind | Tick |
| thymol blue | 1.7 |  |
| bromocresol green | 4.7 |  |
| phenol red | 7.9 |  |
| phenolphthalein | 9.3 |  |

(c) Suggest why there is no suitable indicator for the titration of ethanoic acid with ammonia.  **(2)**