1. A student carried out an investigation with aqueous solutions of nitric acid, sodium hydroxide, ethanoic acid and water.

The student diluted 0.015 mol dm^{-3} nitric acid with an equal volume of water and measured the pH of the diluted acid at 25 °C.

(i) Calculate the pH of 0.015 mol dm^{-3} nitric acid.

[2]

(ii) Calculate the pH of the diluted acid.

[1]

[Total 3 marks]

2. When phenol is mixed with aqueous sodium hydroxide, an acid–base reaction takes place.

$C_6H_5OH(aq) + OH^-(aq) \rightleftharpoons C_6H_5O^-(aq) + H_2O(l)$

....

In the available spaces,

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

[Total 1 mark]

3. Methanoic acid, HCOOH, is a weak organic acid which occurs naturally in ants and stinging nettles.

(a) Use an equation for the dissociation of methanoic acid to show what is meant by a *weak acid*.

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[1]

(b) A 1.50×10^{-2} mol dm^{-3} solution of HCOOH has $[H^+] = 1.55 \times 10^{-3}$ mol dm^{-3}.

(i) Calculate the pH of this solution and give one reason why the pH scale is a more convenient measurement for measuring acid concentrations than $[H^+]$.

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[2]

(ii) Write the expression for K_a for methanoic acid.

[1]

(iii) Calculate the values of K_a and pK_a for methanoic acid.

[3]

(iv) Estimate the percentage of HCOOH molecules that have dissociated in this aqueous solution of methanoic acid.

[1]

[Total 8 marks]

4. A solution of phenol in water has a concentration of 38 g dm^{-3}.
The acid dissociation constant, K_a, of phenol is 1.3×10^{-10} mol dm^{-3}.

(i) Write an expression for the acid dissociation constant, K_a, of phenol.

[1]

(ii) Calculate the pH of this solution.

answer.....

[5]

[Total 6 marks]

5. The K_a values for three acids are shown in the table below.

acid		K_a / mol dm^{-3}
ethanoic acid	CH_3COOH	1.70×10^{-5}
phenol	C_6H_5OH	1.28×10^{-10}
sulphurous acid	H_2SO_3	1.50×10^{-2}

(a) What information is provided by K_a values?

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[1]

(b) When sulphurous acid and ethanoic acid are mixed together, an acid-base reaction takes place.

$H_2SO_3(aq)$ + $CH_3COOH(aq)$ $\rightleftharpoons$ $HSO_3^-(aq)$ + $CH_3COOH_2^+(aq)$

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(i) In the spaces above

- label one **conjugate acid-base pair** as acid 1 and base 1,
- label the other **conjugate acid-base pair** as acid 2 and base 2.

[2]

(ii) Predict and explain the acid-base reaction that would take place if ethanoic acid were mixed with phenol. Include an equation in your answer.

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[2]

(c) The pH value of 0.0450 mol dm^{-3} hydrochloric acid is different from that of 0.0450 mol dm^{-3} ethanoic acid.

Calculate the pH values of these two acids. Show all your working.

[5]

[Total 10 marks]

6. An excess of magnesium was added to 100 cm^3 of 0.0450 mol dm^{-3} hydrochloric acid. The same mass of magnesium was added to 100 cm^3 of 0.0450 mol dm^{-3} ethanoic acid.

Both reactions produced 54 cm^3 of hydrogen gas, measured at room temperature and pressure, but the reaction with ethanoic acid took much longer to produce this gas volume.

Explain why the reactions produced the same volume of a gas but at different rates.

Use equations in your answer.

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[Total 4 marks]

7. A student prepared two solutions.

- Solution **A** was made by mixing together 25 cm^3 0.010 mol dm^{-3} aqueous sodium hydroxide with 50 cm^3 0.010 mol dm^{-3} ethanoic acid, CH_3COOH. Solution **A** is a buffer solution.

- Solution **B** was made by mixing together 25 cm^3 0.020 mol dm^{-3} aqueous sodium hydroxide with 50 cm^3 0.010 mol dm^{-3} ethanoic acid, CH_3COOH. Solution **B** is **not** a buffer solution.

(i) What is meant by a *buffer solution*?

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[1]

(ii) Explain why Solution **A** is a buffer solution whereas Solution **B** is **not**.

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[4]

[Total 5 marks]

8. A student measured the pH of water as 7.0 at 25 °C. The student then warmed the water to 40 °C and measured the pH as 6.7.

What do these results tell you about the tendency of water to ionise as it gets warmer? Explain your reasoning in terms of equilibrium.

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[Total 2 marks]