AS 91166

Demonstrate understanding of the properties of selected organic compounds

Collated Acids, bases and pH Questions

(2018:1) modified

(b) (iv) Sodium ethanoate, CH_3COONa is a salt. When solid sodium ethanoate is dissolved in water, it separates into ions. Use TWO relevant equations to explain whether the solution is acidic or basic.

(2018:3)

(a) The hydrogensulfate ion, HSO_4^-, is an amphiprotic species because it can both accept or donate a proton, thus acting as an acid or base. Complete the equations for the reactions of the hydrogensulfate ion, HSO_4^-, with water in the box below.

HSO_4^- acting as	Equation
an acid	$HSO_4^-(aq) + H_2O(l) \rightleftharpoons$
a base	$HSO_4^-(aq) + H_2O(l) \rightleftharpoons$

(b) The pH and relative electrical conductivity of aqueous solutions of potassium hydroxide, KOH(aq), and ammonia, $NH_3(aq)$, are shown in the table below. Both have concentrations of 0.100 mol L^{-1}.

Chemical	pH	Conductivity
KOH(aq)	13	good
$NH_3(aq)$	11.1	poor

Explain the difference in pH and conductivity of these two solutions. Use relevant equations in your answer.

(2017:1)

(a) Propanoic acid, C_2H_5COOH, is dissolved in water and the resulting solution has a pH of 4.2.

(i) Complete the equation by writing the formulae of the two products.

$C_2H_5COOH(aq) + H_2O(l) \rightleftharpoons$ _____ + _____

(ii) Explain the proton, H^+, transfer in this reaction, and identify the two conjugate acid-base pairs.

(b) Sodium ethanoate, $CH_3COONa(s)$, is a salt. When dissolved in water, it dissociates into ions. Explain, including TWO relevant equations, whether a solution of sodium ethanoate is acidic or basic.

(d) Solutions of ammonia, $NH_3(aq)$, and sodium carbonate, $Na_2CO_3(aq)$, are both basic.

Compare and contrast the electrical conductivity of these two solutions.

(2016:2)

(a) Water is an amphiprotic substance because it can accept or donate a proton, therefore acting as an acid or a base. Complete the equations for the reactions of water, H_2O, with ammonia, NH_3, and the ammonium ion, NH_4^+, in the box below.

H_2O acting as	Equation
an acid	$H_2O(l) + NH_3(aq) \rightleftharpoons$
a base	$H_2O(l) + NH_4^+(aq) \rightleftharpoons$

(b) Sodium carbonate, $Na_2CO_3(s)$, is a salt. When dissolved in water, it dissociates into ions. Explain whether a solution of sodium carbonate would be acidic or basic. In your answer you should include TWO relevant equations.

(d) The table shows the pH of three acidic solutions, ammonium chloride, NH_4Cl, propanoic acid, C_2H_5COOH, and hydrogen chloride, HCl.

	$NH_4Cl(aq)$	$C_2H_5COOH(aq)$	$HCl(aq)$
Concentration / mol L^{-1}	0.1	0.1	0.1
pH	5.62	3.44	1.0

(i) Explain why each of the three solutions in the table above has the same concentration, but a different pH. Use equations to support your answer.

(ii) Explain why the solution of ammonium chloride, $NH_4Cl(aq)$, is a good conductor of electricity, while the solution of propanoic acid, $C_2H_5COOH(aq)$, is a poor conductor of electricity

(2015:2)

(a) Ammonia solution, $NH_3(aq)$, is a common chemical in the school laboratory.

(i) Explain, using an equation, whether ammonia solution is acidic or basic.

(ii) Bottles of ammonia solution are often labelled ammonium hydroxide, $NH_4OH(aq)$.

Explain why both names, ammonia and ammonium hydroxide, are appropriate.

(b) The hydrogen carbonate ion, HCO_3^-, is an amphiprotic species because it can donate or accept a proton, therefore acting as an acid or base. Write equations for the reactions of HCO_3^- with water: one where it acts as an acid, and one where it acts as a base.

HCO_3^- acting as	Equation
an acid	$HCO_3^- + H_2O \rightleftharpoons$
a base	$HCO_3^- + H_2O \rightleftharpoons$

(d) Ethanoic acid solution, $CH_3COOH(aq)$, and ammonium chloride solution, $NH_4Cl(aq)$, are both weakly acidic. Identify and justify, using equations, which acid solution has greater electrical conductivity.

(e) The table shows the pH of two acidic solutions, methanoic acid, HCOOH, and hydrochloric acid, HCl, which both have a concentration of 0.1 mol L^{-1}.

Solution	HCOOH(aq)	HCl(aq)
pH	2.4	1

Compare and contrast the pH of each solution, and their expected rate of reaction with a 2 cm strip of cleaned magnesium ribbon, Mg.

(2014:1)

(a) Ammonia, NH_3, is dissolved in water and the resulting solution has a pH of 11.3.

(i) Complete the equation by writing the formulae of the two products.

$$NH_3(aq) + H_2O(l) \rightleftharpoons \_\_\_\_\_ + \_\_\_\_\_$$

(ii) Explain what is occurring during this reaction. In your answer you should:

- identify the acid and its conjugate base
- identify the base and its conjugate acid
- describe the proton transfer that occurs

(2014:1)

(c) The table below shows the relative electrical conductivity of five solutions of the same concentration, and the colour of pieces of litmus paper which have been dipped into each solution.

Solution	A	B	C	D	E
Electrical conductivity	poor	good	good	poor	good
Red litmus paper	turns blue	stays red	stays red	stays red	turns blue
Blue litmus paper	stays blue	turns red	stays blue	turns red	stays blue

Identify a strong base and a neutral salt, using the information in the table above.
In your answer you should justify your choices by referring to the properties of the identified solutions.

(2013:3)

(a) The table below shows two acids with their conjugate base.

Acid	Conjugate base
HCl	Cl^-
HSO_4^-	SO_4^{2-}

Explain the relationship between an acid and its conjugate base using one example from the table above.

(c) A solution of ethanoic acid, CH_3COOH, is found to be acidic.

(i) Complete the equation for the reaction of ethanoic acid with water.

$CH_3COOH + H_2O \rightleftharpoons$

(ii) Explain why the solution is acidic

(d) The following table shows the concentration and pH of three acids, and the relative rate of reaction with magnesium (Mg) metal.

Acid	Concentration / mol L^{-1}	pH	Relative rate of reaction with Mg
HA	0.100	3.4	slow
HB	0.0100	2	fast
HC	1.00×10^{-5}	5	very slow

(i) Write an equation for the reaction of HA with magnesium.

(ii) Explain the difference between a strong acid and a weak acid.

(iii) Compare and contrast the reactivity of the three acids with magnesium. In your answer:

- determine the concentration of hydronium ions, H_3O^+, in each acid
- compare the concentration of hydronium ions to the concentration of the acid
- explain the relative rate of reaction for each acid with magnesium by referring to the information in the table above.

pH calculations

(2018:1) modified

(b) (ii) The pH of solution X is 10.8. Calculate the hydronium ion concentration, $[H_3O^+]$, and the hydroxide ion concentration, $[OH^-]$, in the solution. $[H_3O^+]$ = $[OH^-]$ =

(iii) Sodium hydroxide solution, NaOH(aq), has a concentration of 0.0125 mol L^{-1}. Calculate the pH of the sodium hydroxide solution.

(2017:1)

(c) (i) A solution of sodium hydroxide, NaOH(aq), has a pH of 11.6.

Calculate the hydronium ion concentration $[H_3O^+]$, and the hydroxide ion concentration, $[OH^-]$, in the solution. Kw = 1×10^{-14}

$[H_3O^+]$ = $[OH^-]$ =

(ii) Calculate the pH of a 2.96×10^{-4} mol L^{-1} solution of potassium hydroxide, KOH(aq).

pH =

(2016:2)

(c) (i) Calculate the pH of a 0.0341 mol L^{-1} hydrochloric acid, HCl(aq), solution.

pH =

(ii) A solution of sodium hydroxide, NaOH(aq), has a pH of 12.4. Calculate the concentrations of both hydronium ions, H_3O^+, and hydroxide ions, OH^-, in this solution.

$[H_3O^+]$ = $[OH^-]$ =

(2015:2)

(c) (i) A solution of nitric acid, HNO_3(aq), has a hydronium ion, H_3O^+, concentration of 0.0243 mol L^{-1}. Determine, by calculation, the pH and the concentration of hydroxide ions, OH^-, in this solution. Kw = 1×10^{-14}

pH = $[OH^-]$ =

(ii) Determine the hydroxide ion concentration, $[OH^-]$, of a solution of potassium hydroxide, KOH(aq), with a pH of 11.8.

(2014:1)

(b) (i) In a solution of potassium hydroxide, KOH, the pH is found to be 12.8. Calculate the hydronium ion concentration, [H_3O+], and the hydroxide ion concentration, $[OH^-]$, in the solution.

$[H_3O^+]$ = $[OH^-]$ =

(iii) Calculate the pH of a 2.25×10^{-4} mol L^{-1} sodium hydroxide, NaOH, solution.
pH =

(2013:3) modified part question

Acid	Concentration / mol L^{-1}	pH	Relative rate of reaction with Mg
HA	0.100	3.4	slow
HB	0.0100	2	fast
HC	1.00×10^{-5}	5	very slow

Determine the concentration of hydronium ions, H_3O^+, in each acid.