LEKTION 2 VECKA 17

Question A1

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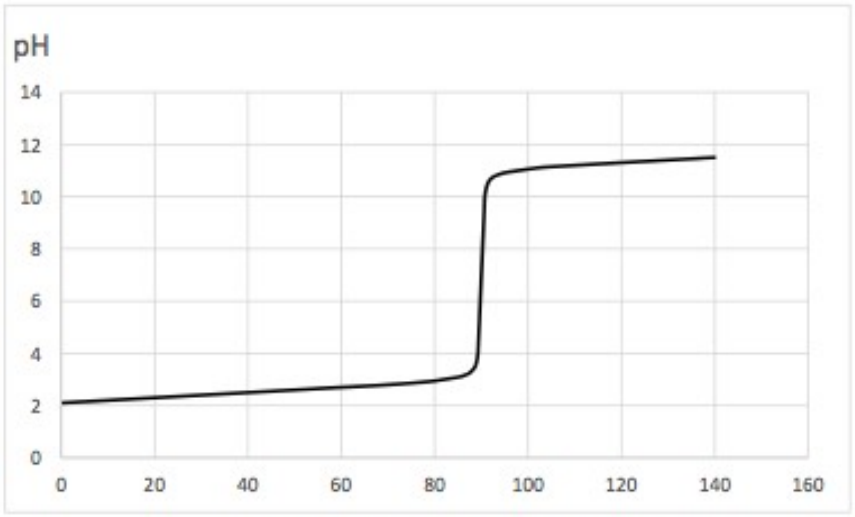
a)	The human stomach secretes about 2 dm^3 of gastric juice every day. If the stomach does not contain any food the mass percentage of hydrochloric acid, HCl(aq), in the gastric juice is about 0.5 to 1%. Many people suffer occasionally from heartburn. In this condition, a reflux of gastric juice into the oesophagus occurs.	
i.	Give the definition of an acid according to Brønsted.	1 mark
	Sodium hydrogen carbonate, $NaHCO_3(s)$, is used as a traditional household remedy.	
ii.	Give the equation for the reaction between sodium hydrogen carbonate and hydrochloric acid.	1 mark
	Sodium hydrogen carbonate, $NaHCO_3(aq)$, is an amphoteric substance.	
iii.	Explain the term amphoteric using relevant chemical equations involving the hydrogen carbonate ion, HCO_3^- (aq).	3 marks
	Common antacids that are used to treat heartburn contain sparingly soluble hydroxides, such as aluminium hydroxide, $Al(OH)_3(s)$, and magnesium hydroxide, $Mg(OH)_2(s)$.	
iv.	Give the equation for the reaction between aluminium hydroxide and hydrochloric acid.	2 marks
v.	Identify the two conjugate acid-base pairs involved in reaction **a) iv.**.	2 marks
vi.	Explain an advantage of these common antacids in the treatment of heartburn compared to the traditionally used sodium hydrogen carbonate.	1 mark

		Marks
b)	Assuming that the only acid in gastric juice is hydrochloric acid, a sample of 5.00 cm^3 was diluted with distilled water and analysed to determine the concentration of hydrochloric acid. This sample was titrated using a 1.00 x 10^{-2} mol dm^{-3} solution of sodium hydroxide, NaOH(aq).	
	The titration curve below shows the variation in pH as an aqueous solution of sodium hydroxide was added progressively.	



volume, in cm^3, of NaOH(aq) added

i.	Using the titration curve determine the volume of sodium hydroxide solution added to reach the equivalence point.	1 mark
ii.	Using the titration curve, determine the pH at the equivalence point.	1 mark

Cresol red is an indicator with two pH ranges of colour change:

Cresol red colour change	pH range of colour change
from orange red to yellow	0.2 – 1.8
from yellow to red	7.0 – 8.8

iii.	Explain why cresol red can be used for this titration referring to what will be observed during the titration.	2 marks
iv.	Give the equation for the titration reaction.	1 mark

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	v. Using the equivalence point show, by calculation, that the molar concentration of hydrochloric acid in the undiluted gastric juice is 1.80×10^{-1} mol dm^{-3}.	2 marks
	vi. Calculate the concentration of hydrochloric acid in mass percentage assuming that the density of the undiluted sample is 1.00 g cm^{-3}.	2 marks
c)	The pathogenic bacterium *Helicobacter pylori* is able to survive in the human stomach, due to the production of ammonia, $NH_3(aq)$.	
	i. Give the equation for the reaction of ammonia with water.	1 mark
	ii. Write the expression for the base ionisation constant, K_b, for ammonia.	1 mark
	Ammonia is a weak base.	
	iii. Calculate the pH of a 1.00×10^{-1} mol dm^{-3} aqueous solution of ammonia at 37 °C.	3 marks
	iv. Explain why the production of ammonia helps *Helicobacter pylori* to survive in the stomach.	1 mark
	Given: $K_b(NH_3(aq)) = 1.9 \times 10^{-5}$ at 37°C, $pK_w(H_2O(l)) = 13.6$ at 37°C	