Questions

Q1.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This question is about acids and bases.

Bromothymol blue, methyl orange and phenolphthalein are indicators used in titrations.

Which, if any, of these indicators could be used for a titration of ammonia, $NH_3(aq)$, with ethanoic acid, $CH_3COOH(aq)$?

(1)

☐ **A** bromothymol blue

☐ **B** methyl orange

☐ **C** phenolphthalein

☐ **D** none of these three indicators

(Total for question = 1 mark)

Q2.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This is a question about buffer solutions.

A buffer solution always

(1)

☐ **A** keeps the pH less than 7.
☐ **B** contains equimolar amounts of acid and its conjugate base.
☐ **C** keeps the pH constant if small quantities of acid or base are added.
☐ **D** resists changes in pH if small quantities of acid or base are added.

(Total for question = 1 mark)

Q3.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This question is about acids and bases.

Which of these mixtures would form a buffer solution with a pH **below** 7?

(1)

☐ **A** NaOH(aq) and excess HCl(aq)

☐ **B** NaOH(aq) and excess CH_3COOH(aq)

☐ **C** excess NaOH(aq) and HCl(aq)

☐ **D** excess NaOH(aq) and CH_3COOH(aq)

(Total for question = 1 mark)

Q4.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This question is about acids and bases.

What is the order of **decreasing** pH for 0.100 mol dm^{-3} solutions of these three acids?

(1)

☐ **A** $CH_3COOH > CH_2ClCOOH > HCl$

☐ **B** $HCl > CH_3COOH > CH_2ClCOOH$

☐ **C** $CH_2ClCOOH > CH_3COOH > HCl$

☐ **D** $HCl > CH_2ClCOOH > CH_3COOH$

(Total for question = 1 mark)

Q5.

This question is about acids and bases.

The pH of two salt solutions, **J** and **K**, are

solution **J** pH = 5
solution **K** pH = 9

The solutions are equimolar.

Which acids and bases could form the salts in solutions **J** and **K**?

(1)

	Acid and base forming the salt in solution **J**	Acid and base forming the salt in solution **K**
☒ **A**	$HCl(aq)$ and $NH_3(aq)$	$CH_3COOH(aq)$ and $NaOH(aq)$
☒ **B**	$HCl(aq)$ and $NaOH(aq)$	$CH_3COOH(aq)$ and $NH_3(aq)$
☒ **C**	$CH_3COOH(aq)$ and $NaOH(aq)$	$HCl(aq)$ and $NaOH(aq)$
☒ **D**	$CH_3COOH(aq)$ and $NH_3(aq)$	$HCl(aq)$ and $NH_3(aq)$

(Total for question = 1 mark)

Q6.

Boric acid, H_3BO_3, is a weak acid with antiseptic properties.

Boric acid can undergo further dissociation.

Which is the conjugate acid of the HBO_3^{2-} ion?

(1)

☒ **A** BO_3^{3-}

☒ **B** $H_2BO_3^-$

☒ **C** H_3BO_3

☒ **D** H_3O^+

(Total for question = 1 mark)

Q7.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

This question is about acids and buffer solutions.

The reaction of ammonia with water can be represented by

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

Which is the acid-conjugate base pair?

(1)

	Acid	Conjugate base
☒ **A**	NH_3	OH^-
☒ **B**	NH_3	NH_4^+
☒ **C**	H_2O	OH^-
☒ **D**	H_2O	NH_4^+

(Total for question = 1 mark)

Q8.

The reaction of sulfuric acid with potassium hydroxide is a neutralisation. The equation for this reaction is

$$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$$

A titration was carried out using the following method.

- Potassium hydroxide solution of unknown concentration was placed in a burette and the initial reading was recorded.
- 25.0 cm^3 of sulfuric acid solution, concentration 0.0800 mol dm^{-3}, was transferred to a conical flask.
- Three drops of phenolphthalein indicator were added to the sulfuric acid.
- Potassium hydroxide was added from the burette until the solution just changed colour and then the burette reading was recorded.
- Repeat titrations were carried out until concordant titres were obtained.

What is the colour of the solution when neutralisation has just occurred?

(1)

- ☒ **A** colourless
- ☒ **B** orange
- ☒ **C** pale pink
- ☒ **D** red

(Total for question = 1 mark)

Q9.

Hydrochloric acid is prepared by dissolving hydrogen chloride gas in water. It is difficult to dissolve a known amount of hydrogen chloride, so the exact concentration of such solutions is uncertain. A solution of hydrochloric acid of concentration between 0.095 mol dm^{-3} and 0.105 mol dm^{-3} was prepared.

Before a class attempted a practical using this solution, a technician standardised the hydrochloric acid with sodium carbonate solution. The technician dissolved 1.30 g of anhydrous sodium carbonate in water and made up the solution to 100 cm^3.

The equation for the reaction which occurs is shown.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

A 10.0 cm^3 portion of the sodium carbonate solution was transferred to a conical flask. Three drops of methyl orange indicator were added and the solution titrated with hydrochloric acid. The results for the experiment are shown.

Titration	1	2	3	4	5
Final burette reading / cm^3	26.00	34.00	36.10	24.15	48.20
Initial burette reading / cm^3	0.00	10.00	11.00	0.05	24.15
Titre / cm^3					
Concordant results (✓)					

The colour change at the end-point when methyl orange is used as an indicator for this titration is from

(1)

☒ **A** orange to yellow

☒ **B** red to orange

☒ **C** yellow to orange

☒ **D** yellow to red

(Total for question = 1 mark)

Q10.

The reaction of sulfuric acid with potassium hydroxide is a neutralisation. The equation for this reaction is

$$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$$

A titration was carried out using the following method.

- Potassium hydroxide solution of unknown concentration was placed in a burette and the initial reading was recorded.
- 25.0 cm^3 of sulfuric acid solution, concentration 0.0800 mol dm^{-3}, was transferred to a conical flask.
- Three drops of phenolphthalein indicator were added to the sulfuric acid.
- Potassium hydroxide was added from the burette until the solution just changed colour and then the burette reading was recorded.
- Repeat titrations were carried out until concordant titres were obtained.

Select the most appropriate piece of apparatus to measure the 25.0 cm^3 of sulfuric acid.

(1)

- ☒ **A** burette
- ☒ **B** measuring cylinder
- ☒ **C** pipette
- ☒ **D** volumetric flask

(Total for question = 1 mark)

Mark Scheme

Q1.

Question Number	Answer	Mark
	The only correct answer is D (none of these three indicators) ***A*** *is incorrect because both acid and base are weak so pH range at equivalence is too narrow for bromothymol blue to change colour* ***B*** *is incorrect because both acid and base are weak so pH range at equivalence is too narrow for methyl orange to change colour* ***C*** *is incorrect because both acid and base are weak so pH range at equivalence is too narrow for phenolphthalein to change colour*	**(1)**

Q2.

Question Number	Answer	Mark
	The only correct answer is D (resists changes in pH if small quantities of acid or base are added) **A** *is not correct because buffer solutions can be alkaline or acidic* **B** *is not correct because buffers do not always contain equal numbers of moles of the acid and its conjugate base* **C** *is not correct because a buffer does not prevent any change in pH*	**(1)**

Q3.

Question Number	Answer	Mark
	The only correct answer is B (NaOH(aq) and excess CH_3COOH(aq)) ***A*** *is incorrect because the solutions would not form a buffer* ***C*** *is incorrect because the solutions would not form a buffer* ***D*** *is incorrect because the solutions would not form a buffer*	**(1)**

Q4.

Question Number	Answer	Mark
	The only correct answer is A ($CH_3COOH > CH_2ClCOOH > HCl$) *B is incorrect because HCl is the only strong acid, so would have the lowest pH* *C is incorrect because $CH_2ClCOOH$ is stronger than CH_3COOH as the Cl atom stabilises the anion* *D is incorrect because the stronger the acid the lower the pH, hence these are in reverse order*	**(1)**

Q5.

Question number	Answer	Mark
	The only correct answer is A (solution **J**: HCl(aq) and NH_3(aq), solution **K**: CH_3COOH(aq) and NaOH(aq)) ***B*** *is incorrect because the salt formed from a strong acid (HCl) and a strong base (NaOH) will have pH 7 while that formed from a weak acid (CH_3COOH) and a weak base (NH_3) will have pH close to 7* ***C*** *is incorrect because the salt formed from a weak acid and a strong base will have a pH of about 9 while that formed from a strong acid and a strong base will have pH 7* ***D*** *is incorrect because the salt formed from a weak acid and a weak base will have a pH of about 7 while that formed from a strong acid and a weak base will have pH of about 5*	**(1)**

Q6.

Question Number	Answer	Mark
	The only correct answer is B ***A*** *is not correct because it is the conjugate base not acid* ***C*** *is not correct because it is not the conjugate acid* ***D*** *is not correct because it is not the conjugate acid*	**(1)**

Q7.

Question Number	Answer	Mark
	The only correct answer is C (H_2O and OH^-) **A** *is not correct because ammonia is acting as a base and not an acid* **B** *is not correct because this is the base – conjugate acid pair* **D** *is not correct because water and the ammonium ion are not an acid-conjugate base pair*	(1)

Q8.

Question Number	Acceptable Answer	Mark
	The only correct answer is C ***A*** *is not correct because this is the appearance of the solution before the potassium hydroxide is added* ***B*** *is not correct because this is the colour that methyl orange would be in neutral solution* ***D*** *is not correct because this is a colour sometimes given for the end-point which is incorrect, and it is the colour of phenolphthalein in acidic solution*	**(1)**

Q9.

Question Number	Answer	Mark
	The only correct answer is C ***A*** *is not correct because this is the reverse of the correct colour change* ***B*** *is not correct because this is doing the reverse titration (acid in flask and carbonate in burette)* ***D*** *is not correct because this is going beyond the endpoint to an acidic solution*	**(1)**

Q10.

Question Number	Acceptable Answer	Mark
	The only correct answer is C ***A*** *is not correct because a burette is used to measure varied volumes* ***B*** *is not correct because a measuring cylinder is less precise* ***D*** *is not correct because a volumetric flask is less precise*	**(1)**