Chemistry Mock 3.A Revision Pack

Question	Maximum Mark	Mark Awarded
#1	4	
#2	7	
#3	6	
#4	17	
#5	8	
#6	6	
#7	10	
#8	11	
#9	12	
#10	6	
#11	9	
#12	7	
#13	5	
Total	108	

#1

A class of students is provided with a mixture of the strong base sodium hydroxide and the weak base sodium carbonate. They are asked to carry out an experiment to find the percentage by mass of each in the sample using the following method.

- Prepare a standard solution of the solid mixture in a 250 cm^3 volumetric flask.
- Measure 25.00 cm^3 of this mixture into a conical flask and add a small amount of an appropriate indicator.
- Add 0.105 mol dm^{-3} hydrochloric acid from a burette whilst swirling the mixture until a permanent colour change occurs. At this point all the sodium hydroxide has reacted.
- Record the results and calculate the volume required to reach the first end-point (volume **A**).
- Add a few drops of a different indicator.
- Add more of the hydrochloric acid from the burette whilst swirling the mixture until a permanent colour change occurs. At this point all the sodium carbonate has reacted.
- Record the results and calculate the additional volume required to reach the second end-point (volume **B**).

(c) One student suggests using 0.100 mol dm^{-3} ethanoic acid for this titration method, however his partner suggests that a different method would be needed.

(i) Calculate the pH of 0.100 mol dm^{-3} ethanoic acid. [2]

(K_a for ethanoic acid = 1.76×10^{-5} mol dm^{-3})

pH = ...

(ii) Suggest how the equivalence point for the titration of a weak acid and a weak base such as sodium carbonate can be found experimentally. [2]

....

....

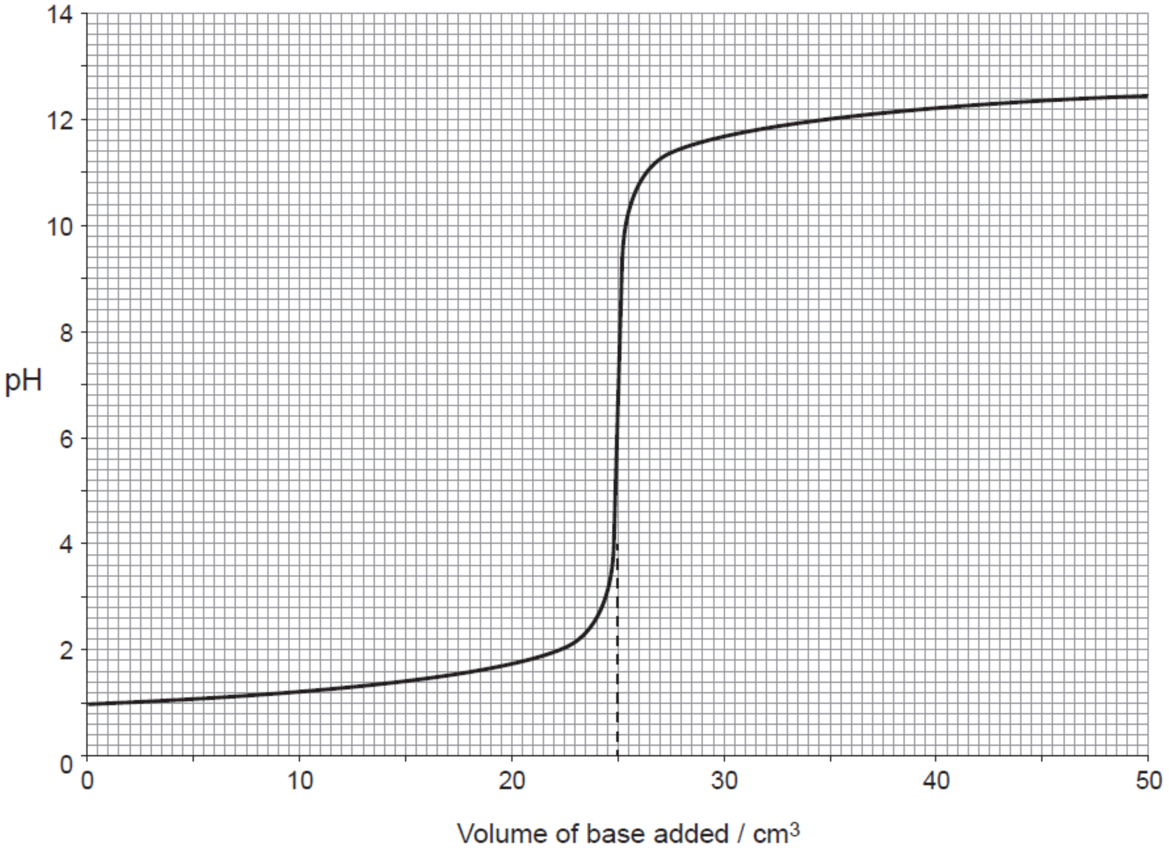
....

....

Question taken from Eduqas examination paper 841101, June 2017

#2

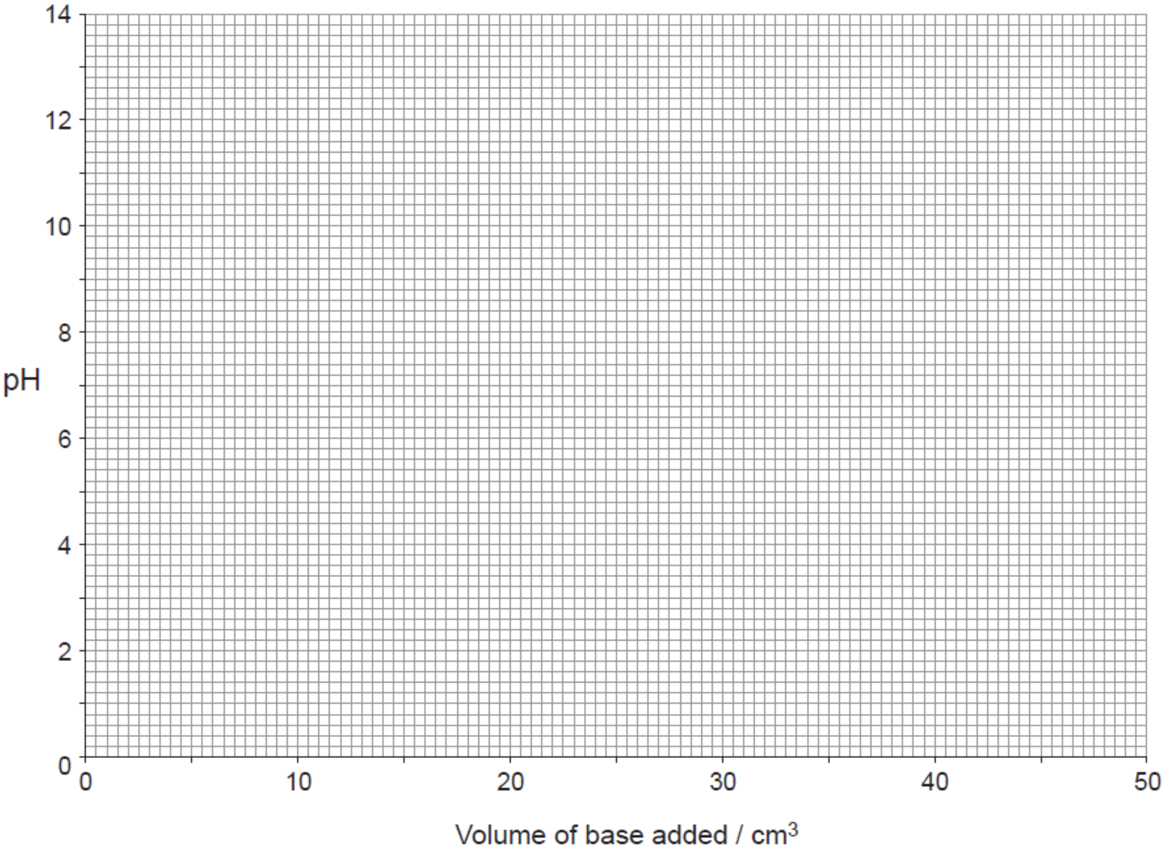
(b) (i) The following curve shows how the pH changes during the titration of a 0.10 mol dm^{-3} solution of a strong acid against a 0.10 mol dm^{-3} solution of a strong base.



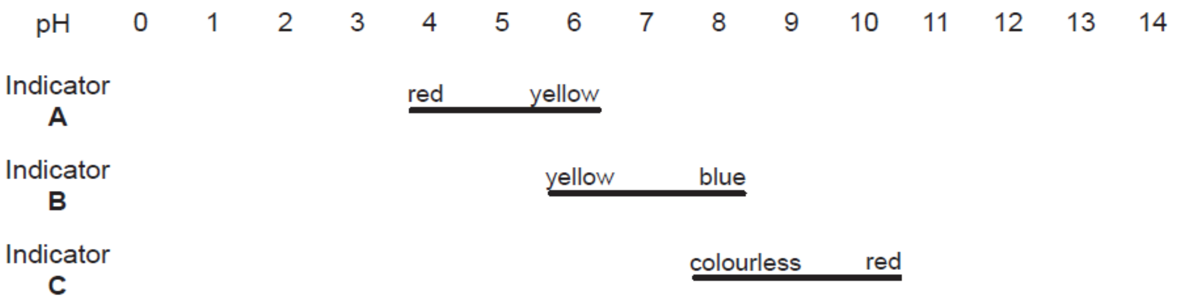
Draw the titration curve obtained when 50.0 cm^3 of a 0.10 mol dm^{-3} solution of a strong base is added gradually to 25.0 cm^3 of a 0.10 mol dm^{-3} solution of a weak acid.

The weak acid has a K_a value of 1.80×10^{-5} mol dm^{-3} at 298 K.

Give the pH values at key points during the titration and explain their significance.
[6 QER]


14
12
10
8
pH
6
4
2
0
0
10
20
30
40
50
Volume of base added / cm³

(ii) From the table below, suggest an appropriate indicator to use in this weak acid/strong base titration. Explain your answer. [1]



Question taken from Eduqas examination paper 841103, June 2022

#3

There are many organic acids produced by living things. These include citric acid in fruit and lactic acid produced during anaerobic respiration.

(c) Lactic acid is a weak monobasic acid with a K_a of 1.40×10^{-4} mol dm^{-3}.

(i) Calculate the concentration of a lactic acid solution of pH 2.89. [2]

Concentration = ... mol dm^{-3}

(ii) A mixture of lactic acid and sodium lactate forms a buffer solution.

I. State what is meant by a 'buffer solution'. [1]

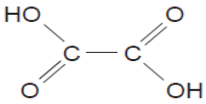
II. Calculate the pH of a buffer solution formed by mixing 100 cm^3 of 0.20 mol dm^{-3} aqueous lactic acid with 50 cm^3 of 0.20 mol dm^{-3} aqueous sodium lactate. [3]

pH = ...

Question taken from Eduqas examination paper 841101, June 2022

#4

Ethanedioic acid, $H_2C_2O_4$, is a dicarboxylic acid which occurs in many plants. The structure of ethanedioic acid is shown below.



Ethanedioic acid has two acidic hydrogens and therefore has two acid dissociation constants, K_{a1} and K_{a2}.

None of the second hydrogens dissociate until all of the first hydrogens have dissociated.

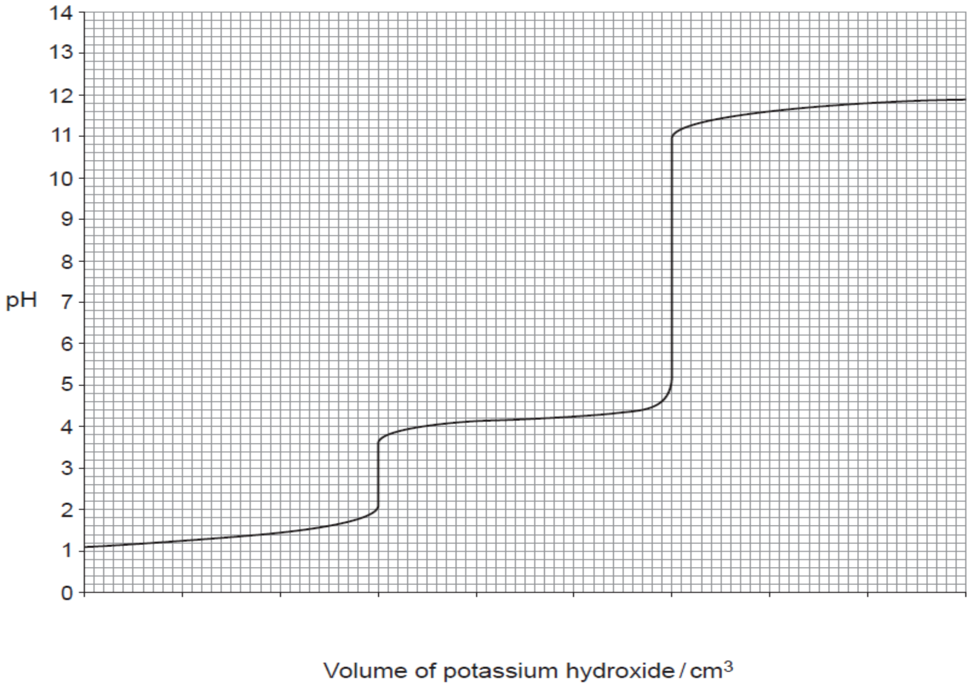
The acid dissociation constants have values of 5.62×10^{-2} and 5.25×10^{-5} mol dm^{-3}, but not necessarily in this order.

(a) Write equations to represent both stages in the dissociation of ethanedioic acid.

For both dissociations, give the value of the respective dissociation constant and explain your choice. [3]

Equation	Value of K_a / mol dm^{-3}
Explanation for choice of K_a value	

(b) The titration curve shows how the pH changes as a solution of potassium hydroxide is added to 30.0 cm^3 of a 0.112 mol dm^{-3} ethanedioic acid solution.



(i) Show that the initial pH of the 0.112 mol dm^{-3} solution of ethanedioic acid is 1.1. [3]

(ii) The potassium hydroxide solution had a concentration double that of the ethanedioic acid.

Complete the scale on the x-axis of the graph. Show your reasoning. [2]

....

....

....

....

(c) Explain the terms **weak** and **dilute** as applied to acid solutions. [2]

Weak ....

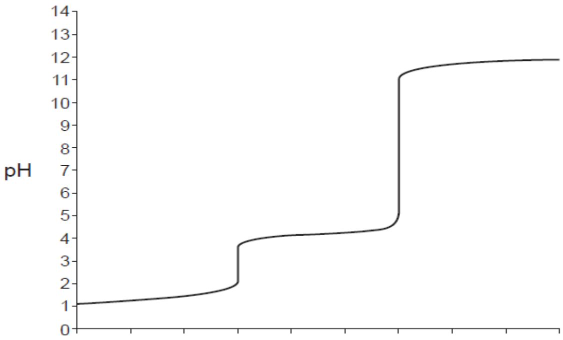
....

Dilute ....

....

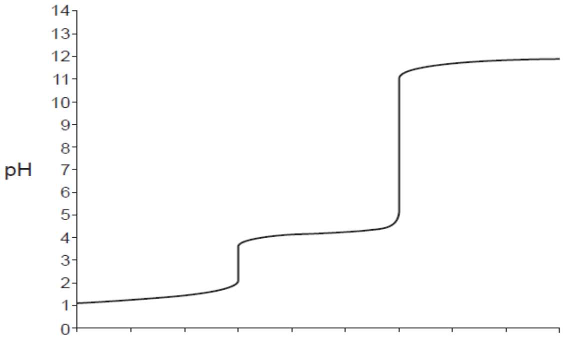
(d) (i) Sketch the titration curve obtained if the titration were repeated using 30.0 cm^3 of ethanedioic acid solution of **lower concentration**.

The concentration of the potassium hydroxide solution remains unchanged. [2]



(ii) Sketch the titration curve obtained if the titration were repeated using 30.0 cm^3 of a **different**, **weaker** dibasic acid, but of the **same concentration** as the ethanedioic acid.

Again, the concentration of the potassium hydroxide solution remains unchanged. [2]



(e) (i) Outline how an indicator works. [1]

....

....

....

(ii) Explain why two indicators are used in the titration of ethanedioic acid with potassium hydroxide solution. [2]

....

....

....

....

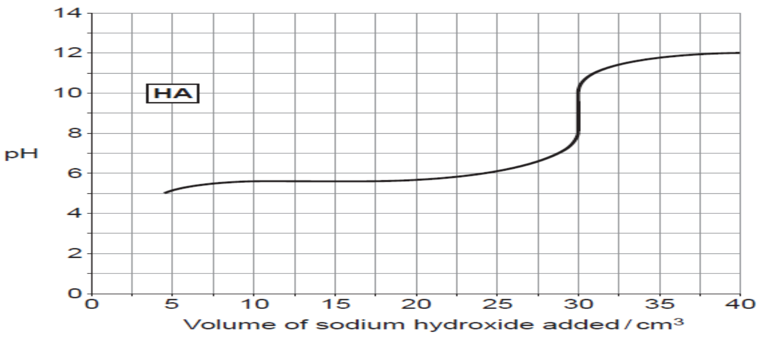
Question taken from Eduqas examination paper 841103, June 2023

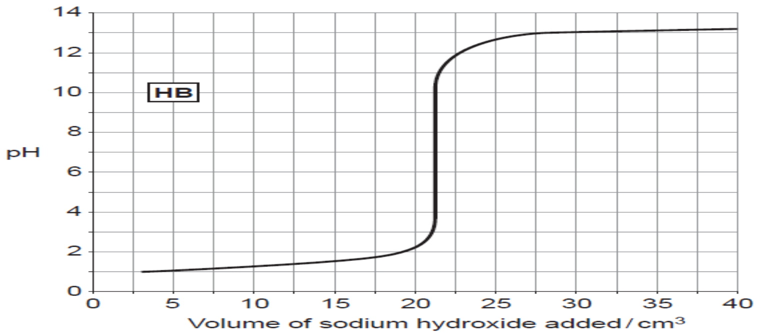
#5

A student carried out two acid-base titrations using two acids, HA and HB.

A 25.0 cm^3 sample of each acid was titrated against a sodium hydroxide solution of concentration 0.150 mol dm^{-3} giving the titration curves shown. The initial pH values are missing from both graphs.

One acid is a strong acid and one is a weak acid.





(d) The students made 250 cm^3 of aqueous sodium hydroxide of concentration 0.150 mol dm^{-3} for these experiments.

(i) Calculate the mass of NaOH required to make this solution. [2]

Mass = ... g

(ii) Outline how this solution could be made. [3]

(iii) Calculate the pH of this aqueous sodium hydroxide at 298 K. [3]

pH = ...

Question taken from Eduqas examination paper 841101, June 2023

#6

A class of students is provided with a mixture of the strong base sodium hydroxide and the weak base sodium carbonate. They are asked to carry out an experiment to find the percentage by mass of each in the sample using the following method.

- Prepare a standard solution of the solid mixture in a 250 cm^3 volumetric flask.
- Measure 25.00 cm^3 of this mixture into a conical flask and add a small amount of an appropriate indicator.
- Add 0.105 $mol\,dm^{-3}$ hydrochloric acid from a burette whilst swirling the mixture until a permanent colour change occurs. At this point all the sodium hydroxide has reacted.
- Record the results and calculate the volume required to reach the first end-point (volume **A**).
- Add a few drops of a different indicator.
- Add more of the hydrochloric acid from the burette whilst swirling the mixture until a permanent colour change occurs. At this point all the sodium carbonate has reacted.
- Record the results and calculate the additional volume required to reach the second end-point (volume **B**).

(b) Explain how an indicator works and give reasons why two different indicators are used to identify the end-points for neutralisation of sodium hydroxide and sodium carbonate. Suggest how you would select appropriate indicators for this experiment. [6 QER]

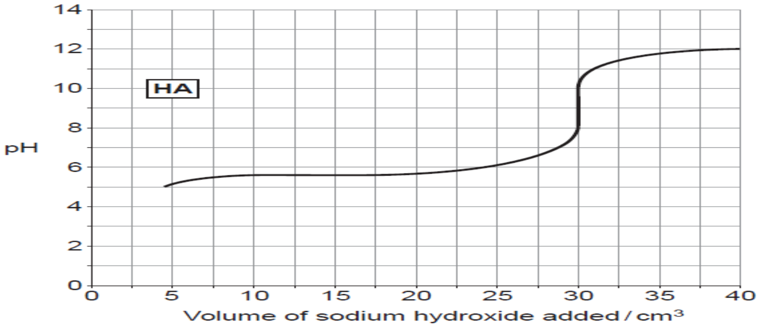
Question taken from Eduqas examination paper 841101, June 2017

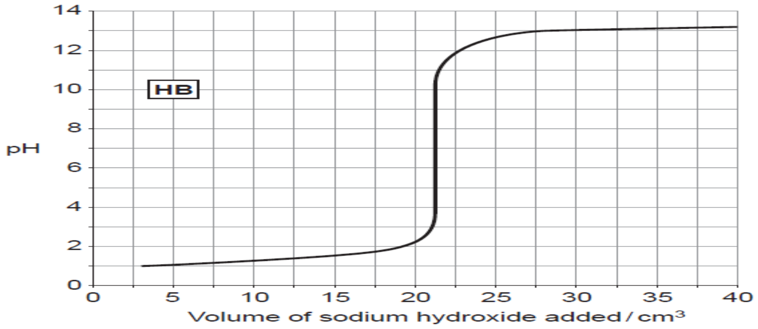
#7

A student carried out two acid-base titrations using two acids, HA and HB.

A 25.0 cm^3 sample of each acid was titrated against a sodium hydroxide solution of concentration 0.150 mol dm^{-3} giving the titration curves shown. The initial pH values are missing from both graphs.

One acid is a strong acid and one is a weak acid.





(a) Describe and explain the differences between the two curves.

- You should identify which acid is strong and which is weak, explaining fully how you have reached your conclusion.
- You should identify which acid is more concentrated and which is more dilute, explaining how you have reached your conclusion.

[6 QER]

(b) Calculate K_a for the weak acid. [2]

K_a = ... mol dm^{-3}

(c) Both these titrations can be performed using appropriate acid-base indicators, but similar experiments using a weak acid and a weak base cannot use acid-base indicators successfully. Explain this difference. [2]

Question taken from Eduqas examination paper 841101, June 2023

#8

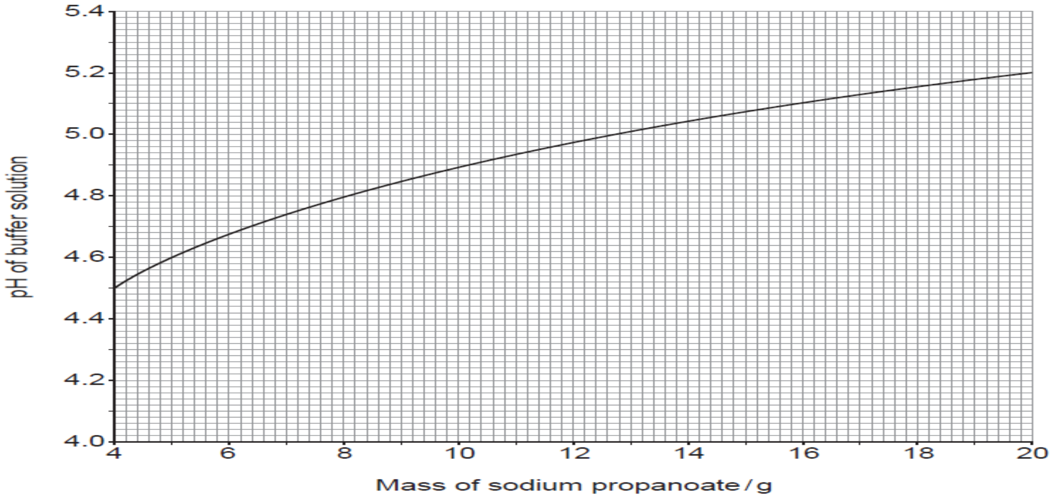
A biochemistry handbook suggests using a mixture of propanoic acid, CH_3CH_2COOH, and sodium propanoate, CH_3CH_2COONa, as a buffer solution.

(a) State what is meant by a buffer solution. **[1]**

(b) Give a use for a buffer. **[1]**

(c) The handbook suggests using 100 cm^3 of 1.00 mol dm^{-3} aqueous propanoic acid and dissolving an appropriate mass of sodium propanoate in the acid at 298 K to form a buffer.

The mass of sodium propanoate needed for different pH values is given in the chart below.



(i) Find the pH of the buffer when the concentration of the sodium propanoate is equal to the concentration of the propanoic acid. **[4]**

pH = ……………………………………

(ii) Find the value of K_a for propanoic acid. **[2]**

K_a = ……………………………………

(iii) At a higher temperature a greater mass of sodium propanoate must be added to the propanoic acid to achieve the same pH.

Explain what information this provides about the effect of temperature on K_a and hence the energy change during the dissociation of propanoic acid. **[3]**

Question taken from Eduqas examination paper 841101, October 2021

#9

There are many common acids and these can be classified as weak acids such as ethanoic acid, or strong acids such as nitric acid and sulfuric acid.

(a) Nitric acid can be prepared from ammonia in a three-step process.

(i) In step 1 of the process, ammonia is oxidised by oxygen to give nitric oxide, NO, and water.

Write an equation for this step. **[1]**

....

(ii) In the second step, nitric oxide is converted into nitrogen dioxide, NO_2.

$$2NO(g) + O_2(g) \longrightarrow 2NO_2(g) \qquad \Delta H^\theta = -114\,kJ\,mol^{-1}$$

The standard enthalpy change of formation of nitric oxide, NO, is 91 kJ mol^{-1}.

Calculate the standard enthalpy change of formation of nitrogen dioxide, NO_2. **[2]**

$\Delta_f H^\theta$ = ... kJ mol^{-1}

(iii) The final step is shown below.

$$3NO_2(g) + H_2O(l) \longrightarrow 2HNO_3(aq) + NO(g) \qquad \Delta H^\theta = -117\,kJ\,mol^{-1}$$

I. Use oxidation states to show that this is a disproportionation reaction. **[2]**

....

....

....

....

II. 1.85 g of NO_2 was added to 120 cm^3 of water at a temperature of 19.7 °C. Calculate the final temperature of the water. **[4]**

Final temperature = ... °C

III. Find the pH of the solution formed in part II. **[2]**

pH = ...

IV. Nitric oxide, NO, is produced as a side product in step 3. Suggest a way of improving the process to avoid this NO being wasted. **[1]**

....

....

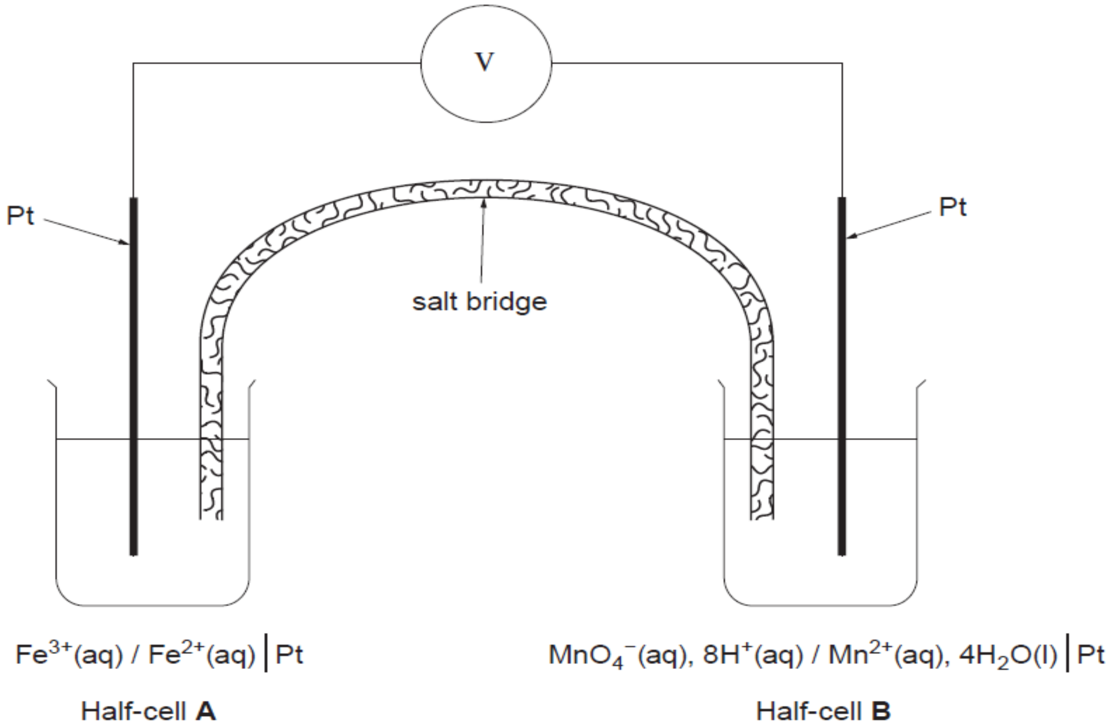
Question taken from Eduqas examination paper 841101, October 2021

#10

A student set up an electrochemical cell made up of the two half-cells for which the half-equations are given below.

$$Fe^{3+}(aq) + e^{-} \longrightarrow Fe^{2+}(aq) \qquad E^{\theta} = +0.77\,V$$

$$MnO_4^{-}(aq) + 8H^{+}(aq) + 5e^{-} \longrightarrow Mn^{2+}(aq) + 4H_2O(l) \qquad E^{\theta} = +1.52\,V$$



(a) Suggest how the student made the salt bridge. [1]

(b) Write an equation for the overall cell reaction and calculate the standard cell potential for this cell. [2]

(c) Describe **one** observation the student would have made in each half-cell after the cell had been connected for a period of time. [2]

Half-cell **A** ....

Half-cell **B** ....

(d) The student measured the cell potential and found that it was different from the value calculated in *(b)*. Suggest a reason for this. [1]

Question taken from Eduqas examination paper 841103, June 2017

#11

(b) The values for some standard electrode potentials are listed in the table below.

	Standard electrode potential, E^{θ} / V
$Li^+(aq) + e^- \rightleftharpoons Li(s)$	−3.04
$Na^+(aq) + e^- \rightleftharpoons Na(s)$	−2.71
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	−0.76
$Fe^{3+}(aq) + 3e^- \rightleftharpoons Fe(s)$	−0.04
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$	+0.54
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	+0.77
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-(aq)$	+1.09
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-(aq)$	+1.36

(i) Give the **formula** of the strongest reducing agent in the table. [1]

(ii) Calculate the EMF of the cell formed when the $Br_2(l) \mid Br^-(aq)$ half-cell is connected to the $Zn^{2+}(aq) \mid Zn(s)$ half-cell. [2]

EMF = ... V

(iii) Use the values in the table to explain why the reaction between gaseous iodine and heated iron wire produces iron(II) iodide whilst chlorine gas and iron wire produce iron(III) chloride. Your answer should include:

- An explanation of the products formed in the two reactions using the standard electrode potentials listed.
- Chemical equations for both reactions.
- A prediction of the product that would be formed when bromine gas reacts with heated iron wire, including a reason.
- An explanation of why the prediction made using the standard electrode potentials above may not be correct.

[6 QER]

Question taken from Eduqas examination paper 841101, June 2017

#12

A student determined the percentage purity of a sample of lead(IV) oxide as follows.

Step	Method
1	1.18 g of the impure lead(IV) oxide, solid **W**, was placed in a conical flask, and 4 g (an excess) of potassium iodide and 80 cm^3 of 1.00 mol dm^{-3} hydrochloric acid added. The conical flask was stoppered and shaken well to ensure that all the lead(IV) oxide had reacted. The solution turned brown due to the formation of iodine. $PbO_2(s) + 4H^+(aq) + 2I^-(aq) \longrightarrow Pb^{2+}(aq) + 2H_2O(l) + I_2(aq)$
2	The solution in the conical flask was poured into a 200 cm^3 volumetric flask using a funnel. The conical flask and the funnel were rinsed with deionised water and the washings transferred into the volumetric flask. The solution was made up to the mark with deionised water. The flask was shaken well to ensure the solution formed was homogeneous. The solution was labelled as solution **X**.
3	25.0 cm^3 of solution **X** was pipetted into a conical flask and titrated against 0.0510 mol dm^{-3} sodium thiosulfate solution. When the colour of the iodine in the flask started to fade, an appropriate indicator was added and the titration continued to the end-point. The equation for the reaction of sodium thiosulfate solution with iodine is as follows. $2S_2O_3^{2-}(aq) + I_2(aq) \longrightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$
4	Step 3 was repeated until concordant results were obtained. The mean volume of sodium thiosulfate used was 21.95 cm^3.

(a) Write the ion/electron half-equation for the oxidation of iodide ions to form iodine. [1]

....

(b) Use the equation for the overall reaction in step 1 to write the ion/electron half-equation for the reduction of lead(IV) oxide in acid conditions to form lead(II) ions. [1]

....

(c) Identify an appropriate indicator that could be used in step 3, and give the colour change at the end-point. [1]

Indicator ....

Colour change at the end-point ....

(d) (i) Calculate the number of moles of sodium thiosulfate used in the titration of 25.0 cm^3 of solution **X**, and hence the number of moles of iodine formed in step 1. [1]

Moles of iodine = ... mol

(ii) Calculate the percentage by mass of lead(IV) oxide in the solid sample **W**. [2]

Percentage by mass = ... %

(e) The balance used in weighing the lead(IV) oxide has an uncertainty for each reading of ±0.005 g.

Calculate the maximum percentage error.
Show your working. [1]

Percentage error = ... %

Question taken from Eduqas examination paper 841103, October 2021

#13

(a) The usual method for measuring the standard electrode potential of a half-cell is to connect it to a standard hydrogen electrode using a high resistance voltmeter and a salt bridge.

(i) State the function of the salt bridge. [1]

....

....

(ii) Draw a labelled diagram of the standard hydrogen electrode.

[3]

(iii) When measuring the standard electrode potential for the $Zn^{2+}(aq) | Zn(s)$ system a piece of zinc metal is placed in an aqueous solution containing $Zn^{2+}(aq)$. Explain why a similar method would not be appropriate for the $Li^{+}(aq) | Li(s)$ system. [1]

....

....

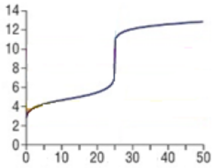
Question taken from Eduqas examination paper 841101, June 2017

Marking Scheme

#1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)		$[H^+]^2 = 1.76 \times 10^{-5} \times 0.1 = 1.76 \times 10^{-6}$ $[H^+] = 1.33 \times 10^{-3}$ mol dm^{-3} (1) pH = – log $[H^+]$ = 2.9 (1)		2		2	2	
		(ii)		use pH probe to measure pH as acid is added (1) plot results to find equivalence point / no sharp increase in pH (1)			2	2		2

#2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		**Indicative content** basic weak acid/strong base curve shape • 25.0 cm^3 of base added at equivalence point • total 50.0 cm^3 of base added • end pH 12-13 • buffer region  more detailed points • initial pH value calculated to be 2.87 • pH at equivalence point > 7 ⇨ salt of weak acid-strong base ⇨ hydrolysis forms OH$^-$ ions • [salt] = [acid] at half-equivalence point • pK_a = pH at half-equivalence = 4.7	3		3	6	2	4
				5-6 marks Calculates initial pH value and pH at half-equivalence; explanation of pH > 7 at equivalence point *The candidate constructs a relevant, coherent and logically structured account including all key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary is used accurately throughout.* **3-4 marks** Attempt at calculation of initial pH; buffer region in curve *The candidate constructs a coherent account including many of the key elements of the indicative content. Some reasoning is evident in the linking of key points and use of scientific conventions and vocabulary is generally sound.* **1-2 marks** Elements of the weak acid/strong base curve shape; 25.0 cm^3 of base at equivalence point *The candidate attempts to link at least two relevant points from the indicative material. Coherence is limited by omission and/or inclusion of irrelevant materials. There is some evidence of appropriate use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give an answer worthy of credit.*						
		(ii)		award (1) for correct indicator and explanation indicator **C** pH change of indicator is on the vertical portion of the curve		1		1		1

#3

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)		$[H^+] = 1.288 \times 10^{-3}$ mol dm^{-3} (1) acid concentration = $\frac{[H^+]^2}{K_a}$ = 0.0118 mol dm^{-3} (1)		2		2	2	
		(ii)	I	solution that keeps pH (relatively) constant when small amounts of acid or base are added	1			1		
			II	concentration of lactic acid = 2 × concentration of sodium lactate $[H^+] = K_a \times \frac{[\text{acid}]}{[\text{salt}]} = K_a \times 2$ (1) $[H^+] = 2.80 \times 10^{-4}$ (1) pH = 3.55 (1)		2	1	3	2	

#4

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(a)		HOOC—COOH $\rightleftharpoons$ HOOC—COO$^-$ + H$^+$ / K_{a1} = 5.62 × 10^{-2} mol dm^{-3} HOOC-COO$^-$ $\rightleftharpoons$ $^-$OOC-COO$^-$ + H$^+$ / K_{a2} = 5.25 × 10^{-5} mol dm^{-3} award (1) for both equations correct award (1) for correct identification of K_a values with sensible attempt at explanation first proton removed from neutral molecule whilst second proton removed from a negatively charged ion therefore more difficult to remove and K_a has a smaller value (1)		1	2	3		
	(b)	(i)	[(COOH)$_2$] = $\frac{[H^+]^2}{K_a}$ (1) 0.112 = $\frac{[H^+]^2}{5.62 \times 10^{-2}}$ ⇨ [H$^+$] = 0.0793 mol dm^{-3} (1) pH = –log 0.0793 = 1.1 (1)		3		3	3	
		(ii)	scale showing first equivalence point at 15 cm^3 **and** second equivalence point at 30 cm^3 (1) mole ratio n(COOH)$_2$: n(KOH) for removal of first proton is 1:1 and [(COOH)$_2$] : [KOH] is in the ratio of 1:2 ⇨ 30 cm^3 (COOH)$_2$: 15 cm^3 of KOH for first equivalence point (1) alternative reasoning n(COOH)$_2$ = $\frac{30.0 \times 0.112}{1000}$ = 0.00336 mol mole ratio n(COOH)$_2$: n(KOH) for removal of first proton is 1:1 therefore n(KOH) = 0.00336 mol volume of KOH = $\frac{0.00336}{0.224}$ = 0.015 dm^3 = 15.0 cm^3 (1)		1	1	2	1	2
	(c)		weak acid ⇨ only partially dissociated in (aqueous) solution (1) dilute acid ⇨ low concentration of acid molecules / H$^+$ ions in solution (1)	2			2		
	(d)	(i)	curve drawn has lower volume of KOH(aq) than original curve at both equivalence points (with one twice the volume of the other) (1) curve has slightly higher initial pH than original curve **and** pH at half-equivalence points for K_{a1} and K_{a2} are both the same as original curve (1)			2	2		
		(ii)	curve drawn has same volume of KOH(aq) as original curve at both equivalence points (1) curve has slightly higher initial pH than original curve **and** pH at half-equivalence points for K_{a1} and K_{a2} are both higher than in the original curve (1)			2	2		
	(e)	(i)	indicators are weak acids or weak bases and the protonated and deprotonated species have different colours	1			1		
		(ii)	equivalence points for K_{a1} and K_{a2} are at different pH values (1) indicator colour change range must lie within the vertical range(s) of the titration curve (1)	2			2		1
			Question total	**5**	**5**	**7**	**17**	**4**	**3**

#5

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		mol NaOH = 0.250 × 0.150 = 0.0375 mol (1) mass = 0.0375 × 40.01 = 1.50 g (1)		2		2		
		(ii)		place NaOH in a beaker and add a small amount of deionised water to dissolve (1) transfer to volumetric flask and rinse beaker/glass rod/funnel several times with all washings going into the flask OWTTE (1) add deionised water up to line, put stopper on and invert several times to mix thoroughly (1)	3			3		3
		(iii)		$[H^+] = \frac{K_w}{[OH^-]} = \frac{1.00 \times 10^{-14}}{0.150}$ (1) $[H^+] = 6.67 \times 10^{-14}$ (1) pH = – log[H⁺] = 13.2 (1)		3		3	3	

#6

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)			**Indicative content** 1. Indicators are weak acids or bases where protonated and deprotonated forms are different colours (can show by equation) 2. Indicator changes colour over a range of pH 3. Different indicators change colour over different pH ranges 4. The colour change range must lie within a vertical range of the titration curve for indicator to be useful 5. Equivalence points for sodium hydroxide / sodium carbonate occur at different pH values 6. Equivalence point for sodium carbonate is acidic, with that of sodium hydroxide in the mixture being neutral OR basic (accept either) 7. To select appropriate indicators, calculate OR find experimentally the pH of the equivalence points and their vertical regions 8. Refer to literature values of pH ranges 9. Name appropriate indicators	2	1	3	6		6
				5-6 marks At least **six** relevant points, including **two** of points 3, 4 and 5 *The candidate constructs a relevant, coherent and logically structured account including all key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary are used accurately throughout.* **3-4 marks** At least **four** relevant points, including at least **two** of points 3, 4 and 5 *The candidate constructs a coherent account including many of the key elements of the indicative content. Some reasoning is evident in the linking of key points and use of scientific conventions and vocabulary is generally sound.* **1-2 marks** At least **three** relevant points *The candidate attempts to link at least two relevant points from the indicative material. Coherence is limited by omission and/or inclusion of irrelevant materials. There is some evidence of appropriate use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give an answer worthy of credit.*						

#7

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(a)			**Indicative content** 1. HA is weak acid / HB is strong acid 2. pH of HA is higher than pH of HB early in titration / after adding 5/10/15 cm^3 NaOH so fewer H^+ ions (ignore reference to INITIAL pH as this is not shown) 3. Vertical region of curve of HA is shorter than HB 4. So equivalence point at a higher pH for HA 5. HA shows a flattening at around 15 cm^3 NaOH due to buffer effect 6. HA is more concentrated than HB 7. More NaOH needed to neutralise HA than HB 8. 30 cm^3 needed for HA and 21.00-21.50 cm^3 needed for HB **5-6 marks** Correct acids identified in terms of strength and concentration; full explanation of both *The candidate constructs a relevant, coherent and logically structured method including all key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary are used accurately throughout.* **3-4 marks** Correct acids identified in terms of strength and concentration; some reasons given for both *The candidate constructs a coherent account including most of the key elements of the indicative content. Some reasoning is evident in the linking of key points and use of scientific conventions and vocabulary are generally sound.* **1-2 marks** Stronger acid or more concentrated acid identified with relevant reason given *The candidate attempts to link at least two relevant points from the indicative content. Coherence is limited by omission and/or inclusion of irrelevant material. There is some evidence of appropriate use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give an answer worthy of credit.*		4	2	6	2	4
	(b)			at half-neutralisation point of HA pH = 5.6 (1) accept 5.5-5.7 $K_a = 10^{-5.6} = 2.51 \times 10^{-6}$ mol dm^{-3} (1) accept 2.00×10^{-6} - 3.16×10^{-6} mol dm^{-3}			2	2	2	
	(c)			indicators must change colour in a vertical region of the curve (1) titrations of HA and HB both have a vertical region but a weak acid-weak base titration does not (1)	2			2		2

#8

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(a)			solution that keeps pH (relatively) constant upon addition of small amounts of acid or base	1			1		
	(b)			award (1) for any of following storing enzymes fermentation (in baking/brewing) dyeing	1			1		
	(c)	(i)		moles of propanoic acid = $1.00 \times \frac{100}{1000}$ = 0.100 mol (1) M_r of sodium propanoate = 23 + 36 + 32 + 5.05 = 96.05 (1) mass of sodium propanoate = 9.605 g (1) pH = 4.87 (1) accept any value in the range 4.86-4.88		1 1 1 1		4	3	
		(ii)		pK_a = pH when [acid] = [salt] ⇨ $K_a = 10^{-pH}$ at this point (1) $K_a = 1.34 \times 10^{-5}$ (1) accept any value in the range $1.32\text{-}1.38 \times 10^{-5}$		1	1	2	2	
		(iii)		since $[H^+] = K_a \times \frac{[acid]}{[salt]}$, if more salt is required, then K_a must be greater (1) if K_a is greater then dissociation equilibrium must have shifted to the right (1) dissociation must be endothermic (1) ecf possible			3	3		

#9

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(a)	(i)		$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$		1		1		
		(ii)		$-114 = (2 \times \Delta_f H^\theta) - (2 \times 91)$ (1) $\Delta_f H^\theta = 34$ (1)		1 1		2	1	
		(iii)	I	oxidation state of N goes from +4 to +5 and +2 (1) it is disproportionation as the N has been oxidised and reduced (1)	1	1		2		
			II	$n(NO_2) = \frac{1.85}{46} = 0.0402$ mol (1) energy released = $\frac{-117 \times 0.0402}{3} = 1.57$ kJ (1) temperature rise = $\frac{1.57 \times 1000}{120 \times 4.18} = 3.1\,°C$ (1) final temperature = 22.8 °C (1)	1	1 1 1		4	1 1 1	
			III	concentration of acid = $\frac{0.0268}{0.120} = 0.2234$ mol dm^{-3} (1) pH = –log 0.2234 = 0.65 (1)		2		2	2	
			IV	award (1) for either of following recycle NO into step 2 add oxygen to oxidise NO (to NO_2)			1	1		

#10

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(a)			filter paper soaked in aqueous KNO_3 / U-tube of agar / gel soaked in saturated KNO_3 (or other suitable named electrolyte)	1			1		1
	(b)			$MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$ (1) E_{cell} = 1.52 – 0.77 = 0.75 V (1)	1 1			2		
	(c)			half-cell **A** solution becomes less green in colour (as the concentration of the Fe^{2+} decreases) / becomes more yellow or brown in colour (as the concentration of the Fe^{3+} increases) (1) half-cell **B** solution becomes less purple (violet) in colour (as the concentration of the MnO_4^- decreases) / becomes a paler pink in colour (as the concentration of the Mn^{2+} increases) (1)		1 1		2		2
	(d)			any of following for (1) • cell not 100 % efficient • cell not at standard temperature / conditions not standard • electrodes become contaminated on the surface (over time) • concentration of solutions changes (over time) • not a high resistance voltmeter			1	1		1
				Question total	**3**	**2**	**1**	**6**	**0**	**4**

#11

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		Li / Li (s)		1		1		
		(ii)		EMF = 1.09 – (–0.76) (1) = 1.85 V (ignore sign) (1)		2		2		2
	(b)	(iii)		**Indicative content** 1. Chlorine is a stronger oxidising agent than Fe^{3+} as shown by a more positive standard electrode potential 2. Chlorine is able to oxidise Fe to Fe^{3+} as the EMF for this reaction is positive / the standard electrode potential for chlorine is more positive than that for Fe^{3+} to Fe 3. Fe^{3+} is a stronger oxidising agent than iodine so will be reduced to Fe^{2+} 4. The standard electrode potential for Fe^{3+} / Fe^{2+} is more positive than that for I_2 / I^-. 5. Would expect bromine to form $FeBr_3$ as bromine is a stronger oxidising agent than Fe^{3+} (including reference to standard electrode potentials) 6. Prediction may be incorrect as not standard conditions (iron is heated / halogen gases rather than solutions / products solids rather than solutions) Relevant equations: • $Fe + I_2 \rightarrow FeI_2$ • $2Fe + 3Cl_2 \rightarrow 2FeCl_3$ • $2\,Fe + 3Br_2 \rightarrow 2FeBr_3$	2	2	2	6		3
				5-6 marks At least **five** relevant points, including point 5 and either point 1 or point 3, as well as at least **two** relevant equations. *The candidate constructs a relevant, coherent and logically structured account including all key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary are used accurately throughout.* **3-4 marks** At least **four** relevant points, including either point 1 or point 3, as well as at least **two** relevant equations. *The candidate constructs a coherent account including many of the key elements of the indicative content. Some reasoning is evident in the linking of key points and use of scientific conventions and vocabulary is generally sound.* **1-2 marks** At least **three** relevant points and **one** relevant equation. *The candidate attempts to link at least two relevant points from the indicative material. Coherence is limited by omission and/or inclusion of irrelevant materials. There is some evidence of appropriate use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give an answer worthy of credit.*						

#12

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(a)			$2I^- - 2e^- \rightarrow I_2$		1		1		
	(b)			$PbO_2 + 4H^+ + 2e^- \rightarrow Pb^{2+} + 2H_2O$			1	1		
	(c)			starch indicator blue/black to colourless	1			1		1
	(d)	(i)		$n(S_2O_3^{2-}) = 0.0510 \times \frac{21.95}{1000} = 0.00112$ $n(I_2)$ in 25.0 cm^3 = 0.000560 $n(I_2)$ formed in step 1 = 8 × 0.000560 = 0.00448	1			1	1	
		(ii)		$n(PbO_2)$ = 0.00448 in 200 cm^3 of solution (1) mass of PbO_2 = 0.00448 × 239 = 1.071 g percentage $PbO_2 = \frac{1.071}{1.18} \times 100 = 90.7$ (1)	1		1	2	2	
	(e)			$\frac{2 \times 0.005}{1.18} \times 100 = 0.85$		1		1	1	

#13

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(a)	(i)		allows ions to flow without the solutions mixing	1			1		1
		(ii)		award (1) for any **two** of following up to maximum of **six** for (3) $H_2(g)$ / 1 atm pressure / $H^+(aq)$ / 1 mol dm^{-3} concentration / 298 K / platinum electrode / appropriate diagram	3			3		3
		(iii)		lithium metal would react with the solution			1	1		1