

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

A-level CHEMISTRY

Paper 1 Inorganic and Physical Chemistry

Time allowed: 2 hours

Materials

For this paper you must have:

- the Periodic Table/Data Booklet, provided as an insert (enclosed)
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do **not** write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

| For Examiner's Use | |
|--------------------|------|
| Question | Mark |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| TOTAL | |

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 105.



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Answer all questions in the spaces provided.

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0 1

This question is about enthalpy changes for calcium chloride and magnesium chloride.

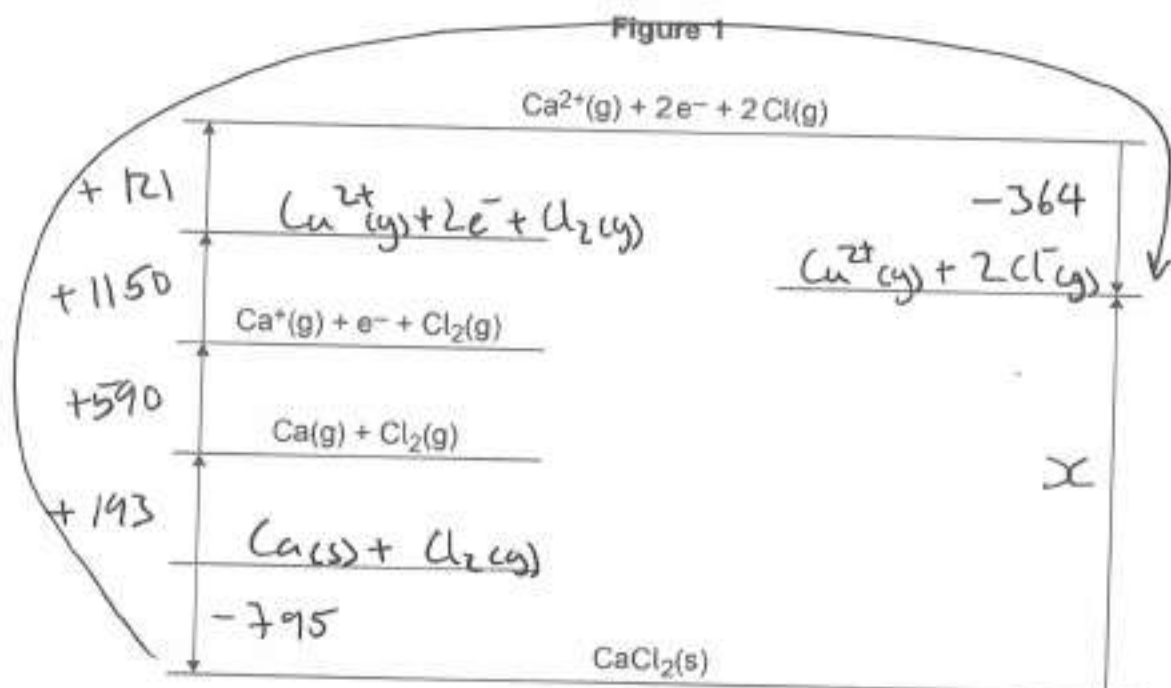
0 1. 1

State the meaning of the term enthalpy change.

[1 mark]

Heat change at constant pressure

Figure 1 shows an incomplete Born-Haber cycle for the formation of calcium chloride.



0 1. 2

Complete Figure 1 by writing the formulas, including state symbols, of the appropriate species on each of the three blank lines.

[3 marks]



0 1 . 3 Table 1 shows some enthalpy data.

Table 1

| | Enthalpy change / kJ mol^{-1} |
|---|---|
| Enthalpy of formation of calcium chloride | -795 |
| Enthalpy of atomisation of calcium | +193 |
| First ionisation energy of calcium | +590 |
| Second ionisation energy of calcium | +1150 |
| Enthalpy of atomisation of chlorine | +121 |
| Electron affinity of chlorine | -364 |

Use Figure 1 and the data in Table 1 to calculate a value for the enthalpy of lattice dissociation of calcium chloride.

[2 marks]

$$\begin{aligned} X &= +(-795) + 193 + 590 + 1150 + 2(121) + 2(-364) \\ &= +2242 \text{ kJ mol}^{-1} \end{aligned}$$

Enthalpy of lattice dissociation 2242 kJ mol^{-1}

Question 1 continues on the next page

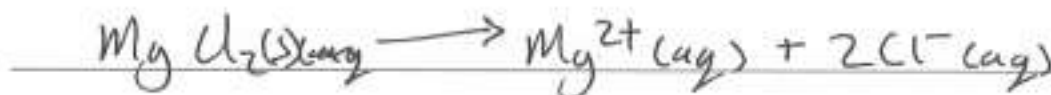
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0 1 . 4 Magnesium chloride dissolves in water.

Give an equation, including state symbols, to represent the process that occurs when the enthalpy of solution of magnesium chloride is measured.

[1 mark]



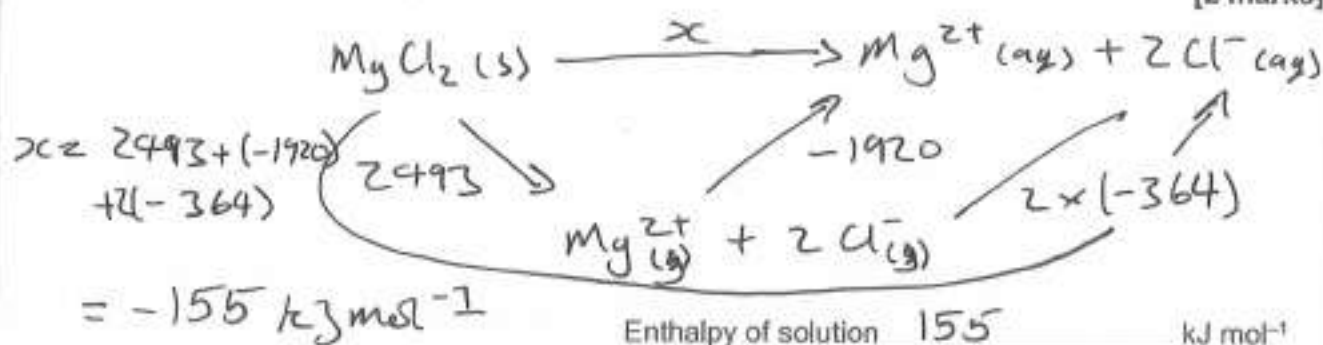
0 1 . 5 Table 2 shows some enthalpy data.

Table 2

| | Enthalpy change / kJ mol^{-1} |
|---|---|
| Enthalpy of lattice dissociation of MgCl_2 | +2493 |
| Enthalpy of hydration of $\text{Mg}^{2+}(\text{g})$ | -1920 |
| Enthalpy of hydration of $\text{Cl}^{-}(\text{g})$ | -364 |

Use your answer to Question 01.4 and the data in Table 2 to calculate a value for the enthalpy of solution of magnesium chloride.

[2 marks]



0 1 . 6 The enthalpy of hydration of $\text{Ca}^{2+}(\text{g})$ is $-1650 \text{ kJ mol}^{-1}$

Suggest why this value is less exothermic than that of $\text{Mg}^{2+}(\text{g})$

[2 marks]

The Ca^{2+} ion has a lower charge to size ratio than Mg^{2+} and so there is a weaker bond between it and $\text{O}^{\delta-}$ in water



0 2 This question is about atomic structure.

0 2 . 1 Define the mass number of an atom.

[1 mark]

The number of protons and the number of neutrons in the nucleus added together

0 2 . 2 Complete Table 3 to show the numbers of neutrons and electrons in the species shown.

[2 marks]

Table 3

| | Number of protons | Number of neutrons | Number of electrons |
|-----------------------|-------------------|--------------------|---------------------|
| ^{46}Ti | 22 | 44 | 22 |
| $^{49}\text{Ti}^{2+}$ | 22 | 27 | 20 |

0 2 . 3 A sample of titanium contains four isotopes, ^{46}Ti , ^{47}Ti , ^{48}Ti and ^{49}Ti

This sample has a relative atomic mass of 47.8

In this sample the ratio of abundance of isotopes ^{46}Ti , ^{47}Ti and ^{48}Ti is 2:2:1

Calculate the percentage abundance of ^{49}Ti in this sample.

[3 marks]

let $^{49}\text{Ti} = x$

$$47.8 = \frac{(46 \times 2x) + (47 \times 2x) + (48 \times (100 - 5x)) + 49x}{100}$$

$$47.8 = \frac{235x + 4800 + 240x}{100} = \frac{-5x + 4800}{100}$$

$$\frac{(47.8 \times 100) - 4800}{5} = x \quad x = 4$$

Abundance of ^{49}Ti 8 %

6

Turn over ►



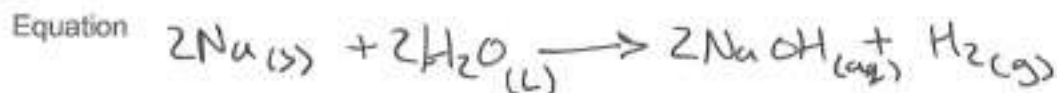
0 3 This question is about elements in Period 3 and their compounds.

0 3. **1** When a piece of sodium is added to 200 cm^3 of water in a large beaker a vigorous reaction occurs. The temperature of the water increases by $25 \text{ }^\circ\text{C}$

Give an equation, including state symbols, for the reaction of sodium with water.

Suggest why it is dangerous to react a similar piece of sodium with 10 cm^3 of water in a boiling tube.

[2 marks]

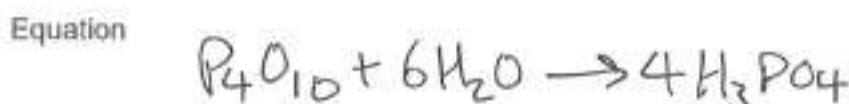


Why it is dangerous The vigorous reaction may cause the reactants to shoot out of the test tube

0 3. **2** Give an equation for the reaction of phosphorus(V) oxide with water.

Suggest a pH for the solution formed.

[2 marks]



pH 0

0 3. **3** Explain, in terms of crystal structure and bonding, why silicon(IV) oxide has a higher melting point than phosphorus(V) oxide.

[4 marks]

SiO_2 is a Giant Covalent Structure held together by many strong covalent bonds. These need a lot of energy to overcome. P_4O_{10} is a simple covalent molecule. Van der Waals forces between molecules in the solid are weak and easily overcome.



0 3 . 4

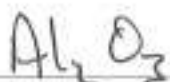
An element in Period 3 forms an oxide that is insoluble in water.
This oxide reacts with sulfuric acid and with aqueous potassium hydroxide.

Give the formula for this oxide.

Give an equation for the reaction of this oxide with sulfuric acid.

[2 marks]

Formula



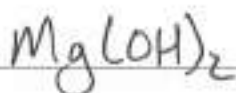
Equation



0 3 . 5

Give the formula of a hydroxide of an element in Period 3 used in medicine.

[1 mark]



0 3 . 6

Identify the element in Period 3, from sodium to chlorine, that has the largest atomic radius.

[1 mark]

$$\text{Na}$$

12

Turn over for the next question

Turn over ►



0 4

This question is about iron and its ions.

0 4

1

Discuss the role of iron as a heterogeneous catalyst in the Haber process.



Your answer should include:

- the meaning of the term heterogeneous catalyst
- how iron acts as a heterogeneous catalyst
- the factors that affect the efficiency and lifetime of the catalyst.

[6 marks]

A heterogeneous catalyst is one that is not in the same phase as the reactants. Iron acts as a heterogeneous catalyst in the Haber process as it takes the hydrogen and nitrogen onto its surface through adsorption at active sites. This weakens the H-H and N=N bonds, allowing them to react before desorbing and moving off. Iron is catalytic here as, although it takes part in the reaction it remains itself chemically unchanged.

The efficiency of the catalyst is affected by the surface area. Larger surfaces have more active sites. Surface area can be increased by the use of support mediums such as a honeycombed



matrix or by grinding the catalyst to a powder.

A catalyst's life time will be affected by factors such as poisoning. Impurities in the reactant mixture such as sulfur may poison the catalyst by binding to its active sites, blocking them to reactants.

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- 04.2 Fe²⁺ ions catalyse the reaction between peroxodisulfate(VI) ions and iodide ions in aqueous solution.



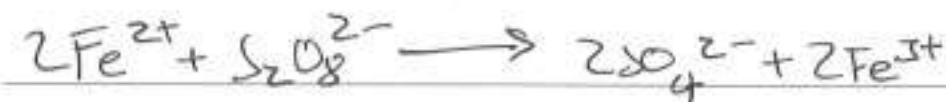
Explain why this reaction is slow before the catalyst is added.

Give **two** equations to show how Fe²⁺ ions catalyse this reaction.

[4 marks]

Why reaction is slow before catalyst added The two negative ions will repel each other so the energy need for a successful collision is high. In other words, its activation energy is high due to electrostatic repulsion

Equation 1



Equation 2



- 04.3 Give a reason why Zn²⁺ ions do **not** catalyse the reaction in Question 04.2.

[1 mark]

Zn does not have a range of oxidation states. Zn²⁺ is its only ion.



0 4 . 4 Iron reacts with dilute hydrochloric acid to form iron(II) chloride and hydrogen.



A 0.998 g sample of pure iron is added to 30.0 cm³ of 1.00 mol dm⁻³ hydrochloric acid.

One of these reagents is in excess and the other reagent limits the amount of hydrogen produced in the reaction.

Calculate the maximum volume, in m³, of hydrogen gas produced at 30 °C and 100 kPa.

Give your answer to 3 significant figures.

In your answer you should identify the limiting reagent in the reaction.

The gas constant, $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

$$n_{\text{Fe}} = \frac{0.998}{55.8} = 0.179 \text{ moles}$$

$$pV = nRT$$

$$V = \frac{nRT}{p}$$

$$n = cV$$

[6 marks]

$$n_{\text{HCl}} = 1 \times \frac{30.0}{1000} = 0.0300 \text{ moles}$$

$n_{\text{Fe}} > n_{\text{HCl}}$ HCl is limiting reagent

$$n_{\text{H}_2} \text{ Produced} = \frac{1}{2} n_{\text{HCl}} = 0.0150 \text{ moles}$$

$$T = 30^\circ\text{C} = 303 \text{ K}$$

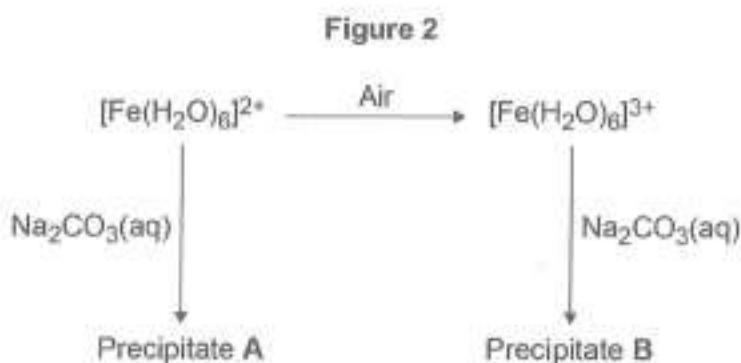
$$V = \frac{0.0150 \times 8.31 \times 303}{100,000} = 3.78 \times 10^{-4} \text{ m}^3$$

Volume of hydrogen $3.78 \times 10^{-4} \text{ m}^3$

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Figure 2 shows some reactions of iron ions in aqueous solution.



0 | 4 | 5 Identify A and state its colour.

[2 marks]

Identity FeCO₃
 Colour Green

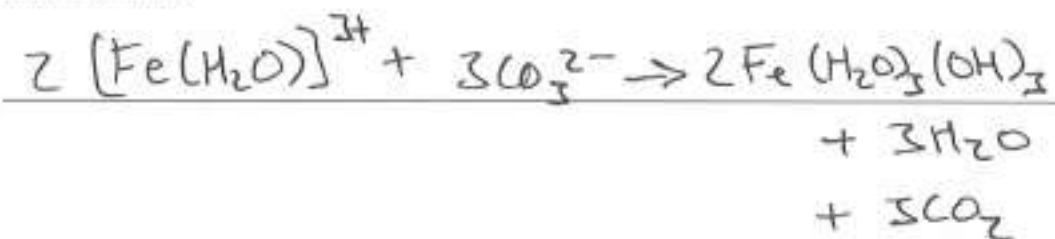
0 | 4 | 6 Give the formula of B and state its colour.

Give an ionic equation for the reaction of $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ with aqueous Na_2CO_3 to form B.

[3 marks]

Formula Fe(H₂O)₃(OH)₃
 Colour Brown

Ionic equation



- 0 4 . 7 Explain why an aqueous solution containing $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ ions has a lower pH than an aqueous solution containing $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ ions.

[3 marks]

Fe^{3+} has a greater charge density than Fe^{2+} . As such Fe^{3+} is more polarising in water than Fe^{2+} . This greater polarisation leads to weaker O-H bonds in the water ligands which will break. This releases H^+ ions into solution, lowering the pH.

25

Turn over for the next question

Turn over ►



0 5 This question is about the equilibrium



0 5 . 1 State and explain the effect, if any, of a decrease in overall pressure on the equilibrium yield of SO_3

[3 marks]

Effect a decrease in the yield

Explanation There are more moles of gas on the left hand side of the equilibrium so it will shift left to oppose the decrease in pressure.

0 5 . 2 A 0.460 mol sample of SO_2 is mixed with a 0.250 mol sample of O_2 in a sealed container at a constant temperature. When equilibrium is reached at a pressure of 215 kPa, the mixture contains 0.180 mol of SO_3

Calculate the partial pressure, in kPa, of SO_2 in this equilibrium mixture.

[4 marks]

$$n_{\text{SO}_2} = 0.46 - 0.18 = 0.28 \text{ moles}$$

$$n_{\text{O}_2} = 0.25 - 0.09 = 0.16 \text{ moles}$$

$$n_{\text{total}} = 0.28 + 0.16 + 0.18 = 0.62 \text{ moles}$$

$$p_{\text{SO}_2} = \frac{0.28}{0.62} \times 215 = 97.1 \text{ kPa}$$

Partial pressure of SO_2 97 kPa



Question 5 continues on the next page

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ANSWER IN THE SPACES PROVIDED**

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1 5

0 5 . 3 A different mixture of SO_2 and O_2 reaches equilibrium at a different temperature.

Table 4 shows the partial pressures of the gases at equilibrium.

Table 4

| Gas | Partial pressure / kPa |
|---------------|------------------------|
| SO_2 | 1.67×10^2 |
| O_2 | 1.02×10^2 |
| SO_3 | 1.85×10^2 |

Give an expression for the equilibrium constant (K_p) for this reaction.

Calculate the value of the equilibrium constant for this reaction and give its units.

[3 marks]

$$\begin{aligned}
 K_p &= \frac{P_{\text{SO}_3}^2}{P_{\text{SO}_2}^2 \times P_{\text{O}_2}} \quad \frac{(\text{kPa})^2}{\text{kPa}^{-1}} \\
 &= \frac{(1.85 \times 10^2)^2}{(1.67 \times 10^2)^2 \times 1.02 \times 10^2} \\
 &= 1.2 \times 10^{-2} \text{ kPa}^{-1}
 \end{aligned}$$

$$\begin{array}{l}
 K_p \quad 1.2 \times 10^{-2} \\
 \text{Units} \quad \text{kPa}^{-1}
 \end{array}$$



0 5 . 4

What is the effect on the value of K_p if the pressure of this equilibrium mixture is increased at a constant temperature?



[1 mark]

Tick (✓) **one** box.

The value of K_p

increases.

stays the same.

decreases.

11

Turn over for the next question

Turn over ►



0 6

This question is about pH.

Pure water dissociates slightly.



The equilibrium constant, $K_c = \frac{[\text{H}^+][\text{OH}^-]}{[\text{H}_2\text{O}]}$

The ionic product of water, $K_w = [\text{H}^+][\text{OH}^-]$

0 6 . 1

Explain why $[\text{H}_2\text{O}]$ is not shown in the K_w expression.

[1 mark]

The concentration of H_2O is almost constant

Table 5 shows how K_w varies with temperature.

Table 5

| Temperature / °C | $K_w / \text{mol}^2 \text{ dm}^{-6}$ |
|------------------|--------------------------------------|
| 10 | 2.93×10^{-15} |
| 20 | 6.81×10^{-15} |
| 25 | 1.00×10^{-14} |
| 30 | 1.47×10^{-14} |
| 50 | 5.48×10^{-14} |

0 6 . 2

Explain why the value of K_w increases as the temperature increases.

[2 marks]

The equilibrium is endothermic in the forward direction so the system shifts right to oppose the temperature increase. This rises $[\text{H}^+][\text{OH}^-]$ value.



0 6 . 3 Give the expression for pH.

Calculate the pH of pure water at 50 °C
Give your answer to 2 decimal places.

Explain why water is neutral at 50 °C

[4 marks]

Expression $\text{pH} = -\text{Log}_{10} [\text{H}^+]$

Calculation

$$[\text{H}^+] = \sqrt{5.48 \times 10^{-14}} = 2.34 \times 10^{-7}$$

$$\text{pH} = -\log_{10} (2.34 \times 10^{-7}) = 6.63$$

$$[\text{H}^+] = [\text{OH}^-]$$

Explanation The dissociation of water gives
one H^+ ion and one OH^- pH 6.63

Question 6 continues on the next page

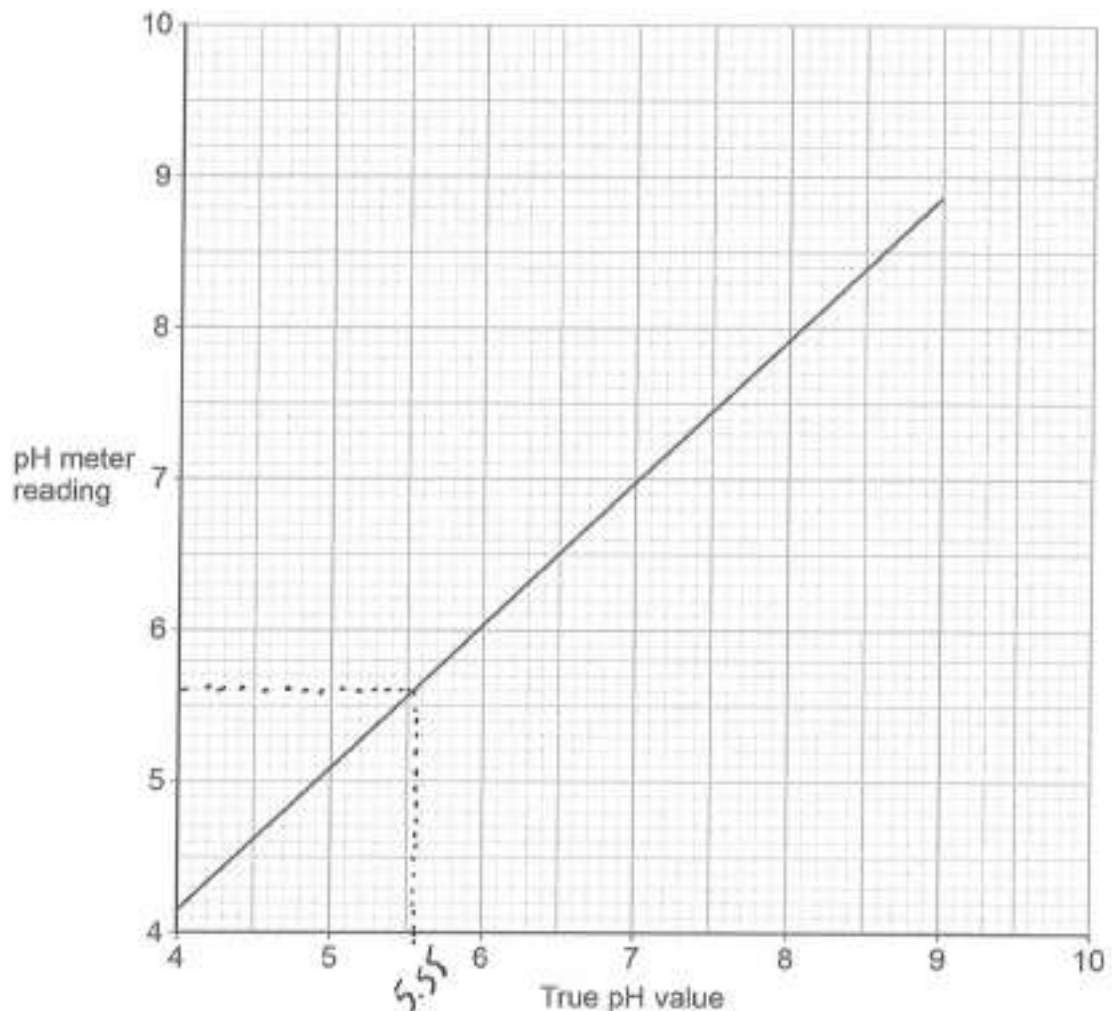
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A pH meter is calibrated using a calibration graph.
To create the calibration, the pH meter is used to measure the pH of separate solutions, each with a known, accurate pH.

Figure 3 shows the calibration graph.

Figure 3



0 6 . 4 Use Figure 3 to give the true pH value when the pH meter reading is 5.6

[1 mark]

5.55

0 6 . 5 Suggest why the pH probe is washed with distilled water between each of the calibration measurements.

[1 mark]

So different solutions do not
contaminate each other



0 6 . 6

The calibrated pH meter is used to monitor the pH during a titration of hydrochloric acid with sodium hydroxide.

Explain why the volume of sodium hydroxide solution added between each pH measurement is smaller as the end point of the titration is approached.

[1 mark]

To avoid missing the end point

Figure 4 shows the pH curve for a titration of hydrochloric acid with sodium hydroxide solution.

Figure 4

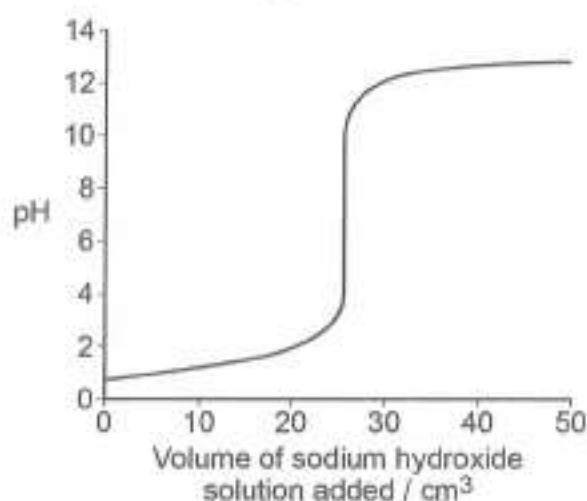


Table 6 shows data about some indicators.

Table 6

| Indicator | pH range | Colour at low pH | Colour at high pH |
|-------------------|------------|------------------|-------------------|
| Bromocresol green | 3.8 – 5.4 | yellow | blue |
| Phenol red | 6.8 – 8.4 | yellow | red |
| Thymolphthalein | 9.3 – 10.5 | colourless | blue |

The student plans to do the titration again using one of the indicators in Table 6 to determine the end point.

0 6 . 7

State why all three of the indicators in Table 6 are suitable for this titration.

[1 mark]

All indicators change within the range of the steep region of the curve

Turn over ►



06.8 36.25 cm³ of 0.200 mol dm⁻³ sodium hydroxide solution are added to 25.00 cm³ of 0.150 mol dm⁻³ hydrochloric acid.

Calculate the pH of the final solution at 25 °C

$K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ at 25 °C

[5 marks]

$$n \text{ OH}^- = \frac{36.25 \times 0.2}{1000} = 7.25 \times 10^{-3} \text{ moles}$$

$$n \text{ H}^+ = \frac{25 \times 0.150}{1000} = 3.75 \times 10^{-3} \text{ moles}$$

$$n \text{ OH}^- \text{ excess} = n \text{ OH}^- - n \text{ H}^+ = 3.50 \times 10^{-3} \text{ moles}$$

$$[\text{OH}^-] = \frac{3.50 \times 10^{-3}}{61.25 \times 10^{-3}} = 5.71 \times 10^{-5} \text{ mol dm}^{-3}$$

$$[\text{H}^+] = \frac{1 \times 10^{-14}}{5.71 \times 10^{-5}} = 1.75 \times 10^{-10}$$

$$\text{pH} = -\log_{10}(1.75 \times 10^{-10})$$

$$= 12.76$$

pH 12.76

16



Turn over for the next question

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0 7

This question is about thermodynamics.
Consider the reaction shown.

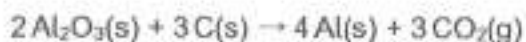


Table 7 shows some thermodynamic data.

Table 7

| Substance | $\text{Al}_2\text{O}_3(\text{s})$ | $\text{Al}(\text{s})$ | $\text{C}(\text{s})$ | $\text{CO}_2(\text{g})$ |
|---|-----------------------------------|-----------------------|----------------------|-------------------------|
| $\Delta_f H^\ominus / \text{kJ mol}^{-1}$ | -1669 | 0 | 0 | -394 |
| $S^\ominus / \text{J K}^{-1} \text{mol}^{-1}$ | 51 | 28 | 6 | 214 |

0 7 . 1

Explain why the standard entropy value for carbon dioxide is greater than that for carbon.

[1 mark]

CO_2 is a gas. It is more disordered than a solid

0 7 . 2

State the temperature at which the standard entropy of aluminium is $0 \text{ J K}^{-1} \text{ mol}^{-1}$

[1 mark]

0K



- 07.3 Use the equation and the data in Table 7 to calculate the minimum temperature, in K, at which this reaction becomes feasible.

$$\Delta G = \Delta H - T\Delta S \quad \text{reaction feasible at } \Delta G = 0 \quad [7 \text{ marks}]$$

$$\begin{aligned} \Delta H &= (0 + 3(-394)) - (2(-1669) + 0) \\ &= -1182 + 3338 \\ &= 2156 \text{ kJ mol}^{-1} \end{aligned}$$

$$\begin{aligned} \Delta S &= [4(28) + 3(214)] - [2(51) + 3(6)] \\ &= 754 - 120 \\ &= 634 \text{ J K}^{-1} \text{ mol}^{-1} = 0.634 \text{ kJ K}^{-1} \text{ mol}^{-1} \end{aligned}$$

$$\Delta G = \Delta H - T\Delta S \quad @ \quad \Delta G = 0$$

$$0 = \Delta H - T\Delta S$$

$$T\Delta S = \Delta H$$

$$T = \frac{\Delta H}{\Delta S}$$

$$T = \frac{2156}{0.634} = 3400 \text{ K}$$

Minimum temperature 3400 K

9

Turn over ►



0 8 This question is about electrode potentials and electrochemical cells.

0 8 . 1 State the meaning of the term electrochemical series.

[1 mark]

electrode potentials in numerical order

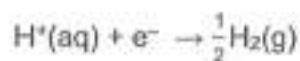
Table 8 shows some electrode potentials.

Table 8

| | E^\ominus / V |
|---|------------------------|
| $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s}) + 6\text{H}_2\text{O}(\text{l})$ | -0.44 |
| $\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \frac{1}{2}\text{H}_2(\text{g})$ | 0.00 |
| $[\text{Co}(\text{NH}_3)_6]^{3+}(\text{aq}) + \text{e}^- \rightarrow [\text{Co}(\text{NH}_3)_6]^{2+}(\text{aq})$ | +0.11 |
| $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}(\text{aq}) + \text{e}^- \rightarrow [\text{Fe}(\text{H}_2\text{O})_6]^{2+}(\text{aq})$ | +0.77 |
| $\text{VO}_2^+(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{VO}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$ | +1.00 |
| $[\text{Co}(\text{H}_2\text{O})_6]^{3+}(\text{aq}) + \text{e}^- \rightarrow [\text{Co}(\text{H}_2\text{O})_6]^{2+}(\text{aq})$ | +1.81 |

Oxidation strength (downward arrow on the left) and *reduction strength* (upward arrow on the right) are indicated.

0 8 . 2 State **two** conditions needed for the following half-cell to have $E^\ominus = 0.00 \text{ V}$



[1 mark]

298 K

100 kPa

0 8 . 3 Identify the weakest reducing agent in Table 8.

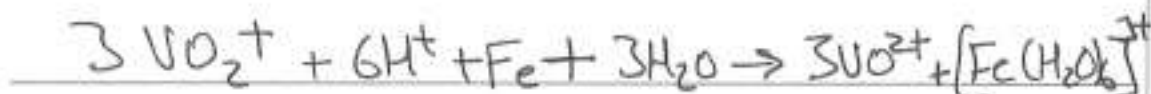
[1 mark]

$[\text{Co}(\text{H}_2\text{O})_6]^{2+}$



- 0 8 . 4 Use half-equations from Table 8 to deduce an equation for the reduction of VO_2^+ to form VO^{2+} in aqueous solution by iron.

[2 marks]



- 0 8 . 5 Use data from Table 8 to explain why $[\text{Co}(\text{H}_2\text{O})_6]^{3+}(\text{aq})$ will undergo a redox reaction with $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}(\text{aq})$

Give an equation for this reaction.

[2 marks]

Explanation The half cell potential of the $\text{Co}^{3+}/\text{Co}^{2+}$ half cell is greater than that of the $\text{Fe}^{3+}/\text{Fe}^{2+}$ half cell

Equation



- 0 8 . 6 Suggest why the two cobalt(III) complex ions in Table 8 have different electrode potentials.

[1 mark]

They have different ligands

Turn over for the next question

Turn over ►



09

This question is about the development of lithium cells.
The value of E^\ominus for lithium suggests that a lithium cell could have a large EMF.

Table 9 shows some electrode potential data.

Table 9

| | E^\ominus / V |
|--|------------------------|
| $\text{Li}^+(\text{aq}) + \text{e}^- \rightarrow \text{Li}(\text{s})$ | -3.04 |
| $2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$ | -0.83 |
| $\frac{1}{2}\text{I}_2(\text{s}) + \text{e}^- \rightarrow \text{I}^-(\text{aq})$ | +0.54 |

09.1

Use data in Table 9 to explain why an aqueous electrolyte is **not** used for a lithium cell.

[2 marks]

Lithium would react with the water in an aqueous electrolyte. The E^\ominus for Li^+/Li is more negative than that of water.

09.2

In the 1970s lithium-iodine cells became a common power source for heart pacemakers. Lithium iodide is the final product of the cell reaction.

Use the data in Table 9 to calculate the cell EMF of a standard lithium-iodine cell.

[1 mark]

$$\text{EMF} = 0.54 - (-3.04) = 3.58 \text{ V}$$

09.3

An EMF value for a commercial lithium-iodine cell is 2.80 V

Suggest why this value is different from the value calculated in Question 09.2.

[1 mark]

Pacemakers operate under non-standard conditions



0 9 . 4 In some lithium cells, lithium perchlorate (LiClO_4) is used as the electrolyte.

Deduce the oxidation state of chlorine in LiClO_4

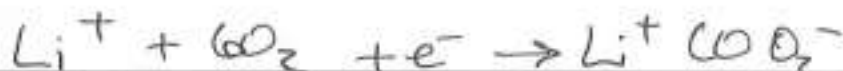
[1 mark]

+7

In other lithium cells, lithium cobalt oxide electrodes **and** lithium electrodes are used.

0 9 . 5 Give an equation for the reaction that occurs at the positive lithium cobalt oxide electrode.

[1 mark]



0 9 . 6 Give an equation for the reaction that occurs at the negative lithium electrode.

[1 mark]



7

END OF QUESTIONS

