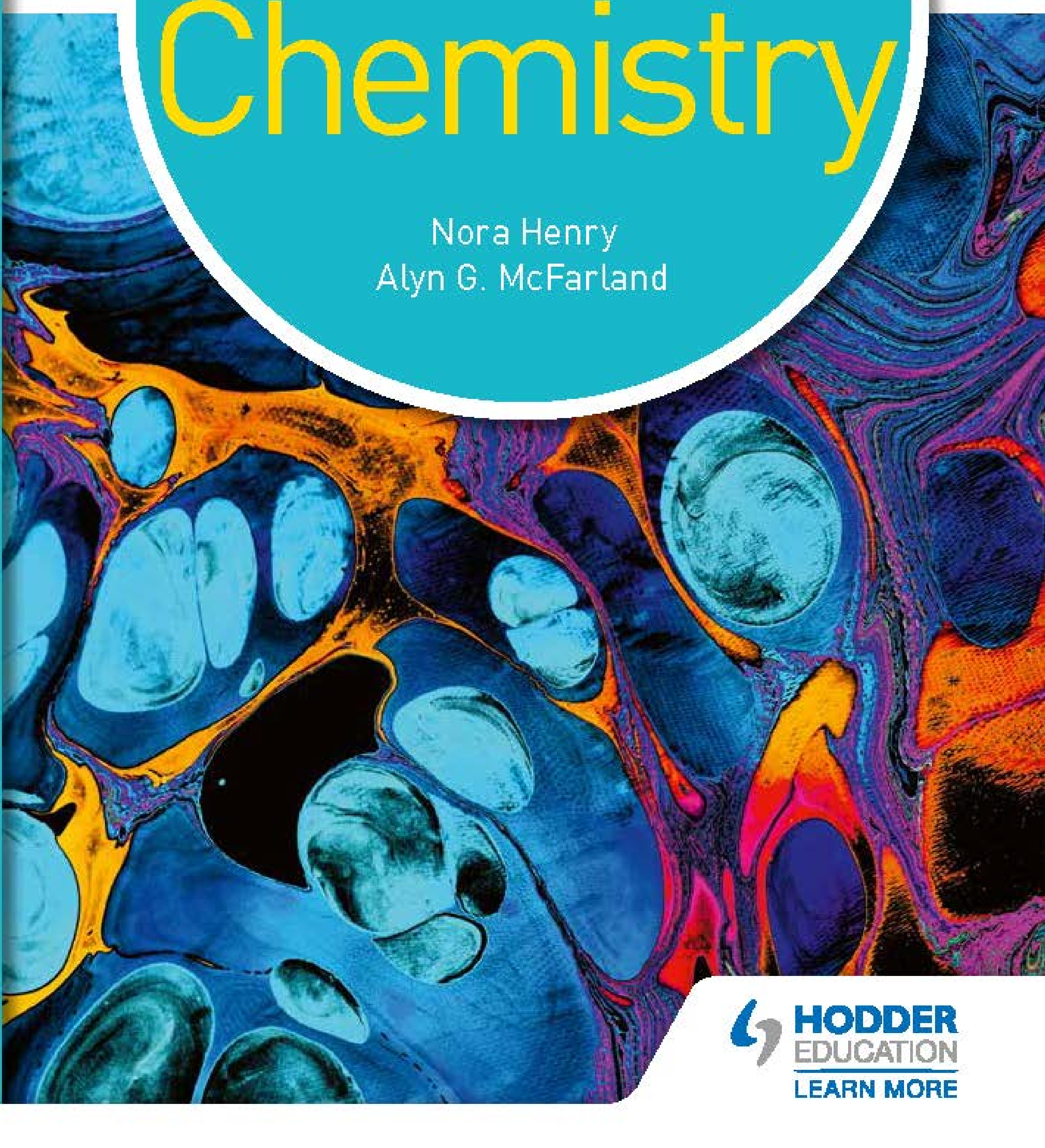
PRACTICE MAKES PERMANENT

600+ questions

AQA A-level Chemistry

Nora Henry
Alyn G. McFarland



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Contents

Introduction

Practice Makes Permanent is a series that advocates the benefits of answering lots and lots of questions. The more you practise, the more likely you are to remember key concepts: practice does make permanent. The aim is to provide you with a strong base of knowledge that you can automatically recall and apply when approaching more difficult ideas and contexts.

This book is designed to be a versatile resource that can be used in class, as homework, or as a revision tool. The questions may be used in assessments, as extra practice, or as part of a SLOP (Shed Loads of Practice) teaching approach.

How to use this book

This book is suitable for the AQA A-level Chemistry course. It covers all the content that you will be expected to know for the final examination.

The content is arranged topic by topic in the order of the AQA specification, so areas can be practised as needed. Within each topic there are:

- **Quick questions** – short questions designed to introduce the topic
- **Exam-style questions** – questions that replicate the types, wording and structure of real exam questions, but highly targeted to each specification point
- **Topic reviews** – sections of exam-style questions that test content from across the entirety of the topic in a more synoptic way.

These topic questions are tagged with the following:

- Page references to the accompanying Hodder Education student books, for example **SB1 p3** refers you to page 3 of *AQA A-level Chemistry Student Book 1* (ISBN 978 1471 80767 1) and **SB2 p8** refers to page 8 of *AQA A-level Chemistry Student Book 2* (ISBN 978 1471 80770 1)
- AQA specification references such as **3.1.1.2**, which can be used if you want to select questions to practise a specific area of the specification
- **MS** indicates questions that test maths skills
- **ER** indicates a 6-mark extended response question, requiring an answer that contains the correct chemistry and shows good communication skills
- **AT** indicates questions that ask you to use practical knowledge of apparatus and techniques
- **PS** indicates questions that ask you to use knowledge of practical skills
- **RP** indicates questions that test understanding of the required practicals.

At the end of the book there is a **full set of practice exam papers**. These have been carefully assembled to resemble typical AQA question papers in terms of coverage, marks and skills tested. We have also constructed each one to represent the typical range of demand in the A-level Chemistry papers as closely as possible.

Full worked **answers** are included at the end of the book for quick reference, with awarded marks indicated where appropriate.

If you are using a different textbook

Some students will be using a different Hodder Education student book for their course: *AQA A-level Chemistry (Year 1 and Year 2)*, ISBN 978 1510 46983 9. If you have this book, there is a mapping grid available at https://tinyurl.com/sp9yp7v to show how each question in *Practice Makes Permanent* links to the content of your student book.

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That is, page 25 Figure 1, and the data sheet at the back of the book.

The questions and answers in this book were not provided by, or approved by, AQA.

1 Physical chemistry

Atomic structure

Fundamental particles, mass number and isotopes

Quick questions

SB1 p3 3.1.1.1 **1** State what is meant by:

a) mass number

b) atomic number

c) isotopes.

SB1 p3 3.1.1.1 **2** Copy and complete **Table 1**.

Species	Number of protons	Number of neutrons	Number of electrons
Al			
Rb			
	7		10
Fe^{2+}		30	
	24		21
Ba			
Se^{2-}			
	25		23

Table 1

SB1 p6–7 3.1.1.2 **3** Name the steps A, B and C which occur in a time of flight mass spectrometer.

Ionisation → A → B → C → Data analysis

SB1 p6–8 3.1.1.2 **4** Decide which of each pair of ions will reach the detector first in a mass spectrometer.

a) $^{35}Cl^{+}$ or $^{37}Cl^{+}$

b) $^{12}C_2H_4^{+}$ or $^{13}C_2H_4^{+}$

c) $^{127}I^{+}$ or $^{125}I^{+}$

Exam-style questions

5 The plum pudding model of an atom can be represented by **Figure 1**.

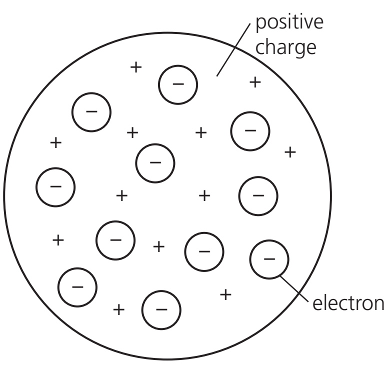

Figure 1

SB1 p3 3.1.1.1

5–1 Compare the plum pudding model with the model of atomic structure used today. [3]

5–2 Name any fundamental particle that would not be deflected by an electric field. [1]

Total: 4

6–1 State the relative charge and relative mass of the fundamental particles of an atom. [3]

SB1 p3 3.1.1.2

6–2 In terms of particles, explain the relationship between two isotopes of the same element. Explain why these isotopes have identical chemical properties. [2]

SB1 p3–6 3.1.1.2 MS 0.2

6–3 A sample of boron has relative atomic mass 10.8 and contains two isotopes, ^{10}B and ^{11}B. Calculate the percentage abundance of ^{11}B in this sample. [2]

SB1 p3–6 3.1.1.2 MS 0.2

6–4 A mass spectrum of a sample of an element showed peaks at *m/z* 113 and *m/z* 115. The relative atomic mass of this sample is 114.5. Calculate the ratio of the number of lighter atoms to the number of heavier atoms in the sample. [2]

Total: 9

SB1 p7–11 3.1.1.2 MS 3.1

7 The mass spectrum of an element is shown in **Figure 2**. Calculate the relative atomic mass and identify the element. Give your answer to an appropriate number of significant figures. [3]

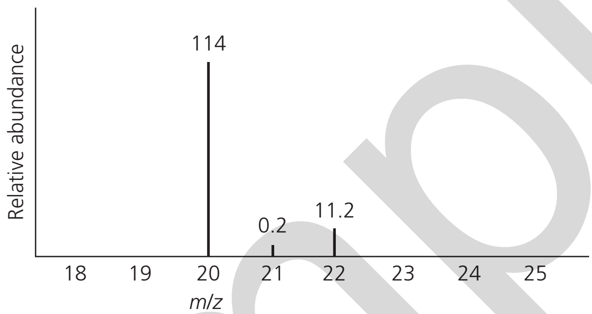

Figure 2

SB1 p3 3.1.1.2

8 How many electrons are there in a strontium ion, Sr^{2+}? [1]

A: 36

B: 38

C: 40

D: 88

SB1 p3 3.1.1.2

9 Which does not have the same number of electrons as a potassium ion? [1]

A: PH_3

B: PH_4^+

C: PH_2^-

D: PH_2^+

SB1 p6–7 3.1.1.2

10 Mass spectrometry is a powerful instrumental method of analysis that can be used to identify elements and determine relative molecular mass. In time of flight spectrometry, particles of the substances are first ionised either by electron impact or by electrospray ionisation.

10–1 **1.** Describe the process of electron impact to ionise a sample of an element X. [3]

2. Give an equation including state symbols to show an atom of X being ionised by electron impact. [1]

10–2 Describe the process of electrospray ionisation. Give an equation, including state symbols, to represent an atom of Y being ionised in this process. [4]

10–3 Suggest which method of ionisation is used if a protein is being analysed in mass spectrometry. Explain your answer. [2]

10–4 State why and how the ions are accelerated in a mass spectrometer. [2]

10–5 The kinetic energy of the ions in a time of flight mass spectrometer is given by:

$KE = \frac{1}{2}mv^2$

where KE = kinetic energy of the particle (J)

m = mass of the particle (kg)

v = velocity of the particle ($m\,s^{-1}$)

A $^{39}K^+$ ion is accelerated to a velocity of $5.525 \times 10^4\,m\,s^{-1}$ in a mass spectrometer. Calculate the kinetic energy of this ion.

The Avogadro constant $L = 6.022 \times 10^{23}\,mol^{-1}$ [4]

Total: 16

SB1 p6–7 3.1.1.2

11 **Figure 3** shows part of a mass spectrometer.

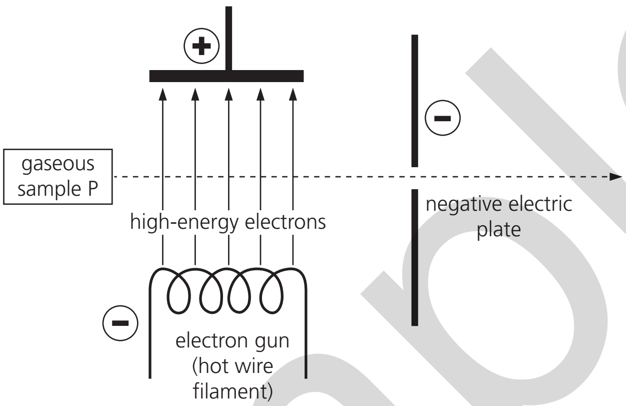

Figure 3

Which of the statements in the list below is correct?

A: This shows electrospray ionisation and acceleration in a mass spectrometer.

B: This shows electrospray ionisation in a mass spectrometer.

C: The process occuring is $P \rightarrow P^+ + e^-$.

D: The process occuring is $P(g) + H^+ \rightarrow PH^+(g)$. [1]

12 **Figure 4** is the mass spectrum for a protein which was ionised by electrospray ionisation.

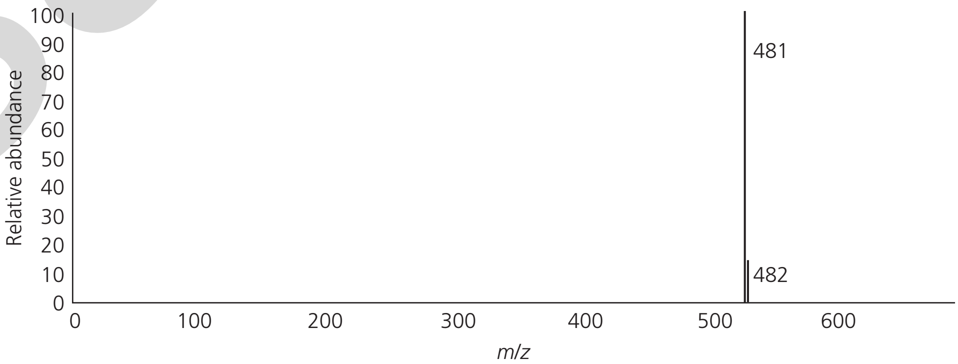

Figure 4

SB1 p6–9 3.1.1.2

12–1 Use the spectrum to determine the relative molecular mass of the protein. [1]

SB1 p6–9 3.1.1.2

12–2 Suggest why there are two peaks in the mass spectrum. [1]

SB1 p6–7 3.1.1.2

12–3 Use the spectrum to justify that this protein has been ionised by electrospray ionisation. [1]

Total: 3

13 A hydrocarbon was ionised and its mass spectrum is shown in **Figure 5**.

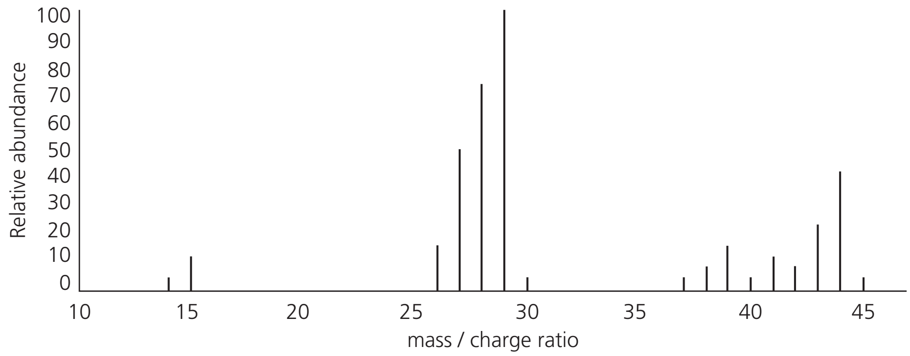

Figure 5

SB1 p8–9 3.1.1.2 **13–1** State the relative molecular mass of the hydrocarbon. *[1]*

SB1 p8–9 3.1.1.2 **13–2** Justify that the hydrocarbon was ionised by electron impact. *[1]*

SB1 p8–9 3.1.1.2 **13–3** A hydrocarbon has the formula C_2H_6. Write an equation for the ionisation of this species by loss of one electron. *[1]*

SB1 p6–7 3.1.1.2 **13–4** Explain why a negatively charged electric plate is used to accelerate the ion formed. *[1]*

Total: 4

Electronic configuration

Quick questions

SB1 p12–17 3.1.1.3 14 Copy and complete **Table 2** to show the electronic configuration of the atoms of the elements shown using s, p, d notation.

Element	Atomic number	Electronic configuration
Potassium	19	
Fluorine	9	
Magnesium	12	
Selenium	34	
Titanium	22	
Sulfur	16	
Iron	26	

Table 2

SB1 p12–17 3.1.1.3 15 Give the electronic configurations of the following ions.

a) Li^+

b) Cl^-

c) O^{2-}

d) Na^+

e) Fe^{2+}

SB1 p18 3.1.1.3 16 Define 'first ionisation energy'.

Exam-style questions

SB1 p18 3.1.1.3 17 Write equations, including state symbols, to show the process that occurs when the following energies are measured: *[4]*

17–1 the first ionisation energy of caesium

17–2 the second ionisation energy of chlorine

17–3 the third ionisation energy of aluminium

17–4 the first ionisation energy of zinc.

SB1 p12–17 3.1.1.1

18 Which species has the same electronic arrangement as a lithium ion, Li^{+}? *[1]*

A: Be^{-}

B: B^{2+}

C: H^{+}

D: He

SB1 p22 3.1.1.3

19–1 Explain why the first ionisation energy of magnesium is lower than the first ionisation energy of beryllium. *[2]*

3.1.1.3

19–2 Suggest an equation for the process which occurs when the fourth ionisation energy of beryllium is measured. *[1]*

SB1 p18–23 3.1.1.3

19–3 Explain why there is no value given in data books for the fifth ionisation energy of beryllium. *[1]*

Total: 4

20 **Figure 6** shows the first ionisation energies of the first eleven elements in the Periodic Table.

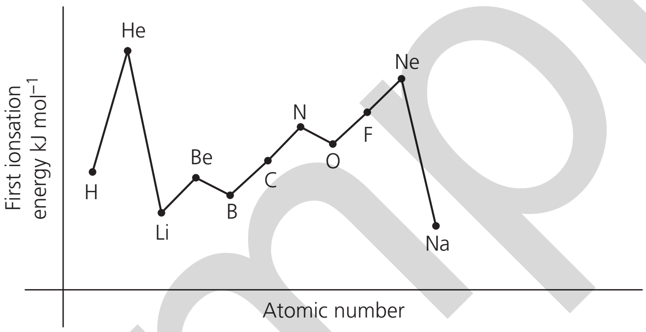

Figure 6

SB1 p18 3.1.1.3

20–1 Write an equation to show the process that occurs when the first ionisation energy of sodium is measured. Give state symbols in your equation. *[1]*

SB1 p22 3.1.1.3

20–2 Explain why the first ionisation energy of sodium is lower than that of lithium. *[2]*

3.1.1.3

20–3 Explain why the first ionisation energy of oxygen is lower than the first ionisation energy of nitrogen. *[2]*

SB1 p22 3.1.1.3

20–4 Copy and complete **Figure 6** for the next three elements after sodium. *[3]*

SB1 p21–3 3.1.1.3

20–5 Explain why neon has the highest ionisation energy in Period 2. *[3]*

SB1 p21–3 3.1.1.3

20–6 State and explain the general trend in ionisation energy across Period 2. *[3]*

SB1 p21–4 3.1.1.3

20–7 Explain why the second ionisation energy of boron is higher than the first ionisation energy of boron. *[1]*

Total: 15

SB1 p20 3.1.1.3

21 The first four ionisation energies of element X are 580, 1800, 2700 and 11 600 $kJ\,mol^{-1}$. Deduce the formula of the chloride of X. *[1]*

SB1 p20 3.1.1.3

22 The first six successive ionisation energies, in $kJ\,mol^{-1}$, of element M are:

578, 1817, 2745, 11578, 14831, 18378

Deduce the formula of the oxide of M. *[1]*

Amount of substance

Amount of substance

Quick questions

SB1 p4 | 3.1.2.1

1 What is meant by 'relative atomic mass'?

SB1 p4 | 3.1.2.1

2 What is the relative molecular mass of calcium hydroxide: $Ca(OH)_2$?

SB1 p35 | 3.1.2.2 | MS 0.1, 0.4, 1.1

3 Calculate the number of atoms in 1.02×10^{-5} mol of argon. (The Avogadro constant, $L = 6.022 \times 10^{23}\ mol^{-1}$)

SB1 p61 | 3.1.2.3 | MS 2.2

4 Rearrange $pV = nRT$ to make n the subject.

SB1 p61 | 3.1.2.3 | MS 0.0

5 What are the units of p, V and T in $pV = nRT$?

SB1 p61 | 3.1.2.4 | MS 0.0

6 What is the meant by the term 'empirical formula'?

SB1 p64 | 3.1.2.4

7 A compound has empirical formula CH_2O and its M_r is 180.0. What is its molecular formula?

SB1 p68 | 3.1.2.5

8 How is percentage atom economy calculated?

SB1 p67 | 3.1.2.5 | PS 4.1

9 How can all the water of crystallisation be removed from a hydrated salt?

Exam-style questions

SB1 p52 | 3.1.2.5 | MS 0.0, 0.1, 1.1

10 A 425 mg sample of solid lithium nitrate was dissolved in 250 cm^3 of deionised water. Which of the following shows the correct standard form and appropriate number of significant figures for the concentration of lithium nitrate in $mol\,dm^{-3}$? *[1]*

A: 2.467×10^{-2}

B: 2.47×10^{-2}

C: 2.50×10^{-2}

D: 24.7×10^{-3}

SB1 p61 | 3.1.2.3 | MS 0.0, 2.2, 2.3

11 A sample of 0.0500 g of a gas has a volume of 30.7 cm^3 at 101 kPa and 298 K. Which of the following is the gas? (The gas constant, $R = 8.31\ J\,K^{-1}\,mol^{-1}$) *[1]*

A: argon

B: carbon dioxide

C: neon

D: oxygen

SB1 p52 | 3.1.2.2 | MS 2.2

12 A saturated aqueous solution of magnesium hydroxide contains 0.173 g of magnesium hydroxide in 100 cm^3 of solution. What is the concentration of hydroxide ions in this solution if the dissolved magnesium hydroxide is fully dissociated into ions? *[1]*

A: $2.97 \times 10^{-3}\ mol\,dm^{-3}$

B: $5.93 \times 10^{-3}\ mol\,dm^{-3}$

C: $2.97 \times 10^{-2}\ mol\,dm^{-3}$

D: $5.93 \times 10^{-2}\ mol\,dm^{-3}$

SB1 p52 | 3.1.2.5 | MS 2.2

13 A 15.0 cm^3 sample of $1.45 \times 10^{-2}\ mol\,dm^{-3}$ sulfuric acid is to be diluted to give a concentration of $7.25 \times 10^{-4}\ mol\,dm^{-3}$. What volume of water should be added? *[1]*

A: 285 cm^3

B: 300 cm^3

C: 315 cm^3

D: 985 cm^3

SB1 p33 | 3.1.2.2 | MS 2.2

14 Which of these contains the most nitrate ions? *[1]*

A: 426 mg of aluminium nitrate

B: 0.899 g of iron(II) nitrate

C: 10.0 cm^3 of 0.250 $mol\,dm^{-3}$ nitric acid

D: 250 cm^3 of 1.50×10^{-3} $mol\,dm^{-3}$ sodium nitrate solution

15 A pure sample of 450 mg of silver carbonate was decomposed by heating to constant mass. The equation for the reaction is:

$2Ag_2CO_3(s) \rightarrow 4Ag(s) + 2CO_2(g) + O_2(g)$

SB1 p65 | 3.1.2.5 | MS 0.0, PS 4.1

15–1 Explain why the sample was heated to constant mass. *[1]*

SB1 p61 | 3.1.2.3 | MS 0.0, 2.2

15–2 Calculate the total volume, in cm^3, of gas produced at 101 kPa and 25.0°C. (The gas constant, $R = 8.31\ J\,K^{-1}\,mol^{-1}$) Give your answer to an appropriate number of significant figures. *[4]*

SB1 p36 | 3.1.2.5 | MS 0.2

15–3 Calculate the mass, in mg, of silver formed. Give your answer to an appropriate number of significant figures. *[2]*

Total: 7

16 The apparatus in **Figure 1** was used to heat a sample of hydrated iron(II) sulfate, $FeSO_4.xH_2O$.

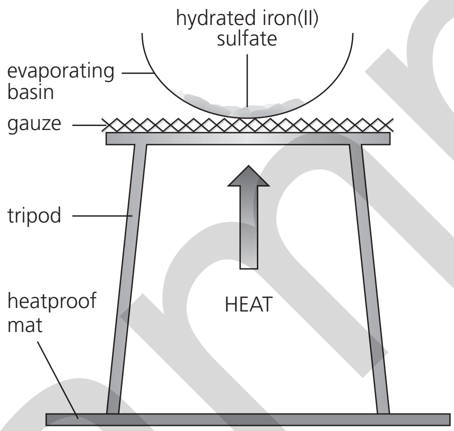

Figure 1

The following mass measurements were obtained:

Mass of evaporating basin = 25.27 g

Mass of evaporating basin and solid before heating = 26.15 g

Mass of evaporating basin and solid after heating for 1 minute = 25.85 g

SB1 p67 | 3.1.2.5 | PS 4.1

16–1 Using the data above, calculate a value for x in $FeSO_4.xH_2O$. Give your answer to 2 decimal places. *[5]*

SB1 p67 | 3.1.2.5 | PS 2.1, 4.1

16–2 The correct value for x is 7. Suggest why the value you calculated in 16–1 was different from this value and describe practically how you would improve the procedure to give a more accurate value for x. (If you were unable to calculate a value for x in 16–1, assume it is 5.24. This is not the correct experimental value). *[2]*

SB1 p67 | 3.1.2.5 | MS 0.3

16–3 Iron(II) sulfate may decompose if heated strongly. If prolonged strong heating is used, suggest what effect this may have on the value of x calculated from experimental data. *[1]*

Total: 8

17 Four indigestion tablets containing calcium carbonate were reacted with $50.0\,cm^3$ of $1.25\,mol\,dm^{-3}$ hydrochloric acid. The remaining solution was transferred to a volumetric flask and deionised water added until the volume reached $250\,cm^3$. Several $25.0\,cm^3$ portions of the resulting solution were transferred to separate conical flasks and titrated with $0.250\,mol\,dm^{-3}$ aqueous sodium hydroxide using phenolphthalein indicator. The results of the titration are given in **Table 1**.

	Rough	Titration 1	Titration 2	Titration 3
Initial burette reading/cm³	0.00	14.20	28.05	30.00
Final burette reading/cm³	14.20	28.05	41.50	43.90
Titre/cm³	14.20	13.85	13.45	13.90

Table 1

The equations for the reactions occurring are:

$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$

$NaOH + HCl \rightarrow NaCl + H_2O$

SB1 p56 | 3.1.2.5 | AT f

17–1 State the colour change observed at the end point. *[1]*

SB1 p56 | 3.1.2.5 | MS 1.2 | AT d

17–2 Calculate the mean titre and justify your choices of titres. *[2]*

SB1 p58–9 | 3.1.2.5 | PS 4.1 | AT d, f, k

17–3 Determine the amount, in moles, of hydrochloric acid which reacted with the calcium carbonate in the tablets. *[4]*

SB1 p58–9 | 3.1.2.5 | MS 0.0, 1.1 | PS 4.1 | AT d, f, k

17–4 Calculate the mass, in mg, in one indigestion tablet. Give your answer to an appropriate number of significant figures. *[3]*

SB1 p55 | 3.1.2.5 | MS 1.3 | PS 2.1 | AT d, f, k

17–5 Suggest one way in which the percentage uncertainty in the experiment could be improved using the same apparatus. Justify your suggested improvement. *[2]*

Total: 12

18 $10.0\,cm^3$ of a solution of magnesium chloride contained 122 mg of magnesium chloride.

SB1 p36 | 3.1.2.5 | MS 1.1

18–1 Calculate the concentration, in $mol\,dm^{-3}$, of the solution of magnesium chloride. Give your answer to an appropriate number of significant figures. *[2]*

18–2 Magnesium chloride solution reacts with silver nitrate solution forming a precipitate. A student added $15.0\,cm^3$ of $0.275\,mol\,dm^{-3}$ silver nitrate solution to the $10.0\,cm^3$ of the magnesium chloride solution. He filtered, dried and weighed the precipitate and obtained 325 mg.

SB1 p31 | 3.1.2.5

1. Write an ionic equation for the formation of the precipitate. *[1]*

SB1 p36 | 3.1.2.5 | MS 1.1 | PS 4.1

2. Determine which reagent is in excess and calculate the theoretical mass of precipitate, in mg, which the student should expect to obtain. Give your answer to an appropriate number of significant figures. *[4]*

SB1 p39 | 3.1.2.5 | MS 0.2, 1.1 | PS 4.1

3. Calculate the percentage yield of the precipitate. Give your answer to an appropriate number of significant figures. (If you were unable to obtain an answer in 2, use 400 mg. This is not the correct value.) *[1]*

SB1 p39 | 3.1.2.5 | MS 1.1, 2.3

18–3 Calculate the total volume of the reagent that is in excess which would be required to react so that the filtrate only contained one solute. Give your answer to an appropriate number of significant figures. *[2]*

Total: 10

SB1 p67 | 3.1.2.5 | RP 1 | AT a, d, e, f, k | PS 4.1

19 A student planned to prepare $250\,cm^3$ of a standard solution of sodium hydroxide of concentration $0.245\,mol\,dm^{-3}$ from solid sodium hydroxide. Solid sodium hydroxide is corrosive.

SB1 p52 | 3.1.2.5 | ER

19–1 Describe the procedure used to prepare this standard solution safely. *[6]*

SB1 p55–7 | 3.1.2.5 | MS 2.2

SB1 p55 | 3.1.2.5 | MS 1.3

19–2 The solution was used in a titration. Several 25.0 cm^3 portions of sulfuric acid of unknown concentration were placed in conical flasks with methyl orange indicator and titrated with the 0.245 mol dm^{-3} sodium hydroxide solution. The mean titre was 17.25 cm^3. The equation for the reaction is:

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

1. Calculate the concentration, in mol dm^{-3}, of the solution of sulfuric acid. *[3]*

2. The uncertainty of the burette is ±0.050 cm^3. Calculate the percentage uncertainty in the mean titre. *[1]*

Total: 10

SB1 p61 | 3.1.2.3 | MS 0.0, 1.1, 2.3 | AT a

20 Two glass flasks are connected via a closed tap as shown in **Figure 2**.

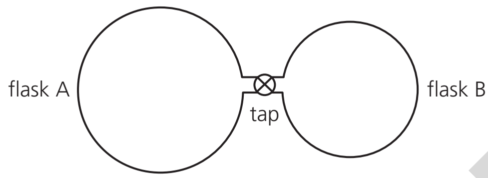

Figure 2

Flask A contains 0.550 g of neon at 298 K and 101 kPa. There is a vacuum in Flask B. (The gas constant, $R = 8.31\ J\ K^{-1}\ mol^{-1}$)

20–1 Calculate the volume, in cm^3, of flask A. Give your answer to an appropriate number of significant figures. *[3]*

20–2 The volume of flask B is $2.50 \times 10^2\ cm^3$. When the tap is opened, the total pressure in both flasks is 71.5 kPa. Calculate the temperature change that occurs. Give your answer to an appropriate number of significant figures. *[3]*

Total: 6

SB1 p56 | 3.1.2.5 | MS 0.0, 2.2 | AT a, d, e | PS 4.1

21 A sample of 158 mg of hydrated sodium carbonate, $Na_2CO_3.xH_2O$, was dissolved in deionised water and the volume made up to 250 cm^3 in a volumetric flask. 25.0 cm^3 portions of this solution were titrated with 0.0125 mol dm^{-3} hydrochloric acid using methyl orange indicator. The mean titre was 14.20 cm^3.

Calculate the value of *x* in $Na_2CO_3.xH_2O$, giving your answer as an integer. *[4]*

SB1 p66 | 3.1.2.2 | MS 2.2 | AT a | PS 2.1

22 A sample of titanium was heated in a crucible as shown in **Figure 3** below.

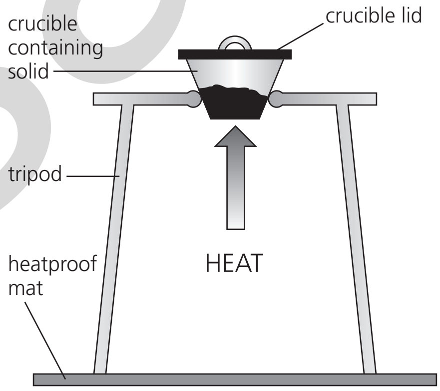

Figure 3

The crucible lid was lifted approximately every 10 seconds during the experiment, and the mass of the crucible and its contents measured every 2 minutes as shown in **Table 2**.

	Mass/g
Mass of crucible	14.24
Mass of crucible and titanium	15.69
Mass of crucible and contents after heating for 2 minutes	16.24
Mass of crucible and contents after heating for 4 minutes	16.66
Mass of crucible and contents after heating for 6 minutes	16.66

Table 2

22–1 Why was the crucible lid lifted every 10 seconds during the experiment? *[1]*

22–2 Explain why heating was not continued beyond 6 minutes. *[1]*

22–3 Calculate the empirical formula of the oxide of titanium formed. *[3]*

Total: 5

23 Aspirin may be synthesised in the laboratory from 2-hydroxybenzoic acid and ethanoic anhydride as shown in the equation below.

$C_7H_6O_3$	+	$C_4H_6O_3$	$\rightarrow$	$C_9H_8O_4$	+	$C_2H_4O_2$
2-hydroxybenzoic acid		ethanoic anhydride		aspirin		ethanoic acid

SB1 p55–7

3.1.2.5 | MS 0.0, 1.1, 2.2 | AT a | PS 4.1

23–1 2.00×10^{-2} g of 2-hydroxybenzoic acid were allowed to react with 2.00×10^{-2} g of ethanoic anhydride. 1.78×10^{-2} g of aspirin were obtained following recrystallisation.

3.1.2.5 | MS 0.0, 0.2, 1.1, 2.2 | AT a | PS 4.1

1. Calculate the theoretical yield, in mg, of aspirin. Give your answer to an appropriate number of significant figures. *[5]*

3.1.2.5 | AT a | PS 2.3, 4.1

2. Calculate the percentage yield of aspirin. Give your answer to an appropriate number of significant figures. (If you were unable to obtain an answer for 1, use 30.0 mg. This is not the correct value). *[1]*

3.1.2.5 | MS 0.2 | AT a | PS 4.1

3. Suggest one reason why the percentage yield is not 100%. *[1]*

3.1.2.5 | MS 0.0, 0.2

4. Calculate the percentage atom economy for this synthesis of aspirin. *[1]*

23–2 For some childhood conditions, 4.85×10^{-4} mol of aspirin per kg weight of the child are administered daily over a course of 14 days. Calculate the total mass of aspirin, in grams, administered to a 25 kg child over the course of 14 days. Give your answer to an appropriate number of significant figures. *[1]*

Total: 9

SB1 p55–7

3.1.2.5 | MS 0.0, 0.2, 1.1, 2.2

24 Potassium iodate(V) reacts with potassium iodide in the presence of sulfuric acid according to the equation:

$KIO_3 + 5KI + 3H_2SO_4 \rightarrow 3K_2SO_4 + 3I_2 + 3H_2O$

The iodine formed also reacts with potassium iodide to form potassium triiodide, KI_3:

$I_2 + KI \rightarrow KI_3$

A sample of 250 mg of potassium iodate(V) was dissolved in 250 cm^3 of deionised water. A 25.0 cm^3 portion of this solution was removed and placed in a conical flask. Excess solid potassium iodide and excess 2.00 mol dm^{-3} sulfuric acid were added.

24–1 Calculate the minimum mass, in mg, of solid potassium iodide which would be required to be added to react with the potassium iodate(V) and convert all the iodine to potassium triiodide. Give your answer to an appropriate number of significant figures. *[4]*

24–2 Calculate the minimum volume, in cm^3, of 2.00 mol dm^{-3} sulfuric acid required to be added to the conical flask. Give your answer to an appropriate number of significant figures. *[2]*

Total: 6

Practice exam papers

Paper 1

1 **Figure 1** shows an incomplete Born–Haber cycle for iron(III) chloride.

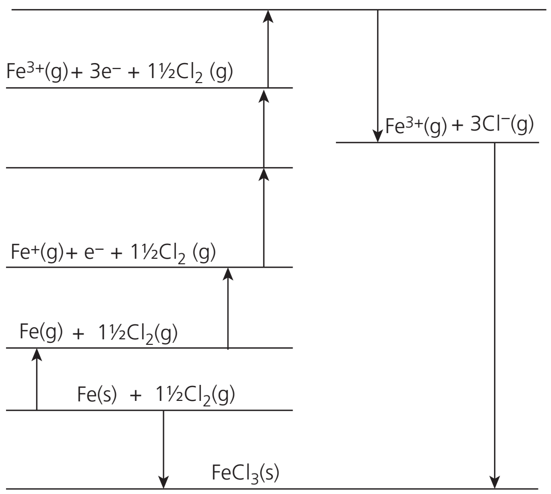

Figure 1

1–1 Copy and complete the missing levels on the cycle. *[2]*

1–2 Calculate the enthalpy of lattice formation of iron(III) chloride using the data in **Table 1**. *[3]*

Enthalpy change	**Value/kJ mol^{-1}**
Enthalpy of formation of iron(III) chloride	−399
Enthalpy of atomisation of iron	+418
First ionisation energy of iron	+760
Second ionisation energy of iron	+1600
Third ionisation energy of iron	+3000
Bond enthalpy for chlorine	+242
First electron affinity of chlorine	−349

Table 1

1–3 The lattice enthalpy calculated from the Born–Haber cycle is an experimental value. A theoretical value can be obtained using the perfect ionic model which is −5327 kJ mol^{-1}.

1. State the assumptions made in the perfect ionic model. *[2]*
2. Comment on the bonding in iron(III) chloride. *[1]*

1–4 **1.** Iron(III) chloride dissolves in water.

Using the value you calculated in 1–2 and the values in **Table 2** below, calculate the enthalpy of hydration of chloride ions. *[2]*

Enthalpy change	**Value /kJ mol^{-1}**
Enthalpy of hydration of iron(III) ions	−4430
Enthalpy of solution of iron(III) chloride	−89

Table 2

2. Give the formula of the complex formed when iron(III) chloride dissolves in water. *[1]*

3. What would be observed when a solution of sodium hydroxide is added to the solution of iron(III) chloride until it is in excess? *[1]*

4. Give an equation for the reaction which occurs when sodium hydroxide is added to iron(III) chloride solution. *[1]*

5. What would be observed when a solution of sodium carbonate is added to a solution of iron(III) chloride? *[2]*

6. Give an equation for the reaction which occurs when sodium carbonate solution is added to a solution of iron(III) chloride. *[2]*

Total: 17

2 Hydrogen iodide decomposes on heating according to the equation:

$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$

2–1 Give an expression for the equilibrium constant, K_p. *[1]*

2–2 At 500°C, an equilibrium mixture contained 1.46 mol of hydrogen iodide, 0.440 mol of hydrogen and 0.100 mol of iodine. The total pressure was 100 kPa.

1. Calculate the mole fractions of hydrogen iodide, hydrogen and iodine in the equilibrium mixture. *[3]*

2. Calculate the partial pressures of hydrogen iodide, hydrogen and iodine in the equilibrium mixture. *[1]*

3. Calculate the value of the equilibrium constant (K_p) for this reaction at 500°C. *[2]*

2–3 In a separate experiment, 1.00 mol of hydrogen iodide were heated to 100°C in a sealed container. The total pressure is 100 kPa. 0.100 mol of iodine were detected in the equilibrium mixture. Calculate the value of the equilibrium constant (K_p) for this reaction at 100°C. *[5]*

2–4 Using your answers to 2–2 question 3 and 2–3, explain whether the decomposition of hydrogen iodide is endothermic or exothermic. *[1]*

Total: 13