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Teddington Sixth Form

A Level Chemistry

Course Details & Transition Tasks 2020-2022

A level Chemistry Subject 7404 and 7405

Exam Board – AQA

Year 1 and 2 – Chemistry

This booklet is designed to give you all the information you need before starting the Chemistry course. Your course will consist of three units:

3.1 Physical Chemistry:

- 3.1.1 Atomic structure
- 3.1.2 Amount of substances
- 3.1.3 Bonding
- 3.1.4 Energetics
- 3.1.5 Kinetics
- 3.1.6 Chemical equilibria, le Chatelier's principle and Kc
- 3.1.7 Oxidation, reduction and redox equations
- 3.1.8 Thermodynamics (Year 2)
- 3.1.9 Rate equations (Year 2)
- 3.1.10 Equilibrium constant Kp for homogeneous systems (Year 2)
- 3.1.11 Electrode potenials and electrochemical cells (Year 2)
- 3.1.12 Acids and bases (Year 2)

3.2 Inorganic Chemistry:

- 3.2.1 Periodicity
- 3.2.2 Group 2, the alkaline earth metals
- 3.2.3 Group 7(17), the halogens
- 3.2.4 Properties of period 3 elements and their oxides (Year 2)
- 3.2.5 Transition metals (Year 2)
- 3.2.6 Reactions of ions in aqueous solution (Year 2)

3.3 Organic Chemistry:

- 3.3.1 Introduction to organic chemistry
- 3.3.2 Alkanes
- 3.3.3 Halogenalkanes
- 3.3.4 Alkenes
- 3.3.5 Alcohols
- 3.3.6 Organic analysis
- 3.3.7 Optical isomerism (Year 2)
- 3.3.8 Aldehydes and ketones (Year 2)
- 3.3.9 Carboxylic acids and derivatives (Year 2)
- 3.3.10 Aromatic chemistry
- 3.3.11 Amines (Year 2)
- 3.3.12 Polymers (Year 2)
- 3.3.13 Amino acids, proteins and DNA (Year 2)
- 3.3.14 Organic synthesis (Year 2)
- 3.3.15 Nuclear magnetic resonance spectroscopy (Year 2)
- 3.3.16 Chromatography (Year 2)

Year 1 Assessment

Paper 1	+	Paper 2
What's assessed • Relevant Physical chemistry topics (sections 3.1.1 to 3.1.4, 3.1.6 and 3.1.7) • Inorganic chemistry (Section 3.2.1 to 3.2.3) • Relevant practical skills		**What's assessed** • Relevant Physical chemistry topics (sections 3.1.2 to 3.1.6) • Organic chemistry (Section 3.3.1 to 3.3.6) • Relevant practical skills
How it's assessed • written exam: 1 hour 30 minutes • 80 marks • 50% of the AS		**How it's assessed** • written exam: 1 hour 30 minutes • 80 marks • 50% of the AS
Questions 65 marks of short and long answer questions 15 marks of multiple choice questions		**Questions** 65 marks of short and long answer questions 15 marks of multiple choice questions

Weighting of Assessment Objectives for Year 1

Assessment objectives (AOs)	Component weightings (approx %)		Overall weighting (approx %)
	Paper 1	Paper 2	
AO1	35	35	35
AO2	43	43	43
AO3	22	22	22
Overall weighting of components	50	50	100

20% of the overall assessment of AS Chemistry will contain mathematical skills equivalent to Level 2 or above.

At least 15% of the overall assessment of AS Chemistry will assess knowledge, skills and understanding in relation to practical work.

Year 2 Assessment

Paper 1	Paper 2	Paper 3
What's assessed • Relevant Physical chemistry topics (sections 3.1.1 to 3.1.4, 3.1.6 to 3.1.8 and 3.1.10 to 3.1.12) • Inorganic chemistry (Section 3.2) • Relevant practical skills	**What's assessed** • Relevant Physical chemistry topics (sections 3.1.2 to 3.1.6 and 3.1.9) • Organic chemistry (Section 3.3) • Relevant practical skills	**What's assessed** • Any content • Any practical skills
How it's assessed • written exam: 2 hours • 105 marks • 35% of A-level	**How it's assessed** • written exam: 2 hours • 105 marks • 35% of A-level	**How it's assessed** • written exam: 2 hours • 90 marks • 30% of A-level
Questions 105 marks of short and long answer questions	**Questions** 105 marks of short and long answer questions	**Questions** 40 marks of questions on practical techniques and data analysis 20 marks of questions testing across the specification 30 marks of multiple choice questions

Weighting of Assessment Objectives for Year 2

Assessment objectives (AOs)	Component weightings (approx %)			Overall weighting (approx %)
	Paper 1	Paper 2	Paper 3	
AO1	30	30	32	30
AO2	48	48	34	45
AO3	22	22	34	25
Overall weighting of components	35	35	30	100

20% of the overall assessment of A-level Chemistry will contain mathematical skills equivalent to Level 2 or above.

At least 15% of the overall assessment of A-level Chemistry will assess knowledge, skills and understanding in relation to practical work.

Maths in Chemistry

In order to be able to develop your skills, knowledge and understanding in Chemistry, you must have acquired competence in, the appropriate areas of mathematics (Arithmetic and numerical computation, handling data, graphs, geometry and trigonometry).
Overall, 20% of the marks in assessments for Chemistry will require the use of mathematical skills. These skills will be applied in the context of Chemistry and will be at least the standard of higher tier GCSE Mathematics.

Required Practicals:

All students taking A-Level Chemistry qualification are expected to have had opportunities to use the following apparatus and develop and demonstrate these techniques. These apparatus and tecniques are common to all A-Level Chemistry specifications.

	Apparatus and techniques
AT a	Use appropriate apparatus to record a range of measurements (to include mass, time, volume of liquids and gases, temperature)
AT b	Use water bath or electric heater or sand bath for heating
AT c	Measure pH using pH charts, or pH meter, or pH probe on a data logger
AT d	Use laboratory apparatus for a variety of experimental techniques including: • titration, using burette and pipette • distillation and heating under reflux, including setting up glassware using retort stand and clamps • qualitative tests for ions and organic functional groups • filtration, including use of fluted filter paper, or filtration under reduced pressure
AT e	Use volumetric flask, including accurate technique for making up a standard solution
AT f	Use acid–base indicators in titrations of weak/strong acids with weak/strong alkalis
AT g	Purify: • a solid product by recrystallisation • a liquid product, including use of separating funnel
AT h	Use melting point apparatus
AT i	Use thin-layer or paper chromatography
AT j	Set up electrochemical cells and measuring voltages
AT k	Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances
AT l	Measure rates of reaction by at least two different methods, for example: • an initial rate method such as a clock reaction • a continuous monitoring method

Carrying out the 12 required practicals below (1 – 6 in year 1 and 7 – 12 in year 2) means that students will have experienced use of each of theses apparatus and techniques

Required activity	Apparatus and technique reference
1 Make up a volumetric solution and carry out a simple acid–base titration	a, d, e, k
2 Measurement of an enthalpy change	a, d, k
3 Investigation of how the rate of a reaction changes with temperature	a, b, k
4 Carry out simple test-tube reactions to identify: • cations – Group 2, NH_4^+ • anions – Group 7 (halide ions), OH^-, CO_3^{2-}, SO_4^{2-}	b, d, k
5 Distillation of a product from a reaction	b, d, k
6 Tests for alcohol, aldehyde, alkene and carboxylic acid	b, c, d, k
7 Measuring the rate of reaction: • by an initial rate method • by a continuous monitoring method	a, k, l a, k, l
8 Measuring the EMF of an electrochemical cell	j, k
9 Investigate how pH changes when a weak acid reacts with a strong base and when a strong acid reacts with a weak base	a, c, d, f, k
10 Preparation of: • a pure organic solid and test of its purity • a pure organic liquid	a, b, d, g, h, k b, d, g, k
11 Carry out simple test-tube reactions to identify transition metal ions in aqueous solution	b, c, d, k
12 Separation of species by thin-layer chromatography	i, k

Assessment of practical skills in Chemistry will be by **WRITTEN EXAMS ONLY**.
The **practical endorsement** does **NOT** apply to AS spec (at the end of the 2 years awarded pass or fail). **Questions in the papers** have been written in the expectation that students have carried out at least the ***12 required practical activities*** (**15%** of the marks relate to practical work).

Essential Textbooks that each student is expected to buy and bring to every lesson:

Year 12:
AQA A-Level Chemistry book 1, Hodder Education, Alyn G. Mc Farland Teresa Quigg and and Nora Henry, ISBN: 978 1471 807671

Year 13:
AQA A-Level Chemistry book 2, Hodder Education, Alyn G. Mc Farland and Nora Henry, ISBN: 978 1471 807701

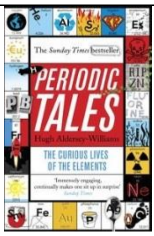
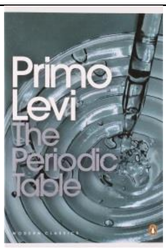
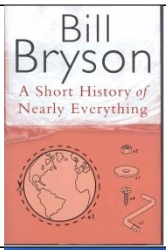
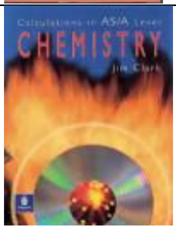
Further reading (non-essential) Textbooks that each student is expected to buy and bring to every lesson:

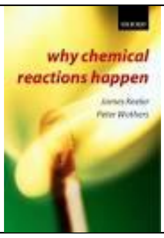
AQA A-Level Chemistry, Oxford, Ted Lister and Janet Renshaw ISBN: 978-0-19-835182-5

Some useful Chemistry Websites (I strongly recommend the first two websites)

- http://www.chemguide.co.uk/ (Superb resource - explains concepts)
- https://chemrevise.org/revision-guides/ (Excellent summary of theory and required practicals)
- www.creativechemistry.org.uk/alevel
- www.knockhardy.org.uk/sci.htm (animations and notes)
- www.chembook.co.uk
- www.s.cool.co.uk
- http://www.mp-docker.demon.co.uk/as_a2/index_aqa.html (quiz)
- Quizlet free app

Chemistry recommended Reading List

Periodic Tales: The Curious lives of the Elements by Hugh Aldersey-Williams		This Sunday Times best-seller appeals to people regardless of their science background. Everything in the universe is made of them, including you. Like you, the elements have personalities, attitudes, talents, shortcomings, stories rich with meaning. Here you'll meet iron that rains from the heavens and noble gases that light the way to vice. You'll learn how lead can tell your future while zinc may one day line your coffin.
The periodic table - Primo Levi		A chemist by training, Primo Levi was imprisoned in a concentration camp during WWII. In these haunting reflections inspired by the elements of the periodic table, he recounts his life; from the inert gas argon - and 'inert' relatives like the uncle who stayed in bed for twenty-two years to 'Cerium' - the improvised cigarette lighters which saved his life in Auschwitz. Really cleverly written and always reminding us that the elements are a part of all of us.
A Short History of Nearly Everything - Bill Bryson.		It's not so much about what we know, as about *how* we know what we know. How do we know what is in the centre of the Earth, or what a black hole is, or where the continents were 600 million years ago? Bryson wrote this for people who weren't interested in science and managed skilfully to turn them around.
Calculations in AS/A level Chemistry - Jim Clark.		Really good to have as a reference book for the duration of your course, it will help you complete all quantitative chemistry
Foundations of Organic Chemistry - Michael Hornby, Josephine Peach		This is a really useful reference book for all the organic chemistry that you will study in A Level and can then follow you to university. Include details of all the types of organic molecules that you will study as well as their reactions.

Why Chemical Reactions Happen - James Keeler, Peter Wothers		By tackling the most central ideas in chemistry, Why Chemical Reactions Happen provides the reader with all the tools and concepts needed to think like a chemist.

Join the royal society of chemistry and keep informed of the newest chemistry discoveries, gain access to hundreds of chemistry journals, learn about local events: http://www.rsc.org

Transition Tasks:

All extended written tasks must be completed on a computer and include your name on each page. If you have taken information from the internet, it must be written in your own words and not pasted from other documents. Reference all your sources, including the full URL and date accessed of websites, or the complete book title, authors, publisher, date of publishing and page numbers.

Week 1 Task: Bonding and structure reasearch

Your task is to make a summary sheet/leaflet about **intermolecular** **AND** **intramolecular** forces found in substances which you will be learning about in AS chemistry. Use the marking guidance to help you attain the marks. You will also be assessed on how well you have presented your work.

Key points which you must discuss:

- Ionic
- Covalent (simple molecular AND giant molecular)
- Dative covalent bonding
- Metallic bonding
- Intermolecular forces (dipole-dipole forces, van der Waals forces and hydrogen bonding)

Content:	Marks available:
Define the different types of **intramolecular** bonds	5
Define the different types of **intermolecular** forces (Attract separate molecules together)	3
Explain EACH **intramolecular bond** using an example to aid your answer (Draw, name and include molecular formulae for each example).	10
Physical properties of substances with each type of **intramolecular** bond	4
Possible structures of substances containing each type of **intramolecular** bond	4
Total content marks:	26
Presentation marks:	6
Total marks:	32

Grade Boundaries:

A*	31
A	26
B	22
C	17
D	12
E	8

Week 2 Task: Quantitative practice: Moles, Formula mass and reacting masses

1. Calculate the **molar mass** of each of the following substances?
   a) Sulfuric acid
   b) Hydrochloric acid
   c) $CuSO_4.5H_2O$
   d) $Pb(NO_3)_2$
   e) $Ca(OH)_2$

2. Write the formulae of the following (OH^-, CO_3^{2-}, SO_4^{2-}, HCO_3^-).
   a) Sodium chloride
   b) Potassium hydroxide
   c) Sodium carbonate
   d) Lithium sulfate
   e) Potassium iodide
   f) Potassium hydrogen carbonate
   g) Copper(II) chloride
   h) Magnesium chloride
   i) Ammonium carbonate

3. In each case calculate the number of moles of the material in the mass stated.
   a) 0.0981 g of H_2SO_4
   b) 9.00 g of H_2O
   c) 88.0 g of CO_2
   d) 1.70 g of NH_3
   e) 230 g of C_2H_5OH
   f) 560 g of C_2H_4
   g) 0.641 g of SO_2
   h) 18.20 g of HBr

4. In each case calculate the mass in grams of the material in the number of moles stated.
   a) 3 moles of SO_3
   b) 1 mole of HBr
   c) 0.15 moles of HNO_3
   d) 0.11 moles of Na_2CO_3
   e) 0.012 moles of H_2SO_4
   f) 0.45 moles of NaCl
   g) 0.70 moles of $NaNO_3$

5. When 1.17g of potassium is heated in oxygen 2.13g of an oxide is produced. In the case of this oxide the empirical and molecular formulae are the same. What is the molecular formula of the oxide

6.

a) $\_ H_2$ + O_2 → $\_ H_2O$

b) $BaCl_2$ + $\_ NaOH$ → $Ba(OH)_2$ + $\_ NaCl$

c) H_2SO_4 + $\_ KOH$ → $\_ K_2SO_4$ + H_2O

d) K_2CO_3 + $\_ HCl$ → $\_KCl$ + H_2O + CO_2

e) $Pb(NO_3)_2$ + NaI → PbI_2 + $NaNO_3$

f) $Al_2(SO_4)_3$ + $NaOH$ → $Al(OH)_3$ + Na_2SO_4

7. What mass of barium sulfate would be produced from 10 g of barium chloride in the following reaction?

$$\mathbf{BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + HCl}$$

8. What mass of silver nitrate as a solution in water would need to be added to 5 g of sodium chloride to ensure complete precipitation of the chloride?

$$\mathbf{AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_2(aq)}$$

Week 3 Task: Atomic structure and Finding the relative molecular mass using time of flight mass spectrometry

Read through the AQA PDF on how "Time of Flight Mass Spectrometry TOFMS" works
https://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-SG-TOFMS.PDF

Make brief notes on the key stages in TOFMS

Answer the **Time of Flight Mass Spectrometry Question pack .** The pack has the answers at the end for you to self-mark and add corrections in green pen. You may well find some of these questions difficult. Just do your best and we'll go through it in class when we study TOFMS.

Week 4 Task: Atomic structure: Electron configuration

Part 1: Read through the following "Chemguide" web page on ***electron configuration in atoms***.
https://www.chemguide.co.uk/atoms/properties/elstructs.html

Make notes on electron configuration in atoms.

Answer the questions by clicking on the link in the green box at the bottom of the page. Self-mark and correct using the answers link in the same green box:

Part 2: Read through the following "Chemguide" web page on ***electron configuration in ions***.
https://www.chemguide.co.uk/atoms/properties/ionstruct.html#top

Make notes on electron configuration in ions.

Answer the questions by clicking on the link in the green box at the bottom of the page. Self-mark and correct using the answers link in the same green box:

Week 5 Task: Acid-base titrations

Part 1: Read through and answer the questions on the BBC bitesize Titrations revision (includes the recalling the method to make a salt from an acid and an alkali)
https://www.bbc.co.uk/bitesize/guides/zx98pbk/revision/1

Part 2: Read through pages 4 – 6 on the "practical-guide-aqa1 Chemrevise.pdf".
https://chemrevise.files.wordpress.com/2018/04/practical-guide-aqa1.pdf
These pages go through the method for an acid-base titration.

Part 3: Apply your knowledge: Answer the Titration practice questions and then self-mark and correct in green pen using the mark scheme at the end of the questions.

Week 6 Task: Organic Chemistry introduction

Part 1: Read through the following "Chemguide" web page on ***how to draw organic molecules***.
https://www.chemguide.co.uk/basicorg/conventions/draw.html#top

Make notes on how to draw organic molecules.

Answer the questions by clicking on the link in the green box at the bottom of the page. Self-mark and correct using the answers link in the same green box:

Part 2: Read through the following "Chemguide" web page on ***how to name organic molecules***.
https://www.chemguide.co.uk/basicorg/conventions/names.html#top

Make notes on how to name organic molecules.

Answer the questions by clicking on the link in the green box at the bottom of the page. Self-mark and correct using the answers link in the same green box:

Week 7 Task: Organic Chemistry: Alkanes

Part 1: Read through the following "Chemguide" web page on ***Alkanes and cycloalkanes***.
https://www.chemguide.co.uk/organicprops/alkanes/background.html#top

Make notes on alkanes including their physical and chemical properties.

Answer the questions by clicking on the link in the green box at the bottom of the page. Self-mark and correct using the answers link in the same green box:

Part 2: Read through the following "Chemguide" web page on ***Burning alkanes and cycloalkanes***.
https://www.chemguide.co.uk/organicprops/alkanes/oxygen.html#top

Make notes on complete versus incomplete combustion and the products formed in each case.

Answer the questions by clicking on the link in the green box at the bottom of the page. Self-mark and correct using the answers link in the same green box:

Week 8 Task: Organic Chemistry: Alkenes and cracking alkanes

Part 1: Read through the following "Chemguide" web page on ***Alkenes***.
https://www.chemguide.co.uk/organicprops/alkenes/background.html#top

Make notes on alkenes including their physical properties and reactivity.

Answer the questions by clicking on the link in the green box at the bottom of the page. Self-mark and correct using the answers link in the same green box:

Part 2: Read through the following "Chemguide" web page on ***cracking alkanes***.
https://www.chemguide.co.uk/organicprops/alkanes/cracking.html#top

Make brief notes on catalytic and thermal cracking and the products formed in each case.

Answer the questions by clicking on the link in the green box at the bottom of the page. Self-mark and correct using the answers link in the same green box:

Week 9 Task: Organic Chemistry: Isomerism

Part 1: Read through the following “Chemguide” web page on ***structural isomerism***.
https://www.chemguide.co.uk/basicorg/isomerism/structural.html#top

Define what an isomer is and make notes on the different types of structural isomerism.

Answer the questions by clicking on the link in the green box at the bottom of the page. Self-mark and correct using the answers link in the same green box:

Part 2: Read through the following “Chemguide” web page on ***geometric isomerism***.
https://www.chemguide.co.uk/basicorg/isomerism/geometric.html#top

Make notes on geometric isomerism, including what causes it and the effect of geometric isomerism on physical properties.

Answer the questions by clicking on the link in the green box at the bottom of the page. Self-mark and correct using the answers link in the same green box:

Week 10 Task: Empirical formula and organic review questions

Part 1: Read through the following “BBC Bitesize” web pages (4 and 5) on ***how to calculate the empirical formula from data***.
https://www.bbc.co.uk/bitesize/guides/z8d2bk7/revision/4

Part 2: Apply your knowledge: Answer the Organic chemistry review practice questions and then self-mark and correct in green pen using the mark scheme at the end of the questions.

The Periodic Table of the Elements

Key

relative atomic mass
symbol
name
atomic (proton) number

1	2											3	4	5	6	7	0
							1.0 **H** hydrogen 1										(18) 4.0 **He** helium 2
(1)	(2)											(13)	(14)	(15)	(16)	(17)	
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	96.0 **Mo** molybdenum 42	[98] **Tc** technetium 43	101.1 **Ru** ruthenium 44	102.9 **Rh** rhodium 45	106.4 **Pd** palladium 46	107.9 **Ag** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La *** lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac †** actinium 89	[267] **Rf** rutherfordium 104	[268] **Db** dubnium 105	[271] **Sg** seaborgium 106	[272] **Bh** bohrium 107	[270] **Hs** hassium 108	[276] **Mt** meitnerium 109	[281] **Ds** darmstadtium 110	[280] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

* 58 – 71 Lanthanides	140.1 **Ce** cerium 58	140.9 **Pr** praseodymium 59	144.2 **Nd** neodymium 60	[145] **Pm** promethium 61	150.4 **Sm** samarium 62	152.0 **Eu** europium 63	157.3 **Gd** gadolinium 64	158.9 **Tb** terbium 65	162.5 **Dy** dysprosium 66	164.9 **Ho** holmium 67	167.3 **Er** erbium 68	168.9 **Tm** thulium 69	173.1 **Yb** ytterbium 70	175.0 **Lu** lutetium 71
† 90 – 103 Actinides	232.0 **Th** thorium 90	231.0 **Pa** protactinium 91	238.0 **U** uranium 92	[237] **Np** neptunium 93	[244] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[247] **Bk** berkelium 97	[251] **Cf** californium 98	[252] **Es** einsteinium 99	[257] **Fm** fermium 100	[258] **Md** mendelevium 101	[259] **No** nobelium 102	[262] **Lr** lawrencium 103

Time of Flight Mass Spectrometry Questions

https:filestore.aqa.org.ukresourceschemistryAQA7 4047405SGTOFMS.PDF

Name: ______________

Class: ______________

Date: ______________

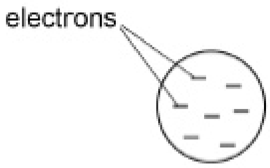
Time:	**40 minutes**
Marks:	**37 marks**
Comments:	Use the mark scheme at the end of the questions to self-mark and correct your work in green pen.

Q1.

This question is about atomic structure.

In the nineteenth century JJ Thomson discovered the electron. He suggested that negative electrons were found throughout an atom like ‘plums in a pudding of positive charge’.

The diagram shows an atom of element **R** using the ‘plum pudding’ model.
An atom of **R** contains seven electrons.



(a) State **two** differences between the ‘plum pudding’ model and the model of atomic structure used today.

1. ____

____

2. ____

____

(2)

(b) Deduce the full electron configuration of an atom of element **R**.

____

(1)

(c) Identify **R** and deduce the formula of the compound formed when **R** reacts with the Group 2 metal in the same period as **R**.

____

(1)
(Total 4 marks)

Q2.

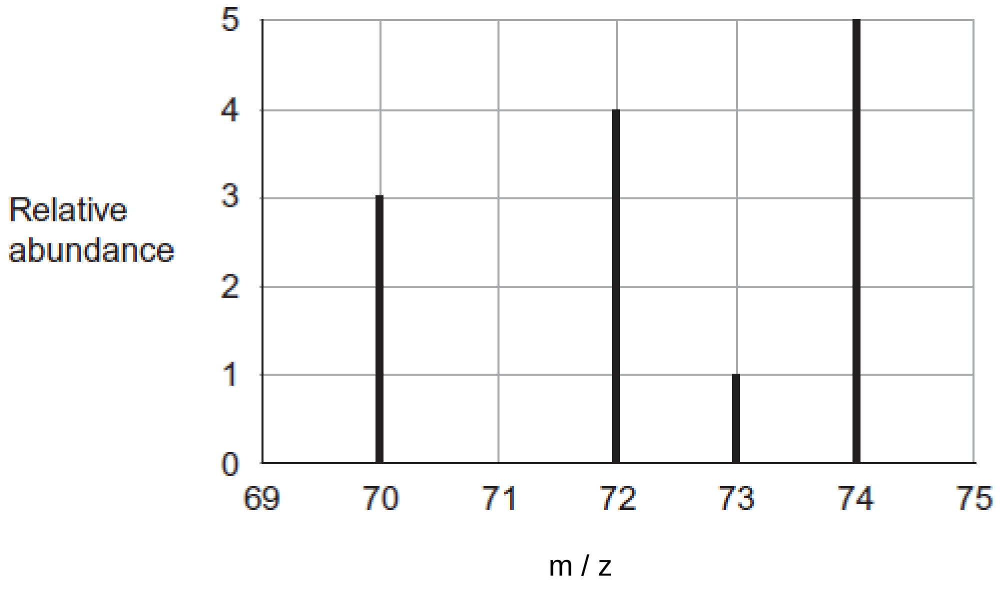
Which statement about time of flight mass spectrometry is correct?

A	The current in the detector is proportional to the ion abundance	⬭
B	Sample particles gain electrons to form positive ions	⬭
C	Particles are detected in the order of their kinetic energies	⬭
D	Ions are accelerated by a magnetic field	⬭

(Total 1 mark)

Q3.

The mass spectrum of the isotopes of element **X** is shown in the diagram.



(a) Define the term *relative atomic mass*.

____

____

____

____

(2)

(b) Use data from the diagram to calculate the relative atomic mass of **X**.

Give your answer to one decimal place.

____

____

____

____

____

____

(3)

(c) Identify the ion responsible for the peak at 72

____

(1)

(d) Identify which one of the isotopes of **X** is deflected the most in the magnetic field of a mass spectrometer. Give a reason for your answer.

Isotope ____

Reason ____

(2)

(e) In a mass spectrometer, the relative abundance of each isotope is proportional to the current generated by that isotope at the detector.

Explain how this current is generated.

____

____

____

____

(2)

(f) **X** and **Zn** are different elements.

Explain why the chemical properties of ^{70}**X** and ^{70}**Zn** are different.

____

____

(1)

(Total 11 marks)

Q4.

(a) A sample of sulfur consisting of three isotopes has a relative atomic mass of 32.16. The following table gives the relative abundance of two of these isotopes.

Mass number of isotope	32	33
Relative abundance / %	91.0	1.8

Use this information to determine the relative abundance and hence the mass number of the third isotope.
Give your answer to the appropriate number of significant figures.

Mass number = ____________________

(4)

(b) Describe how ions are formed in a time of flight (TOF) mass spectrometer.

____

____

____

____

____

(2)

(c) A TOF mass spectrometer can be used to determine the relative molecular mass of molecular substances.

Explain why it is necessary to ionise molecules when measuring their mass in a TOF mass spectrometer.

(2)

(Total 8 marks)

Q5.

A sample of ethanedioic acid was treated with an excess of an unknown alcohol in the presence of a strong acid catalyst. The products of the reaction were separated and analysed in a time of flight (TOF) mass spectrometer. Two peaks were observed at m / z = 104 and 118.

(a) Identify the species responsible for the two peaks.

(2)

(b) Outline how the TOF mass spectrometer is able to separate these two species to give two peaks.

(4)

(Total 6 marks)

Q6.

A sample of bromine was analysed in a time of flight (TOF) mass spectrometer and found to contain two isotopes, ^{79}Br and ^{81}Br

After electron impact ionisation, all of the ions were accelerated to the same kinetic energy (KE) and then travelled through a flight tube that was 0.950 m long.

(a) The $^{79}Br^{+}$ ions took 6.69×10^{-4} s to travel through the flight tube.

Calculate the mass, in kg, of one ion of $^{79}Br^{+}$
Calculate the time taken for the $^{81}Br^{+}$ ions to travel through the same flight tube.

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

$KE = \frac{1}{2} mv^2$ where m = mass (kg) and v = speed (m s^{-1})

$v = \frac{d}{t}$ where d = distance (m) and t = time (s)

Mass of one ion of $^{79}Br^{+}$ ____________________ kg

Time taken by $^{81}Br^{+}$ ions ____________________ s

(5)

(b) Explain how ions are detected and relative abundance is measured in a TOF mass spectrometer.

____

____

____

____

____

____

(2)

(Total 7 marks)

Time of Flight Mass Spectrometry Questions Mark scheme:

Q1.

(a) Assume current model unless otherwise stated.

Statement about the nucleus:
(Central) nucleus contains protons and neutrons.

Allow "protons and neutrons are in the centre of the atom"

1

Statement about electrons
Electrons are now arranged in energy levels/shells/orbitals

Ignore "mostly empty space"

Ignore electrons surround / orbit nucleus

Allow additional statement about neutrons but must be separate from statement about nucleus to score

e.g.

no neutrons in plum pudding / neutrons now recognised

1

(b) $1s^2 2s^2 2p^3$

Ignore commas, capitals and subscripts

Allow $1s^2 2s^2 2px^1 2py^1 2pz^1$

1

(c) (R is N (nitrogen))

Formula Be_3N_2

Accept Be_3R_2 *only if stated R = nitrogen*

Accept N_2Be_3

1

[4]

Q2.

A

[1]

Q3.

(a) Average / mean mass of 1 atom (of an element)
1/12 mass of one atom of ^{12}C

If moles and atoms mixed, max = 1

1

Mark top and bottom line independently.
All key terms must be present for each mark.

1

OR

Average / mean mass of atoms of an element
1/12 mass of one atom of ^{12}C

OR

$$\frac{\text{Average / mean mass of atoms of an element} \times 12}{\text{mass of one atom of } ^{12}C}$$

OR

$$\frac{\text{(Average) mass of one mole of atoms}}{1/12 \text{ mass of one mole of } ^{12}C}$$

OR

$$\frac{\text{(Weighted) average mass of all the isotopes}}{1/12 \text{ mass of one atom of } ^{12}C}$$

OR

Average mass of an atom / isotope (compared to C−12) on a scale in which an atom of C−12 has a mass of 12

This expression = 2 marks.

(b) $$\frac{(70 \times 3) + (72 \times 4) + 73 + (74 \times 5)}{13} = \frac{941}{13}$$

1

1

= 72.4

72.4 only

1

(c) $^{(72)}Ge^+$ or germanium$^+$

Must show '+' sign.

Penalise wrong mass number

1

(d) 70

If M1 incorrect or blank CE = 0/2

Ignore symbols and charge even if wrong.

1

Lowest mass / lowest m/z

Accept lightest.

Accept fewest neutrons.

1

(e) Electron(s) transferred / flow (at the detector)

M1 must refer to electron flow at the detector.

If M1 incorrect CE = 0/2

1

(From detector / plate) to the (+) ion

Do not allow from a charged plate.

1

(f) They do not have the same electron configuration / they have different number of electrons (in the outer shell)

Ignore electrons determine the properties of an atom.

Ignore they are different elements or different number of *protons.*

1

[11]

Q4.

(a) Abundance of third isotope = 100 – 91.0 –1.8 = 7.2%

1

$$\frac{(32 \times 91) + (33 \times 1.8) + (y \times 7.2)}{100} = 32.16$$

1

$7.2y = 32.16 \times 100 - 32 \times 91 - 33 \times 1.8 = 244.6$

1

$y = 244.6 / 7.2 = 33.97$

$y = 34$

Answer must be rounded to the nearest integer

1

(b) (for electrospray ionisation)

A high voltage is applied to a sample in a polar solvent

1

the sample molecule, M, gains a proton forming MH^+

1

OR

(for electron impact ionisation)

the sample is bombarded by high energy electrons

1

the sample molecule loses an electron forming M^+

1

(c) Ions, not molecules, will interact with and be accelerated by an electric field

1

Only ions will create a current when hitting the detector

1

[8]

Q5.

(a) $[CH_3OCOCOOH]^+$

Allow names

1

$[CH_3OCOCOOCH_3]^+$

Do not allow molecular formula

1

(b) Positive ions are accelerated by an electric field

1

To a constant kinetic energy

1

The positive ions with m / z of 104 have the same kinetic energy as those with m / z of 118 and move faster

1

Therefore, ions with m / z of 104 arrive at the detector first

1

[6]

Q6.

(a) = 79 / (1000 × 6.022 × 10^{23}) = 1.31 × 10^{-25} kg

1

Then either follow **method 1** (or **method 2** below)

Do not mix and match methods

Method 1

$V_{79} = \frac{d}{t}$ = 0.950 / 6.69 × 10^{-4}

= 1420 ms^{-1}

In method 1, M2 can be awarded in M3

1

KE = ½ mv^2

= ½ × 1.312 × 10^{-25} × $(1420)^2$

= 1.32 × 10^{-19} J

Mark consequential to their velocity and mass. Allow mass of 79 etc.

1

$V_{81} = \sqrt{(\frac{2KE}{m})}$

= √ 1.963 × 10^6

= 1.40 × 10^3 ms^{-1}

(allow 1.398 × 10^3 - 1.402 × 10^3)

Mark consequential to their velocity and mass. Allow mass of 81 etc.

1

$t = \frac{d}{v} = \frac{0.950}{v_{81}}$

= 6.80 × 10^{-4} s

Mark consequential to their M4

Accept 6.77 – 6.80 × 10^{-4} s

1

Method 2

$m_1(d/t_1)^2 = m_2\ (d/t_1)^2$
or
$m_1 / t_1^2 = m_2 / t_2^2$

1

$t_2^2 = t_1^2\ (m_2/m_1)$
Or
$t_2^2 = (6.69 \times 10^{-4})2 \times (81/79)$

1

$t_2^2 = 4.59 \times 10^{-7}$

Mark consequential to their M3

1

$t = 6.77 \times 10^{-4}$ s

Mark consequential to their M4

Accept 6.77 – 6.80 × 10^{-4} s

1

(b) ion hits the detector / negative plate <u>and</u> gains an electron

1

Not positive plate

(relative) abundance is proportional to (the size of) the current

1

[7]

Titration practice questions

Name: ____________________

Class: ____________________

Date: ____________________

Time:	**23 minutes**
Marks:	**21 marks**
Comments:	**Self mark in green pen using the answers at the end of the questions**

Q1.

A solution of volume 500 cm^3 contains 150 g of ammonia.

What is the concentration, in mol dm^{-3}, of ammonia in this solution?

A 0.51 ⬭

B 8.82 ⬭

C 16.7 ⬭

D 17.6 ⬭

(Total 1 mark)

Q2. Questions 2, 3, 4, 5 and 6 all refer to the method below:

A student devised an experiment to find the concentration of sulfuric acid in a sample of battery acid.

- A measuring cylinder was used to transfer 10 cm^3 of battery acid to a volumetric flask.
- Distilled water was added to the volumetric flask until the volume reached 250 cm^3
- A 25.0 cm^3 sample of diluted acid was transferred from the volumetric flask to a conical flask using a pipette.
- A few drops of methyl orange indicator were added to the acid in the conical flask before titrating the acid with sodium hydroxide.
- The titration was repeated five times but concordant results were **not** obtained. (Note: Methyl orange is red in acid and yellow in alkali.)

Which suggestion would improve the chances of obtaining concordant titres?

A Invert the volumetric flask several times after adding the distilled water. ⬭

B Wash the pipette with distilled water between each titration. ⬭

C Add extra drops of indicator to the sample when nearing the end point in each titration. ⬭

D Use a more concentrated solution of sodium hydroxide in the burette. ⬭

(Total 1 mark)

Q3.

Which suggestion about rinsing the conical flask between each titration would improve the accuracy of the titrations?

A Rinsing with acid. ◯

B Rinsing with alkali. ◯

C Rinsing with water. ◯

D No rinsing with any liquid. ◯

(Total 1 mark)

Q4.

Which suggestion would reduce the overall measurement uncertainty in the titration?

A Use less concentrated alkali in the burette. ◯

B Use phenolphthalein indicator instead of methyl orange. ◯

C Use smaller samples of the diluted acid in each titration. ◯

D Begin each titration with the burette filled to the 0.00 cm^3 mark. ◯

(Total 1 mark)

Q5.

Which of these is important in ensuring that the student's experiment is safe?

A Do the titration in a fume cupboard. ◯

B Wear gloves when measuring out the battery acid. ◯

C Wash hands before doing the titration. ◯

D Carry the burette horizontally when collecting the apparatus. ◯

(Total 1 mark)

Q6.

Which colour change is observed at the end point in each titration?

A	Yellow to red	⬭
B	Red to orange	⬭
C	Yellow to orange	⬭
D	Red to yellow	⬭

(Total 1 mark)

Q7.

Ethanedioic acid ($H_2C_2O_4$) is a diprotic acid. Beekeepers use a solution of this acid as a pesticide.

A student carried out a titration with sodium hydroxide solution to determine the mass of the acid in the solution. The student repeated the titration until concordant titres were obtained.

$$H_2C_2O_4(aq) + 2NaOH(aq) \longrightarrow Na_2C_2O_4(aq) + 2H_2O(l)$$

(a) The student found that 25.0 cm^3 of the ethanedioic acid solution reacted completely with 25.30 cm^3 of 0.500 $mol\,dm^{-3}$ sodium hydroxide solution.

Calculate the mass, in mg, of the acid in 25.0 cm^3 of this solution.

Mass of acid = ____________________ mg

(4)

(b) The student used a wash bottle containing deionised water when approaching the end-point to rinse the inside of the conical flask.

Explain why this improved the accuracy of the titration.

____

____

____

(1)

(c) Give the meaning of the term concordant titres.

____

____

____

(1)
(Total 6 marks)

Q8.

(a) Calculate the concentration, in mol dm^{-3}, of the solution formed when 19.6 g of hydrogen chloride, HCl, are dissolved in water and the volume made up to 250 cm^3.

____

____

____

(3)

(b) The carbonate of metal **M** has the formula M_2CO_3. The equation for the reaction of this carbonate with hydrochloric acid is given below.

$$M_2CO_3 + 2HCl \rightarrow 2MCl + CO_2 + H_2O$$

A sample of M_2CO_3, of mass 0.394 g, required the addition of 21.7 cm^3 of a 0.263 mol dm^{-3} solution of hydrochloric acid for complete reaction.

(i) Calculate the number of moles of hydrochloric acid used.

____

____

(ii) Calculate the number of moles of M_2CO_3 in 0.394 g.

____

____

(iii) Calculate the relative molecular mass of M_2CO_3

____

____

(iv) Deduce the relative atomic mass of **M** and hence suggest its identity.

*Relative atomic mass of **M*** _______________________________________

____

*Identity of **M*** ____

(6)
(Total 9 marks)

Titration practice questions Mark scheme:

Q1.

D

[1]

Q2.

A

[1]

Q3.

C

[1]

Q4.

A

[1]

Q5.

B

[1]

Q6.

B

[1]

Q7.

(a) **M1** Amount NaOH = 0.02530 × 0.500 = 0.01265 mol

567-590 = 4 marks

0.567-0.590 = 3 marks

1

M2 Amount acid = 0.006325 mol (i.e. **M1** ÷ 2)

Allow ECF at each stage

1

M3 M_r = 90(.0)

***M3** can be scored from use of value of 90(.0) within working*

1

M4 mass acid = 569 (mg) (allow 567 to 576) (i.e. **M2** × **M3** in mg)

***M4** should be to at least 2sf. Any individual marks for **M1/2/3** should be to at least 2sf (or 90 for **M3**)*

1

1134-1180 = 3 marks (due to not dividing moles of NaOH by 2)

1.134-1.180 = 2 marks (due to not dividing moles of NaOH by 2 and not converting to mg)

(b) Idea that it ensures all ethanedioic acid / acid / sodium hydroxide / alkali / reactants are in the mixture / solution / reaction or the idea that some of the ethanedioic acid / acid / sodium hydroxide / alkali / reactants would be on the sides of the flask

the idea that it is the transfer of all the acid/alkali alone is not enough

1

(c) Titres that are within 0.1 cm^3 of each other

Units are needed

Allow 0.05-0.15 cm^3

Do not allow idea of identical results

Allow answers that refer to titres that are within the uncertainty of the burette/apparatus of each other

1

[6]

Q8.

(a) Moles HCl = $\frac{mass}{M_r} = \frac{19.6}{36.5}$ **(1)** (= 0.537)

Concentration = $\frac{0.537}{0.25}$ **(1)**

= 2.15 (mol dm^{-3}) **(1)**

Conseq on $\frac{mass}{M_r}$ correct

min 2 d.p. 2.14 to 2.15

Ignore wrong units

A.E. lose one mark

3

(b) (i) $\frac{21.7}{1000} \times 0.263$ = 5.7**(1)** × 10^{-3} (mol) **(1)**

5.7 to 5.71 × 10^{-3}

(ii) $\frac{5.71 \times 10^{-3}}{2}$ = 2.85 × 10^{-3} (mol) **(1)**

Conseq

(iii) $\frac{0.394}{2.85 \times 10^{-3}}$ = 138 **(1)**

Conseq

(iv) *Relative atomic mass of **M***: 138 - 60 = 78 **(1)**

$\frac{78}{2}$ **= 39 (1)**

***Identify of M*: Potassium or K or K^+ (1)**

Conseq

If 78 = M_r then M = selenium

6

[9]