THE NATIONAL MATHEMATICS AND SCIENCE COLLEGE

Chemistry

SUMMER PREPARATION WORK FOR A LEVEL

Year 1 Transition Work

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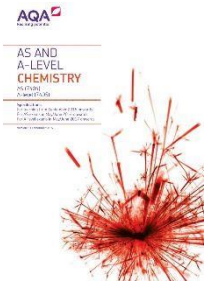
Introduction

We would like to welcome you to the Chemistry Department at NatMatSci

We delighted to welcome you onto your A-level course and keen to get the very best from you - not only academically, but also in terms of your personal development too. The key to this is communication (two-way) so here is an introduction for you from us; make sure you ask about anything you do not understand! In this letter we will address things which are particular to Chemistry.

In this booklet you will find some tasks to support you in preparation for the A-level course in September. We expect that you find this work very accessible – if you would like some more challenging work then please email Dr Ro p.robotham@natmatsci.ac.uk so that I can link you to our Transition OneNote book of more challenging topics and ideas to extend you.



The course

We follow the AQA Chemistry (7405) specification.

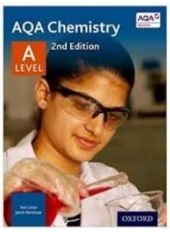
Assessed Practical

The A level has 12 assessed practical components which are formally assessed across the two year program, as well as practical competences being developed and assessed throughout all practical work over the duration of the A level course. You must avoid having planned absences on the dates of these. They will take place in normal lessons.

You should refer to your personal timetable and the Programme of Study and write the times of these on your calendar at home!

The assessed practical sessions lead to an endorsement of practical skills separately from your A-level grade. They are also assessed formally on the A-level exam papers. All 12 core practicals must be completed to pass the practical endorsement component of the course.

Textbooks



The textbooks, on loan to you, cost over £40 to replace so we would urge you to look after it carefully as it needs to be in an undamaged state for you to reclaim your deposit. There are books to use in lessons, and an extensive collection of extension materials in the library and laboratories.

Chemical sciences review

This magazine aimed at A level students. A student keen to progress to higher education should be seeking to use this as a regular source of extension. (It is a particularly useful source for those seeking to achieve A* at A2.)

If you want to purchase a paper copy the cost is approximately £15 for four magazines over the year. Please find more information here

https://www.hoddereducation.co.uk/subjects/science/products/general/chemistry-review-magazine-volume-30,https://www.hoddereducation.co.uk/subjects/science/products/general/chemistry-review-magazine-volume-30,-2020-212020-21

Revision guides

If you decide to buy one then please make certain it is for the new AQA specification (details above). In the past our students have found the CGP Student book and also the Philip Allen revision guides which are slightly more expensive but more supportive of exam technique possibly. If you want to browse our department copies before you buy please ask. We will issue you with aCGP revision guide as you start your Year 2 course with us.

We really hope you enjoy your chemistry here! Please remember the key to success is hard work and communication.

Best wishes

Dr Robotham and Miss Turner

The transition to A-level is large, even for pupils who have completed their Pre-A Course at NatMatSci. ***We want you to be better prepared for the work that is to come, to help you achieve the highest grade!*** So we have created this booklet to help you prepare for that challenge.

When you start your first year of A-level you will sit a baseline test to enable us to see what you already know. Some practise GCSE level exam questions have been provided in this document to help you prepare for the test.

Expectations

- You should aim to spend approximately 4 hours to complete the work in the booklet.
- You should also aim to review at least one of the books on the suggested reading list, or a scientific article you have read recently, and be prepared to explain what you have read about to your new classmates

Topics needed for A-level chemistry

This work is to help you prepare for the Year 1 course. We will assume that you are confident with all the topics covered in this workbook when we begin the A-level Chemistry course.

Each topic has a suggested video/videos to watch; a summary sheet of the key information and/or a revision mat for you to complete; key words and terms that you need to be familiar with; and some exam questions.

Please complete the exam questions and mark your answers using the mark scheme at the end of this workbook. Record your marks for each section in the table below and use the comments box to let us know of any areas that you found difficult so that we can address these when we begin the A-level course.

The topics are as follows:

(1) Atomic structure
(2) Bonding and properties
(3) Rates of reaction and energy change
(4) Amount of substance
(5) Introduction to organic chemistry

Ideas for work to do over the summer

Write notes

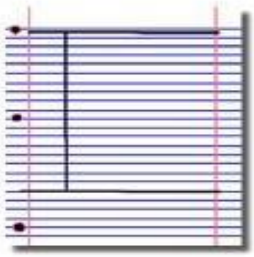
Work your way through the topics you need to know outlined above and write summary notes about each section. Make sure you understand what you are writing. Don't just copy from the textbook, try to convert it into your own words so you are actively trying to learn each topic.

Revise the topics

Make your revision an active process. If you just read your notes through this will probably not be enough for you to remember all the details. Try some of the following tactics until you find a system that works for you. Use a different strategy for each topic:

1. Making Cornell notes - we will review how to do this when you start with us in the new year

1. Divide your page into three sections like this



2. Write the name, date and topic at the top of the page

3. Use the large box to make notes. Leave a space between separate idea. Abbreviate where possible.

4. Review and identify the key points in the left hand box

5. Write a summary of the main ideas in the bottom space

2. Draw a mind map or concept map. This is similar to a spider diagram joining all ideas about particular topic together. Include key words you must know
3. Read through the text then go away and do something else. After 5 a short period of time return to your desk and see how much you can remember by writing everything down. Then compare to your original notes. Keep doing this until you can remember virtually all of the information.
4. Write yourself some test questions with model answers. You could do this on cards with the question on one side and the answer on the other. Get a friend or family member to test you.

Techniques for answering exam questions

1. Check how many marks the question is worth. If it is worth 2 marks you have to make two separate points to get both marks.

2. On any questions that ask you to *describe* the graph you should start by referring to the x axis (which will be the independent variable) and say how this changes the variable on the y axis. If there is a change in the trend of the line then you will need to refer to this. Finally, to get high marks on graph questions you should give figures from the graph.

3. Example answer: In the first 10 minutes (this tells you the independent variable is time) the rate of the reaction (the dependent variable) increases to [insert figure here]. The rate of reaction then starts to slow down from 11 minutes onwards until it reaches [insert figure here]. By 20 minutes the rate of the reaction has completely stopped.

4. If you are asked to ***explain*** a graph you need to use your scientific knowledge, i.e you will need to use scientific key words in your answer. The examiner is expecting you to tell them *why* something is happening.

5. If you are given an ***Evaluate*** question you need to work out advantages and disadvantages of the topic being asked by the examiner. You also need to give a conclusion. Your conclusion can't just say 'I think this is a good/bad idea'. You need to write a one sentence conclusion which summarises your perspective e.g. 'This is a good idea because the advantage of … far outweighs the disadvantage of …'

6. Avoid using words like 'it'. Say what 'it' is. If the examiner is unsure what you are referring to they will automatically mark it wrong.

7. Don't panic if you see a question you don't believe you have learned. Sometimes examiners throw these kinds of questions in and expect you to be able to *apply* your knowledge. Usually this kind of question will start with '***Suggest***…'. Read the question very carefully and highlight the key words. Ask yourself: what part of this course is this likely to link to. Then try to answer the question.

Now review the topics and complete the practice GCSE level questions

When you are confident you have completed a significant amount of revision try the practice GCSE questions below. The mark scheme is at the end of the questions so you can mark the work yourself or get a family member to mark the answers (this will hopefully avoid bias!).

After the questions have been marked you should then go back through the answers using the examiners' report (at the end of the mark scheme) and highlight those areas you have not done as well in. It is probably worth revising these topics again. Alternatively it could be your exam technique. Some ideas for helping you improve your exam technique are provided below.

As you complete the tasks in the booklet, review your answers and complete this record sheet to record your marks and what you answered well and what you need to work on.

Record sheet

Atomic structure	Mark: /27	Comments:
Bonding and properties	Mark: /30	Comments:
Rates of reaction and energy change	Mark: /28	Comments:
Amount of substance	Mark: /32	Comments:
Introduction to organic chemistry	Mark: /28	Comments:
Electrolysis	Mark: /25	Comments:

1. Atomic Structure

Watch the video: https://www.ted.com/talks/jon_bergmann_just_how_small_is_an_atom?language=en

You may need to watch this a few times as the narrator speaks very quickly but it is a good introduction to the size of an atom and scale of the nucleus compared to atomic size.

If the video is too fast for you then try this one: https://www.youtube.com/watch?v=ooWfzpUIoNM

Make notes on:

- Particles present in an atom
- Where these particles are found in an atom
- Relative mass and charge of these particles
- Size of an atom
- Electron arrangement in atoms
- Isotopes

Notes and Key words and terms

Word/term	Definition
atom	
element	
proton	
neutron	
nucleus	
electron	
electron configuration	
isotope	

Atomic Structure Revision Mat

Complete the following table:

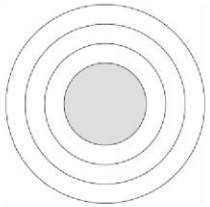
Name of particle	Relative charge	Relative mass	Location in the atom
Proton		+1	
	0		
Electron			shells

Use the following isotopes of carbon to explain what isotopes are

Why do isotopes of an atom have the same chemical properties?

Give the number of protons, neutrons and electrons in atoms of the following elements and draw the electron arrangement.

Boron $^{9}_{5}B$

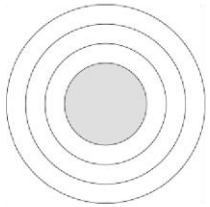


___ protons

___ neutrons

_____electrons

Phosphorus $^{31}_{15}P$

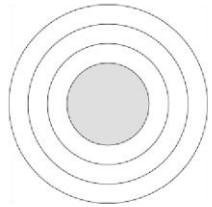


___ protons

___ neutrons

_____electrons

Calcium $^{40}_{20}B$



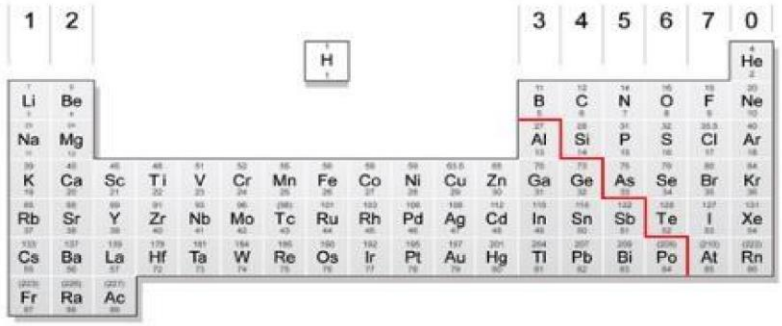
___ protons

___ neutrons

_____electrons

How is the position of an element on the periodic table linked to its atomic structure?

Hint: what does the group number tell us about an atom of that element? What does the period an element in tell us about the atomic structure?



The Periodic Table of the Elements

1	2											3	4	5	6	7	0
																	(18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass **symbol** name atomic (proton) number									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	[97] 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 radius 88	[227] Ac † actinium 89	[267] Rf rutherfordium 104	[270] Db dubnium 105	[269] Sg seaborgium 106	[270] Bh bohrium 107	[270] Hs hassium 108	[278] Mt meitnerium 109	[281] Ds darmstadtium 110	[281] Rg roentgenium 111	[285] Cn copernicium 112	[286] Nh nihonium 113	[289] Fl flerovium 114	[289] Mc moscovium 115	[293] Lv livermorium 116	[294] Ts tennessine 117	[294] Og oganesson 118

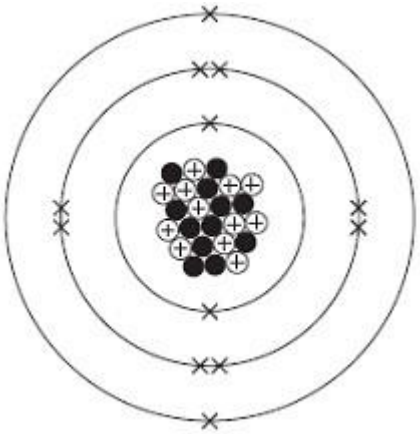
140.1 Ce cerium 58	140.9 Pr praseodymium 59	144.2 Nd neodymium 60	[145] Pm promethium 61	150.4 Sm samarium 62	152.0 Eu europium 63	157.3 Gd gadolinium 64	158.9 Tb terbium 65	162.5 Dy dysprosium 66	164.9 Ho holmium 67	167.3 Er erbium 68	168.9 Tm thulium 69	173.0 Yb ytterbium 70	175.0 Lu lutetium 71
232.0 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

* **58 – 71** Lanthanides

† **90 – 103** Actinides

Atomic structure exam questions

Q1. The diagram represents a magnesium atom.



(a) Use words from the box to answer these questions.

electron	**neutron**	**nucleus**	**proton**

(i) What is the name of the central part of the atom? .....

(1)

(ii) What is the name of the particle with no charge? .....

(1)

(iii) What is the name of the particle with a negative charge? .....

(1)

(b) Use the diagram above to help you answer these questions.

(i) Draw a ring around the atomic (proton) number of this magnesium atom.

12 24 36

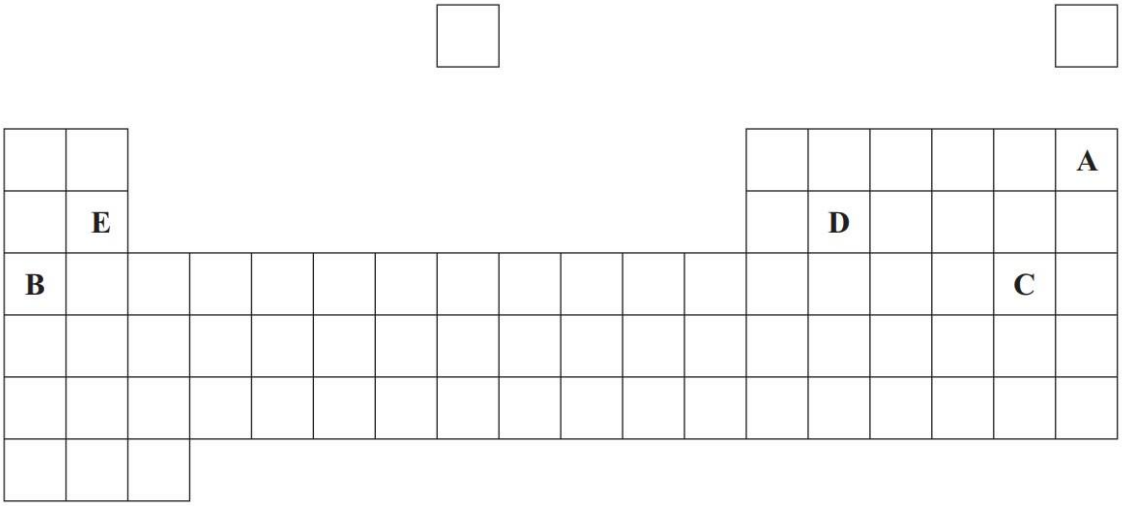
(1)

(ii) Draw a ring around the mass number of this magnesium atom.

12 24 36

(1)

Q2. Part of the Periodic Table is shown.



In each part of this question, place a cross (☒) in one box to identify the letter, **A** to **E**, that represents

a) a noble gas

A ☒ **B** ☒ **C** ☒ **D** ☒ **E** ☒

[1]

b) a Group 2 metal

A ☒ **B** ☒ **C** ☒ **D** ☒ **E** ☒

[1]

c) a Group 7 non-metal

A ☒ **B** ☒ **C** ☒ **D** ☒ **E** ☒

[1]

d) Complete these sentences by placing a cross (☒) in one box next to the correct answer.

i) The elements in the Periodic Table are arranged in order of increasing

- ☒ number of neutrons
- ☒ atomic number
- ☒ relative atomic mass
- ☒ mass number

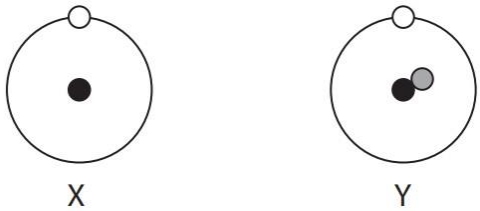
[1]

ii) Elements in the same group in the Periodic Table have the same number of

- ☒ electrons in the outer shell
- ☒ protons in the nucleus
- ☒ neutrons in the nucleus
- ☒ Atoms

[1]

Q3. The diagram below shows two different atoms of hydrogen, **X** and **Y**.



i) The particle furthest from the centre of each atom is

- ☒ An electron
- ☒ A neutron
- ☒ A nucleus
- ☒ A proton

[1]

ii) The particle present in atom Y but not in atom X is

- ☒ An electron
- ☒ A neutron
- ☒ A nucleus
- ☒ A proton

[1]

Q4. This question is about the element beryllium.

a) Use words from the box to complete the sentences about beryllium.

Each word may be used once, more than once or not at all.

electrons	**negative**	**neutral**	**neutrons**
nucleus	**positive**	**protons**	**shells**

[7]

An atom of beryllium has a central ..... that contains particles called ..... and ..... . Around these particles there are ..... orbiting in ..... . An atom of beryllium has no charge because it contains equal numbers of ..... and ..... . The particles with the lowest mass in an atom of beryllium are called ..... .

b) Beryllium forms a compound with the formula $Be(OH)_2$

i) How many different elements are there in $Be(OH)_2$?

.....

[1]

ii) What is the total number of atoms in the formula $Be(OH)_2$?

.....

[1]

Q5. Different atoms of oxygen can be represented as

$$^{16}_{8}O \text{ and } ^{18}_{8}O$$

Explain why these atoms are isotopes of each other

.....

.....

.....

.....

.....

(3)

Q6. Which number in the table is –1?

particle	charge	relative mass
electron	**A**	**B**
neutron	**C**	1
proton	**D**	1

[1]

Q7. What is the electronic structure of an atom with a proton number 5 and a mass number 11?

A 1, 8, 2 **B** 2, 8, 1 **C** 2, 3 **D** 3, 2

[1]

2. Bonding and properties

Watch the videos:

https://www.youtube.com/watch?v=Mx8Gb5xewYI

https://www.youtube.com/watch?v=uvjjpzMf7S4&list=PLsorq7UsrfYsFLSgTetRVjzN6QYvf3jpC&index=4

https://www.youtube.com/watch?v=GEjA7ewsrGE&list=PLsorq7UsrfYsFLSgTetRVjzN6QYvf3jpC&index=6

https://www.youtube.com/watch?v=Qd2_LeCW7wo&list=PLsorq7UsrfYsFLSgTetRVjzN6QYvf3jpC&index=7

Make notes on:

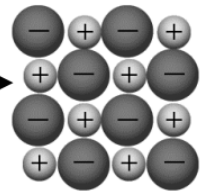
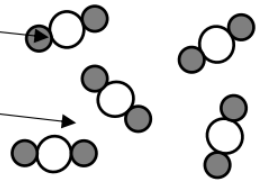
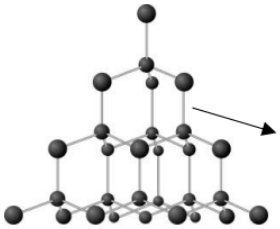
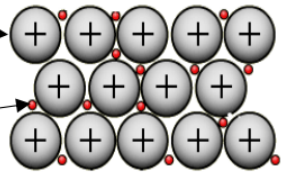
- Which type of elements bond ionically
- How ions are formed
- What ionic bonding is (what is the attraction between)
- The properties of ionically bonded compounds
- Which type of elements bond covalently
- How molecules are formed
- What covalent bonding is (what is the attraction between)
- The properties of simple molecular compounds
- The properties of substances with a giant covalent structure
- Which type of elements have metallic bonding
- What metallic bonding is (what is the attraction between)
- The properties of metallically bonded compounds

Notes and Key words and terms

Word/term	Definition
ion	
lattice	
electrostatic attraction	
molecule	
covalent bond	
intermolecular force	
macromolecular	
delocalised electron	
malleable	
ductile	

Properties of different structures Summary Sheet

Learn the words/terms in **bold**

Structure	Properties	Explanation
Giant ionic structure ***Lattice*** *of positive and negative ions strongly attracted together* 	**High** melting points and boiling points.	The **strong electrostatic forces** between positive and negative ions require lots of energy to overcome.
	Do not conduct electricity as **solids.** **Conduct** electricity as **liquids/solutions**.	**Solid:** the ions are in **fixed positions**. **Liquid/solution:** The **ions** are **free to move**.
Simple molecular structure *Strong covalent bonds* *Weak intermolecular forces* 	**Low** melting and boiling points.	Although the covalent bonds between the atoms in molecules are strong, the **intermolecular forces** between the molecules are **weak** and little energy is needed to overcome them.
	Do not conduct electricity.	The molecules are **neutral** so there are **no charged particles able to move**.
Giant covalent/macromolecular structure  *Strong covalent bonds*	**High** melting and boiling points.	There are **strong covalent bonds** throughout the structure which require lots of energy to overcome.
	Do not conduct electricity, except **graphite**.	**Diamond/Silica:** There are **no moving charges**. **Graphite:** There are **delocalised electrons**.
Metallic structure ***Layers*** *of* ***positive ions*** ***Delocalised electrons*** *(from the outer shells of the metal atoms)* 	**High** melting and boiling points.	The **strong electrostatic forces** between positive ions and delocalised electrons require lots of energy to overcome.
	Malleable (bendy) & **ductile** (can be pulled into a wire)	The **layers of ions** are able to **slide** over each other.
	Conduct electricity **Conduct** heat	The **delocalised electrons** are able to move **through the structure**. **Delocalised electrons** can pass on **vibrations** easily.

Bonding and Properties Revision Mat

Ionic bonding occurs in compounds formed from _____ combined with ___-_____

Covalent bonding occurs in most ___-_____ elements and in compounds of ___-_____

Metallic bonding occurs in metallic _____ and _____.

non-metals, alloys, metals, non-metals, elements, non-metals, metals

Draw dot-cross diagrams to show the bonding in the following molecules (only draw outer shell electrons)

CH_4

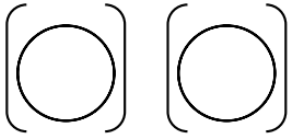
NH_3

Cl_2

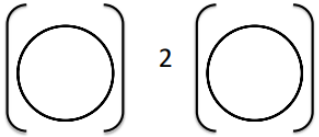
O_2

Draw dot cross diagrams for the following ionic compounds (remember to show the charge on the ions) Only draw outer shell electrons.

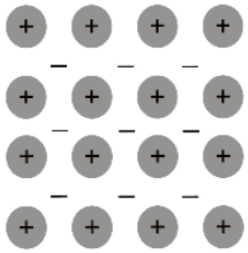
sodium fluoride



magnesium chloride



lithium oxide



The diagram above shows the bonding in a metal, label the diagram.

Use your labelled diagram to explain why metals

(a) Conduct electricity

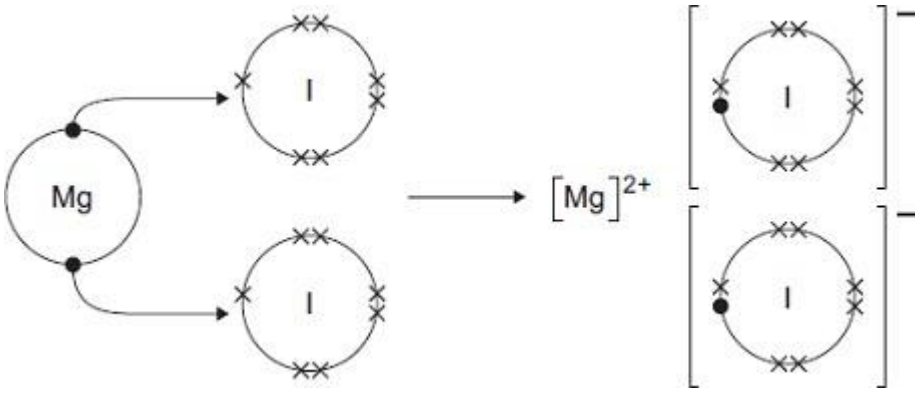
(b) Are malleable (can be bent)

Bonding and properties exam questions

Q1. The diagram shows how magnesium and iodine atoms form magnesium iodide.

Only the outer electrons are shown.

The dots (●) and crosses (×) are used to represent electrons.



Use the diagram to help you to answer this question.

Describe, as fully as you can, what happens when magnesium reacts with iodine to make magnesium iodide.

To gain full marks you should use the words atom, electron and ion in your answer.

.....

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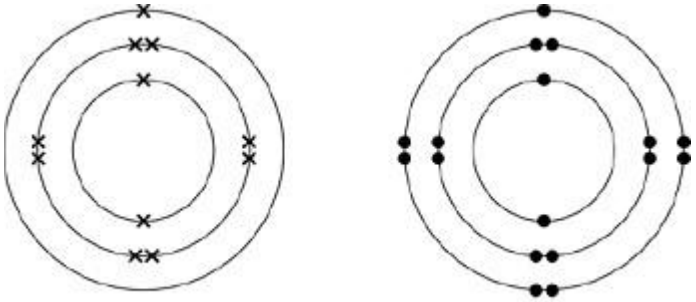
(4)

Q2. Sodium chloride is an ionic compound. It is formed when sodium reacts with chlorine.

(a) The diagrams show the arrangement of the electrons in atoms of sodium and chlorine.



Sodium atom Chlorine atom

(i) Draw and label diagrams to show the arrangement of the electrons in the ions formed when sodium reacts with chlorine.

(2)

(ii) Give the symbols of the ions formed when sodium reacts with chlorine.

.....

(1)

(b) Sodium chloride is a typical ionic compound.

(i) Sodium chloride has a very high melting point.

Explain why.

.....

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.....

.....

(3)

(ii) Explain why solid sodium chloride does not conduct electricity but when molten it does conduct electricity.

.....

.....

.....

.....

(3)

(Total 9 marks)

Q3. Calcium and magnesium are elements. They are found in the Earth's crust as compounds, often carbonates and sulfates. Magnesium is also found as its chloride.

(a) Calcium and magnesium are in the same Group in the Periodic Table. State which Group this is.

.....

(1)

(b) Use the Periodic Table to help you to answer this question.

(i) Write the chemical formula of magnesium chloride.

.....

(1)

(ii) Name the type of bonding in magnesium chloride.

.....

(1)

(Total 3 marks)

Q4. (a) Copper is a metal. Explain how it conducts electricity.

.....

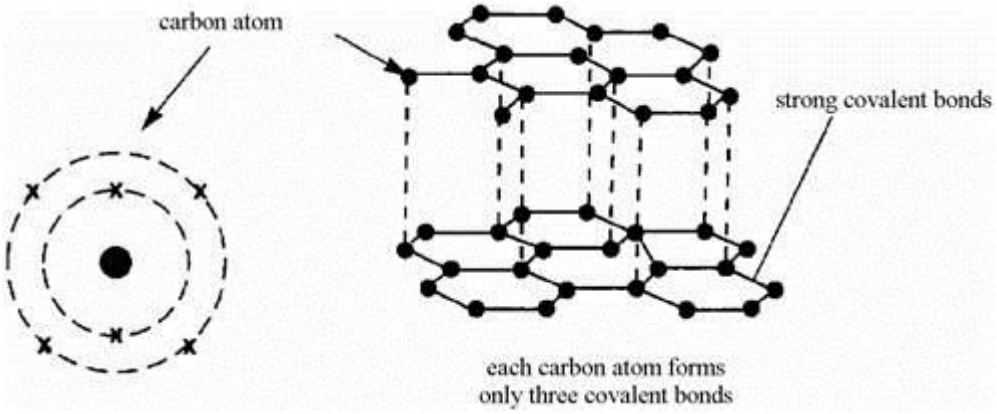
.....

.....

.....

(2)

(b) Graphite is a non-metal.



Use the information to explain why graphite conducts electricity.

.....

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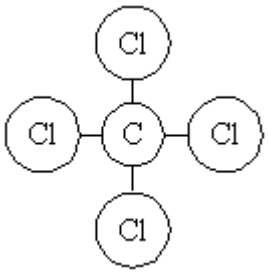
(3)

(Total 5 marks)

Q5. Chlorine will combine with the non-metal element, carbon, to form this molecular compound.



(a) What is the type of bond in this molecule?

.....

(1)

(b) Explain how these bonds are formed. (You may use a diagram).

.....

.....

.....

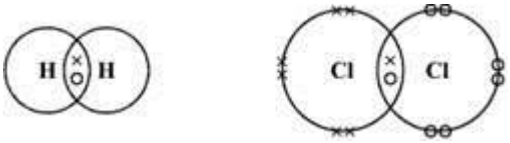
.....

(2)

(Total 3 marks)

Q6. Hydrogen chloride (HCl) can be made by the reaction of hydrogen (H_2) with chlorine (Cl_2).

(a) The diagrams represent molecules of hydrogen and chlorine.



Draw a similar diagram to represent a molecule of hydrogen chloride (HCl). You need show only the outer energy level (shell) electrons.

(1)

(b) The word equation for the reaction of hydrogen with chlorine is shown below.

hydrogen + chlorine → hydrogen chloride

Write a balanced symbol equation for this reaction.

.....

(2)

(c) Hydrogen chloride gas reacts with magnesium to form the ionic compound called magnesium chloride. Use the table of ions on the Data Sheet to help you to write the formula of magnesium chloride.

.....

(1)

(d) Why does magnesium chloride have a much higher melting point than hydrogen chloride?

.....

.....

.....

.....

(2)

(Total 6 marks)

3. Rates of reaction and energy change

Watch the videos:

https://www.youtube.com/watch?v=7i90fiz9SmY

https://www.youtube.com/watch?v=QvfIBPlH3zg&list=PLsorq7UsrfYsFLSgTetRVjzN6QYvf3jpC&index=13

https://www.youtube.com/watch?v=jd6U5nQcqKc

Make notes on:

- Definition of rate of reaction
- How reaction rate can be followed experimentally
- Factors that affect rate of reaction
- Collision theory and activation energy
- Definitions of exothermic and endothermic reactions
- Energy profile diagrams for exothermic and endothermic reactions • Using bond energy to calculate energy change for a reaction.

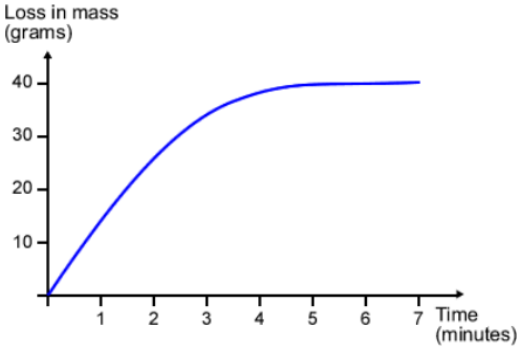
Key words and terms

Word/term	Definition
rate	
frequency	
collision theory	
activation energy	
concentration	
catalyst	
exothermic	
endothermic	
bond energy/enthalpy	

Rate of Reaction Revision Mat

The rate of a chemical reaction can be calculated by measuring either how much ..... is formed or how much ..... is used up over time. Rate =

Interpreting rates of reaction graphs:



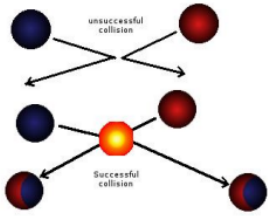
Initially the rate of reaction is ....., the rate then .... and finally the reaction stops.

The ..... of the line gives the rate. The steeper the line, the ..... the rate.

Average rate between minute 2 and 4 =

Collision Theory:

For a chemical reaction to occur the reactants must ..... with sufficient energy (this is called the ..... energy).



<u>Factors affecting rate:</u>

Concentration (or **pressure** of a gas): increasing the concentration ..... the rate. There are more particles therefore the ..... of collisions increases.

Surface area (of a ..... reactant): increasing the surface area ..... the rate. There are more particles available therefore the ..... of collisions increases.

Temperature: Increasing the temperature ..... the rate. The particles have more energy therefore they move more ..... which increases the frequency of ..... and more collisions have the ..... energy needed to make products.

Catalyst: Adding a catalyst will ..... the rate. A catalyst ..... the ..... energy needed for a reaction to occur therefore more collisions are successful in making product. The catalyst is not .... in the reaction.

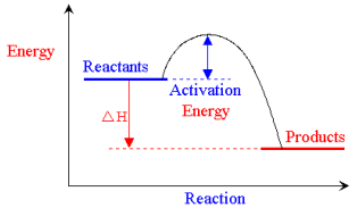
Energy Changes Revision Mat

What is an exothermic reaction?

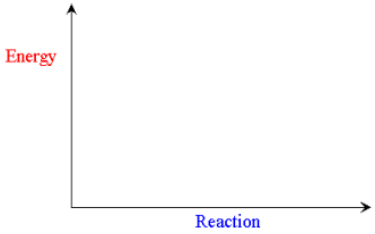
What is an endothermic reaction?

How could you determine whether a reaction was exothermic or endothermic? (what observations would you need to make)

Describe how this energy profile diagram shows that the reaction is exothermic



Draw a similar energy provide diagram for an endothermic reaction



How would the diagram change if there was a catalyst present?

Use the bond energies given to calculate the energy change for the following reaction:

$$2H_2 + O_2 \rightarrow 2H_2O$$

Bond	Bond energy in kJ per mole
H – H	436
O = O	498
O – H	464

Rates of reaction and energy change exam questions

1. A student is investigating the rate of the reaction between nitric acid and zinc carbonate. The equation for this reaction is shown below.

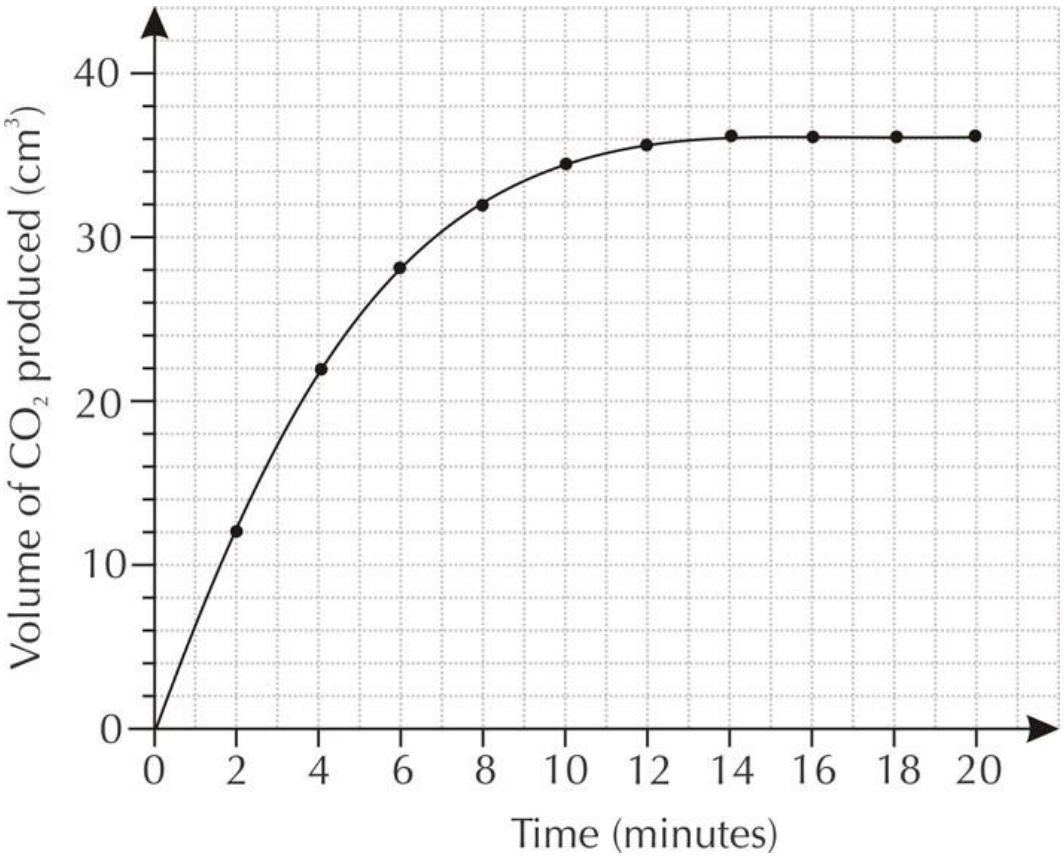
$$2HNO_{3(aq)} + ZnCO_{3(s)} \rightarrow Zn(NO_3)_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$$

The student used a gas syringe to measure the volume of carbon dioxide produced by this reaction and recorded the volume every 2 minutes for 20 minutes.

a. Suggest another technique that the student could have used to measure the rate of this reaction.

(1)

b. The student's results are shown on this graph.



i. Use the graph to estimate how long it took for all of the reactants to be used up in this reaction.

…… minutes

(1)

ii. Calculate the rate of reaction during the first 2 minutes of this reaction. Give your answer in cm^3/min.

.....

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.....

.....

(2)

iii. Explain why the rate of this reaction decreased as the reaction progressed.

.....

.....

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.....

(2)

iv. The student repeated his experiment at a higher temperature. All other conditions were kept the same. Sketch a curve on the graph to show the results he might expect.

(2)

2. In industry, vanadium(v) oxide is used as a catalyst in the following reaction:

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$$

Sulfur trioxide (SO_3) is used in the synthesis of sulfuric acid.

a.

i. What is a catalyst?

.....

.....

(1)

ii. Discuss the advantages and disadvantages of using catalysts in industrial reactions.

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(4)

b. Increasing the pressure changes the rate of this reaction.

i. State the effect that using a higher pressure will have on the rate of this reaction.

.....

.....

.....

.....

(1)

ii. Explain why increasing the pressure has an effect on the rate of this reaction.

.....

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(2)

3. A reusable hand warmer contains a solution of sodium acetate trihydrate. When the hand warmer is activated, the sodium acetate trihydrate crystallises and heat is released. The word equation for this reaction is shown below:

sodium acetate trihydrate solution $\rightleftharpoons$ solid sodium acetate trihydrate

a. What type of reaction is this? Tick the correct answer. **[1 mark]**

neutralisation ☐ exothermic ☐ combustion ☐ endothermic ☐

b.

i. Using the information above, explain why hand warmers that contain sodium acetate trihydrate are reusable.

.....

.....

.....

.....

(2)

ii. Suggest how the hand warmer could be reset after use, so that it is ready to be used again. Explain your answer.

.....

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.....

(2)

4. An airship caught fire when it was coming into land in 1937.

The airship was filled with hydrogen. A spark or flame ignited the hydrogen. The hydrogen reacted with oxygen in the air to produce water.

(a) The equation for the reaction can be represented using structural formulae for the chemicals.

$$2\ H – H + O = O \rightarrow 2\ H – O – H$$

Use the bond energies given in the table to help you to calculate the energy change for this reaction in the space on the next page.

Bond	Bond energy in kJ per mole
H – H	436
O = O	498
O – H	464

.....

.....

.....

.....

.....

.....

Energy change = ... kJ

(3)

(b) Explain, in terms of making and breaking bonds, why this reaction is exothermic.

.....

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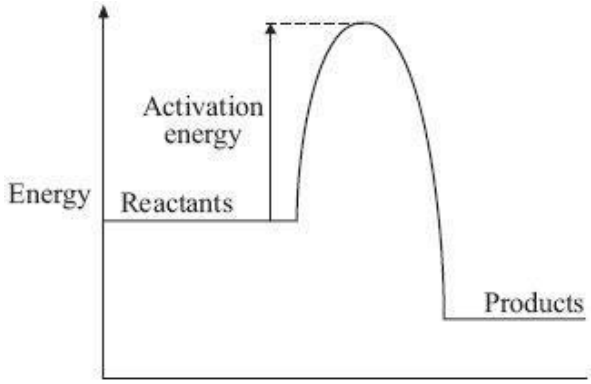
(1)

(**c)** Use the energy level diagram for this reaction to help you to answer these questions.



(i) The hydrogen did **not** burn until ignited by a spark or flame.

Explain why.

.....

.....

(1)

(ii) Platinum, a transition metal, causes hydrogen to ignite **without** using a spark or flame.
Explain why.

.....

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.....

.....

(2)

4. Amount of substance

Watch the videos:

https://www.youtube.com/watch?v=Ynpr65sMma0

https://www.youtube.com/watch?v=wPGVQu3UXpw

https://www.youtube.com/watch?v=MEQ1YGxfAQ4

Make notes on:

- Relative atomic mass M_r
- Avogadro number and the definition of a mole
- Calculating the number of moles using $n=m/M_r$
- Molar gas volume at room temperature and pressure
- Solutions and concentration (including $n=cV$)
- How to conduct a titration and use results to find an unknown concentration
- Empirical formula and how to determine it from percentage mass data
- Water of crystallisation calculations

Key words and terms

Word/term	Definition
mole	
Avogadro constant/number	
relative atomic mass	
solution	
solvent	
solute	
concentration	
titration	
empirical formula	
molecular formula	
water of crystallisation	

Amount of substance revision mats

What is a mole?

How can you calculate the number of moles if you know the mass of a pure substance?

Calculate the number of moles in 685 g of NH_3

Calculate the number of moles in 20.0 g of C_4H_{10}

Molar gas volume

What volume does one mole of gas occupy at room temperature?

Find the volume of 0.250 moles of methane (CH_4) at room temp.

Find the mass of 100 cm^3 of ammonia gas at room temperature

Reacting masses

Find the volume of hydrogen gas formed when 0.540 g of calcium reacts with hydrochloric acid.

$$Ca(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2(g)$$

Empirical formula

Give a definition of empirical formula

Calculate the empirical formula for a compound containing N = 82.4% by mass, and H = 17.6%.

0.150 g of copper reacts with oxygen form 0.188 g of copper oxide. Find the empirical formula of copper oxide

Concentration calculations

Give the equation that links number of moles, concentration and volume

How many moles of NaOH are there in $25cm^3$ solution of concentration $0.5moldm^{-3}$?

What mass of NaOH do you need to dissolve in $25cm^3$ water to make a solution of concentration $0.5moldm^{-3}$?

What volume of water would you need to dissolve 100g NaOH in to make a solution of concentration $0.5moldm^{-3}$?

Titration calculations

Find the volume of 1.20 $moldm^{-3}$ hydrochloric acid that reacts with 25.0 cm^3 of 1.50 $moldm^{-3}$ sodium hydroxide. Give your answer to 3 significant figures.

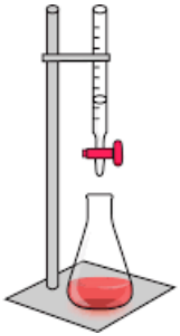
$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H2O(l)$$

25.0 cm^3 of 0.200 $moldm^{-3}$ sodium hydroxide solution reacted with 28.7 cm^3 sulfuric acid. Calculate the concentration of the sulfuric acid in $moldm^{-3}$.

$$2\ NaOH(aq) + H2SO4(aq) \rightarrow Na2SO4(aq) + 2\ H2O(l)$$

Titrations

Label the diagram showing titration apparatus and explain how to perform a titration to find the concentration of an alkaline solution



Amount of substance exam questions

You will need the use the following formula in these questions.

number of moles (n) = $\frac{\text{mass (m)}}{\text{Mr}}$	**concentration (c) = $\frac{\text{number of moles (n)}}{\text{Volume in dm}^3\text{ (V)}}$**

1 mole is 6.02×10^{23}

1 mole of any gas occupies 24 dm^3 at standard condition (25 °C and 1 atm).

1) a) Calculate the M_r of the following:

i) Br_2 ii) $Zn(OH)_2$ iii) Na_2SO_4

(3)

b) Calculate the percentage by mass of oxygen in $Zn(OH)_2$.

(1)

2) a) The molecular formula of some compounds is shown. What is the empirical formula of each one?

i) C_9H_{18} ii) B_4H_{10} iii) SO_3

(3)

b) Work out the molecular formula of the following compounds given the information below?

i) empirical formula = P_2O_5 $M_r = 284$

ii) empirical formula = CH_2 $M_r = 56$

(2)

c) Work out the empirical formula of the following compound given the information about its composition by mass: K 44.8%, S 18.4%, O 36.8%.

(3)

3) 1.05 g of iron reacts with oxygen to form 1.50 g of iron oxide. Show the empirical formula of iron oxide is Fe_2O_3

(2)

4) What mass of aluminium oxide is produced when 54 g of aluminium reacts with excess oxygen?

$$4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$$

(3)

5) What mass of potassium oxide is formed when 2 g of potassium is burned in oxygen?

$$4K(s) + O_2(g) \rightarrow 2K_2O(s)$$

(3)

6) Calculate the concentration of sodium hydroxide solution given that 25 cm^3 of it reacts with 18.2 cm^3 of 0.100 $moldm^{-3}$ sulfuric acid.

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

(3)

What volume of 0.01 moldm^{-3} silver nitrate solution reacts with 0.1 g of copper?

$$2AgNO_3(aq) + Cu(s) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$$

(3)

7) 25.0 cm^3 of an acid H_2A reacts with 23.45 cm^3 of 0.1 mol/dm^3 sodium hydroxide solution. Find the concentration of H_2A.

$$H_2A(aq) + 2NaOH(aq) \rightarrow 2Na_2A(aq) + 2H_2O(l)$$

(3)

8) What volume of hydrogen is produced when 5.4 tonnes of aluminium reacts with excess hydrochloric acid?

$$2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2(g)$$

(3)

Amount of substance more challenging questions

1) Calcium chloride is used to absorb household humidity. Water molecules become attached to each calcium chloride formula unit, forming a complex called a *hydrate.*

   a. State the formula of calcium chloride.

   b. A student has found out that the calcium chloride hydrate contains 0.018 mol of water for every 0.0091 mol of calcium chloride. How many water molecules are attached to each calcium chloride formula unit?

   c. Explain why the term *formula unit* has been used, rather than *molecule*.

2) A 20.0 cm^3 sample of lithium hydroxide solution of unknown concentration is neutralised by 12.25 cm^3 of 0.15$moldm^{-3}$ sulfuric acid. Calculate the concentration of the lithium hydroxide solution.

3) A solution is made by dissolving 0.40 g of solid sodium hydroxide in 250cm^3 of water. It is found that 28.2 cm^3 of this solution is needed to completely neutralise a 40.0cm^3 sample of ethanoic acid (CH_3COOH) of unknown concentration. Calculate the concentration of the ethanoic acid. (Ethanoic acid and sodium hydroxide react in a 1:1 ratio)

4) The carbonate of metal M has the formula M_2CO_3. A sample of M_2CO_3, of mass 0.394g, required the addition of 21.7cm^3 of a 0.263 mol dm^{-3} solution of hydrochloric acid for complete reaction. Calculate the relative formula mass of M_2CO_3 and therefore deduce the identity of M.

5) When 75.0cm^3 0f 0.500$moldm^{-3}$ hydrochloric acid were added to 1.25g of impure $MgCO_3$ some acid was left unreacted. This unreacted acid required 21.6 cm^3 of a 0.500 $moldm^{-3}$ solution of sodium hydroxide for complete reaction. Calculate the percentage by mass of magnesium carbonate in the impure sample.

6) Ammonium sulfate reacts with aqueous sodium hydroxide as shown by the equation below.

$$(NH_4)_2SO_4 + 2NaOH \rightarrow 2NH_3 + Na_2SO_4 + 2H_2O$$

A sample of ammonium sulfate was heated with 100.0 cm^3 of 0.500 mol dm^{-3} aqueous sodium hydroxide. To ensure that all the ammonium sulfate reacted, an excess of sodium hydroxide was used. Heating was continued until all of the ammonia had been driven off as a gas. The unreacted sodium hydroxide remaining in the solution required 27.3cm^3 of 0.600 $moldm^{-3}$ hydrochloric acid for neutralisation.

Calculate the mass of ammonium sulfate in the sample.

5. Introduction to organic chemistry

Watch the videos:

https://www.youtube.com/watch?v=ZeUNWY7YDAo

https://www.youtube.com/watch?v=mkkjiqcItWo

https://www.youtube.com/watch?v=Bx8bQpUCexo&list=PLsorq7UsrfYsFLSgTetRVjzN6QYvf3jpC&index=14

Make notes on:

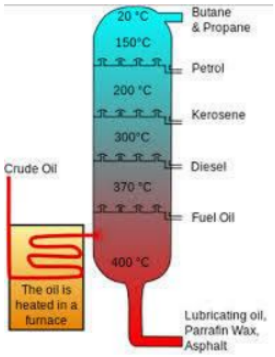
- How crude oil was formed
- Fractional distillation of crude oil
- Alkanes – chemical formula and names of first 6 alkanes, general formula
- Trends in physical properties of alkanes – boiling point and viscosity
- Isomers of alkanes, displayed formula and how to name the different isomers
- Catalytic cracking of alkanes
- Alkenes – chemical formula and names of first 6 alkenes, general formula
- Combustion products of hydrocarbons
- Polymerisation of alkenes by addition polymerisation

Key words and terms

Word/term	Definition
crude oil	
fractional distillation	
hydrocarbon	
alkane	
homologous series	
catalytic cracking	
alkene	
saturated hydrocarbon	
unsaturated hydrocarbon	
combustion	
isomer	
polymer	
monomer	
polymerisation	

Introduction to organic chemistry revision mat

Describe how fractional distillation is used to separate the different components of crude oil



Give the general formula for alkenes

Complete the table

Name	Molecular formula	Structure (displayed formula)
ethene	C_2H_4	
propene	C_3H_6	
butene	C_4H_8	

How can bromine water be used to test for an unsaturated hydrocarbon?

Give the general formula for alkanes

Complete the table

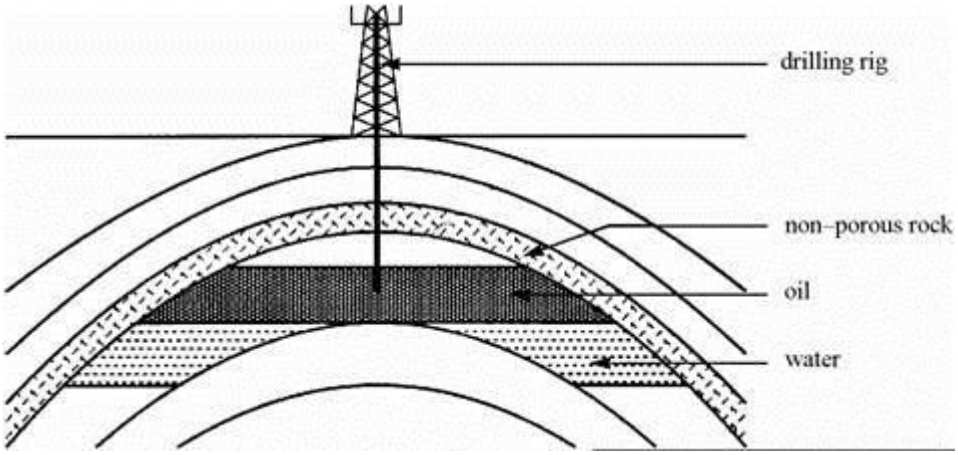
Name	Molecular formula	Structure (displayed formula)
methane	CH_4	
ethane	C_2H_6	
propane	C_3H_8	
butane	C_4H_{10}	
pentane	C_5H_{12}	

How can long chain hydrocarbons be made into shorter chain hydrocarbons that are more useful?

What is polymerisation?

Introduction to organic chemistry exam questions

1. Crude oil is obtained by drilling into the Earth's crust. The diagram shows a section through the Earth's crust to show how this is done.

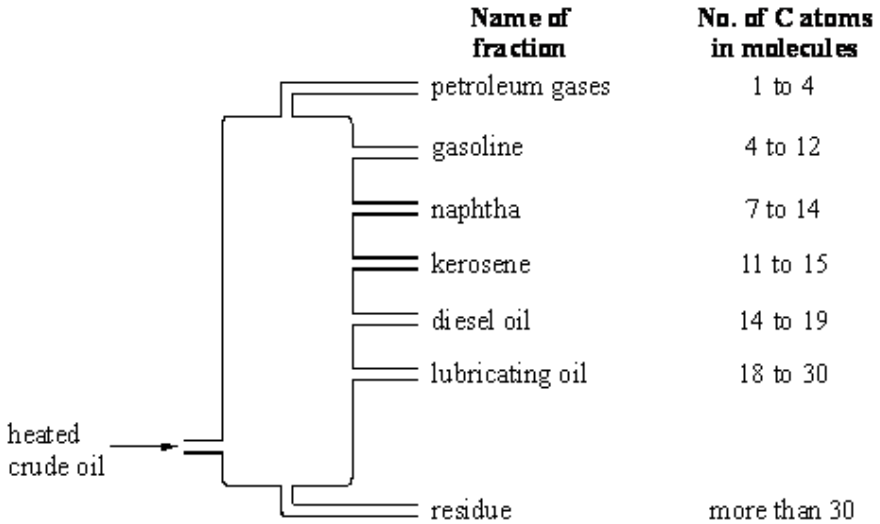


(a) Crude oil contains many hydrocarbons. Which elements do hydrocarbons contain?

.....

(1)

(b) The crude oil is separated by fractional distillation. The diagram shows a column used for this.



(i) Explain, as fully as you can, how fractional distillation works.

.....

.....

.....

.....

(3)

(ii) Naphtha burns more easily than diesel oil. Explain why.

.....

.....

.....

(1)

(iii) Naphtha contains a saturated hydrocarbon with the formula C_7H_{16} . Draw the **structural formula** of this compound.

(2)

2. Crude oil is a complex mixture of hydrocarbons, mainly alkanes. The number of carbon atoms in the molecules ranges from 1 to over 100.

(a) How does the boiling point change as the number of carbon atoms in the molecules increases?

.....

.....

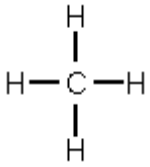
(1)

(b) Name the method used to separate petroleum into fractions.

.....

(1)

(c) The simplest hydrocarbon is methane, CH_4. Its structure can be represented:



Draw the displayed formula of ethane, C_2H_6.

(1)

3. One reason the oil industry is important is that it uses crude oil to produce many of the plastic materials we use in everyday life.

(a) The first stage in the formation of a plastic material is called cracking. Butane (C_4H_{10}), a hydrocarbon in crude oil, can be cracked to produce two different hydrocarbons, ethane (C_2.4) and ethene (C_2H_4)

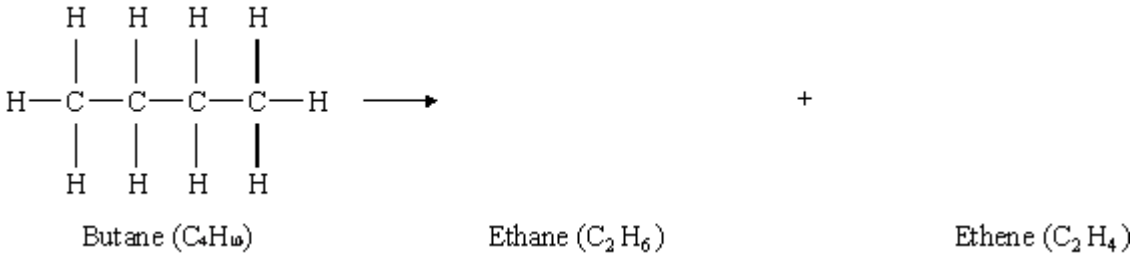
(i) For cracking to happen what needs to be done to the hydrocarbon?

.....

.....

(2)

(ii) Complete the equation for the cracking of butane using displayed formulae.



(2)

(iii) Complete the balanced chemical equation far the complete combustion of ethane in oxygen.

.....C_2.4(g) + ...(g) → .....(g) + ...(l)

(3)

(b) The second stage is the formation of the plastic material by polymerisation.

Describe how ethene (C_2H_4) forms poly(ethene). You do not need to give the reaction conditions or the names of catalysts.

.....

.....

.....

.....

.....

(3)

4. (a) Alkenes can be made by cracking large alkane molecules.

(i) Give a chemical test which would show the difference between an alkene and an alkane.

Test .....

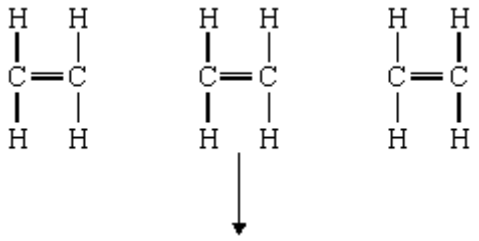
Result of test .....

.....

(2)

(b) Alkenes, such as ethene, can be made into polymers.

(i) Complete the following to show how the ethene molecules bond to form part of a polymer.



(1)

(ii) Name the polymer formed from ethene.

.....

(1)

(iii) Explain **one** important problem caused by the everyday use of this polymer.

.....

.....

(2)

Mark schemes

Atomic structure

M1.(a) (i) nucleus

1

(ii) neutron

1

(iii) electron

1

(b) (i) 12

1

(ii) 24

1

M2.

(a) A

1

(b) E

1

(c) C

1

(d) (i) atomic number

1

(d) (ii) electrons in the outer shell

1

M3.

(i) an electron

1

(ii) a neutron

1

M4.

Nucleus protons neutrons electrons shells protons electrons electrons

8

(b) (i) 3

1

(b) (ii) 5

1

Q52.

M5.

Both have same number (8) of protons, O-16 has 8 neutrons O-18 has 10 neutrons

3

M6.

A

1

M7.

C

1

Bonding and properties

M1 any **four** from:

- magnesium (atom) reacts with **two** iodine (atoms)
- magnesium (atom) loses electrons
- **2** electrons (from each atom)
- Iodine (atom) gains electron(s)
- **1** electron or an electron (to each atom)
- iodide ion formed *allow iodine ion*
- iodide has negative charge / is a negative ion / particle
- magnesium ion formed
- magnesium has positive charge
- oppositely charged ions attract
- a giant structure / lattice is formed

4

If covalent bonding mentioned – then you cannot score any marks

M2. (a) (i) both ions having correct numbers of electrons

2

(ii) Na^+ and Cl^-

1

(b) (i) because there are strong forces of attraction
accept strong bonds

1

between oppositely charged ions
accept positive and negative ions

1

that need lots of energy to overcome / break

1

(ii) because the current is carried by ions

1

which cannot move when solid *ignore reference to electrons not being able to move*

1

but can move when molten *do not accept references to electrons moving*

1

M3. (a) Group 2 / Alkaline Earth Metals

1

(b) (i) $MgCl_2$/Mg^{2+} $(Cl^-)_2$
(or equation with correct answer)

1

(ii) ionic

1

[3]

M4. (a) *idea that*

- copper has free electrons / electrons that move through the structure *gains 1 mark*

but

- in copper, electrons from the highest (occupied) energy level /outer shell, are free / can move through the structure *gains 2 marks*

2

(b) *idea that*

- in graphite, only three bonds are formed by each carbon atom *for 1 mark*
- one outer electron (per atom), free to move *for 1 mark*
- an electric current is a flow of (free) electrons* *for 1 mark* *(* this mark to be given in **either** (a) **or** (b) but not in both)*

3

(a) covalent bonds *for 1 mark*

1

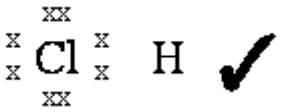
(b) any reference to shared electrons *gains 1 mark*

but idea that bond is shared pair of electrons / overlap of atomic orbitals to form a molecular orbital *gains 2 marks*

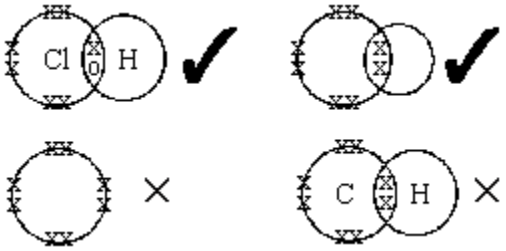
2

[3]

M5. (a) bonding pair in the overlap **and** 6 other electrons arranged around the chlorine



must have either circles or symbols
need not be pairs but must not be in the overlap region accept without H and Cl if clear accept all x's or all o's



1

(b) H_2 + Cl_2 → 2HCl

accept multiples or fractions

accept correct formulae but not balanced for 1
mark correctly balanced equation containing
'correct' lower / upper case symbols gets 1 mark

2

(c) $MgCl_2$

1

(d) because magnesium chloride is made of ions **or** is ionic

accept there are strong forces of attraction between the ions / particles in $MgCl_2$ or strong electrostatic attractions
*accept more energy to separate particles in $MgCl_2$ do **not***
*accept $MgCl_2$ molecules do **not** accept reference to breaking bonds*

1

hydrogen chloride is made of molecules **or** is covalent

*accept there are only weak forces of attraction (between the particles / molecules) in HCl do **not** accept weak covalent bonds do **not** accept reference to breaking bonds do **not** accept $MgCl_2$ is a solid and HCl is a gas*

1

[6]

Rate of reaction and energy change

1.

a. E.g. measuring the decrease in mass as the CO_2 is given off using a mass balance / use a gas syringe

1

b.

i. 14 minutes

1

ii. 12 cm^3 of CO_2 was produced in the first 2 minutes, so the rate of reaction was 12 ÷ 2 = **6 $cm^3 min^{-1}$**. ***(2 marks for correct answer, otherwise 1 mark for dividing a volume read from the graph by a time read from the graph)***.

2

iii. As the reaction progresses, the reactants get used up, so the concentration of the reactants decreases

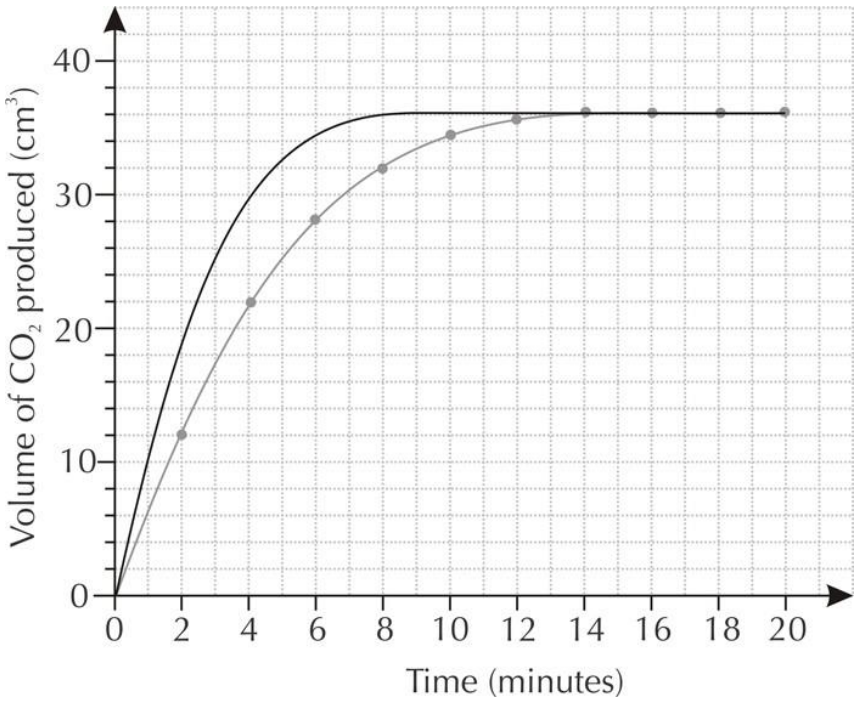
1

This means there are fewer collisions between the reacting particles

1

iv. ***(1 mark for the curve being steeper than the original curve, 1 mark for the curve ending at the same level as the original curve).***

2



2.

a.

i. A catalyst is a substance that can speed up the rate of a reaction, without being changed or used up

1

ii. Advantages: e.g. using a catalyst increases the rate of reaction, so more product can be produced in the same amount of time. / Using a catalyst means the reaction will work at a lower temperature, so energy costs can be reduced. / Using a catalyst means the reaction will work at a lower temperature, which is good for sustainable development. ***(1 mark for each, maximum 2 marks)***

Disadvantages: e.g. catalysts are expensive to buy. / Catalysts only work with one reaction. / Catalysts can be poisoned by impurities. ***(1 mark for each, maximum 2 marks)***

b.

i. Increasing the pressure will increase the rate of reaction

1

ii. At higher pressures, the reactant molecules are closer together

1

so there will be more frequent collisions between the reacting particles

1

3.

a. exothermic

1

b.

i. The reaction is reversible

1

so the solid sodium acetate trihydrate that is formed when the hand warmer is activated can be converted back into sodium acetate trihydrate solution

1

ii. The conversion of sodium acetate trihydrate solution to solid sodium acetate trihydrate is exothermic, so the reverse reaction (the conversion of solid sodium acetate trihydrate back to sodium acetate trihydrate solution) must be endothermic

1

This means the hand warmer could be reset by heating it

1

4. (a)

$$2\ H-H + O=O \rightarrow 2\ H-O-H$$

Bond	Bond energy in kJ per mole
H – H	436
O = O	498
O – H	464

Energy needed to break bonds = **(2x436) + 498 = 1370 kJmol^{-1}**

Energy released when bonds form = **(4x464) = 1856 kJmol^{-1}**

Energy change = 1370-1856

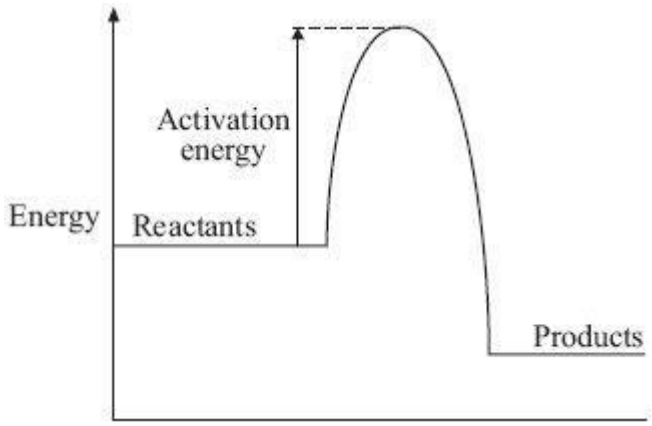
Energy change = ...-**486.**... kJmol^{-1}

(3) (b) Explain, in terms of making and breaking bonds, why this reaction is exothermic.

More energy is released when the new bonds are formed (O-H) than is needed to break the bonds in the reactants (H-H and O=O)

(1)

c) Use the energy level diagram for this reaction to help you to answer these questions.



(i) The hydrogen did **not** burn until ignited by a spark or flame. Explain why.

Energy is needed to overcome the activation energy

(1)

(ii) Platinum, a transition metal, causes hydrogen to ignite **without** using a spark or flame.

Explain why.

Platinum is a **catalyst**

And **lowers the activation energy** so less energy is needed for a collision to be successful

(2)

Amount of substance

1) a) Calculate the M_r of the following:

i) Br_2 = 159.8 ii) $Zn(OH)_2$ = 99.4 iii)Na_2SO_4 = 142.1 (3)

b) Calculate the percentage by mass of oxygen in $Zn(OH)_2$. 32% (1)

2) a) The molecular formula of some compounds is shown. What is the empirical formula of each one?

i) C_9H_{18} = CH_2 ii) B_4H_{10} = B_2H_5 iii)SO_3 = SO_3 (3)

b) Work out the molecular formula of the following compounds given the information below?

i) empirical formula = P_2O_5 M_r = 284 P_4O_{10}

ii) empirical formula = CH_2 M_r = 56 C_4H_8

(2)

c) Work out the empirical formula of the following compound given the information about its composition by mass: K 44.8%, S 18.4%, O 36.8%.

	K	S	O
Mass in 100g	44.8	18.4	36.8
M_r	39.1	32.1	16.0
n	1.145	0.573	2.300 **(1)**
ratio	2	1	4 **(1)**

K_2SO_4

(1)

3) 1.05 g of iron reacts with oxygen to form 1.50 g of iron oxide. Show the empirical formula of the iron oxide is Fe_2O_3

	Fe	O
Mass	1.05	0.45
M_r	55.8	16.0
n	0.0188	0.0281 **(1)**
ratio	1	1.5 **(1)**

(2)

4) What mass of aluminium oxide is produced when 54 g of aluminium reacts with excess oxygen

$4\ Al(s) + 3\ O_2(g) \rightarrow 2\ Al_2O_3(s)$

n Al = 54/27 = 2 moles **(1)**

n Al_2O_3 = 0.5 n Al (4:2 ratio) = 1 mole **(1)**

m Al_2O_3 = 1x M_r = 102g **(1)**

5) What mass of potassium oxide is formed when 2 g of potassium is burned in oxygen?

$4\ K(s) + O_2(g) \rightarrow 2\ K_2O(s)$ n K = 2/39.1 = 0.512 moles **(1)** n K_2O = 0.5 n K (4:2 ratio) = 0.0256 mole **(1)**

m K_2O = 0.0256 x M_r = 2.41g **(1)**

6) Calculate the concentration of sodium hydroxide solution given that 25 cm^3 of it reacts with 18.2 cm^3 of 0.100 $moldm^{-3}$ sulfuric acid.

$H_2SO_4(aq) + 2\ NaOH(aq) \rightarrow Na_2SO_4(aq) + 2\ H_2O(l)$

n H_2SO_4= 18.2/1000 x 0.1 = 0.00182moles **(1)**

n NaOH = 2 x n H_2SO_4= 2 x 0.00182 = 0.00364moles **(1)**

concentration NaOH = 0.005/0.0182 = 0.1456 $moldm^{-3}$ **(1)**

7) What volume of 0.01 moldm^{-3} silver nitrate solution reacts with 0.1 g of copper?

$2\ AgNO_3(aq) + Cu(s) \rightarrow Cu(NO_3)_2(aq) + 2\ Ag(s)$

n Cu = 0.1/63.5 = 0.00157 moles **(1)**

n $AgNO_3$ = 0.00157 x 2 = 0.00315moles **(1)**

volume = 0.00315/0.01 = 0.315dm^3 = 315cm^3 **(1)**

8) 25.0 cm^3 of an acid H_2A reacts with 23.45 cm^3 of 0.1 moldm^{-3} sodium hydroxide solution. Find the concentration of H_2A.

$H_2A(aq) + 2\ NaOH(aq) \rightarrow 2\ Na_2A(aq) + 2\ H_2O(l)$

n NaOH= 23.45/1000 x 0.1 = 0.002345moles **(1)**

n H_2A = 0.5 x n NaOH = 0.5 x 0.002345 = 0.00117moles **(1)**

concentration NaOH = 0.00117/0.025 = 0.0469 moldm^{-3} **(1)**

9) What volume of hydrogen is produced when 5.4 tonnes of aluminium reacts with excess hydrochloric acid?

$2\ Al(s) + 6\ HCl(aq) \rightarrow 2\ AlCl_3(aq) + 3\ H_2(g)$

n Al = 5.4 x 10^6/27 = 2 x 10^5 moles **(1)**

n H_2 = 1.5 n Al (2:3 ratio) = 3 x 10^5 mole **(1)**

volume = 3 x 10^5 x 24 =7.2 x 10^6 dm^3 **(1)**

Challenge questions

1)a) $CaCl_2$;

b) about 2;

calcium chloride is an ionic compound and ionic compounds are not made up of molecules because they are giant structures.

2) 0.184 moldm^{-3}

3) 0.0282 moldm^{-3}

4) K

5) 89.7%

6) 2.22g

Introduction to organic chemistry answers

M1. (a) hydrogen and carbon

1

(b) (i) the oil is evaporated / boiled / liquid converted to gas / vaporised

oil is condensed/changed back to liquid/cooled below boiling point

(not just cooled)

liquids of different boiling points condense at different levels / fractions with lower boiling points form near the top / boiling point linked to chain length or Mr *each for 1 mark*

3

(ii) Assume they mean naphtha unless they say otherwise.
smaller molecules
/contains less atoms
/lower boiling point
/more volatile
/less bonds to break
/lower activation energy

If the answer is given the opposite way around then diesel must be specified.

any one for 1 mark

1

(iii)

$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$

2

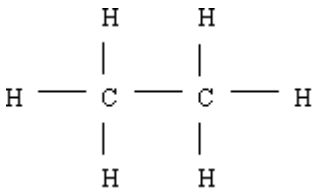
M2. (a) the more C atoms the higher the b.pt./temperature
Allow just higher. **Not** answer based on melting point
for 1 mark

1

(b) (fractional) distillation/fractionation
for 1 mark

1

(c)



must include H atoms and lines **not** $CH_3 - CH_3$

for 1 mark

1

M3. (a) (i) heat

accept increase temperature ignore pressure

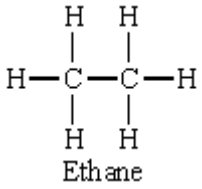
1

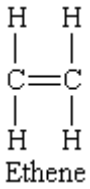
with a catalyst

1

(ii)

1





accept displayed formulae only

1

(iii) O_2

1

$CO_2 + H_2O$ *ignore state symbols*

1

correct balancing

$2 + 7 \rightarrow 4 + 6$ *accept* $1 + 3\frac{1}{2} \rightarrow 2 + 3$ *only if reactants and products correct*

1

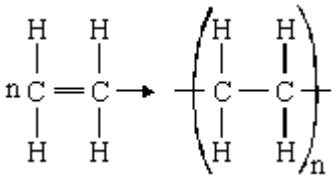
(b) double bond breaks

1

many (ethene) molecules *accept many monomers*

1

bond together *accept join* ***or*** *combine for*
bond accept



for first ***2*** *marks ignore unsaturated becomes saturated*

1

[10]

M4

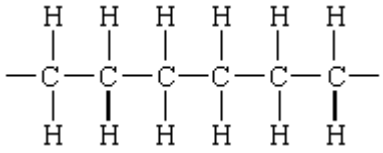
(i) use bromine water/(alkaline) permanganate
accept bromine

1

alkene makes bromine water turn colourless or lose its colour *accept*
alkane does not change the red/orange colour of bromine ***not***
change colour/goes clear

1

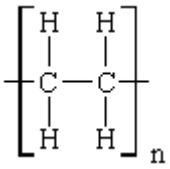
(b) (i)



either of these must show bonds at end

1

or



not *H on ends allow 3 instead of n* ***not***
any other number

(ii) poly(ethene) – brackets not essential *accept polythene*

1

(iii) **large amount** of waste polymer/poly(ethene)/polythene/litter
accept large amount of crude oil ***or*** *finite resource used*

1

it is not biodegradable *accept it does not decompose/decay/break down*

it causes pollution/it creates toxic fumes when burnt are neutral ***not*** *it is not recyclable*

2

How did you do?

Review any areas that you are not confident with.

Suggested book list

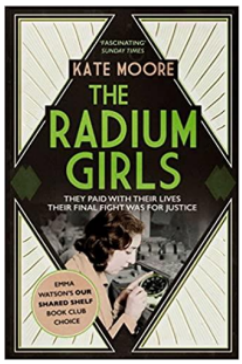
Try reading one of these recommended books.

Chemistry is a huge subject so choose a book about the area of chemistry that you are most interested in. Then prepare a review of that book to share with your new class mates.

Here are some suggestions

The Periodic Table

Primo Levi is best known for his extraordinary accounts of his time in Auschwitz as a prisoner of the Nazis, how he lived, how he survived, and how he finally found his way home. These books, If This Is A Man, and The Truce, should be read by anyone and everyone. But Levi was an industrial chemist by training, and another of his books, the unpromisingly titled The Periodic Table, celebrates this first love. Forget the title. Each chapter has the name of an element, and each is a self-contained story. These vary hugely, from pure fantasy to historical fable to autobiographical snippets. Vanadium describes how his knowledge of that element's properties helped him survive the concentration camp. Lead tells the story of a mediaeval lead worker. Carbon, the best of all, narrates the journey of a carbon atom as it travels into and out of the living world. These are wonderful stories, wholly original and utterly compelling.

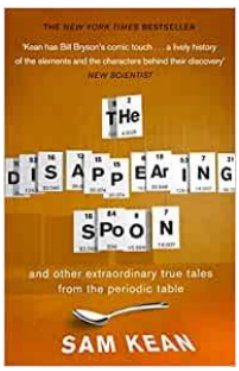


The Radium Girls

All they wanted was the chance to shine. Be careful what you wish for...

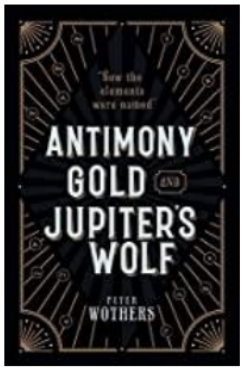
The first thing we asked was, Does this stuff hurt you? And they said, No. The company said that it wasn't dangerous, that we didn't need to be afraid.

As the First World War spread across the world, young American women flocked to work in factories, painting clocks, watches and military dials with a special luminous substance made from radium. It was a fun job, lucrative and glamorous the girls shone brightly in the dark, covered head to toe in dust from the paint. However, as the years passed, the women began to suffer from mysterious and crippling illnesses. It turned out that the very thing that had made them feel alive their work was slowly killing them. Their employers denied all responsibility, but these courageous women in the face of unimaginable suffering refused to accept their fate quietly, and instead became determined to fight for justice. Drawing on previously unpublished diaries, letters and interviews, *The Radium Girls* is an intimate narrative of an **unforgettable true story**.



The Disappearing Spoon

Why did Gandhi hate iodine (I, 53)? Why did the Japanese kill Godzilla with missiles made of cadmium (Cd, 48)? How did radium (Ra, 88) nearly ruin Marie Curie's reputation? And why did tellurium (Te, 52) lead to the most bizarre gold rush in history? The periodic table is one of our crowning scientific achievements, but it's also a treasure trove of passion, adventure, betrayal and obsession. The fascinating tales in The Disappearing Spoon follow carbon, neon, silicon, gold and every single element on the table as they play out their parts in human history, finance, mythology, conflict, the arts, medicine and the lives of the (frequently) mad scientists who discovered them. Why did a little lithium (Li, 3) help cure poet Robert Lowell of his madness? And how did gallium (Ga, 31) become the go-to element for laboratory pranksters? The Disappearing Spoon has the answers, fusing science with the classic lore of invention, investigation, discovery and alchemy, from the big bang through to the end of time.



Antimony, Gold and Jupiter's Wolf – How the elements were named.

The iconic Periodic Table of the Elements is now in its most satisfyingly elegant form. This is because all the 'gaps' corresponding to missing elements in the seventh row, or period, have recently been filled and the elements named. But where do these names come from? For some, usually the most recent, the origins are quite obvious, but in others - even well-known elements such as oxygen or nitrogen - the roots are less clear. Here, Peter Wothers explores the fascinating and often surprising stories behind how the chemical elements received their names. Delving back in time to explore the history and gradual development of chemistry, he sifts through medieval manuscripts for clues to the stories surrounding the discovery of the elements, showing how they were first encountered or created, and how they were used in everyday lives. As he reveals, the oldest-known elements were often associated with astronomical bodies, and connections with the heavens influenced the naming of a number of elements. Following this, a number of elements, including hydrogen and oxygen, were named during the great reform of chemistry, set amidst the French Revolution.

Websites

https://www.bbc.co.uk/sounds/category/factual-scienceandnature?sort=popular

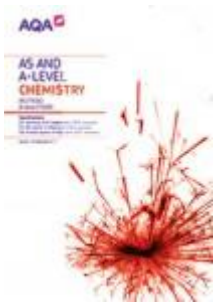
http://www.newscientist.com

http://www.guardian.co.uk/science

Getting ahead with the A level

You could just wait until we start the course in September, or you could get ahead by looking at what we will cover in the first term.

1. Download a copy of the specification:

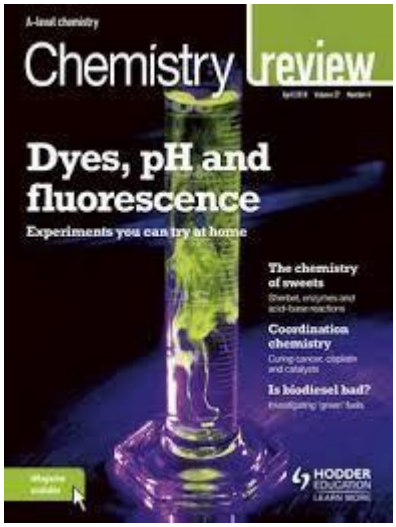


https://filestore.aqa.org.uk/resources/chemistry/specifications/AQAhttps://filestore.aqa.org.uk/resources/chemistry/specifications/AQA-7404-7405-SP-2015.PDF7404-7405-SP-2015.PDF

We will begin by reviewing basic inorganic chemistry and structure and bonding.

Then we will build on your organic knowledge and start to work towards our first Olympiad which you will be sitting in January

We encourage you to review research articles and to contribute to the discussions about these articles. To look at the kind of articles we will be reviewing, look at past issues of Biological Sciences Review.



We look forward to seeing you in September

Don’t forget to email Dr Ro if you would like the extension materials