Progression – Chemistry

Get ready for A-level!

We teach the AQA specification. Here is the specification for the 2 year course. AS and A-level Chemistry Specification Specifications for first teaching in 2015 (aqa.org.uk)

Content overview for year 1:

3.1.1 Atomic structure
3.1.2 Amount of substance
3.1.3 Bonding
3.1.4 Energetics
3.1.5 Kinetics
3.1.6 Chemical equilibria and Kc
3.1.7 Oxidation, reduction and redox equations
3.2.1 Periodicity
3.2.2 Group 2
3.2.3 Group 7
3.3.1 Introduction to organic chemistry
3.3.2 Alkanes
3.3.3 Halogenoalkanes
3.3.4 Alkenes
3.3.5 Alcohols
3.3.6 Organic analysis

Tasks to complete before September

In order to prepare for your course, you need to complete all of the tasks below. Please organise yourself with a folder / wallet to keep your notes/ answers to these questions. Within the first two weeks of your course, you will sit a baseline assessment concerning this content.

Useful textbooks / workbooks:

A-Level Chemistry for AQA: Year 1 & 2 Student Book with Online Edition: course companion for the 2023 and 2024 exams (CGP AQA A-Level Chemistry): Amazon.co.uk: CGP Books, CGP Books: 9781789080476: Books

A-Level Chemistry: AQA Year 1 & 2 Complete Revision & Practice with Online Edition: ideal for the 2023 and 2024 exams (CGP AQA A-Level Chemistry) : CGP Books, CGP Books: Amazon.co.uk: Books

Calculations in AS / A Level Chemistry: Amazon.co.uk: Clark, Jim: 9780582411272: Books

Websites:

Chemistry Revision - PMT (physicsandmathstutor.com)

A-Level Chemistry - Home

chemguide: helping you to understand Chemistry - Main Menu

AQA | Find past papers and mark schemes

chemrevise | Resources for A-level and GCSE Chemistry

A level chemistry will use your knowledge from GCSE and build on this to help you understand new and more demanding ideas. Complete the following tasks to make sure that your knowledge is up to date

1. **Ions and formula.**

   You can predict the charge of some ions from the position of the element in the periodic table, whereas other ions you need to learn. Watch these 2 short videos on positive and negative ions and make a list of all the ones you need to know:
   Positive Ions - YouTube
   Negative Ions - YouTube
   Then watch this video on common formulae and list those too.
   Common Chemical Formulae - YouTube

Positive Ions	Negative Ions	Common Formulae

2. **Oxidation and Reduction.**

At GCSE you learnt that oxidation is adding oxygen to an atom or molecule and that reduction is removing oxygen, or that oxidation is removing hydrogen and reduction is adding hydrogen. You may have also learnt that oxidation is removing electrons and reduction is adding electrons.
At A level we use the idea of oxidation number a lot!
You know that the metals in group 1 react to form ions that are +1, i.e. Na+ and that group 7, the halogens, form -1 ions, i.e. Br -.
We say that sodium, when it has reacted, has an oxidation number of +1 and that bromide has an oxidation number of -1. All atoms that are involved in a reaction can be given an oxidation number. An element, Na or O2, is always given an oxidation state of zero (0). Any element that has reacted has an oxidation state of + or -.
As gaining electrons is reduction, if, in a reaction the element becomes more negative it has been reduced, if it becomes more positive it has been oxidised.

You can read about the rules for assigning oxidation numbers here:
http://www.dummies.com/how-to/content/rules-for-assigning-oxidation-numbers-to-elements.html

Or watch this video:
https://www.youtube.com/watch?v=Ny5TGn9BV2Y

Elements that you expect to have a specific oxidation state actually have different states, so for example you would expect chlorine to be -1. It can have many oxidation states: NaClO, in this compound it has an oxidation state of +1 There are a few simple rules to remember:

- Metals have a + oxidation state when they react
- Oxygen nearly always has an oxidation state of -2
- Hydrogen has an oxidation state of +1 (except in metal hydrides when it is -1)
- The charges in a molecule must cancel

Work out the oxidation state of the underlined atom in the following:

a) $Mg\underline{C}O_3$ b) $\underline{S}O_3$ c) $NaClO_3$ d) $\underline{Mn}O_2$ e) $\underline{Fe}_2O_3$ f) $\underline{V}_2O_5$

g) $K\underline{Mn}O_4$ h) $\underline{Cr}_2O_7$ i) $\underline{Cl}_2O_4$

3. Chemical equations.

Balancing chemical equations is the stepping stone to using equations to calculate masses in chemistry. There are loads of websites that give ways of balancing equations and lots of exercises in balancing. Some of the equations to balance may involve strange chemicals- don't worry about that, the key idea is to get balancing right.

Visit the following:

ChemTeam: Balancing Chemical Equations
Balancing Chemical Equations - Chemical Equations | Conservation of Mass - PhET Interactive Simulations (colorado.edu)

Balance the following equations

a. $H_2 + O_2 \rightarrow H_2O$

b. $S_8 + O_2 \rightarrow SO_3$

c. $HgO \rightarrow Hg + O_2$

d. $Zn + HCl \rightarrow ZnCl_2 + H_2$

e. $Na + H_2O \rightarrow NaOH + H_2$

f. $C_{10}H_{16} + Cl_2 \rightarrow C + HCl$

g. $Fe + O_2 \rightarrow Fe_2O_3$

h. $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

i. $Fe_2O_3 + H_2 \rightarrow Fe + H_2O$

j. $Al + FeO \rightarrow Al_2O_3 + Fe$

4. Measuring chemicals – The mole.

From this point on, you need to be used an A level periodic table (not a GCSE one). You can view one here: A-level Chemistry Specimen data booklet Chemistry (A-level)

Now that we have our chemical equations balanced, we need to be able to use them in order to work out masses of chemicals we need or we can produce. The mole is the chemists equivalent of a dozen. Atoms are so small that we cannot count them out individually; we weigh out chemicals.

For example:
magnesium + sulfur - → magnesium sulfide
Mg + S → MgS

We can see that one atom of magnesium will react with one atom of sulfur. If we had to weigh out the atoms we need to know how heavy each atom is. From the periodic table: Mg = 24.3 and S = 32.1

If I weigh out exactly 24.3g of magnesium this will be 1 mole of magnesium. If we counted how many atoms were present in this mass it would be a huge number (6.02 x 1023!!!!). If I weigh out 32.1g of sulfur then I would have 1 mole of sulfur atoms. So 24.3g of Mg will react precisely with 32.1g of sulfur, and will make 56.4g of magnesium sulfide. Here is a comprehensive page on measuring moles, there are a number of descriptions, videos and practice problems. You will find the first 6 tutorials of most use here, and problem sets 1 to 3.

ChemTeam: Mole

Answer the following:

How many moles of phosphorus pentoxide (P_4O_{10}) are in 85.2g?

How many moles of potassium are in 73.56g of potassium chlorate (V) ($KClO_3$)?

How many moles of water are in 249.6g of hydrated copper sulfate(VI) ($CuSO_4.5H_2O$)? For this one, you need to be aware the dot followed by $5H_2O$ means that the molecule comes with 5 water molecules so these have to be counted in as part of the molecules mass.

What is the mass of 0.125 moles of tin sulfate ($SnSO_4$)?

If I have 2.4g of magnesium, how many g of oxygen(O_2) will I need to react completely with the magnesium?

$2Mg + O_2 \rightarrow MgO$

5. Solutions and concentrations.

In chemistry, a lot of the reactions we carry out involve mixing solutions rather than solids, gases or liquids. You will have used bottles of acids in science that have labels saying 'Hydrochloric acid 1M', this is a solution of hydrochloric acid where 1 mole of HCl, hydrogen chloride (a gas) has been dissolved in 1dm^3 of water. The dm^3 is a cubic decimetre, it is actually 1 litre but from this point on as an A level chemist you will use the dm^3 as your volume measurement.

Calculating molarity units molar concentration of solutions practice questions on molarity how to make up a standard solution how to determine solubility gcse chemistry igcse KS4 science A level GCE AS A2 O Level practice questions exercises (docbrown.info)

Answer the following:

a. What is the concentration (in mol dm^{-3}) of 9.53g of magnesium chloride ($MgCl_2$) dissolved in 100cm^3 of water?

b. What is the concentration (in mol dm^{-3}) of 13.248g of lead nitrate ($Pb(NO_3)_2$) dissolved in 2dm^3 of water?

c. If I add 100cm^3 of 1.00 mol dm^3 HCl to 1.9dm^3 of water, what is the molarity of the new solution?

d. What mass of silver is present in 100cm^3 of 1moldm^{-3} silver nitrate ($AgNO_3$)?

e. The Dead Sea, between Jordan and Israel, contains 0.0526 moldm^{-3} of Bromide ions (Br^-). What mass of bromine is in 1dm^3 of Dead Sea water?

6. **Titrations.**

One key skill in A level chemistry is the ability to carry out accurate titrations. You may well have carried out a titration at GCSE, at A level you will have to carry them out very precisely and be able to describe in detail how to carry out a titration - there will be questions on the exam paper about how to carry out practical procedures. You can read about how to carry out a titration here

Titration calculations - Higher - Titrations - AQA - GCSE Chemistry (Single Science) Revision - AQA - BBC Bitesize

Remember for any titration calculation you need to have a balanced symbol equation; this will tell you the ratio in which the chemicals react.
E.g. a titration of an unknown sample of sulfuric acid with sodium hydroxide.
A 25.00cm^3 sample of the unknown sulfuric acid was titrated with 0.100$moldm^{-3}$ sodium hydroxide and required exactly 27.40cm^3 for neutralisation. What is the concentration of the sulfuric acid?

Step 1: the equation $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

Step 2: the ratios 2 : 1

Step 3: how many moles of sodium hydroxide $27.40cm^3 = 0.0274dm^3$

number of moles = c x v = 0.100 x 0.0274 = 0.00274 moles

step 4: using the ratio, how many moles of sulfuric acid

for every 2 NaOH there are 1 H_2SO_4 so, we must have 0.00274/2 =0.00137 moles of H_2SO_4

Step 5: calculate concentration. concentration = moles/volume in dm^3 = 0.00137/0.025 = ***0.0548 moldm^{-3}***

Here are some additional problems which are harder, ignore the questions about colour changes of indicators.

A Level Quantitative Analysis: Volumetric Titration Calculations Questions acid-base/alkali, EDTA, silver nitrate-chloride ion titration exam questions aspirin assay titrations worked out problems solving practice exam questions revision notes (docbrown.info)

Try this question:

Q6. A solution of barium nitrate will react with a solution of sodium sulfate to produce a precipitate of barium sulfate.

$Ba(NO_3)_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaNO_3(aq)$

What volume of 0.25$moldm^{-3}$sodium sulfate solution would be needed to precipitate all of the barium from 12.5cm^3 of 0.15 mol dm^{-3} barium nitrate?

Complete this worksheet:

1 Complete the table using ✓s to show which type of structure the following substances have. (8)

Substance	Monatomic	Simple molecular	Giant covalent	Ionic	Metallic
helium (He)					
nitrogen fluoride (NF_3)					
silicon chloride ($SiCl_4$)					
strontium chloride ($SrCl_2$)					
iron oxide (Fe_2O_3)					
phosphorus (P_4)					
silicon dioxide (SiO_2)					
iridium (Ir)					

2 Give the formula of each of the following ionic substances. (8)

a) potassium bromide .....

b) aluminium sulfide .....

c) magnesium hydroxide .....

d) iron(III) nitrate .....

e) cobalt(II) carbonate .....

f) ammonium nitrate .....

g) titanium(IV) oxide .....

h) rubidium sulfate .....

3 Write a balanced equation for each of these reactions. (10)

a) potassium oxide + hydrochloric acid

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b) barium + water

.....

c) propane (C_3H_8) + oxygen

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d) magnesium + nitric acid

.....

e) zinc(II) carbonate + sulfuric acid

.....

4 Write an ionic equation for each of these reactions. (3)

a) redox reaction between solution of copper(II) sulfate and magnesium metal

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b) acid-base reaction between nitric acid and calcium hydroxide

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c) precipitation of silver(I) bromide when solutions of potassium bromide and silver(I) nitrate are mixed

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5 Convert these quantities into the units shown.

a) 25 cm^3 to m^3 ..... (1)

b) 150 cm^3 to dm^3 ..... (1)

c) 40 MPa to Pa ..... (1)

d) 7.5 mg to g ..... (1)

6 6.15 g of hydrated magnesium sulfate, $MgSO_4.xH_2O$ decompose to form 3.00 g of anhydrous magnesium sulfate on heating. Calculate the formula mass of hydrated magnesium sulfate and the value of *x*.

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..... (4)

7 Determine the limiting reagent and then calculate the mass of titanium produced when 10.00 g of titanium chloride react with with 2.00 g of magnesium.

$$TiCl_4 + 2Mg \rightarrow 2MgCl_2 + Ti$$

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..... (4)

8 Describe what each of the following formulae tells you about the substance shown.

a) Ammonia has the molecular formula NH_3 .....

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..... (2)

b) Silicon dioxide has the formula SiO_2 .....

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..... (2)

c) Aluminium oxide has the formula Al_2O_3 .....

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..... (2)

d) Sulfur has the molecular formula S_8 .....

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..... (2)

9 The element carbon exists in several different forms (allotropes), including diamond, graphite and graphene.

a) Explain why these forms of carbon all have high melting points.

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..... (3)

b) Explain why graphite and graphene are electrical conductors but diamond is not.

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..... (3)