AS Chemistry Bridging work

There are two tasks to complete.

1) **Complete the essay- select a title below.**

2) **Complete the "10 things I…" sections below.**
   Read and follow the instructions for that section.

All Work is due to be submitted in the first week of the new term in September.

Essay

Write an essay on your chosen topic.
The essay should be no more than two sides of A4 and should include a reference list and diagrams, if appropriate.
The essay should be written in an appropriate style and pay due care to spelling, punctuation, grammar and the use of scientific conventions and notation where appropriate. This should be your own work and not copied word for word from other sources.

Essay Titles

1) **The development of atomic theory**

   Describe the development of our understanding of atomic theory.
   What were the major theories and discoveries that allowed the model to develop?

2) **Combating Plastic Pollution.**
   Plastics and polymers have revolutionised the modern world. However, their overuse is now causing a pollution crisis.
   Describe what polymers are (include diagrams) and the different types. Explain why polymers are causing a pollution problem. Research and describe some possible solutions to the plastic pollution problem.

3) **Water and bonding**

   Water has many unusual properties due to the nature of the bonding within it and between its molecules.
   Describe the nature of bonding in water.
   Research and describe how and why the physical and chemical properties of water are different to the other hydrides of group 6 (hydrogen sulphide, hydrogen selenide, hydrogen telluride and hydrogen polonide) using data to support your comments.
   Describe some of the unusual properties of water and the impact that this had had on planet Earth.

Ten things I should probably remember from GCSE !!

The following pages contain reminders of the work you did at GCSE which is still relevant at A level.

Try to complete as many sections as you can.

As a minimum, you should read the summaries and attempt 1-2 questions per section.

If you are able, you can complete more.

The aim is to remind yourself of the core ideas and principles from GCSE.

Atomic Structure – what is in an atom?

Atoms contain

- Small dense nucleus comprised of **positive protons** and **neutral neutrons**
- **Negative electrons** orbit the nucleus in energy levels (shells)
- An atom is mostly empty space as most of the mass is concentrated in the nucleus
- The size of the atom is governed by the numbers of orbiting electrons

Atoms on the Periodic Table

- **Atomic number, Z** – represents the number of protons in an atom
- **Relative atomic mass, A** – represents the number of protons and neutrons added together, those particles with mass.

Properties of atoms

- Atoms are **electrically neutral** as they contain the same number of electrons and protons
- Atoms gain or lose electrons to become charged – **IONS**
- Atoms containing the same numbers of protons but different numbers of neutrons are called **ISOTOPES**

Arranging electrons

- Energy level 1 contains 2 electrons – called an s level
- Energy level 2 contains 8 electrons – split into two sub-levels, s and p
- Energy levels always fill up from the bottom

Questions

1. Complete the table

Particle	Relative mass	Charge
Proton		
Neutron		
Electron		

2. How many protons are there in fluorine?

3. How many neutrons are there in manganese?

4. How many electrons are there in bromine?

5. What is the charge on an atom that loses 2 electrons?

6. What is the charge on an atom that gains 3 electrons?

7. Two isotopes of chlorine are chlorine-35 and chlorine-37. How many protons, neutrons and electrons are there in each isotope?

8. How many electrons are there in Ca^{2+} ?

Calculations

Mass and moles

The mole is an amount of chemical. It stands for a fixed number of particles. That number is 6.022×10^{23}. The number is huge! Instead of counting out atoms for reactions we use a rule to convert masses of substance into a number of moles and vice versa.

1 mole of a substance is the Mr of the substance weighed out in grams (g).

So 1g of H atoms contains 1 mole of H atoms.
1g of H_2 molecules contains 0.5 moles of Hydrogen molecules as the mass of a molecule of hydrogen is 2.

To convert mass in to moles you need to do mass (g)/Mr of the substance.
Be wary of questions giving mass in kg. You need to convert Kg to g first. (100g in 1kg so times the mass in kg by 1000 first).

Remember $n = \frac{m}{Mr}$.

Mr can be relative atomic mass for atoms/elements (A_r), Molecular mass (M_r) for covalent substances or formula mass for ionic substances.

Relative molecular/ formula masses

- Only tool required is your periodic table
- Add up the masses of the elements from the periodic table raking into account the numbers of elements
- Where there are brackets the small number outside the bracket multiplies everything inside the bracket.

e.g. $Al_3(PO_4)_2$

Al = 3 x 27 = 81
$(PO_4)_2$ = [31 + (4x16)] x 2 = 190

Total = 271

Questions

1) Work out the relative molecular/ formula mass of these elements and compounds.
a. O_2
b. S
c. H_2O
d. CO_2
e. SO_3
f. $CaCl_2$
g. $C_2H_5NH_2$
h. $(CH_3CO)_2O$
i. C_6H_5OH
j. Fe_2O_3
k. $K_2Cr_2O_7$
l. $Al_2(SO_4)_3$
m. $KMnO_4$
n. CaC_2O_4
o. CH_3COOH

2) Calculate the number of moles of particles in 0.1 kg of each substance in questions a-g.
State if the type of particle would be atoms or molecules or formula mass.

Writing Equations

In order to write a correct equation you need a correct formula. This means you need to learn common formulae – such as acids - the charges of common ions and the formulae of polyatomic ions. Once you have these charges the best method is the criss-cross.

E.g. Aluminium nitrate

- Identify the ions and charges

  Al^{3+} and NO_3^{1-}

- Put a circle around the number on each charge

  Al^{3+} and NO_3^{1-}

- Criss – cross your numbers

  Al^{3+} and NO_3^{1-}

  Al $(NO_3)_3$

  $Al(NO_3)_3$ – you need brackets or it looks like you have 33 nitrogens! If the number is a 1 we don't write it down.

With correct formulae you need to recall how chemicals react.

- ACID + BASE = SALT + WATER
- ACID + METAL = SALT + HYDROGEN
- ACID + METAL CARBONATE = SALT + CARBON DIOXIDE + WATER
- HYDROCARBON + OXYGEN = CARBON DIOXIDE + WATER
- X + YZ = XZ + Y (single replacement)
- AB + CD = AD + BD (double replacement)

Remember certain gases hang out in 2s – **H_2, N_2, O_2, halogens**

Lastly you have to balance the equation

- Numbers go at the front
- Don't change the FORMULAE!

Questions

1. Work out the following formulae
   a. magnesium hydroxide
   b. lithium bromide
   c. aluminium oxide
   d. potassium sulphate
   e. calcium carbonate

2. Complete these word equations
   a. sodium hydroxide + hydrochloric acid
   b. aluminium + nitric acid =
   c. magnesium carbonate + sulphuric acid =
   d. C_2H_6 + oxygen =
   e. Iron + copper sulphate =
   f. magnesium sulphate + barium chloride =

3. Turn the word equations in qu.2 into symbol equations

4. Balance your equations

Chemical Bonds

There are three types of chemical bond:-

- Ionic bonding
- Covalent bonding
- Metallic bonding

Ionic Bonding

- Bond formed between **oppositely charged ions held together by electrostatic forces of attraction**
- Ionic bonds form between a metal and a non-metal
- The formula of a ionic compound denotes the smallest repeating unit
- Each ionic crystal is a giant ionic lattice

Covalent bonding

- Molecules formed between two atoms **sharing a pair of electrons**
- Bonds usually formed between two non-metals
- The formula of a covalent compound is the individual molecule
- Covalently bonded substances can also be **MACROMOLECULAR** – giant compounds containing many covalent bonds

Metallic bonding

- **Positive metal ions surrounded by a sea of electrons**
- The larger the ion the stronger the bond

Co-ordinate or dative covalent bonds (new for A level)

- Covalent bond formed between two atoms when **both electrons come from one atom**

Questions

1. Explain the formation of NaCl, MgO and $MgCl_2$. Use diagrams to illustrate your answers.

2. Draw dot and cross diagrams to show the formation of ammonia (NH_3), water (H_2O), nitrogen (N_2), oxygen (O_2) and methane (CH_4).

3. Explain the difference in strength between the metallic bond in aluminium and sodium. Use diagrams to illustrate your answer.

4. Draw a dot and cross diagram to show how ammonia (NH_3) can form a co-ordinate covalent bond with a hydrogen ion (H^+).

5. Predict the type of bonding formed between
a. copper and chlorine
b. sulphur and fluorine

Properties of ionic and covalent compounds

Ionic Bonds

- Forces between oppositely charged ions are very strong
- The bigger the charge on the ion the stronger the bond
- Ionic compounds have **very high melting points** as a lot of energy is required to overcome the forces of attraction
- Ionic compounds are **soluble** in water because it is a **polar** molecule
- Ionic compounds do not conduct electricity unless they are **MOLTEN** – this allows the ions freedom to move

Covalent Bonds

- The covalent bond itself is very strong
- The intra-molecular forces between molecules are very weak and therefore not a lot of energy is needed to overcome them – **low melting points**
- Intra-molecular forces increase with mass
- Covalent molecules are **non-polar** and **not soluble in water** – they are soluble in other non-polar liquids
- Covalent molecules **do not conduct electricity** – there are no free electrons to carry the current

Giant covalent molecules - Macromolecular

- Made up of strong covalent bonds – a lot of energy is required to break these bonds – they have **very high melting points**
- Macromolecules are **not soluble** in water – you would have to break many strong covalent bonds
- Covalent macromolecules do not conduct electricity – exception - **graphite**

Questions

1. Explain how adding salt to water allows it to conduct electricity

2. Draw the structure of diamond and graphite. Explain how graphite is able to conduct electricity.

3. Explain how you could distinguish between identical looking crystals if you knew that one crystal was ionic and one macromolecular covalent.

4. Explain why ionic compounds can dissolve in polar liquids and covalently bonded substances don't dissolve.

5. Which compound will have the higher melting point?

   a. C_5H_{12}
   b. $C_{10}H_{22}$

Explain your reasoning.

6. Which compound has the higher melting point?

   a. NaCl
   b. $MgCl_2$

Explain your reasoning

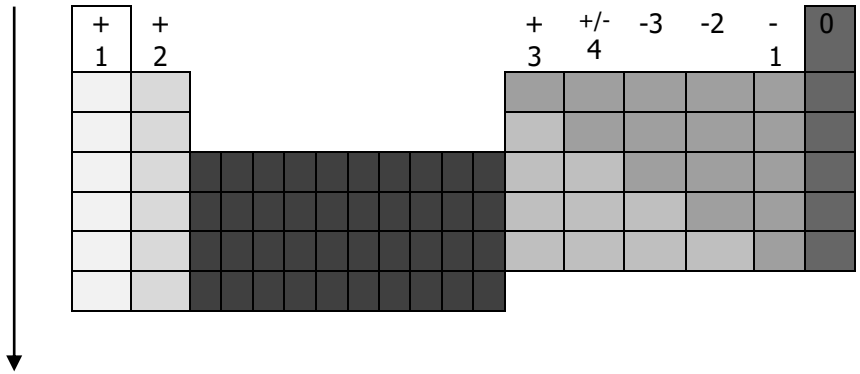
The Periodic Table

The periodic table will always be given out in an exam and it is full of useful information

- Columns are known as GROUPS – they are families of elements with similar chemical properties
- Rows are known as PERIODS – elements exhibit periodic behaviour
- The larger number on the table is the MASS number – the total number of protons and neutrons added together
- The smaller number on the periodic table is the ATOMIC number – this is the number of protons contained in that particular atom
- The periodic table also tells you the symbol of each atom

You can also use the periodic table to work out the electronic structure of the elements and the number of ions present
As you go from left to right on the periodic table you can work out the charge of the most common ions

Miss out the middle



If you learn this you will always know the charge of a common ion.

Questions

1. Write down the atomic number of these elements. Na, B, At, W

2. Write the down the mass number of these elements. Ca, F, K, As

3. Calculate the number of neutrons in these elements. Ge, H, I, V

4. What period are these elements in? F, Cs, Au, He

5. What is the charge on the following ions?
Br, Sr, Rb, S, Xe, Ge, Sb

6. What is the electronic configuration of these elements? Kr, Ne, F, Li, Cu, Zn, Mn

Energy, rates of reaction (kinetics)

- Energy is transferred during chemical reactions.
- When energy is transferred into reactions overall the reaction is said to be endothermic and the surroundings cools down (reaction feels colder).
- When energy is transferred to the surroundings from the reaction it is called exothermic and the surroundings heat up (reaction feels hotter).
- Reaction rate is a measure of how fast the reaction takes place in a given amount of time.
- You can measure changes in pH, colour, volume of gas produced, change in mass etc to give a rate.
- 4 factors affect the rate of reaction.
- Surface area, temperature, concentration of reactants, addition of a catalyst.
- You should be able to recall how these factors can be used to increase or decrease rates of reaction.
- Yield is used a measure of a reactions success.
- Theoretical yield is a calculation (using moles theory) to calculate what the maximum possible yield can be.
- Actual yield is a measure of how much was actually made
- Percentage yield is a calculation that expresses the actual yield compared to the theoretical yield.
- High yield and fast reaction rates for the lowest cost are best for chemical industries.
- Remember energy cost money!

1. In a reaction between limestone and hydrochloric acid which form of limestone would you use for the fastest rate? Powdered, small chips, large lumps.

2. When how would you stop a reaction from going to fast because it produces excess heat.

3. Sketch a graph of volume of gas made against time. Label the areas with the fastest and slowest rates of reaction.

4. On the same graph sketch two other lines to show the same reaction happening at higher and lower temperatures than the original reaction. Label accordingly.

5. Why is it only necessary to add a small amount of catalyst to a reaction?

Reversible reactions and equilibria.

Some reactions are reversible. The backwards reaction can take place at the same time as the forwards reaction under the same reaction conditions.

It is important to remember that the reactants and products are in a sealed container. All reactants and products will be at the same temperature and pressure.

These reversible reactions eventually reach a point where the **RATE** of the forwards and backwards reaction will become equal. This means that the **relative concentrations** of reactants and predicts **remain constant**. The reaction has reached **dynamic equilibrium**.

These reactions can be difficult to control as the ratio or reactants and products is controlled by picking the correct conditions of temperature and pressure. This is done according **to Le chatalier's principle** which state the reaction system will always seek to oppose the change applied to it.

$N_{2(g)} + 3\ H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

In the reaction above (the Haber process) the forwards reaction is known to be exothermic. Raising the temperature forces the reaction to oppose that change. This means that the endothermic direction is favoured, this has the result of absorbing the extra heat energy and favours the production of Nitrogen and hydrogen. This has the knock on effect of reducing the concentration on ammonia (NH_3). So in this case raising the temperature to increase the rate of reaction wouldn't be a good idea.

We would say "raising temperature moves the equilibrium to the left as this opposes the change (by favouring the endothermic direction).

Increasing pressure always favour the side of the reaction (equation) that has the **least moles of gas.**

1) In the example above explain the effect of raising pressure and lowering pressure on the position of equilibrium.

$SO_{3(g)} + H_2O_{(} \rightleftharpoons H_2SO_{4(g)}$

2) In the reaction above what conditions would you use to increase the yield of H_2SO_4 given that the forward reaction exothermic.

3) In practice in the Haber process the mixture of ammonia gas and unreacted hydrogen is cooled so that the ammonia gas condenses and then removed. Explain how this helps the overall yield of ammonia increase.

$2HI_{(g)} \rightleftharpoons H_{2(g)} + I_{2(g)}$

4) In this example above pressure has no effect. Explain why?

Chemical reactions Part 1.
There are many different chemical reactions that can take place.

Making salts.
A salt is the by-product of when acids and bases react together.
Acids are substances that release hydrogen ions (H^+) into solution. These substances dissolve in water to give it a pH of less than 7.
Some acids are described as strong acids- these fully ionise in solution. All of their molecules break up and produce large numbers of hydrogen ions. E.g. Sulphuric acid H_2SO_4 pH 1-2.

Some are described as weak acids e.g. Ethanoic acid CH3COOH. Here only a relatively small number of acid molecules ionise. So the number of H+ ions made is a much smaller and the pH is higher (3-6)

Bases are chemicals that can neutralise acids.
Alkalis are soluble bases. They release Hydroxide ions (OH-) when they dissolve. E.g. Sodium Hydroxide.
A neutralisation reaction is always

$H^+ + OH^- \rightarrow H_2O$

So what about Metal oxides and carbonates?
Metal oxides and metal carbonates are bases but are insoluble in water.

Here the Oxide ion itself can react with hydrogen ions to neutralise it.
$2H^+ + O^{2-} \rightarrow H_2O$

Or in the case of carbonates

$2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$

Here the oxide ion is part of the carbonate ion and as you can see CO_2 is released.

1) Write word and symbol equations for the reactions between
   Nitric acid and iron (III) oxide
   Copper Carbonate and Sulphuric acid.
   Potassium Hydroxide and Hydrochloric acid.

2) Suggest a reaction that will produce nickel sulphate.

Chemical reaction part 2
Reduction/oxidation reactions Part A.

Redox reactions involve the transfer from one thing to another.

Reduction – Gain of electrons by a substance (species)
Oxidation – Loss of electrons by a substance (species).

We use the word species at A-level because we want to say specifically what "thing" in a compound is being reduced or oxidise.

Remember gain of oxygen is oxidation because oxygen is good at gaining control of electrons in a compound.

Displacement reactions are examples of redox reaction (metal displacement and halogen displacement are the same type of reactions.)

The reactivity of a metal depends on its ability to for a positive ion. Na is very good, K is even better. Cu is pretty rubbish at it. Fe and Zn sit somewhere in the middle. Carbon also appears in this list as carbon is pretty good at reducing most metals. Even Hydrogen crops in the list too, somewhere near the bottom.

Metal displacement reactions.

Iron + copper oxide → Iron (III) Oxide + Copper.

$2Fe + 3CuO \rightarrow Fe_2O_3 + 3Cu$

Here Iron reduced Copper oxide.
Actually, we can say the Iron atoms reduce the Cooper ions in the copper oxide. This can be shown using electron ion equations (aka- half equations, aka ionic equation)

$Fe \rightarrow Fe^{3+} + 3e^-$
The iron atoms loos electrons and forms the Iron (III) ions.

$Cu^{2+} + 2e^- \rightarrow Cu.$
The copper ions in the copper oxide gain those electrons and form copper atoms (i.e. copper metal).

Notice the electrons appear on opposite sides of the reaction arrow. This is important for developing this idea further at A level.

The Fe reaction is the oxidation half equation and the Cu equation is the reduction half equation.

This will work as long as the metal (element) is more reactive than the metal already in the compound.

1) Write the chemical equation for the displacement of Silver from silver nitrate ($AgNO_3$) using Copper.
2) Explain why Hydrogen gas can be used to extract copper from Copper oxide (CuO). Use chemical equations and half equations to support your answer.

Displacement reactions part B Halogen/halide redox.

The halogens are very good oxidising agents. They are good at stealing electrons form other species and oxidising the species react with (whilst reducing themselves).

The ability to gain electrons is related to the size of the halogen atom F has only 2 shells, Cl has 3 Br has 4 and I has 5. As the outer electron shell gets further away from the nucleus the attraction to gain electrons gets weaker and weaker. So F_2 is a very strong "gainer of electrons" (at A level we would say it is a strong **oxidising agent),** whilst I_2 is much weaker (compared to F_2).

We can study the displacement reactions of the halogens like this.

$2\ KBr + Cl_2 \rightarrow Br_2 + 2KCl$

Chlorine is able to gain electrons from the bromide ions. This means the bromide ions turn back into Bromine atoms and pair up.

Again this can be broken down into two half equations showing the movement of electrons.

$2Br^- \rightarrow Br_2 + 2e^-$

Notice here how the number of ions and atoms has to balance.

$Cl_2 + 2e^- \rightarrow 2Cl^-$

These displacement reactions will work as long as the halogen (atom form of the element) is higher up the group (smaller atom) than the halide ion (the ionic form).

You will see at A level that the halogen are used to oxidise lots of different things (because they are very good at gaining electrons). One of these is chlorine in bleach.

1) Write the word and symbol equations for the reaction between Potassium iodide and Fluorine.
2) Work out the half equations involve.
3) Iodine is not able to displace Chloride ions form Sodium chloride. Using half equations and referring to the sizes of the atoms, explain why this reaction does not happen.

Oil and hydrocarbons.

Carbon compounds are very special numerous and varied. Hydrocarbons are the simplest and a natural source of these is crude oil.

Homologous series- a family of related chemicals.
Organic molecule- molecule based on carbon (and usually hydrogen)
Functional Group- the part of the molecules that is different between one family of molecules and another.
Molecular formula- shows the actual number and type of atoms in a compound
Displayed formula- shows the position of atoms and bonds in a molecule.

A good skill for this area is to quickly recognise functional groups and structures of molecules. Is it an alkane, alkene or something else?

Fractional Distillation separates Hydrocarbons in crude oil in to "fractions" which have similar chain lengths. This is a physical process.

Hydrocarbons

The chemicals found in crude oil are mainly hydrocarbons. They are a family of molecules made form only hydrogen and carbon. Examples of family members are methane ethane and propane.
Alkanes- are saturated hydrocarbons, they hold as much hydrogen as possible as there are no double bonds only C-C bonds

Alkenes- have at least one C=C bond. This bond could hold extra hydrogen (or other atoms, so it is an unsaturated hydrocarbon.

Short chain alkanes are useful as fuels. They are volatile and burn well in air and give out useful amounts of energy.

Long chain hydrocarbons, whilst some are useful as fuel such as diesel and heavy fuel oil used in ships, it doesn't burn as easily and so these hydrocarbons are much lower in demand.

Cracking- A chemical process that breaks long chain hydrocarbons in to shorter one and sometimes produces Alkenes as well.

1) Find a diagram of a fractional distillation tower. Annotate it (labels and describe) how crude oil is separated into fractions.
2) Research the use of Cat cracking and thermal cracking. Describe the two processes and state the differences in products produced.
3) Draw the first four members of the

   Alkane
   Alkene
   Alcohol
   Carboxylic acid
   Homologous series.
   State the family name and highlight the functional group in each family of molecules.