A Level Chemistry

Ribston Hall High School

Pre Course Holiday Task

Name:

School:

GCSE Grades in i) Chemistry or Science:

ii) Maths:

The following are a series of questions on topics you have covered at GCSE and that are essential to you getting a good start to A Level Chemistry. If you know these things it will help you with the topics studied in Year 12 Chemistry.

Some of these questions might require GCSE knowledge that has not been covered by your exam board at GCSE. Use A Level and GCSE Chemistry web sites to help you, such as:

http://www.chemguide.co.uk/

http://www.bbc.co.uk/education/subjects/zs6hvcw

The topic titles will help you to find information about the questions if required.

Part 1: Atomic Structure and Bonding

Atomic Structure

1) Which subatomic particles are found in nucleus?
2) What is the charge on an ion formed when an arom loses two electrons?
3) What is the charge on an ion formed when an atom gains two elecrons?

Atomic Number, Mass Number and Isotopes

1) Use the periodic table to work out how many neutrons are in a neutral phosphorous atom.
2) In terms of the number of the subatomic particles, state two similarities and one difference between two isotopes of the same elements.
3) Three neutral isotopes of carbon have mass numbers 12,13 and 14.

   State the numbers of protons, neutrons and electrons in each.

Calculating the Relative Atomic Mass

1) Find the relative atomic mass of Lithium if its composition is 8% ^{6}Li and 92% ^{7}Li
2) Find the relative atomic mass of Carbon if its composition is 99% ^{12}C and 1% ^{13}C
3) Find the relative atomic mass of Silver if its composition is 52% $^{107}Ag$and 48% ^{109}Ag
4) Find the relative atomic mass of Sodium fluoride, NaF
5) Find the relative atomic mass of Chloromethane, CH_3Cl

Elecronic Structure

1) Draw diagrams to show the electron arrangements of the following elements:

   Carbon, Fluorine, Magnesium, sulfur.

2) Use the simple notation show above to write the electron arrangements of these elements:

   Lithium, Sodium, Potassium, Beryllium, Magnesium, Calcium.

3) Give the electron configurations of oxygen and chlorine.

4) Give one similarity between elements that are in the same group.

Formation of Ions

1) What is the charge on a Sodium ion?

2) Which group typically forms 1- ions?

3) What is the formula of a sulfite ion? Remember to include the overall charge on the ion.

Ionic Bonding

1) Draw a diagram showing how a magnesium atom reacts with an oxygen atom to form magnesium oxide, MgO. Your diagram should show the electron transfer process.

2) In Potassium oxide, what is the ratio of K^+ ions and O^{2-} ions? What is the ionic formula?

Ionic Compounds

1) Put these ionic compounds in the order of melting point, highest to lowest:

   Lithium oxide (Li_2O), Beryllium oxide (BeO), Lithium fluoride (LiF). Explain why you have put them in that order.

2) Explain why the ionic compound, potassium chloride (KCl), can conduct electicity when molten or dissolved, but not when it is solid.

Covalent Bonding

1) Draw simple dot-and-cross diagrams to show the bonding in the following molecules:

a) Chlorine (Cl_2)

b) Water (H_2O)

c) Ethane (C_2H_6)

d) Oxygen (O_2)

Small Covalent Molecules

1) Draw a dot-and- cross diagram to show the bonding in hydrogen fluoride (HF). Label the bonding electrons and lone pairs of electrons.

2) Explain why nitrogen is a gas at room temperature, despite the nitrogen atoms in each molecule being strongly bonded to each other.

Giant covalent Molecules

1) Devise a series of tests that would allow you to distinguish between two unknown crystalline solids, one of which is an ionic compound and the other a giant covalent structure.

2) Why won't diamond dissolve in water when sodium chloride will?

Metallic Bonding

1) Predict, with reasoning whether potassium or calcium will have a higher melting point.

2) Draw a diagram to show the bonding in a sample of sodium.

3) Sodium has a metallic structure, whilst sodium chloride (NaCl) is an ionic compound.

Give one similarity and one difference between the physical properties of these substances.

Part 2: Inorganic Chemistry

Trends in Properties across the Periodic Table

The table below shows some of the physical properties of Period 3 Oxides.

The final row has been deduced from these properties.

	Na_2O	MgO	Al_2O_3	SiO_2	P_4O_{10}	SO_2
State (at room temperature and standard pressure)	solid	solid	solid	solid	solid	gas
Melting point (^0C) (at standard pressure)	1275	2800	2072	1650	570	-73
Electrical conductivity (when molten)	good	good	good	none	none	none
Bonding	Ionic lattice	Ionic lattice	Ionic lattice	Giant covalent structure	Small covalent molecule	Small covalent molecule

1) Explain how the data is the first three rows of the table above supports the idea that the bonding type changes from ionic to covalent as you move across Period 3.

2) Use the information on Period 3 Oxides to predict the trend in the melting points of elements as you go across Period 3.

3) Predict the type of bonding you would expect in chlorides of:

a) Sodium b) Phosphorous

Writing and Balancing Equations

1) Write a balanced symbol equation for the combustion of Methane (CH4) in oxygen

Methane + oxygen → Carbon dioxide + Water

2) Write the balanced symbol equations for the following reactions:

a) The complete combustion of ethanol (C_2H_5OH) in oxygen (O_2) to give carbon dioxide (CO_2) and Water (H_2O)

b) The reaction of calcium hydroxide ($Ca(OH)_2$) with hydrochloric acid (HCl) to give calcium chloride ($CaCl_2$) and Water (H_2O)

3) Balance the following ionic equation:

$Cl_2 + Fe^{2+} \rightarrow Cl^- + Fe^{3+}$

Include the state symbols given that Cl_2 is a gas and everything else is aqueous

Group2

1) The following are descriptions of the reactions of Be and Ca with cold water.

Use them to predict the reactions of Mg and Sr

>Beryllium will not react with cold water at all.

>Calcium reacts steadily with cold water to produce hydrogen gas and calcium hydroxide.

2) Predict with reasoning the trend in boiling points of Group2 Metals

Group7

1) Predict with reasoning, what would happen if you mixed the following halogens and halide solutions.
   a) Cl_2 and Br^-
   b) I_2 and Cl^-
   c) I_2 and Br^-
   d) Cl_2 and I^-

2) Draw a diagram to show the bonding between atoms in a fluorine molecule.

Acids and Bases

1) Write a balanced equation for the reaction between nitric acid and potassium hydroxide.
2) Write equations to show what happens when the following substances are mixed with water:
   a) Sulphuric acid
   b) Potassium hydroxide
   c) Nitric acid

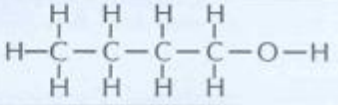
Part 3: Organic Chemistry

Organic Molecules

There are different ways of representing a Molecule's Structure

Chemists have a different ways of representing an organic molecule's **Formula**.

Here are a few ways that you'll need to be able to be interpret:

FORMULA	WHAT IT SHOWS YOU	FORMULA FOR BUTANOL (an alcohol)
General formula	This describes **any member** in a homologous series. The number of carbons is represented by 'n' and the number of hydrogens in terms of 'n'.	$C_nH_{2n+1}OH$ (this is true for all alcohols.)
Molecular formula	This shows the number of **atoms** of each **element** in a molecule.	$C_4H_{10}O$
Structural formula	This shows the molecule **carbon by carbon**, with all attached hydrogens and functional groups.	$CH_3CH_2CH_2CH_2OH$
Skeletal formula	The **bonds** of the carbon skeleton are drawn, with any **functional groups**. The carbon atoms and attached hydrogens aren't shown.	
Displayed formula	All the **atoms** and **bonds** are drawn to show how the molecule is arranged.	

1) Draw the skeletal and displayed formulae for the molecule with the structural formula $CH_3CHOHCH_2CH_3$

2) What is the molecular formula of the compound with the structural formula CH_3CH_2COOH?

Alkanes

1) Draw out the structures of the next two alkanes, pentane (C_5H_{12}) and Hexane (C_6H_{14}).
2) a) Write out the molecular formulae of the first four alkanes.

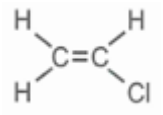
   b) We can work out a general formula for the alkanes of the form $C_n H_?$, where n is the number of Carbon atoms. Work out, in terms of n, what should be in the place of?

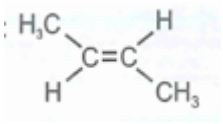
3) Write a balanced equation for the complete combustion of propane in oxygen.

Alkenes

1) Draw out a structure for the next alkene: pentene (C_5H_{10}).
2) Draw out two alternative structures for hexane (C_6H_{12}).
3) Work out the general formula for the alkenes 0f the form $C_n H_?$

Polymerisation

1) What property of alkenes allows them to form polymers?
2) Using the standard way of representing polymers, draw the polymers formed by the following alkenes:
   a) Chloroethene 

   b) Butene 

Alcohols

1) Draw two different isomers of butanol, C_4H_9OH.
2) Work out the general formula of alcohols, using the form $C_nH_?OH$.
3) Predict, with reasoning, wether ethane or ethanol will have a higher melting point.

Part 4: Physical Chemistry

Reactions Rates

1) Describe how you could measure the rates of the following reactions:
   a) The endothermic reaction between citric acid and sodium bicarbonate to give carbon dioxide, water and a sodium salt.
   b) The precepitation reaction between sodium thiosulfate and hydrochloric acid to form a sulfur precipitate, sulfur dioxide gas, sodium chloride and water.

c) The reaction between solid calcium carbonate and hydrochloric acid to produce calcium chloride and carbon dioxide gas.

Collision Theory

1) Two particles in a reaction vessel collide but don't react. Give two reasons why the reaction may not have happened.
2) What is activation energy of a reaction?
3) Draw an enthalpy profile diagram for a reaction. On your diagram, label the reactants, products and activation energy.

Reaction Rates and Catalysts

1) Describe two things you could do to increase the rate of a reaction between aqueous species.
2) Why do increasing the pressure increases the rate of reaction between gases?
3) What's a catalyst?
4) Give two advantages pf using a catalyst in industrial reactions.

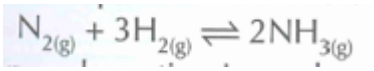
Reversible Reactions

1) Compare the rates of the forward and backward reactions of a reversible reaction at the following points:
    a) At the start of the reaction.
    b) At equilibrium.
2) What is dynamic equilibrium?

Le Chatelier's Principle

$$C_2H_4 + H_2O \rightleftharpoons C_2H_5OH$$

1) You are making ethanol from ethene and steam using the reactions shown above. What will happen to the yield of ethanol if you increase the amount of steam in the reaction mixture?
2) Ammonia is produced industrially using the following reversible reaction



The forward reaction is exothermic and the backwards reaction is endothermic. How will the position of equilibrium change if you:
    a) Increase the temperature of the reaction?
    b) Remove some ammonia from the reaction?

The Mole

One mole of a substance contains **6. 02 x 10^{23}** particles. 6. 02 x 10^{23} mol $^{-1}$ is known as **Avogadro's constant**.

$$\textbf{Number of moles} = \frac{\textbf{Mass of substance (g)}}{\textbf{Molar mass (gmol}^{-1}\textbf{)}}$$

1) Find the molar mass of sulphuric acid, given that 0.700 moles weighs 68.6g.
2) How many moles of sodium chloride are present in 117 g of NaCl?
3) I have 54.0 g of water (H_2O) and 84.0 g of iron (Fe). Do I have more moles of water or of iron?

Determination of Formulae from Experiments

Empirical and Molecular Formulae

The **empirical formula** of a compound is the **simplest ratio** of the atoms of each elements in the compound.

The **molecular formula** of a compound gives the **actual number** of atoms of each element in the compound.

For example, a compound with the molecular formula **C_2H_6** has the empirical formula **CH_3**. The **ratio** of the atoms is one C to every Hs.

1) Find the empirical formulae of the following oxides:
    a) An oxide containing 12.9g of lead to every 1.00g of oxygen.
    b) An oxide containing 2.33g of iron to every 1.00g of oxygen.
    (Relative atomic mass values: Pb = 207.2, O = 16.0, Fe = 55.8)
2) Calculate the empirical formula of the carboxylic acid that is comprised of 4.30% hydrogen, 26.1% carbon and 69.6% oxygen.
    (Relative atomic mass values: H = 1.0, C = 12.0, O = 16.0)

Calculation of Molecular Formulae

$$\textbf{Percentage Composition of element X} = \frac{\textbf{Total of element X in compound}}{\textbf{Total mass of compound}} \times \textbf{100\%}$$

1) Calculate the molecular formula of a compound containing 52.2% carbon, 13.0% hydrogen and 34.8% oxygen if the relative formula mass of the compound is 46.0.
    (Relative atomic mass values: H = 1.0, C = 12.0, O = 16.0)
2) Calculate the molecular formula of a hydrocarbon with relative formula mass of 78.0 that contains 92.3% carbon.
    (Relative atomic mass values: H = 1.0, C = 12.0)
3) Find the percentage composition of oxygen in each of the following compounds:
    a) Ethanol (C_2H_5OH).
    b) Nitric acid (HNO_3).
    c) Propanone (C_3H_6O)

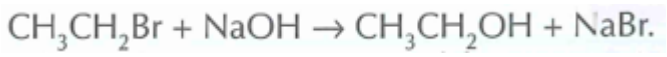
Atom Economy

1) Lots of reactions make **more than one product**. Some of them will be **useful**, but others will be just **waste.**
2) The **atom economy** of a reaction tells you how much of the **mass** of the reactants is converted into the **useful products**, and how much is wasted during the reaction.

$$\textbf{Atom economy} = \frac{\textbf{Total } M_r \textbf{ of desired products}}{\textbf{Total } M_r \textbf{ of all products}} \times 100$$

3) If a reaction has **100% atom economy** then **all** the atoms in the reactants have been turned into **useful** (desired) **products**. The higher the atom economy, the 'greener' the process.

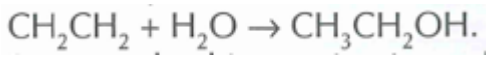
a) Ethanol can be made from bromoethane in the following reaction:



$$CH_3CH_2Br + NaOH \rightarrow CH_3CH_2OH + NaBr.$$

What is the atom economy of this reaction?

b) In industry, ethanol is made from ethene and steam using the following reaction:

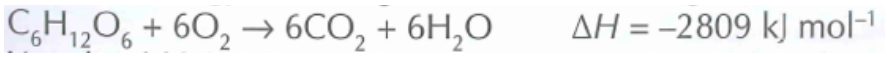


$$CH_2CH_2 + H_2O \rightarrow CH_3CH_2OH.$$

Suggest why this reaction is used, rather than the reaction in part a)

Endothermic and Exothermic Reactions

1) Are the following reactions exothermic or endothermic?
   a) Burning coal
   b) Sodium hydrogen carbonate + hydrochloric acid (temperature drops)
   c) Acid + hydroxide (gets hotter)
   d) Methane + Steam (cools as they react)
2) a) Draw an energy level diagram for the following reactions:

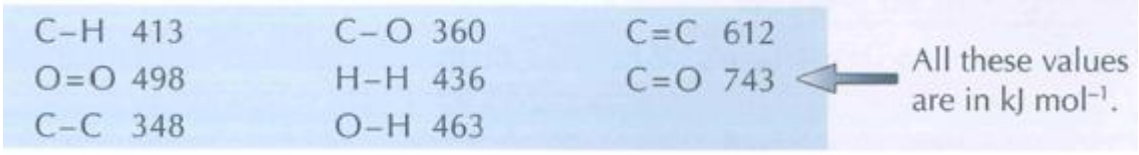


$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O \qquad \Delta H = -2809 \text{ kJ mol}^{-1}$$

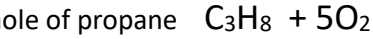
You should label the products, reactants and enthalpy change on your diagram.

b) is the reaction in part a) endothermic or exothermic?

Bond Energy



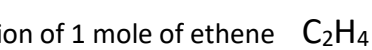
1) calculate the energy change of the following reactions:
   (Use the values for the average bond energies given above)

a) burning 1 mole of propane 

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

b) burning 1 mole of ethanol 

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

c) hydrogenation of 1 mole of ethene 

$$C_2H_4 + H_2 \rightarrow C_2H_6$$

Part 5: Practical Chemistry

Planning Experiments

1) A student is measuring the effect of temperature on the time taken for a lump of magnesium to react completely in a sample of concentrated hydrochloric acid.
    a) What is the dependent variable in the student's experiment?
    b) Name two variables that the students should control to make the experiment a fair test.

Presenting and Interpreting Data

1) Kay measured the volume of gas given off in a reaction her results were 22.0 cm^3, 23.0 cm^3, 22.0 cm^3, 19.0 cm^3, and 24.0 cm^3. Identify any anomalous results and calculate the mean.