Assignment Brief 5.1

Unit Name: Chemicals for a purpose	**Unit Number:** Unit 5
Assignment Title: Useful Chemical Compounds	**Assignment Number:** 5.1
Date Set:	**Due Date:**

Assessment Objective(s): AO1a,b and c

Brief:

The structure of chemical compounds gives rise to their properties and this assignment shows how the uses of some compounds are linked to their structure and properties.

Task 1:

(AO1a and AO1b)

Examples of four compounds – **two** inorganic and **two** organic – and the relationship between their formulae / structure, properties and uses.

Task 2

(AO1c)

An investigation into **one** of the four chosen compounds in more detail.

This compound should be made from oil.

Max marks possible for this task: 21

Resources:

Teaching Approach

PRELIMINARY WORK

Candidates need to be aware that, at this stage, inorganic compounds are generally ionically bonded and organic compounds are covalently bonded.

Candidates will have studied bonding at KS3/4 but some revision of this may be necessary.

For ionic bonding, the approach to 'full shells' may be helpful and, when candidates are confident with this approach, they will be able to deduce formulae for less familiar compounds that could be chosen for the tasks that follow.

Examples of important inorganic compounds that lend themselves to this assignment could include aluminium oxide, calcium oxide, hydroxide and carbonate, sodium carbonate and titanium dioxide. The Royal Society of Chemistry has, in recent years, produced some booklets on the heavy inorganic chemicals industry – including sodium carbonate and the limestone industry.

Candidates will have less experience of organic compounds but covalent bonding occurs at KS4 and some revision may be needed. Covalent bonding can be described as an electron sharing process, with or without mention of the need to attain a 'full shell for stability'. Most GCSE specifications need candidates to have studied the chemistry of petroleum and this could be a starting point for discussion about the properties and formulae of simple organic compounds such as methane and ethanol.

Some inorganic compounds are more covalent in their properties, but nevertheless lend themselves well to this assignment – ammonia and sulphuric acid are important examples.

It may be necessary to discuss briefly hydrogen bonding and other intermolecular forces.

LINKING FORMULAE/STRUCTURE AND PROPERTIES

Work at GCSE/KS4 will have discussed the general properties of compounds of both bonding types.

It is probably important, for this assignment, that candidates are aware of the simple properties of compounds having ionic and covalent bonding.

Ionically bonded compounds

- High melting (and boiling) temperatures and therefore generally solids.
- Non conductors of electricity as solids but conductors when molten or in aqueous solution.
- The solubility in water varies and depends, in simple terms, on the values of the lattice enthalpy and the enthalpy of solution.

Covalently bonded compounds

- Generally relatively low melting temperatures but could be solids, liquids or gases.
- Non conductors of electricity whether they are solid, liquid, gaseous or in aqueous solution.
- Solubility in water depends, in simple terms, on their ability to hydrogen bond with water.

CANDIDATES CHOICE OF COMPOUNDS

It is expected that many candidates will need some guidance on their choice of compounds although the unit specification outlines a number of compounds that should be studied. This list is not restrictive and it is hoped that candidates will be imaginative and choose compounds from outside this basic list.

As well as reference to the usual traditional books, the use of internet search engines will now make information gathering much easier.

Food chemistry provides many compounds, mainly organic in origin, that have possibilities for choices. Amongst these could be sweeteners (natural and artificial), preservatives, antioxidants and permitted colouring agents.

Materials used in the extraction of metals might be a useful source for inorganic compounds.

For example, the use of calcium oxide/carbonate in the Blast Furnace and the lining of the furnace with basic refractory materials such as magnesium oxide.

The pharmaceutical industry also provides a number of possibilities. For example the use and action of certain antibiotics and pain killers such as paracetamol.

The third focus for this assignment is that **one** of the four required compounds should be studied in more detail and be derived from oil. There are very many compounds that fit into this category, for example detergents of various types, polymers and simpler molecules such as ethanoic acid.

Although the expected emphasis should be on a vocational approach, the compounds chosen by candidates can also be studied in a practical way and many 'industrial' compounds lend themselves to imaginative practical work in the laboratory.

PRESENTATION OF THE MATERIAL

It is hoped that candidates will produce their findings in an ordered way and will also use a variety of presentation techniques which might include tables, pie charts and graphs.

The material should be researched from a number of sources and a suitable bibliography provided showing the range of sources used.

It is to be expected that correct scientific terminology should be used in the submitted material and words such as ion, atom and molecule used in their correct context.

MARKING OF THE SUBMITTED MATERIAL

The total marks for this assessment objective (AO1) are 21 and it is expected that work should be detailed and comprehensive in nature to score highly.

EXEMPLAR MATERIALS

The information given below is not supposed to reflect a particular mark band or an example of ordered good practice but provides an example of the material and information that might be expected from a candidate.

Sodium carbonate

Sodium carbonate is a white solid material of formula Na_2CO_3.

It is made in industry by the Solvay process from strong sodium chloride solution (brine) by reacting it with ammonia and carbon dioxide. Eventually sodium carbonate is made by heating sodium hydrogencarbonate, which is made during the process

$$2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$$

Sodium carbonate is marketed as anhydrous sodium carbonate, Na_2CO_3 and as a decahydrate, Na_2CO_3. $10H_2O$, under the name washing soda.

Both compounds are very soluble in water giving sodium ions and carbonate ions.

$$Na_2CO_3 \rightarrow 2Na^+ + CO_3^{2-}$$

The compound dissolves in water because there are 'strong' bonding forces between the sodium ions and polar water molecules and also between the negative carbonate ions and water molecules.

The ionic bonding in sodium carbonate enables it to conduct electricity in aqueous solution but, as a solid, the ions are strongly attracted to each other and it is a non-conductor.

Solid sodium carbonate exists as a strongly bonded ionic lattice and much energy is needed to overcome the attractive forces between ions. As a result sodium carbonate has a high melting temperature of 852^{o}C.

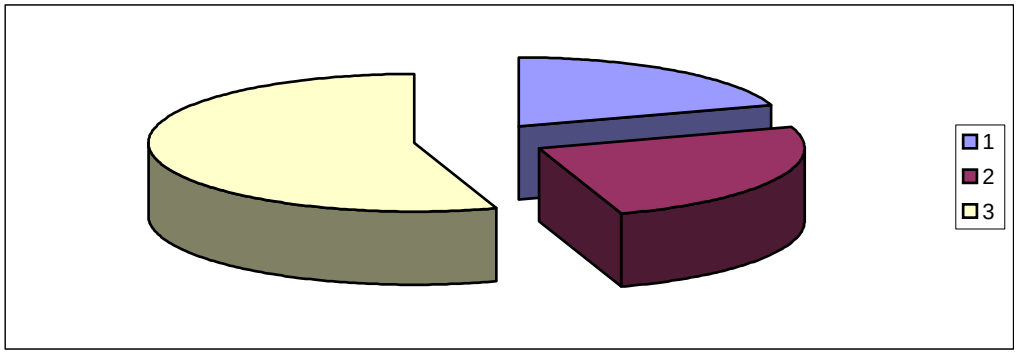
The water molecules in the decahydrate are not bonded to the sodium carbonate as strongly and the compound loses water on gentle heating, eventually giving anhydrous sodium carbonate.

A solution of washing soda is quite alkaline and has been used to remain perspiration stains from clothing, as perspiration is acidic and is neutralised by the alkaline washing soda, giving a soluble material that is washed away. Sodium carbonate, being alkaline, reacts with grease and removes it from clothes, hence its use in washing powders.

Upwards of a million tonnes of sodium carbonate are produced in the United Kingdom every year.

Some is produced as a fine powder – light soda ash and some is produced as larger crystals – heavy soda ash. The two types have different uses.

Heavy Soda Ash

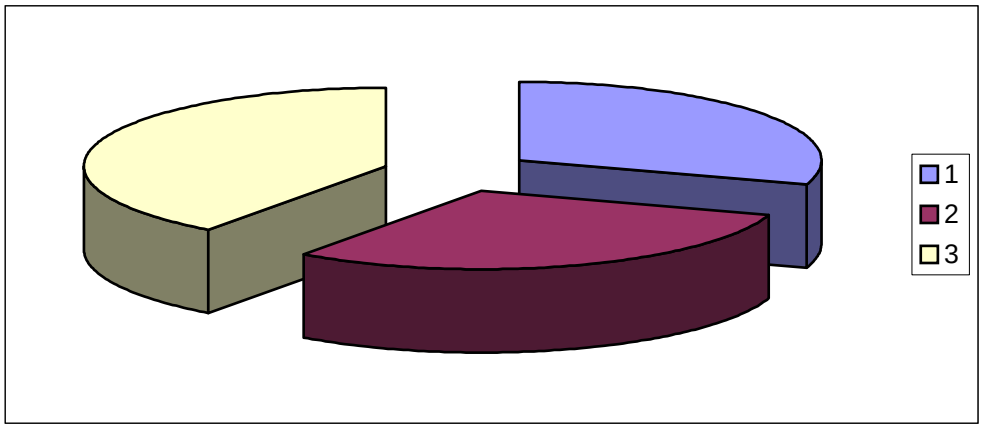


1 20% Chemicals, detergents and the metal industry

2 25% Plate glass, glass fibre

3 55% Glass containers

Light Soda Ash



1 30% Food, drinks, detergents and textiles

2 30% Water purification, treatment of salt water

3 40% Making phosphates, chromates and silicates

A large proportion of the sodium carbonate goes into glass production. Sodium carbonate is an alkaline material and neutralises acidic silica in glass making giving sodium silicate – a constituent of glass.

Its alkalinity is used to produce sodium phosphate and sodium chromate by neutralisation of phosphoric and chromic acids.

Sodium carbonate is also used in the treatment of salt water. Impure salt water contains dissolved calcium and magnesium compounds. When a solution of sodium carbonate is added the carbonate ions react with the calcium and magnesium ions giving insoluble calcium and magnesium carbonates which are precipitated, leaving purer salt water.