# C5: Chemicals of the natural environment

## A: Chemicals in the four spheres

* The Earth is made up of the core at the centre, the mantle and the outer layer called the crust.
* The lithosphere is broken into tectonic plates, and is made up of the crust and upper mantle, and contains mainly the elements silicon and oxygen in the form of silicates.
* The hydrosphere includes the rivers and oceans and is almost entirely made up of water.
* The biosphere is living things and is made of carbon, hydrogen and oxygen.
* The atmosphere is the layer of air around the Earth contains mainly nitrogen and oxygen.
* Chemicals move between the spheres.

## B: Chemicals in the atmosphere

* The atmosphere contains approximately:
  + 78% nitrogen
  + 21% oxygen
  + 1% argon
  + 0.03% carbon dioxide
  + Small amounts of water vapour
* All chemicals in the atmosphere are gases, so they have low melting and boiling points.
* All chemicals in the atmosphere are non-metallic elements or compounds of non-metallic elements.
* Most chemicals in the atmosphere are small molecules.
* Only argon exists as single atoms.
* Attractive forces between chemicals in the atmosphere are weak because they are gases.
* The forces that hold the atoms of molecules together in the atmosphere are strong, so the molecules do not split up.
* Molecular models can be used to represent bonds between atoms in molecules.
* O2 and CO2 have double bonds.
* The atoms in the atmosphere form molecules by forming covalent bonds.
* Covalent bonding is when the atoms share electrons.

## C: Chemicals of the hydrosphere

* Water is liquid at room temperature, even though it has a smaller mass than molecules of nitrogen, oxygen and carbon dioxide.
* Ice floats because it expands instead of contracts during freezing so it is less dense than water.
* Water is a good solvent for salts because it dissolves ions.
* Pure water does not conduct electricity but aqueous solutions of salts do.
* Atoms in a molecule of water are not arranged in a straight line, but are at an angle.
* In the covalent bonds of water molecules, the electrons are not evenly shared, so there is a slight negative charge on the oxygen side of the hydrogen atoms.
* The attractions between water molecules and their shape mean ice has an open structure that is less dense than water.
* The water cycle shows the movement of water between the spheres.
* Salts are found in the hydrosphere, including sodium chloride, the most common salt.

## D: Chemicals of the lithosphere

* ‘Lithos’ is the Greek word for stone or rock.
* Rocks are made up of minerals, which are naturally occurring elements.
* Silicon and oxygen are non-metals, and the most common elements in the lithosphere.
* Ionic compounds crystallize when water evaporates, forming evaporate minerals.
* Sodium chloride crystals are cubed shape, and form a giant ionic compound by ionic bonding.
* This means that there is not an individual molecule of sodium chloride.
* Sodium chloride has strong attractive forces, so it takes lots of energy to break the arrangement of ions.
* Quartz is made from the mineral silica, which consists of silicon dioxide, and is used in many things, for example glass making and communication systems.
* Each silicon atom forms 4 bonds, whereas oxygen atoms form 2 bonds, so one oxygen atom bonds to 2 silicon atoms.
* This makes a giant covalent structure.
* Silicate minerals can contain other elements such as aluminium, iron and calcium.

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| --- | --- | --- |
| Property of SiO2 | Comments | Uses |
| Very hard | Strong, rigid structure; will scratch steel | Sandpaper and scouring pads |
| High melting and boiling points | Strong rigid structure, difficult to break down | High-temp lab glassware |
| Electrical insulator | No free electrons or ions | Used as an insulator on electrical devices |
| Insoluble in water | Resists weathering ending up as sand | Used for buildings |

## E: Chemicals of the biosphere

* Biochemistry is the study of living things.
* Carbon is the basis of all living things, and can be formed into a large variety of things because:
* Proteins are polymers that are built by combining amino acids.
* Carbohydrates contain carbon, hydrogen and oxygen, and are needed for energy.
* Photosynthesis is a process in plants that makes the carbohydrate glucose.
* Respiration makes energy from glucose.
* Plants store glucose as starch because glucose is soluble, so affects the osmotic balance.
* DNA and RNA are nucleic acids, and carry genetic codes

## F: Human impacts on the environment

* Elements move through the spheres naturally.
* Human activities can influence the natural cycles.
* The carbon cycle:
  + Carbon dioxide in the atmosphere
  + Carbon released from combustion of fossil fuels
  + Carbon released during respiration, and taken in from photosynthesis
  + Carbon released from deforestation
  + Carbon dissolved in hydrosphere
* The nitrogen cycle:
  + Nitrogen gas in the atmosphere
  + Nitrate and ammonium ions in the hydrosphere and lithosphere
  + Plants absorb nitrate and ammonium ions
  + Plants cannot use nitrogen from the air, only specialized bacteria and algae can do this by nitrogen fixation.
  + Nitrogen fixation also happens when there is lightening and through the Haber process to make fertilisers.

## G: Metals from the lithosphere

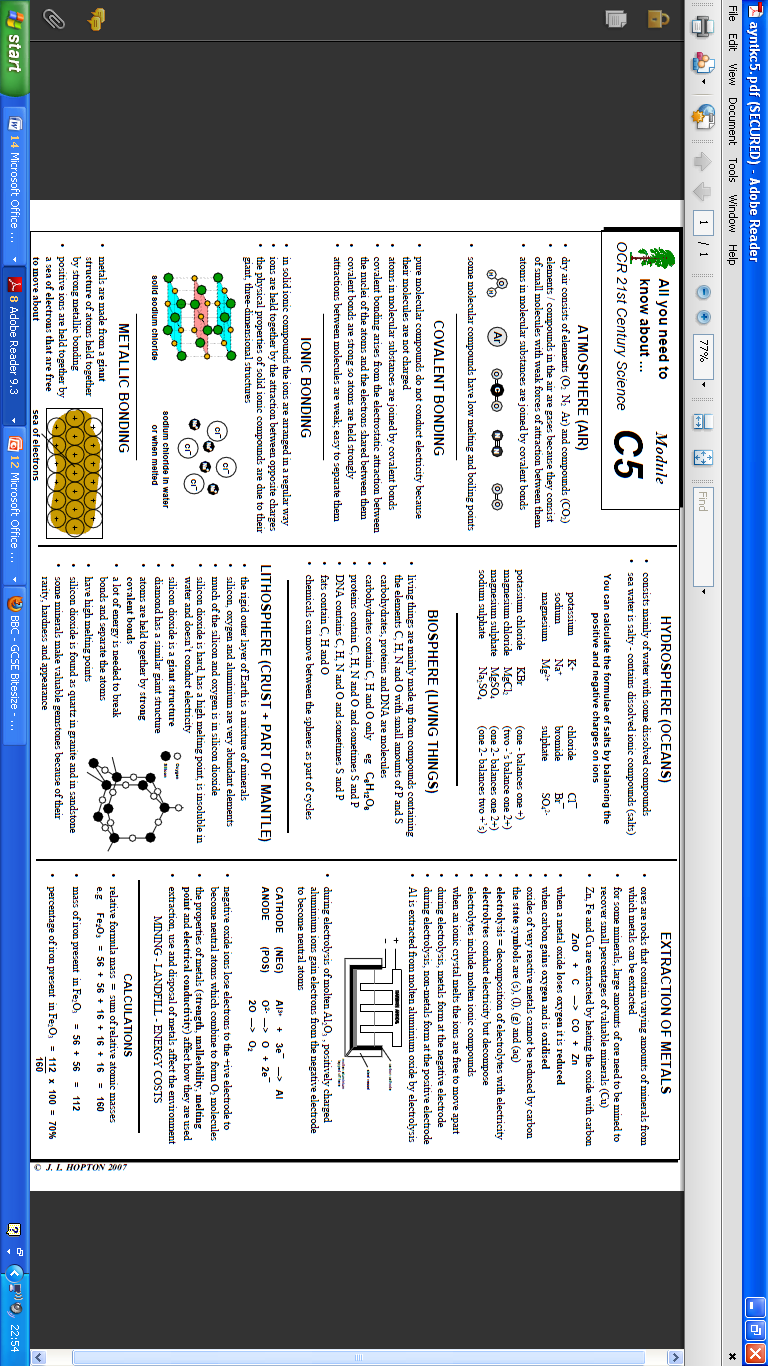
* All metals come from the lithosphere, but are often found as compounds called minerals.
* Ores are minerals that contain useful compounds.
* Reactive metals have to be extracted from their ores.
* Concentrating the ore is the process of separating the valuable mineral from dirt and rock.
* Some metals can be extracted from their oxide by reduction; using a reducing agent to remove oxygen when it is oxidized.
* Relative atomic masses can be used to work out how much metal is needed during reduction.
* Relative formula mass is the total of the relative atomic masses in a chemical.
* Electrolysis is used to extract more reactive metals that cannot be extracted by reduction.
* The negative electrode is the carbon lining.
* The electrolyte is a hot, molten ore.
* The metal is attracted to the negative electrode.
* When extracting a metal, you need to consider:
  + How the ore can be reduced; the more reactive the harder it is to reduce
  + Whether there is a good supply; cost of concentrating may be too high to be worthwhile
  + What the energy costs are; energy is needed to extract metals, particularly in electrolysis
  + What the impact on the environment will be; recycling should be considered

## H: Structure and bonding in metals

* The structure of metals is regular and closely packed in a regular lattice.
* Metallic bonds are strong but flexible and occur when metal atoms lose their electrons in their outer shell, which drift in a sea of electrons.
* The attraction between the sea of electrons and the positive ions holds the structure together.
* Overall, metal crystals are neutral.
* The electrons can conduct electricity because the electrons can move freely.

## I: The life cycle of metals

* Mining is the process of getting ores from the lithosphere.
* Processing ores is removing waste from the ores.
* Metal extraction is the process of removing metals from their ores.
* Metals are used for many different products such as vehicles.
* Recycling is used to reduce cost both financially and to the environment of the metal.

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