MODULE C5: CHEMICALS OF THE NATURAL ENVIRONMENT

C5.1 What types of chemicals make up the atmosphere and hydrosphere?

1. recall that dry air consists of gases, some of which are elements (for example oxygen, nitrogen and argon) and some compounds (for example carbon dioxide);
2. recall the symbols for the atoms and molecules of these gases in the air;
3. recall that most non-metal elements and most compounds between non-metal elements are molecular;
4. understand that some molecular elements and compounds have low melting and boiling points;
5. interpret qualitative and quantitative data about the properties of molecular elements and compounds, for example melting and boiling points;
6. understand that the elements and compounds in the air are gases because they consist of small molecules with weak forces of attraction between the molecules;
7. understand that pure molecular compounds do not conduct electricity because their molecules are not charged;
8. **understand that bonding within molecules is covalent and arises from the electrostatic attraction between the nuclei of the atoms and the electrons shared between them: covalent bonds are strong;**
9. translate between representations of molecules including molecular formulae, 2-D diagrams in which covalent bonds are represented by lines and 3-D diagrams for:
   - elements that are gases at 20°C;
   - simple molecular compounds.
10. recall that the Earth's hydrosphere (oceans) consists mainly of water with some dissolved compounds;
11. recall that sea water in the hydrosphere is 'salty' because it contains dissolved ionic compounds called salts;
12. understand that solid ionic compounds form crystals because the ions are arranged in a regular way;
13. understand that ions in a crystal are held together by the attraction between opposite charges: this is ionic bonding;
14. understand how the physical properties of solid ionic compounds (melting point, boiling point, electrical conductivity) relate to their giant, three-dimensional structures;
15. describe what happens to the ions when an ionic crystal dissolves in water;
16. explain that ionic compounds conduct electricity when dissolved in water because the ions are charged and they are able to move around independently in the liquid;
17. **be able to work out the formulae for salts in the sea given a table of charges on ions (for example sodium chloride, magnesium chloride, magnesium sulfate, potassium chloride and potassium bromide.**

MODULE C5: CHEMICALS OF THE NATURAL ENVIRONMENT

C5.2 What types of chemicals make up the Earth's lithosphere?

1. recall that the Earth's lithosphere (the rigid outer layer of Earth made up of the crust and the part of the mantle just below it) is made up of a mixture of minerals;
2. recall that silicon, oxygen and aluminium are very abundant elements in the crust;
3. be able to interpret data about the abundances of elements in rocks;
4. recall that much of the silicon and oxygen is present in the Earth's crust as the compound silicon dioxide;
5. recall the properties of silicon dioxide: (for example hardness, melting point, electrical conductivity and solubility in water);
6. explain the properties of silicon dioxide in terms of a giant structure of atoms held together by strong covalent bonding (for example melting point, boiling point, hardness, solubility and electrical conductivity);
7. understand that silicon dioxide is found as quartz in granite, and is the main constituent of sandstone;
8. understand that some minerals are valuable gemstones because of their rarity, hardness and appearance;
9. **interpret data and explain the uses and properties of other elements and compounds with giant covalent structures (no recall expected).**

MODULE C5: CHEMICALS OF THE NATURAL ENVIRONMENT

C5.3 Which chemicals make up the biosphere?

1. understand that living things are mainly made up from compounds containing the elements carbon, hydrogen, oxygen and nitrogen with small amounts of other elements such as phosphorus and sulfur;
2. interpret data about the percentage composition of carbohydrates, proteins, fats and DNA;
3. recall that carbohydrates, proteins and DNA are molecular;
4. given a diagram of a molecule, identify the elements in the compound and write its formula;
5. interpret flow charts describing chemical changes in cycles between the spheres (for example, the oxygen, carbon or nitrogen cycles) (no recall expected).

MODULE C5: CHEMICALS OF THE NATURAL ENVIRONMENT

C5.4 How can we extract useful metals from minerals?

1. recall that ores are rocks that contain varying amounts of minerals from which metals can be extracted;
2. recall that for some minerals, large amounts of ore need to be mined to recover small percentages of valuable minerals (for example in copper mining);
3. recall examples of metals that can be extracted by heating the oxide with carbon (for example zinc, iron and copper (technical details not required));
4. recall that when a metal oxide loses oxygen it is reduced while the carbon gains oxygen and is oxidised;
5. understand that some metals are so reactive that their oxides cannot be reduced by carbon;
6. be able to balance unbalanced symbol equations;
7. recall and use state symbols: (s), (l), (g) and (aq) in equations;
8. be able to use the Periodic Table to obtain the relative atomic masses of elements;
9. **be able to calculate the mass of the metal that can be extracted from a mineral given its formula or an equation;**
10. describe electrolysis as the decomposition of an electrolyte with an electric current;
11. understand that electrolytes include molten ionic compounds;
12. describe what happens to the ions when an ionic crystal melts;
13. recall that, during electrolysis, metals form at the negative electrode and non-metals form at the positive electrode;
14. describe the extraction of aluminium from aluminium oxide by electrolysis;
15. **show that during electrolysis of molten aluminium oxide the positively charged aluminium ions gain electrons from the negative electrode to become neutral atoms;**
16. **show that during electrolysis of molten aluminium oxide, negatively charged oxide ions lose electrons to the positive electrode to become neutral atoms which then combine to form oxygen molecules;**
17. **use ionic theory to explain the changes taking place during the electrolysis of a molten salt (limited to using diagrams or symbol equations to account for the conductivity of the molten salt and the changes at the electrodes).**

MODULE C5: CHEMICALS OF THE NATURAL ENVIRONMENT

C5.4 How can we extract useful metals from minerals?

18. recall the properties of metals related to their uses (limited to strength, malleability, melting point and electrical conductivity);
19. explain the properties of metals in terms of a giant structure of atoms held together by strong metallic bonding;
20. **understand that in a metal crystal there are positively charged ions held closely together by a sea of electrons that are free to move;**
21. evaluate, given appropriate information, the impacts on the environment that can arise from the extraction, use and disposal of metals.