AQA Chemistry 1a - Products from Rocks

12.1 How do rocks provide building materials?

The exploitation of rocks provides essential building materials.
Limestone is a naturally occurring resource that provides a starting point for the manufacture of cement, concrete and glass. Throughout Unit Chemistry 1, candidates should know that atoms are held together in molecules and lattices by chemical bonds, but no detailed knowledge of the types of chemical bonding is required. Candidates should be able to interpret chemical equations in symbol form and should be able to balance equations in terms of numbers of atoms.

You should be able to:

- consider and evaluate the environmental, social and economic effects of exploiting limestone and producing building materials from it
- evaluate the developments in using limestone, cement, concrete and glass as building materials, and their advantages and disadvantages over other materials.

Know that:

- All substances are made of atoms. A substance that is made of only one sort of atom is called an element. There are about 100 different elements. Elements are shown in the periodic table. The groups contain elements with similar properties.
- Atoms of each element are represented by a chemical symbol, eg O represents an atom of oxygen, Na represents an atom of sodium.
- Atoms have a small central nucleus around which there are electrons.
- When elements react, their atoms join with other atoms to form compounds. This involves giving, taking or sharing electrons and the atoms are held together by chemical bonds. (No further knowledge of ions, ionic and covalent bonding is required in this unit.)
- Atoms and symbols are used to represent and explain what is happening to the substances in chemical reactions.
- The formula of a compound shows the number and type of atoms that are joined together to make the compound.
- No atoms are lost or made during a chemical reaction so the mass of the products equals the mass of the reactants and we can write balanced equations showing the atoms involved.
- Limestone, containing the compound calcium carbonate ($CaCO_3$), is quarried and can be used as a building material.
- Calcium carbonate can be decomposed by heating (thermal decomposition) to make calcium oxide (quicklime) and carbon dioxide.
- Carbonates of other metals decompose on heating in a similar way.
- Quicklime (calcium oxide) reacts with water to produce slaked lime (calcium hydroxide).
- Limestone and its products have many uses, including slaked lime, mortar, cement, concrete and glass.

12.2 How do rocks provide metals and how are metals used?

Metals are very useful in our everyday lives. Ores are naturally occurring rocks that provide an economic starting point for the manufacture of metals. Iron ore is used to make iron and steel. Copper can be easily extracted but copper rich ores are becoming scarce. Aluminium and titanium are useful metals but are expensive to produce.

You should be able to:

- consider and evaluate the social, economic and environmental impacts of exploiting metal ores, of using metals and of recycling metals

- evaluate the benefits, drawbacks and risks of using metals as structural materials and as smart materials
- explain how the properties of alloys (but not smart alloys) are related to models of their structures.

Know that:
- Ores contain enough metal to make it economical to extract the metal and this changes over time.
- Unreactive metals such as gold are found in the Earth as the metal itself but most metals are found as compounds that require chemical reactions to extract the metal.
- Metals that are less reactive than carbon can be extracted from their oxides by reduction with carbon, for example iron oxide is reduced in the blast furnace to make iron. (Details of the blast furnace are not required.)
- Iron from the blast furnace contains about 96% iron. The impurities make it brittle and so it has limited uses.
- Removing all of the impurities would produce pure iron. Pure iron has a regular arrangement of atoms, with layers that can slide over each other, and so is soft and easily shaped, but too soft for many uses.
- Most iron is converted into steels. Steels are alloys since they are mixtures of iron with carbon and other metals. The different sized atoms added distort the layers in the structure of the pure metal, making it more difficult for them to slide over each other, and so alloys are harder. Alloys can be designed to have properties for specific uses. Low carbon steels are easily shaped, high carbon steels are hard, and stainless steels are resistant to corrosion.
- Many metals in everyday use are alloys. Pure copper, gold, and aluminium are too soft for many uses and so are mixed with small amounts of similar metals to make them harder for everyday use.
- Smart alloys can return to their original shape after being deformed.
- The elements in the central block of the periodic table are known as transition metals. Like other metals they are good conductors of heat and electricity and can be bent or hammered into shape. They are useful as structural materials and for making things that must allow heat or electricity to pass through them easily.
- Copper has properties that make it useful for electrical wiring and plumbing. Copper can be extracted by electrolysis of solutions containing copper compounds. (No details are required of the extraction process.) The supply of copper-rich ores is limited. New ways of extracting copper from low-grade ores are being researched to limit the environmental impact of traditional mining.
- Low density and resistance to corrosion make aluminium and titanium useful metals. These metals cannot be extracted from their oxides by reduction with carbon. Current methods of extraction are expensive because:
    - there are many stages in the processes
    - much energy is needed.
- We should recycle metals because extracting them uses limited resources and is expensive in terms of energy and effects on the environment.

12.3 How do we get fuels from crude oil?

Crude oil is an ancient biomass found in rocks from which many useful materials can be produced. Crude oil can be fractionally distilled. Some of the fractions can be used as fuels.

You should be able to:
- evaluate the impact on the environment of burning hydrocarbon fuels
- consider and evaluate the social, economic and environmental impacts of the uses of fuels
- evaluate developments in the production and uses of better fuels, for example ethanol and hydrogen.

Know that:
- Crude oil is a mixture of a very large number of compounds.

- A mixture consists of two or more elements or compounds not chemically combined together. The chemical properties of each substance in the mixture are unchanged. It is possible to separate the substances in a mixture by physical methods including distillation.
- Most of the compounds in crude oil consist of molecules made up of hydrogen and carbon atoms only (hydrocarbons). Most of these are saturated hydrocarbons called alkanes, which have the general formula C_nH_{2n+2}
- The many hydrocarbons in crude oil may be separated into fractions, each of which contains molecules with a similar number of carbon atoms, by evaporating the oil and allowing it to condense at a number of different temperatures. This process is fractional distillation.
- Some properties of hydrocarbons depend on the size of their molecules. These properties influence how hydrocarbons are used as fuels.
- Most fuels contain carbon and/or hydrogen and may also contain some sulfur. The gases released into the atmosphere when a fuel burns may include carbon dioxide, water (vapour), carbon monoxide and sulfur dioxide. Particles may also be released.
- Sulfur dioxide causes acid rain, carbon dioxide causes global warming, and particles cause global dimming.
- Sulfur can be removed from fuels before they are burned, for example in vehicles. Sulfur dioxide can be removed from the waste gases after combustion, for example in power stations.