OCR
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A2 GCE APPLIED SCIENCE

G628/01/CS Sampling, Testing and Processing

PRE-RELEASE CASE STUDY – CANDIDATE INSTRUCTIONS

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INFORMATION FOR CANDIDATES

- This document consists of **8** pages. Any blank pages are indicated.

Notes for Guidance

1. This pre-release Case Study contains two articles, which are needed in preparation for the externally assessed examination in Sampling, Testing and Processing.

2. You will need to read the articles carefully. In the examination, the first section of the paper will contain questions based on the two articles. You will be expected to apply your knowledge and understanding of the work covered in Unit G628/01 to answer these questions. The marks available for this section will be approximately 75% of the marks for the paper.

3. You can seek advice from your teacher about the content of these articles, and you can discuss them with others in your class.

4. You will **not** be able to bring your copy of the Case Study material, or other materials, into the examination. The examination paper contains fresh copies of the two articles. You will find these as an insert in the examination paper. You will not have time to read these articles for the first time in the examination if you are to complete the paper within the specified time. However, you should refer to the articles when answering the questions.

Coconuts

Coconuts are very important agricultural products that have wide and varied uses. They are vital contributors to the economies of the country where they are grown. Coconuts are drupes; other drupes include mangoes, apricots, peaches and plums. The familiar coconut that we see sold in shops, is the fruit of the coconut palm. These palms have been known since the Eocene period (approximately 50 million years ago). The palms can grow to 30 metres tall, although dwarf coconut palms are also known. Coconuts are grown in more than 90 countries and the total production is around 62 million tonnes each year. Most of the world production is in tropical Asia, with Indonesia, the Philippines and India accounting for around three quarters of the world's production. This suggests that coconut palms need high humidity and mean temperatures of between 28 °C and 37 °C. Coconut palms thrive on sandy soil and are very tolerant of salinity. They require direct sunlight for successful growth and this implies that they do not like to grow under a tree canopy.

The most useful part of the coconut palm is the familiar 'coconut'. However, coconuts sold in the United Kingdom and other non-tropical countries often have some of the fibrous layer removed.

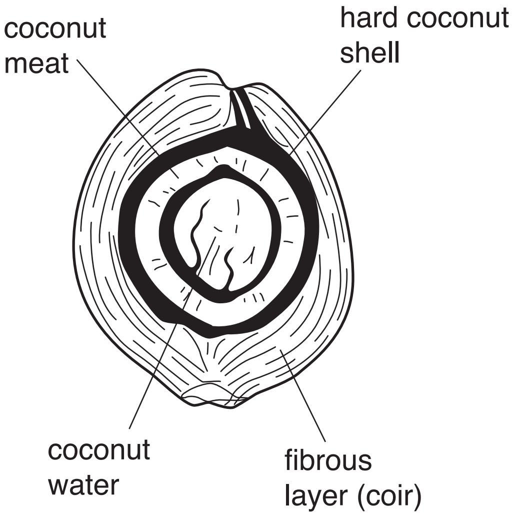

Fig. 1a

The fibrous layer is called coir. This can be used for upholstery padding, as string and rope, and for fishing nets. The material is naturally high in sodium and potassium and these are leached out for use in horticulture, particularly in the growing of mushrooms. This is done by immersing the coir in a solution of calcium nitrate, when the sodium and potassium ions are replaced by calcium ions. This is an example of ion exchange.

Coconut water is the clear liquid inside young green coconuts. As the coconut grows and ripens, the colour of the coconut and its size change and the quantity of coconut water becomes less. This liquid is mainly water that only contains small quantities of dissolved materials.

Coconut water/100 g	
Energy	79 kJ
Sugars	2.6 g
Fibre	1.1 g
Fat	0.2 g
Potassium	250 mg
Sodium	100 mg

The selling of coconut water has become a £250 million/year industry. Unfortunately the marketing of unpasteurised coconut water as 'raw' by some manufacturers suggests that this product is completely safe for human consumption. A producer was told that their coconut water had a pH of 5.1 and in order for the product to be safe from the growth of potentially harmful bacteria the pH needed to be 4.6 or lower. There is still concern about the marketing of this material.

The coconut meat (the white fleshy part of the coconut) can be used fresh, or dried for use in cooking, particularly in cakes. The raw coconut meat contains approximately 34% of fat, 15% of carbohydrates and 3% of protein with the remainder being mainly water. The coconut meat can be treated to produce coconut oil. There are two ways to obtain the oil, the dry process or the wet process.

Dry process Coconut meat is extracted from the shell and dried, producing copra. This is then pressed to extract the oil, leaving a residue, which is used as animal feed, since it is high in protein and fibre. A more modern method of extraction uses the solvent hexane to dissolve out the oil. In industry the hexane could then be removed from the solution by vacuum distillation (and reused). If a similar method is carried out in the laboratory hexane can be removed from the oil by simple distillation as hexane has a boiling point of 69 °C.

Wet process Hot water is passed through grated coconut meat. Coconut milk (an emulsion of water and coconut oil) is produced. A centrifuge is used to separate the coconut oil and water. The wet process is less economically viable than the dry process as it results in a 10–15% lower yield.

In general, 1000 mature coconuts, each weighing an average of 1.44 kg, produce 167 kg of copra from which around 68 to 69 dm^3 of coconut oil can be obtained. Coconut oil is used in the cooking industry and, increasingly, as a feedstock for biodiesel fuel. The oil can also be used to make soap, but soap made from coconut oil tends to be harder than soaps made from other vegetable oils.

The production of coconuts continues to be a very important industry in many tropical countries and research continues to find new uses for this versatile commodity.

Making and testing polymers

Polymers are large molecules that contain many repeating units. They are extremely important materials because of their wide range of properties. They include familiar plastics such as poly(ethene) (commonly called polythene), and natural macromolecules for example DNA and proteins. Polymerisation is the joining together of many small molecules called monomers, to form polymers. The resulting polymer includes soft solids and glass-like materials. A familiar naturally occurring polymer is cellulose. This is the main constituent of the cell wall of plants and is made up of β-glucose units. Cotton is 98% cellulose. Starch however is a polymer made up of α-glucose units. There are a number of synthetic polymers where the backbone consists of a chain of carbon atoms. A section of the structure of poly(propene) (commonly called polypropylene) is shown below where the repeating section is in square brackets. In industry poly(propene) is produced from propene using a gas phase or a liquid phase process.

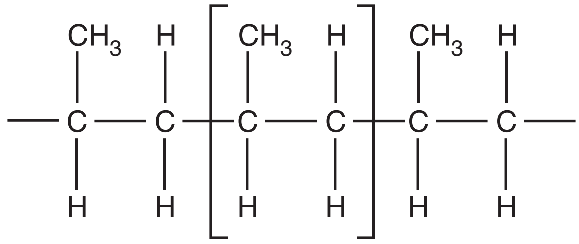

Fig. 2a

Synthetic polymers can be thermoplastic or thermosetting polymers. Thermoplastic polymers can be softened by heating and return to the starting state when cooled. These include polythene, polypropylene, nylon and Perspex. Thermosetting polymers are hardened and set when they are heated. Unlike thermoplastics they cannot be resoftened once they have hardened and set. These include Bakelite and urea-formaldehyde plastics.

Casein is a polymer which makes up about 80% of the protein in milk. It can be obtained from defatted milk powder (for example Marvel©) by adding 100 cm^3 of vinegar to 1 dm^3 of the warmed milk solution, made from the powder. The casein can be drained through a piece of muslin gauze, rinsed with water and left to dry in the air. The casein can then be treated with borax solution to produce a wood glue. Casein can also be treated with methanal (formaldehyde) solution to prepare a casein-containing plastic. However, methanal solution is a toxic material, which is generally not suitable for use in 'A' level courses.

Cellulose is not soluble in water or in most organic solvents. However, if cotton wool is reacted with ethanoic acid in the presence of a catalyst it is converted into cellulose triethanoate (or cellulose triacetate, CTA). The polymer CTA is much more soluble in organic solvents than cellulose and can be dissolved in a suitable solvent and then spun, to produce fibre. Other uses for CTA are in the photographic industry and as a film coating on vinyl record sleeves. CTA is also used as the membrane for reverse osmosis, which is a process that can be used in water purification and in the desalination of water. In reverse osmosis pressure is applied to the incoming solution so that dissolved materials (solutes) are retained on the pressurised side of the membrane and purified solvent passes through the membrane.

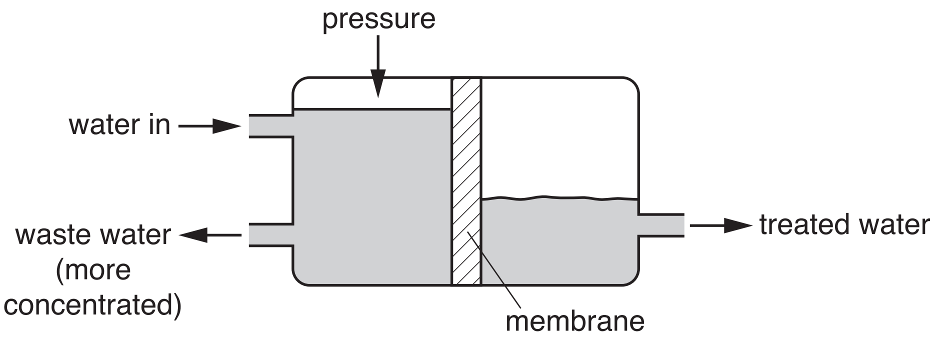

Fig. 2b

The membrane allows smaller molecules such as water to pass through the membrane but does not allow larger molecules or ions through.

A polymeric material that can be produced in the laboratory by a simple method is ‘slime’. This can be produced in a number of ways, of which a simple method is by crosslinking the chains of polyvinyl alcohol (found in white PVA glue) with the borate ions from borax. ‘Slime’ is safe and easy to make and has a number of interesting properties.

Perspex is an example of a synthetic polyester. It can be depolymerised to the monomer by heating and repolymerised by the use of a suitable catalyst. Another synthetic polymer is nylon, which is a polyamide. There are several different types of nylon, depending on the starting materials. Nylon can be made in the laboratory from two starting materials. One of these is dissolved in a solvent that is immiscible with the water solution of the other starting material. A film of nylon is formed at the interface of the two solutions and can be drawn up from the mixture as a continuous thread. Nylon stretches when a fibre is fixed at one end and a force is applied to the other end. Other polymers stretch in different ways and this helps to illustrate just one of the variations between the vast range of these large molecules that contain many repeating units.

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