Oxford Cambridge and RSA

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

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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 and also have covered the ‘what you need to learn’ section of the unit. 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 the unit 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.

Alum – its extraction and uses

Alum is the common name for potash alum, which is hydrated potassium aluminium sulfate $K_2SO_4.Al_2(SO_4)_3.24H_2O$. The name sometimes refers to a class of compounds where the potassium and aluminium have been replaced by other groups or elements. However, this article is principally concerned with potash alum. Up to the 16th century there was no known source of this material in the United Kingdom and the substance had to be imported. However, from the 17th century, alum was extracted from shales occurring near the coast of North East Yorkshire. Although mining of these shales for alum ended in the mid-19th century, the remains of the Peak Alum Works can still be found on the cliffs near Ravenscar. These alum shales include aluminium-containing minerals as well as other materials, principally iron pyrites.

The mining of these shales was very labour intensive. A considerable quantity of soil and rock needed to be removed before the alum shales were reached. Very often this work was carried out using pick axes and wheelbarrows. After removal, the shales were placed on coal and wood fires. This slow roasting process (calcining) was done on a very large scale, typically in rows 50 metres long and 25 metres high. The calcining process lasted many months, so that good yields of alum would be obtained.

At the end of the process, the bluish-grey shales became a red-brown colour, due to the iron compounds present. The product was then placed into a pit that contained water. This process separated the soluble products from the insoluble residue. The solution obtained was then concentrated by evaporation until density measurements showed that it was of the required concentration. If potash alum was needed then seaweed ash was added, and if ammonium alum was needed then urine was added to provide a source of nitrogen. The solution of alum obtained was cloudy because it contained a suspension of fine material such as iron(III) oxide. This insoluble material was allowed to settle and then removed. The clear solution enabled purer alum crystals to be obtained. In practice, the alum crystals were often pale brown, rather than white, as they were contaminated with potassium iron(III) sulfate (iron alum). The production of alum at Ravenscar was very inefficient, as only about 2 tonnes of alum was obtained from 100 tonnes of shale. A similar extraction of alum could be carried out in the laboratory using alum samples that contain insoluble material such as coarse iron(III) oxide. In a laboratory, the colour and the amount of suspended material can be investigated by using colorimetry.

The main reason for the manufacture of alum from these shales was for its use as a mordant in the dyeing of wool, cotton, linen and other natural fibres. Other chemical substances can be used as mordants but alum was one of the first materials to be used and is still suggested as the mordant for dyeing fabrics in the laboratory. A number of variables need to be considered in order to obtain the best dyeing results. The alum industry went into decline very quickly after Perkin isolated aniline purple in 1856. This, and other similar dyes, did not need a mordant.

In modern industry, the word ‘alum’ often refers to aluminium sulfate rather than hydrated potassium aluminium sulfate. However, both compounds can be used in the water industry, although aluminium sulfate is often preferred. The use of alum causes flocculation, which carries down impurities in the water as a sediment. This use of alum requires a pH of 7.5 to 8.0. In 1988, the water supply of Camelford in Cornwall was contaminated when 20 tonnes of aluminium sulfate were added to water that was ready for drinking, rather than into water that was awaiting treatment. A number of short and long-term health problems have resulted from this contamination.

Alum, in its various forms, has been an essential commodity for many centuries and it continues to have a number of important uses today.

Carrots

The wild ancestors of carrots came from Iran and Afghanistan. The modern carrot came to Europe in the 8th century and the carrot that is familiar to us first appeared in the Netherlands in the 17th century. Although we are more familiar with the orange variety, there are carrots that are purple, red, yellow and even white. Carrots are biennial plants, although they are ready for harvesting about four months after planting the seed. Yields vary according to the weather, their nutrition and the soil type. A row that is 3 m long, with plants that are 15 cm apart, could be expected to produce around 3.5 kg of carrots.

One of the major carrot pests is the carrot root fly. These flies lay their eggs around the growing carrots. The larvae burrow into the growing roots causing discolouring and wilting of the leaves. Spraying of the plants with the contact insecticide cyhalothrin is effective, but this insecticide is not generally available to the public. Simple barrier methods to repel the carrot root fly can be very successful.

Carrots are surprisingly sweet. Analysis shows that they contain around 5% sugars. As a result, carrots can be used in cakes and puddings. The orange colour in carrots is due largely to β-carotene. A typical carrot of mass 60 g contains 5 mg of this orange substance. When β-carotene is consumed, the body breaks it down into vitamin A. Unfortunately, when carrots are eaten, β-carotene is not easily absorbed by the body. β-carotene is an unsaturated hydrocarbon and is more easily released from carrots by cooking them in oil. The analysis of carrot varieties for their β-carotene content is carried out by using high-performance liquid chromatography (HPLC).

Carrots are a very important vegetable crop. Apart from being a source of vitamin A, they also provide the consumer with fibre, largely cellulose. Table 2a shows some typical nutritional information for a sample of carrots.

Nutritional information	
typical values	per 100 g
sugars	4.7 g
fibre	2.8 g
protein	1.0 g
fat	0.2 g
β-carotene	8 mg
vitamin C	6 mg

Table 2a

Carrots contain vitamin C but the proportion present is not as great as in citrus fruits and kiwi fruits. The vitamin C content in carrots can be found by a titration method using dichlorophenol-indophenol (DCPIP). Vitamin C is slowly destroyed as temperatures increase, so it is likely that cooked carrots contain less vitamin C than raw ones.

Carrot juice tends to be opaque as when the carrots are juiced it is difficult to separate fine pulp from the juice. Health food shops sell carrot juice, which is an important source of β-carotene and also a number of minerals.

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