OXFORD CAMBRIDGE AND RSA EXAMINATIONS

ADVANCED GCE

G628/CS

APPLIED SCIENCE

Sampling, Testing and Processing

PRE-RELEASE CASE STUDY – CANDIDATE INSTRUCTIONS

For issue on or after 14 February 2011

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

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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 80% 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.

APPLES

Apple trees originated in Asia and archaeological evidence shows that some 8500 years ago, apples were being grown and eaten in Jericho, now in modern-day Jordan. Apple varieties arrived in England around the time of the Norman Conquest. Although the Black Death and various wars slowed their cultivation countrywide, it was Henry VIII who was responsible for the development of large-scale apple orchards in Kent. During the next three hundred years, apple production slowly increased until the Victorians discovered a number of overseas varieties that were subsequently grown in the United Kingdom. They found that the new varieties had a better flavour, were more resistant to pests and even produced higher yields. At present, the UK National Fruit collection lists around 3500 different varieties of apple.

Currently, the number of different home-grown apple varieties is relatively few and in 2007 only 31% of eating apples available in the United Kingdom were home-grown. Of these the Cox is by far the most popular and more of these apples are produced than the rest of the eating apples put together. The Bramley apple is also extensively grown in this country but this is a cooking apple. Although Henry VIII had established extensive apple orchards in the south of England, in the last eight years the amount of land used for apple growing has decreased by about 30%, perhaps due to the popularity of imported apple varieties and an increasing need for fresh apples all the year round. It is common to see apples in shops that have originated in New Zealand and Chile. The economic merits of these imported apples versus the 'green' debate would form an interesting discussion!

Unfortunately, all fruit trees are susceptible to a number of fungal, bacterial and viral problems and also to attack by insect pests. Three of the main problems experienced by apple trees are

- mildew, a fungal problem characterised by light coloured powdery patches on the leaves, flowers and fruits
- scab, seen as brown blotches on the leaves and fruit
- aphids, insects that suck the sap from the trees and may weaken the tree or introduce diseases.

A number of methods of prevention and treatment have been tried. Removal of any conditions likely to allow the start of these problems must be the first consideration. Once disease or pest attacks have started, there are many available ways by which the problem can be treated. Older methods tended to use 'contact' products. Some of these contained toxic mercury and copper compounds that built up in the soil around the trees. Many of the more modern products tend to be 'systemic' in their action. However, these can cause problems if not used at the correct time in the growing season. Additionally, young apple trees may be attacked by mammals such as mice or deer. These feed on the soft tree bark, particularly in wintertime when other food is scarce.

Although imported apples help to provide a source of this fruit all the year round, it is also essential that methods for the extended storage of apples are used. Apples are stored in sealed refrigerated chambers that are maintained at a desired temperature with the concentrations of oxygen, carbon dioxide and nitrogen kept at specified levels. These conditions help to reduce respiration of the fruit, delay ripening and prevent shrivelling. As a result, some varieties of apple can now be kept 'fresh' virtually all year round.

In addition to the necessity for storage, fruit breeders are always working to improve the flavour of apples and to overcome any spoilage during their storage for a number of weeks. EC rules stipulate that apples have to match required standards of size, colour and shape but surprisingly, there are no set criteria for smell and flavour. This might be because there are differences between varieties in smell and flavour and often the choice is a matter of personal taste.

The balance between sweetness and acidity in apples is determined by the amount of sugars and acids (mainly malic acid) respectively. Experiments have shown that more 'acidic' apples retain their flavour when cooked. This is particularly true of cooking apples like the Bramley variety.

The smell or aroma of apples is caused by different blends of volatile materials, particularly esters, alcohols and aldehydes. The identification and proportion of these substances can be found by using techniques such as chromatography, mass spectroscopy and infrared absorption spectroscopy. Refractive index measurements can be used to find the concentration of sugars present.

The relative nutritional value of foods is of increasing interest to many people. On average, a large apple of mass 150 g contains around 80% water. Table 1a shows an approximation of some of the remaining material.

Table 1a

Carbohydrates:	20.0 g
containing sugars	15.6 g
and dietary fibre	4.4 g
Fat	0.3 g
Protein	0.4 g
Minerals	0.1 g
Vitamins	4.9 mg

Apples provide a ready source of material for student investigations. Unripe apples tend to have less sugars and the detection, identification and development of these as the apples ripen is a popular topic. This is normally carried out as an invasive procedure but newer instrumental methods are being developed that are non-invasive. The flesh of cut apples tends to turn brown fairly quickly and the literature gives details of suitable experiments that investigate why this is caused and how this browning can be inhibited. Two major products made from apples, cider and apple juice, are also readily available and provide starting materials for project work.

In 2007, the United Kingdom grew around 150 000 tonnes of apples which equates to something around 1.5 billion apples. Apples, which were introduced into this country around 1000 years ago, continue to be an important contributor to the ready availability of fresh and nutritious food.

MERCURY – A NON-BIOLOGICAL ELEMENT?

Although the element mercury is named after the planet, its chemical symbol, Hg, comes from the Latin word 'hydrargyrum', meaning liquid silver. This description of mercury was given to it by Aristotle, nearly 2400 years ago. It is the only common metallic element that is a liquid at room temperature and pressure – hence liquid silver. Mercury has no biological function although it is present in every living thing because of the ingestion of organomercury compounds and the volatile nature of liquid mercury even at room temperature.

Mercury and its compounds are very toxic and there is increasing concern about pollution wherever they are used. Small quantities of the liquid metal occur naturally but it is more common to discover it as its ore, cinnabar (mercury(II) sulfide), a reddish ore. This was once sold as the red pigment vermilion. Cinnabar is a relatively rare material with the main deposits once being in Spain, Italy, Slovenia and Peru. Many of these deposits are largely exhausted. Most of the world's mercury is now produced in China, which does not export it. Consequently, other countries must rely on smaller producers or obtain their mercury by recycling.

One way of producing mercury is to simply heat cinnabar in air and condense mercury as a liquid. Wuchuan mine in China has been producing mercury for about 400 years but large-scale mining only began in 1949 and ended in 2003. Even so, illegal mining of the ore is still occurring on a small scale in this area resulting in extensive pollution of the surrounding countryside. This has also been made worse by illegal production of liquid mercury from the ore. Mercury vapour can escape into the atmosphere, and waste materials containing mercury are washed into nearby streams and rivers.

Mercury continues to play an important part in gold mining, although many countries have outlawed its use. It is still used illegally in Asia, Latin America and Africa where as much as 1000 tonnes of mercury is used annually for this purpose. How much of this mercury is recycled or left as a pollutant is not known. Mercury is used because it has the ability to bond to gold particles in gold panning and is therefore a popular choice for separating the gold. This unregulated use of mercury is leading to an ecological disaster. As a result, some areas of Borneo are devoid of vegetation and local fish stocks have dwindled by more than 70%. There is doubt about the wisdom of eating the remaining fish, for fear of mercury poisoning.

Since mercury has been extracted for hundreds of years, it is natural that it (and its compounds) have been used for possible medical remedies. The liquid metal was once smeared onto the skin in the hope that it accelerated saliva production. This certainly produced more saliva but at the expense of acute mercury poisoning. It was also believed that life could be prolonged and fractures healed by the drinking of mercury. One Chinese emperor drank a mixture of liquid mercury and powdered jade in the hope of achieving eternal life. He died of acute liver failure. The use of mercury compounds, too, has a disturbing history. A treatment for syphilis was to drink a solution of mercury(II) chloride. It certainly killed the organism responsible for the disease but the effects of mercury poisoning were probably worse than the original condition. The use of mercury compounds in modern medicine is rapidly declining but some traditional medicines still contain alarming quantities of mercury. Poisonous insect stings are treated by taking pills that each contain about 0.02 g of mercury and one type of calming tablet contains 0.07 g of mercury.

The analysis of mercury and its compounds proves difficult because of their toxic nature. The preferred method is a modified form of Atomic Absorption Spectroscopy (AAS) where the mercury concentration of an unknown solution is compared to solutions of known concentration.

Mercury and its compounds still have some commercial and industrial uses, although their use is declining. Some present uses include

- **thermometers and barometers (being phased out)**
- **hearing aid batteries (these give a constant voltage, even when largely run down)**
- **fluorescent tubes (a tube 1 metre long contains 10 mg of mercury)**
- **making caustic soda (sodium hydroxide) from brine (salt water).**

Mercury only forms weak bonds with other elements. For this reason mercury fulminate is extensively used as a detonator for explosives. Whether this is a positive or negative use is a matter for debate.

Mercury and its compounds have been known for hundreds of years but increasing knowledge of their toxicity has reduced their use, as safer and more effective alternatives have been developed.

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