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A2 GCE APPLIED SCIENCE

G628/01/IT Sampling, Testing and Processing

PRE-RELEASE CASE STUDY – INSTRUCTIONS FOR TEACHERS

To prepare candidates for the examination taken on: Tuesday 14 June 2016

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INFORMATION FOR TEACHERS

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

Notes for Guidance

1. The Case Study material should be issued to candidates on or after the date shown on the front of the Candidate Instructions sheet G628/01/CS, at the discretion and convenience of the centre. Candidates can be given the material at any point, but it is suggested that this should be at least four weeks before the examination date.

2. Teachers are advised to ensure that candidates are fully conversant with the skills and knowledge outlined in the unit before being given the Case Study.

3. Candidates will need to read the articles carefully. Time can be built into the teaching programme to introduce the Case Study material. Candidates should be able to discuss freely the articles, and be given support and advice in the interpretation of the materials so that they are prepared to answer the questions based on them in the externally assessed examination.

4. Candidates will be expected to apply their knowledge and understanding of the unit to questions based on the two articles. The marks available for this section will be approximately 75% of the marks for the paper.

5. The Case Study material **must not** be taken into the examination. The examination paper will contain fresh copies of the two articles, as an insert in the paper. Candidates should be reminded that they will not have sufficient time during the examination to read the articles for the first time. However, they may use the articles printed in the Insert in the examination paper to help them answer the questions.

Manganese

Manganese is a reactive grey-silver metal that does not occur naturally. In many ways it is similar to iron – it tarnishes in the air and slowly corrodes in water. It has only one stable isotope, ^{55}Mn. The most common mineral, pyrolusite (manganese dioxide), is a brown-black solid, which principally occurs in South Africa. Some cave paintings using manganese pigments, such as pyrolusite, are known to be 24 000 to 30 000 years old. Manganese also occurs extensively as nodules on the ocean floor where there are estimated to be 500 billion tonnes of nodules. Exploitation and recovery of these nodules will be extremely challenging, as they often occur at depths of 4000 to 6000 metres below the surface of the sea. The composition of these nodules varies, but those of the greatest economic interest contain around 30% of manganese, together with around 1.5% of nickel, 1.5% of copper and 0.25% of cobalt.

Manganese was first isolated in 1774, by heating manganese dioxide with carbon. The pure metal is rather brittle, but when combined with iron in steel, gives an alloy that has a high tensile strength. Manganese has an important use as an alloying agent for aluminium. The addition of a little manganese to the aluminium used for drink cans greatly increases the resistance of aluminium to corrosion.

The most important manganese compound is manganese dioxide, which is mainly used in batteries (mostly dry cells). In 2002, more than 230 000 tonnes of this black solid were used in batteries. Fig. 1a shows a simplified diagram of a dry cell. It uses a mixture of ammonium chloride and manganese dioxide in a paste, with an outer zinc case and a central carbon electrode.

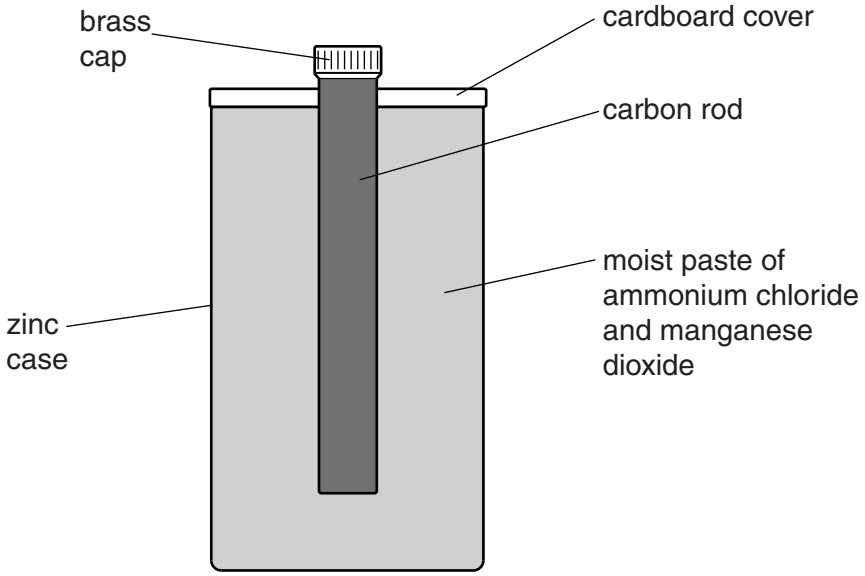

Fig. 1a

Manganese dioxide is a familiar material in school and college laboratories. It is an effective catalyst in the decomposition of hydrogen peroxide into oxygen and water. Measuring the volume of oxygen given off from a certain volume of aqueous hydrogen peroxide is a simple way of finding its concentration.

In recent years there has been increased interest in herbal teas, many of which are produced from plants that contain relatively high amounts of minerals, such as manganese. Herbal teas are not a new idea; fermented rosebay willowherb (*Epilobium angustifolium*) tea was a traditional Russian hot beverage for hundreds of years before it was largely replaced by present-day tea.

Rosebay willowherb (sometimes called fireweed) is one plant that is rich in minerals and, unlike modern tea, does not contain harmful uric acid or oxalates. One big advantage of this plant is that it grows abundantly in the wild and is freely available. After harvesting, the leaves are removed, left to ferment under suitable conditions and then left to dry. Rosebay willowherb contains a relatively high amount of manganese. One method of finding the amount of manganese present would be to collect some leaves and burn them to ash. Further treatment would give a purple solution of potassium manganate(VII) (permanganate). The amount of manganese present can then be found by using colorimetry.

Potassium manganate(VII) is an example of a manganese compound that has some uses in water purification. It is particularly useful where the water to be used is not mains water. The compound is very effective in destroying traces of organic material present in the water, as well as removing taste and odours produced by algae. Samples of the water need to be tested with potassium manganate(VII) at suitable intervals to determine the amount to be added for purification. It will also oxidise iron compounds and sulfides to insoluble compounds that can then be removed. Potassium manganate(VII) produces an intensely purple solution that changes to a yellow-brown colour during this water purification process, and eventually produces insoluble brown-black manganese dioxide. If too much of the potassium manganate(VII) is used, then the treated water will remain a pink-purple colour.

Manganese is one of the most abundant metals in the soil. This metal and its relatively non-toxic compounds are still used extensively in many areas.

Oranges

Oranges were probably first cultivated in the Far East about 4500 years ago. In Europe, citrus fruits, including the orange, first arrived in Italy in the eleventh century, but it was not until about 400 years ago that the sweet orange became well established in Europe, and then later in the United States. Oranges are rich in Vitamin C; early European sailors planted orange trees along their discovery routes to prevent the disease scurvy.

Most citrus fruits grow well under moderate temperatures, between 16 °C and 29 °C. Oranges cannot be grown outside in Britain, but they have been grown inside for the last two hundred years in greenhouses.

Collecting and harvesting oranges can be very labour-intensive, because they are difficult to pick using harvesting machines. Ripe oranges may still have some orange-green skin colour and ethene gas can be used to turn this into the familiar orange colour. However, the use of this gas does not lead to internal ripening. Oranges can be stored for a few weeks in refrigerated conditions before they are distributed to the shops, but once returned to room temperature their shelf life is about a month. Over the years much research has been carried out into the development of different orange varieties. The many varieties of orange differ in a number of features, such as their acidity, sweetness, size and peel thickness.

A major problem with orange production is attack by bacteria that are carried by sap-sucking psyllid insects. This bacterial attack produces citrus greening disease. There is no known cure for this disease, and where it has occurred the usual treatment is to quarantine the affected area.

Many people peel their oranges and eat the fleshy part, which contains most of the juice. The outer rind is also edible, but it is not sweet. Large numbers of oranges are picked and pressed to produce orange juice. Ripe oranges provide juice that is acidic, with a pH of 3 to 4. The total amount of soluble solids in the juice is about 10%, and the acid content is about 1.5%. Oranges are an excellent source of Vitamin C. A typical orange of mass 150 g contains about 80 mg of Vitamin C. Some orange juice is concentrated and chilled to produce frozen concentrated orange juice (FCOJ). It is in this form that most orange juice is exported. This concentrated juice has a degree Brix (ºBx) of about 65. The Brix scale gives a measure of the sugar content in an aqueous solution. One degree Brix is 1 g of sugar in 100 g of solution. To make 'ready to serve' orange juice from FCOJ, water is added to bring the Brix degree level down to 12, which is the average value for freshly squeezed orange juice.

One simple way of measuring the Brix value for orange juice is to use a hydrometer (Fig. 2a) to measure its density, and then look up the Brix value in tables.

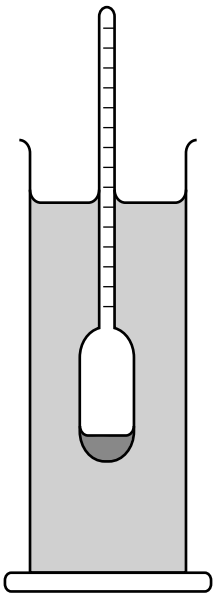

Fig. 2a

Another method is to measure the refractive index of the sugar solution. However, if this method is used, it is important to use a reference temperature.

A third method is to measure the infrared absorption spectrum of the juice. The intensity of certain frequencies in the spectrum provides an indication of the sugar content in the juice.

Oranges provide products other than edible fruits and orange juice. Oils can be obtained from both the peel and the flowers. Orange oil is obtained by pressing orange peel. The oil consists principally of limonene, together with small quantities of other compounds. The different compounds present in orange oil can be separated by gas-liquid chromatography, and then identified from a study of their retention times.

Orange flower oil can be obtained from fresh orange flowers. The petals are covered with water and the mixture, then steam distilled. This process gives a distillate containing two layers, with the orange flower oil on the top and an aqueous layer beneath. The two layers can be separated using a separating funnel, seen in Fig. 2b.

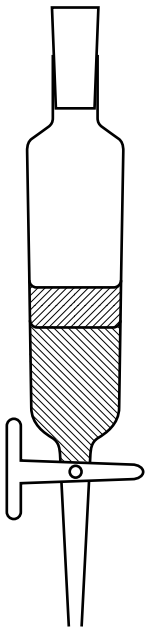

Fig. 2b

Oranges continue to be a vitally important commercial crop, with very large quantities grown annually.