OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE **G628/CS**

APPLIED SCIENCE

Unit 9: Sampling, Testing and Processing

PRE-RELEASE CASE STUDY – CANDIDATE INSTRUCTIONS

For issue on or after 17 November 2007

CUP/T43782

This document consists of **7** printed pages and **1** blank page.

Notes for Guidance

1. This pre-release case study contains two articles, which are needed in preparation for the externally assessed examination in Unit 9: 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 60% 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.

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Arsenic contamination from a mine in Northern Spain

Mercury continues to be a very important metal although it is very toxic. In nature, mercury seldom occurs as the element but more often as its sulphide, cinnabar, and this often occurs with a number of ores of other metals. In the Asturias region of Northern Spain mercury deposits occur together with arsenic-containing ores. There are few commercial uses for arsenic and much of the arsenic-containing material has been left on spoil heaps. Over a period of time leaching of arsenic occurs from the spoil heaps into the ground water system. This causes an environmental risk to both ecosystems and humans.

The mines in the Asturias region were closed in 1974 as a consequence of international concerns about the environmental effects of mercury and a drop in the market price for the element. Unfortunately, in this region there are still remains of mining activities. These include substantial quantities of spoil materials on the surface, without any preventative measures to stop the leaching out of soluble arsenic compounds by rain water.

Much of the arsenic in the spoil heaps has been derived from the mercury extraction process, rather than mining, and is present as arsenic(III) oxide, As_2O_3.

During the most productive time of one mine's operation, around 17 000 kg of mercury was obtained each month. Cinnabar was roasted at a temperature of 580 °C to give sulphur dioxide and mercury vapour. These vapours were then passed through a series of condensers to give mercury as a liquid. The solid waste material was stock-piled. The size of the spoil heap is estimated to be 150 000 m^3, with depths of up to 10 m. The concentration of arsenic in the spoil heaps varies according to the stage of the mining and extraction that has produced it.

Leaching of arsenic has meant that soil, plants and water have become contaminated for some distance from the mine. The removal of arsenic by rain water depends on a number of factors that include the type and pH of the soil and the concentration of arsenic present.

Recently, scientists have collected representative samples and taken them to a laboratory. At the laboratory the solid samples were then crushed and sieved and all the samples analysed for arsenic and metals such as copper and lead.

Soil samples were collected by dividing the surface into 50 cm × 50 cm grids and then removing a sample from each grid at a depth of 20 cm.

Samples of stream sediments, downstream from the mining area, and water from wells were collected. They were analysed for arsenic and other metals, including mercury, by inductively coupled plasma-emission spectroscopy (ICP-ES) and atomic absorption spectroscopy (AAS).

A summary of the results of these analyses for arsenic is shown in Table 1.1.

Table 1.1

source of sample	concentration of arsenic / mg kg^{-1}	number of samples taken
spoil heap	20 – 72 000	12
soil	5 – 9120	76
sediment	650 – 800	3
uncontaminated soil	5 – 10	10
ground water	0.02 – 3190	5
uncontaminated ground water	0.001	10

At present no remedial action is being taken to reduce this environmental pollution by arsenic and mercury. This is a matter of serious concern for both the short and long term health of plants and animals.

Jute – a fibre with a thousand uses

The jute plant (Corchorus) has been cultivated in Bengal since ancient times, when it was grown mainly as a garden plant, and its leaves used as a vegetable and for medicinal purposes.

Around 200 years ago jute fibre began to be recognised as an important and cheap raw material and processing the fibre into textile products became established in Dundee, Scotland.

Jute is a plant that requires a warm and wet climate. It is a major economic product of Bangladesh, where monsoon temperatures are in the range 20–40 °C with a humidity of 70–80%. The plant requires 5–8 cm of rainfall weekly during its growing period. Most jute varieties grow well if the soil has a pH between 5.0 and 8.6.

The plants have a higher carbon dioxide assimilation rate than trees. One hectare of jute plants can remove 15 tonnes of carbon dioxide from the atmosphere and release 11 tonnes of oxygen during its 100 day growing period.

All plants are susceptible to attack by diseases and insect pests, and jute is no exception to this. Rotting occurs because of fungal organisms and, in addition, up to 12% of jute may be lost by insect attack, principally by the jute-hairy caterpillar (*Spilosoma obliqua*), which feeds on the leaves. The use of modern insecticides can reduce this problem but this is not always affordable as jute is often grown by the poorer farmers. Recently, a natural insecticide made from the leaves of the neem plant has been shown to be a cheap and effective alternative to expensive synthetic insecticides.

When the jute plant is ripe the stalks are cut off close to the ground, tied into bundles and soaked in water for about 20 days. This process softens the tissues and enables the outer fibres to be separated from the inner tissues. The fibres are then washed and dried.

Source: NYP Corp

Fig. 2.1

In the Indian sub-continent jute (hessian) bags are commonly used by farmers for storing both food and farm products. Unfortunately, the way in which the bags are woven leaves gaps for insects to enter. One method to prevent this occurring is to spray the bags with sodium arsenate solution. This compound is very poisonous and whether it should be used for this purpose is doubtful, but the method is nevertheless effective.

One of the many uses for jute is as a textile, but with the development of synthetic materials such as polypropylene and polyesters, the jute industry went into decline. However, there has been something of a revival with jute being used in combination with other fibres. Jute has a big advantage in that it is completely biodegradable and it does not stretch very much (low extensibility), unlike many synthetic alternatives.

The energy cost of producing jute is only 2% of the energy cost of producing glass fibres. There has been considerable research into using jute fibres as a replacement for glass fibres in composite materials, where a polymeric matrix is reinforced with fibres.

Jute is the second most important vegetable fibre after cotton. It will have an increasing importance as dependence on oil-derived synthetic textiles declines due to oil shortages and increasing costs.

Copyright Acknowledgements:

Fig. 2.1 Source: NYP Corp, www.nyp-corp.com