HSA Forensic Laboratories have been accredited since 1996 and are currently accredited under the ANSI National Accreditation Board (ANAB) Forensic Testing Laboratory Programme.

All procedures and methods performed in the laboratories (as set out in this Primer) are validated to conform to international best practices and standards.

A Guide to Forensic Analysis

Illicit Drugs Laboratory

The analysis of exhibits containing drugs listed in Section 17 (Presumption concerning trafficking) of the Misuse of Drugs Act 1973 is performed using internationally accepted methodologies and validated instrumentation.

The analytical procedure involves a visual examination, classification of contents into different groups if required, description of contents, weight determination, homogenisation, sample preparation, qualitative and quantitative analysis.

HSA
Health Sciences Authority

General Scheme for the Quantitative Analysis of Drugs

Analytical Procedure

Visual Examination/ Grouping/ Description

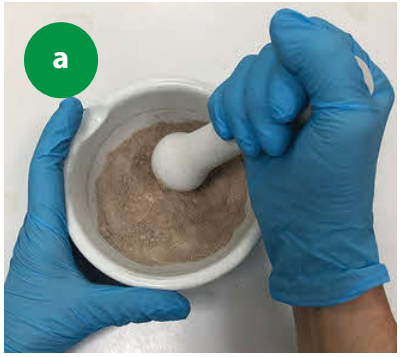
1 The contents of the exhibit are visually examined and separated into groups based on the physical appearance (e.g. form and colour) of the contents if necessary. The physical appearance of each group is documented and each group is analysed separately.

Weight Measurement

2 The weight of the content in each group is obtained using an analytical balance.

Quality assurance procedure:
All balances are calibrated annually and verified daily using standard weights before use.

Homogenisation



3 The content is pulverised and homogenised using one of the homogenisation methods: (a) mortar and pestle (b) laboratory blender.

Homogenisation will ensure that the test sample taken for analysis is representative of the whole exhibit.

Qualitative Analysis - Screening Tests

(i) Colour Tests

4 **A colour test can be performed to screen for the possible class of drugs present.**

Example:

A purple colouration obtained for Marquis Test indicates the possible presence of opiates.

(ii) Handheld Raman Spectroscopy

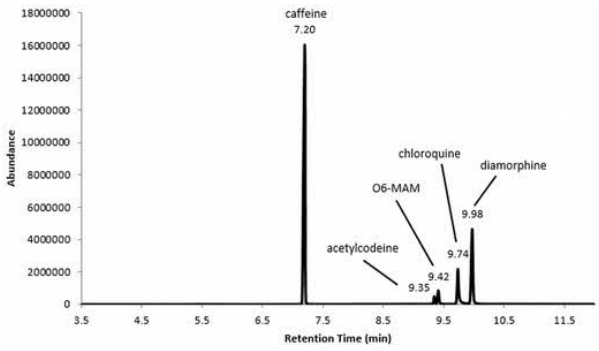
5 **A handheld Raman spectrometer can be used to screen for drugs present in unknown substances.**

The sample needs to be relatively pure in order to determine its identity.

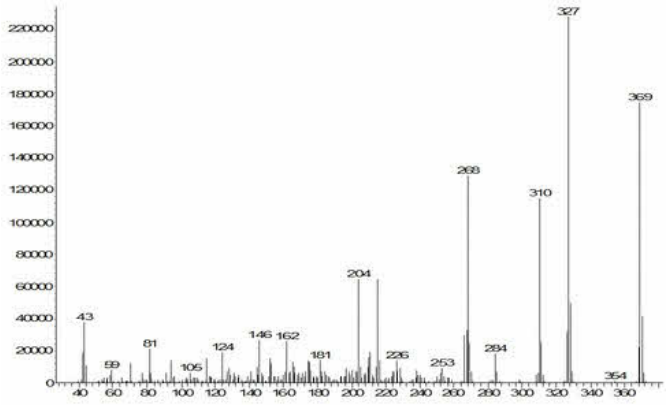
A positive match is achieved when the spectrum of the sample matches to that of a reference standard in the database.

Qualitative Analysis

6 **A small amount of sample is dissolved in a solvent for qualitative analysis by Gas Chromatography-Mass Spectrometry (GC-MS).**



Example of a gas chromatogram of a heroin exhibit.



Example of a MS fragmentation pattern of diamorphine.

7 **The sample solution is analysed by GC-MS, a confirmatory technique used to determine the identity of the drug present.**

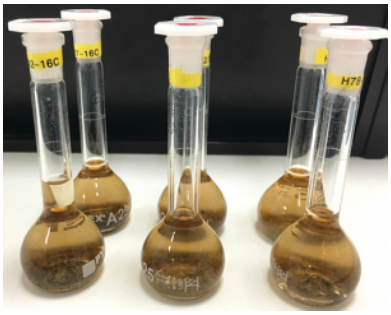
GC-MS is an analytical method that combines two techniques - GC and MS, to identify the different compounds present in a sample. The GC separates the different compounds present in a sample based on their properties and interactions with the GC column. The MS produces the mass fragmentation pattern of the compound which is specific to its chemical structure. This allows the identification of the compound by comparing to the drug standard or database.

To perform the analysis, a sequence containing a listing of samples to be analysed is created. The GC-MS automatically analyses the samples based on the sequence. After the analysis is completed, the results are interpreted.

Quality assurance procedure:

Performance check for the GC-MS is conducted and evaluated prior to its use for analysis. Solvent used for dissolution of samples is analysed to ensure that the solvent and the instrument meet the required quality standard.

Quantitative Analysis



8 **An amount of the homogenised sample is accurately weighed and dissolved in a solvent for quantitative analysis by the Liquid Chromatography-Diode Array Detection (LC-DAD) and/or Gas Chromatography-Flame Ionisation Detection (GC-FID).**

A small amount of test sample such as 0.1 gram is sufficient for quantitative analysis.

A Liquid Chromatograph with Diode Array Detector.

A Gas Chromatograph with Flame Ionisation Detector.

9 **The sample solutions prepared are analysed by LC-DAD and/or GC-FID to determine the purity of the drug present in the sample.**

Both techniques firstly separate the different compounds present in the sample based on their properties and interactions with the column. The detector measures the signal intensity of the compound present in the sample and the amount of compound present is determined with reference to a drug standard with known concentration.

A sequence is created for the instrumental analysis. The instrument then automatically analyses the samples based on the sequence.

After the analysis is completed, the purity result of the compound present in each of the analysed samples will be computed automatically.

Quality assurance procedure:
The instrument is calibrated using drug standard solution. The calibration of the instrument is checked using two quality control samples before and after each batch of samples to ensure the accuracy of the analysis.
Solvent used for dissolution of samples is analysed for each batch of analysis to ensure that the solvent and the instrument meet the required quality standard.

Report Generation

Once all the necessary tests are performed and the results obtained, the Analyst reviews and interprets all examination records and data from the analysis, and prepares a certificate under Section 16 of the Misuse of Drugs Act 1973.

All documentation and the certificate are reviewed by an independent senior Analyst before the certificate is released.

The remaining contents of the exhibit after analysis are returned to the law enforcement agency.

References

1. Houck, Max M., and Jay A. Siegel. Fundamentals of Forensic Science. Academic Press, Elsevier Ltd, 2015.

2. White, P. Crime Scene to Court: The Essentials of Forensic Science. Royal Society of Chemistry, 2016.

Glossary

Abundance – The signal intensity of the compound.

Calibration of balances – The process of adjusting the balance using standard weights so as to achieve the required accuracy.

Calibration of LC or GC – The process of configuring the LC/GC using specially prepared drug standard solutions so as to provide accurate results for analysed samples.

Column (refer to both LC and GC column) – A glass or stainless steel coil that is filled with a stationary phase coated on the inner surface of the column. The sample solution will move through the column with the mobile phase. Depending on the compounds' affinity for the stationary phase and mobile phase, each compound in the sample solution will move at its own pace through the column, hence separating one compound from the other along the way.

DAD – Diode Array Detection. A Diode Array Detector measures the ultraviolet and visible absorption of the compound at single or multiple wavelengths. This is the most common detector used in LC.

FID – Flame Ionisation Detection. A Flame Ionisation Detector measures the concentration of organic compounds in a gas stream. This is the most common detector used in GC.

GC – Gas Chromatography, a separation technique using an inert gas as the mobile phase.

Homogenise – To make uniform and consistent.

LC – Liquid Chromatography, a separation technique using a liquid mobile phase.

Mobile phase – The liquid or gas that flows through a chromatographic system, moving the compounds to be separated at different rates over the stationary phase in the column.

MS – Mass Spectrometry, an analytical technique that ionizes chemical species and measures the ions based on their mass-to-charge ratio, forming a characteristic fragmentation pattern.

Pulverise – To reduce to powder by pounding or grinding.

Qualitative analysis – Identification of the drugs present in the sample.

Quantitative analysis – Determination of the amount of drugs present in the sample.

Quality control samples – Standard solutions of known concentrations analysed together with samples to check the accuracy of the whole sequence run.

Retention time – The time taken for a compound to travel through a column. It is measured from the time of injection to detection.

Stationary phase – The solid or liquid phase of a chromatographic system on which the compounds to be separated are selectively bonded.

Screening Tests – Initial, qualitative drug tests which are conducted to indicate the possible presence of a suspected substance.

Sequence – A listing of samples to be analysed along with the method and other necessary test parameters such as the position of the sample vials and injection volume to be used for each analysis. Once defined, the sequence for an instrument may run unattended, automatically analysing the samples defined in the sequence.