Department of Forensic Science

CONTROLLED SUBSTANCES TRAINING MANUAL

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1 INTRODUCTION

1.1 Purpose and Scope

1.1.1 The purpose of this manual is to provide a uniform coordination of the training of forensic drug chemists employed by the Commonwealth of Virginia. This work is intended to be used in a formal training program that will establish a certain minimum standard of professional competency throughout the statewide branches of the Department of Forensic Science.

1.1.2 Certain inherent qualities of drug evidence prohibit the establishment of a rigid set of standard procedures to cover each and every case. Therefore, enough latitude has been given to allow for independent thought and individual freedom in selecting alternative courses of action. Upon completion of this course the trainee will be thoroughly familiar with the options available to handle most pieces of evidence that will be encountered.

1.1.3 The sequence in which the tasks are presented in the outline should not necessarily be considered as a mandatory order of instruction. Exposure to legal aspects and testimony will be continuous throughout the training.

1.2 Coordination of the Program

1.2.1 The Training Coordinator (TC) will be the Section Supervisor, Group Supervisor, or designee, in each lab.

1.2.2 The coordinator will be responsible for the overall training, but may delegate certain duties and blocks of instruction to other chemists.

1.2.3 Any inter-laboratory training should be arranged through the appropriate coordinators.

1.3 Training Period

1.3.1 The length of the training period is a highly variable matter and will be left to the determination of the Chemistry Program Manager. Certain individuals may require less time than others, depending on experience, education, or learning ability. However, the full training period for trainees with no prior experience should require a minimum of 6 to 9 months. Training is complete upon successful completion of the Final Competency Examinations (as outlined in the DFS Quality Manual).

1.4 Location of Training

Whenever practical, the bulk of an individual's training will occur in the lab to which they will be assigned.

1.5 Training Goals

The training should culminate so that the trainee has the following:

- The knowledge of the basic chemistry, pharmacology and scheduling of controlled substances
- The knowledge of the principles and practices of forensic analytical chemistry related to the analysis of controlled or commonly abused substances
- The knowledge of the theory and applications of the variety of instrumentation and specialized techniques used to analyze controlled substances
- The ability to successfully navigate the Department’s Laboratory Information Management System (LIMS) to properly conduct evidence transfers, create accurate certificates of analysis, and manage subpoena disposition.
- The ability to perform accurate forensic analysis independently and proficiently
- The ability to skillfully present and defend analytical findings in courts of record
- The ability to perform administrative and technical review of case files

1.6 Instructions to the Trainee

1.6.1 The trainee is expected to keep a loose-leaf notebook of information compiled on the *Color Test / TLC Worksheet* (221-F200) for the drug knowns listed in Appendix A. This will be completed during the Practical Exercises associated with Introduction to Drugs, Color Tests and Thin Layer Chromatography. This notebook will be checked by the TC upon its completion.

1.6.2 The written answers to the study questions listed in each section will be used as reference material once the trainee is qualified as an examiner. Therefore, references are to be listed for each answer whenever possible. A list of useful references has been provided in the References sections. The completed study questions are to be turned into the TC as scheduled. After discussion(s) with the TC, study question answers may be expanded and/or modified to meet expectations.

1.6.3 The trainee will assist with casework throughout the training, but only under the direct supervision of a qualified examiner and after demonstrating competence (per ¶ 1.7.5).

1.6.4 The trainee's progress will be evaluated with study questions, practical exercises, written examinations, oral sessions, mock trials, and competency examinations. Written examinations will be evaluated on a Pass/Fail basis. "Pass" means that the trainee has shown competence in understanding and explaining the examination concepts. After discussion with the TC, written examination answers may be expanded and/or modified to meet expectations.

1.6.5 The trainee should provide a weekly progress report to the TC.

1.7 Instructions to Training Coordinators

1.7.1 As previously stated, the intent of the manual is to provide a guide that will ensure each and every trainee of receiving certain basic principles and fundamentals necessary to the complete education of a forensic drug chemist. All of the listed topics must be incorporated into the program. Some of the topics will strongly suggest an order of events and this ranking should be followed. Any significant deviation from the manual must be cleared first with the Chemistry Program Manager.

1.7.2 The performance of the trainee will be evaluated during the course of the program. The TC must submit regular evaluations of the new chemist's progress (using the Qualtrax Workflow) to the trainee's direct Supervisor, Section Supervisor, Chemistry Program Manager, and Laboratory Director. The coordinator is to discuss this evaluation with the trainee prior to forwarding it to the appropriate reviewers. Any relevant comments by either the trainee or coordinator are to be included with the report.

1.7.3 The TC is responsible for maintaining the Department's training program documentation during the training period. Each section in the chart of the *Controlled Substances Training Worksheet – Examiner* (221-F201) must be initialed and dated upon completion of the specified task. If any task is not completed, for any reason, this must be explained in the training worksheet and approved by the Chemistry Program Manager.

1.7.3.1 The contents of the sections may be skipped for previously trained and qualified examiners who have demonstrated to the TC a comprehensive knowledge of the section's subject matter with the approval of the Chemistry Program Manager.

1.7.3.1.1 The TC will submit a written recommendation to the Chemistry Program Manager outlining the sections which may be omitted or modified and the justification for doing so.

1.7.3.1.2 A copy of the approved recommendation will be placed in the training binder.

1.7.3.2 Written examination questions for each section will be selected or derived from the study questions by the TC.

1.7.3.3 The written examination will be given in a “closed book” format.

1.7.4 If the trainee cannot meet the criteria expected of them during the period allowed for training, then steps must be taken to effect appropriate action.

1.7.5 Supervised Casework Work-Alongs:

1.7.5.1 Prior to handling evidence/performing supervised work-alongs on casework, the trainee shall demonstrate competence through the successful completion of practical exercises or completion of a competency test. The trainee shall be authorized to perform supervised casework tasks within the scope of the associated practical exercise(s), or competency test, following successful completion of the practical exercise(s) or competency test.

1.7.5.2 The “Controlled Substances Training Documentation” form (221F-201) or a MFR shall serve to document the aforementioned authorizations by the TC.

1.7.6 The TC is responsible for ensuring that the trainee is thoroughly prepared for legal questioning. This can be done by a combination of mock trials, prearranged as well as impromptu question and answer sessions, and observation of courtroom testimony given by experienced examiners.

1.7.6.1 The scheduling of practice mock trials is to be done by the TC. These are to be conducted throughout the training period. The trainee will undoubtedly benefit from verbalizing at the end of each module.

1.8 Unknown Samples

1.8.1 A program of graduated training samples is to be interspersed throughout the training period.

1.8.1.1 The sets of unknowns will become more difficult with successive samples.

1.8.1.2 The TC should prepare or direct the preparation of the samples.

1.8.1.3 The samples should be prepared so that their identity is known to the TC.

1.8.1.4 The final sets of unknowns that will be used for the final mock trial will be prepared by the TC and approved by the Chemistry Program Manager. The unknown samples shall be relevant casework-like samples to include, at a minimum, a powder, a tablet/capsule, a sample for quantitation, and plant material.

1.8.1.5 The actual number of training samples submitted to the trainee is left to the determination of the TC.

1.8.2 The trainee should receive unknowns which will be presented as if they were real cases. To the greatest extent possible, all of the related paperwork, security, analyses, and report writing will be handled in the same way as an actual submission. Items of paraphernalia should be included from time to time in the samples.

1.8.3 After the submission of the report for each set of unknowns, the TC must review all of the work with the trainee, including any notes, instrumental data, results obtained and report wording. The evidence itself should be checked for proper labeling and handling.

1.9 Final Competency Examinations

1.9.1 Practical Test

1.9.1.1 A competency examination will be conducted following the successful completion of the blocks of instruction.

1.9.1.2 Case samples will be fabricated and validated per Quality Manual – Competency Exam/Practical Test. The competency samples shall include both qualitative and quantitative samples and shall be approved by the Chemistry Program Manager.

1.9.1.3 The fabricated case serves as a monitor of the trainee's competency in applying techniques and procedures to actual casework samples.

1.9.2 Oral Technical

1.9.2.1 Prior to the final mock trial, an oral technical examination of the trainee will be conducted to ascertain the technical knowledge of the individual. Minimally, the Chemistry Program Manager and TC shall be in attendance. This will be limited to no more than 4 hours.

1.9.2.2 It is expected that the chemical structures of any drugs and reagents utilized in the final mock case be known and understood by the trainee.

1.9.2.3 After the technical, supervision/management will assess the trainee's performance.

1.9.2.4 The outcome of the examination will be deemed either "Satisfactory" or "Not satisfactory".

1.9.2.5 If the panel determines that the trainee's performance was not satisfactory, steps must be taken to effect the appropriate action.

1.9.3 Mock Trial

1.9.3.1 A recorded final mock trial will follow the successful completion of the oral technical examination. The fabricated case prepared for the Practical Test will be used in a mock trial setting..

1.9.3.2 The atmosphere of the final mock trial will be formal. That is, it will be conducted in the same manner as a real courtroom situation. This includes conduct, protocol, attire, and all other aspects. Answers and explanations are to be delivered as to a lay jury.

1.9.3.3 The final mock trial will not exceed two (2) hours.

1.9.3.4 The role of prosecutor will be assumed by the TC or a designee. There may be two defense lawyers, one of whom must be a qualified drug chemist. The Chemistry Program Manager must agree with the selection of all participating players for the trial. This agreement may be captured in an email or MFR for inclusion in the training binder.

1.9.3.5 The trial may be stopped at any time upon the request of any of the involved parties.

1.9.3.6 After the trial, the Evaluation Committee (EC) will assess the trainee's performance. The EC shall consist of the TC, Section Supervisor (and Group Supervisor, if in the supervisory chain of command), Laboratory Director, and Chemistry Program Manager.

1.9.3.7 Each member of the EC shall offer their opinion as to whether the candidate successfully completed the exercise. The candidate must clearly demonstrate his/her ability to present and defend the practical test results on the stand in a manner that meets Department testimony standards. At least one Mock Trial Evaluation Form shall be completed and signed by each member of the EC to document the candidate's performance.

1.9.3.8 The outcome of the trial will be deemed either "Satisfactory" or "Not satisfactory".

1.9.3.9 If the EC determines that the trainee's performance was not satisfactory, steps must be taken to effect the appropriate action.

1.9.3.10 This evaluation will be immediately followed by a short performance critique.

1.9.3.11 The TC will review the recording of the trial with the trainee as soon as possible. Other participants/observers should provide any comments to the TC as soon as possible.

1.9.4 Satisfactory performance on the entire competency examination must be achieved before the individual is qualified to perform the duties of an examiner.

1.9.5 The TC will complete pages three and four of the *Controlled Substances Training Worksheet - Examiner* (221-F201) as documentation.

1.10 Transition from Trainee to Examiner

1.10.1 After the new chemist has successfully completed this training, there follows a period of adjustment. The job of the coordinator is to ensure that this transition from trainee to qualified examiner takes place as smoothly as possible. If the TC is also the chemist's supervisor, it is an easy matter to monitor the work of the new person. If this is not the case, the coordinator will have to work with the person's supervisor to ensure that everything is proceeding satisfactorily.

1.10.2 Casework will be introduced stepwise under the close supervision of a qualified senior chemist.

1.10.3 All reports must be technically reviewed prior to release by the supervisor or designee(s) for a period of at least three months.

1.10.4 The supervisor, TC, or designee will accompany and monitor the newly qualified examiner to court for the first several cases.

1.10.5 The new chemist will be required to evaluate the training program approximately 4-6 months following qualification. The DFS *Training Program Evaluation Form* (100-F121) should be forwarded to the Chemistry Program Manager. The Chemistry Program Manager will review the completed evaluation form and use the information to improve the training of future chemists.

1.11 Training for Forensic Laboratory Specialists

1.11.1 Training for Forensic Laboratory Specialists (FLS) within the Controlled Substances Section will be coordinated by the Section Supervisor or designee.

1.11.2 The training period is variable and the FLS will incrementally begin working independently on duties where the training segment is complete while continuing training on additional duties. The FLS should be working independently on most tasks after approximately two months.

1.11.3 The TC is responsible for maintaining the training program documentation during the training period. Each section in the chart of *Controlled Substances Training Worksheet - FLS* (221-F202) must be initialed and dated upon completion of the specified task. Not all sections may be applicable depending on location. If any task is not completed, for any reason, this must be explained in the training worksheet.

1.11.4 Completion of Training

1.11.4.1 The training will be considered complete when the FLS has completed all of the segments that had been required by the TC.

1.11.4.2 The *Controlled Substances Training Worksheet - FLS* (221-F202) for the FLS training will be initialed and completed for each area assigned by the TC and any other personnel who assisted in the training in accordance with the Department Quality Manual.

1.11.4.3 When the training is complete, a MFR detailing the recommendation to qualify the trainee in the applicable duties will be submitted to the Chemistry Program Manager for approval. This process will also prompt an update of the FLS's work authorization by the Laboratory Director. Once approved, the TC will notify all Controlled Substances supervisors, section supervisors within their laboratory, the QA Section Supervisor and training records will then be stored in accordance with the Department Quality Manual.

1.11.4.4 If the FLS cannot meet the criteria expected of them during the period allowed for training, steps will be taken to effect appropriate action.

2 ORIENTATION

2.1 Minimum Requirements for Orientation

2.1.1 Introduction to local operating facilities and personnel

2.1.2 Assignment of a work/study area

2.1.3 Coverage of the following:

- Quality Manual
- Departmental Administrative policies
- Regional Operating Procedures (ROP)
- Section Procedures Manual
- Section Training Manual
- DFS Safety Manual
- Organization of the Department of Forensic Science
- ISO/IEC 17025:2017
- ANAB AR 3125

2.1.4 Introduction to the technical capabilities of all regional laboratories, to include definitions of the regional boundaries and areas of overlap

2.1.5 Explanation of the purpose of the training program including an insight into the course of events and what the trainee is expected to accomplish

2.1.6 Explanation of the operation of local, state and federal law enforcement agencies and court systems

2.1.7 Clarification of the duties of a forensic drug chemist

2.1.8 Introduction to LIMS

2.1.9 Discussion of ethics in forensic science

2.1.10 General overview of forensic science technical areas and DFS Section Specific Modules (Qualtrax)

3 BASIC LITERATURE AND REFERENCES

3.1 This section is intended to introduce the trainee to the pertinent technical literature available. In some instances, it may be helpful to demonstrate the usefulness of certain works. Other pertinent references are listed in the References sections of this manual. The trainee must have a working knowledge of the sources most frequently used, including but not restricted to the following:

3.1.1 *United States Pharmacopeia/National Formulary*

3.1.2 *Merck Index*

3.1.3 *Physician's Desk Reference*

3.1.4 *DEA Logo INDEX*

3.1.5 Horwitz, *Official Methods of Analysis of the Association of Official Analytical Chemists*

3.1.6 Schirmer, *Modern Methods of Pharmaceutical Analysis*

3.1.7 Clarke, *Isolation and Identification of Drugs*, Volumes 1, Second Edition and 2, First Edition

3.1.8 Florey, *Analytical Profiles of Drug Substances*, Volumes 1 – 20

3.1.9 Brittain, *Analytical Profiles of Drug Substances*, Volumes 21-29

3.1.10 Moffat, ed., *Clarke's Isolation and Identification of Drugs, 2nd ed.*

3.1.11 Moffat, ed., *Clarke's Analysis of Drugs and Poisons, 3rd ed.*

3.1.12 Mills, et al., *Instrumental Data for Drug Analysis*

3.1.13 Schultes and Hofmann, *The Botany and Chemistry of Hallucinogens*

3.1.14 Bailey and Rothblatt, *Handling Narcotic and Drug Cases*

3.1.15 Feigl, *Spot Tests in Organic Analysis*

3.1.16 *Alphabetical Listing of Drug Products/Distributors* - DEA Publication

3.1.17 *Analysis of Drugs* - DEA Publication

3.1.18 *Microgram Bulletin* - DEA Publication (archived)

3.1.19 *Microgram Journal* – DEA Publication (archived)

3.1.20 McLafferty, F. W., *Interpretation of Mass Spectra*, Second Edition

3.1.21 Sunshine, I., *Handbook of Mass Spectra of Drugs*

3.1.22 Willard, Merritt & Dean, *Instrumental Methods of Analysis*

3.1.23 McFadden,W. H. , *Techniques of Combined Gas Chromatography/Mass Spectrometry; Application in Organic Analysis*

3.1.24 Beynon, Saunders and Williams, *The Mass Spectra of Organic Molecules.*

3.1.25 Watson, J. T., *Introduction to Mass Spectrometry; Biomedical, Environmental and Forensic Applications*

3.1.26 *Drug Identification Bible.* Grand Junction, CO: Amera-Chem, Inc., various editions.

3.1.27 Silverstein, R. M. et al., *Spectrometric Identification of Organic Compounds* New York: John Wiley & Sons, 1991.

3.1.28 Rösner, Peter, et al., *Mass Spectra of Designer Drugs*, Germany: Wiley-VCH, 2007.

3.1.29 CND ANALYTICAL REFERENCES

- Amphetamines and related phenethylamines
- Substituted 3,4-Methylenedioxyamphetamines
- Cocaine, Local Anesthetics, and common diluents
- Precursors and Chemicals
- Methylaminorex and analogs
- Narcotics
- Anabolic Steroids
- Hallucinogens
- Barbiturates

3.1.30 Drozd, J., *Chemical Derivatization in Gas Chromatography*

3.1.31 Saferstein, Richard, *Forensic Science Handbook*, Volume II

3.1.32 Watson, J.T., *Introduction of Mass Spectrometry*, 3rd Edition

3.1.33 *Basic Training Program of Forensic Drug Chemists*, D.E.A. Publication

3.1.34 Course Materials from the VCU Drug Analysis courses, including PowerPoint presentations and handouts

4 INTRODUCTION TO DRUGS

4.1 Objectives

4.1.1 To familiarize the trainee with different classes of drugs of abuse

- Narcotics
- Stimulants
- Depressants
- Hallucinogens
- Miscellaneous prescription drugs
- Cannabimimetic Agents
- Substituted Cathinones / Research Chemicals
- Cannabis (Marijuana/Industrial Hemp)

4.1.2 To familiarize the trainee with simple pharmacology of the major classes of drugs

4.1.3 To familiarize the trainee with the molecular structures of the most commonly abused drugs

4.1.4 To familiarize the trainee with the origin and physical form of some of the more common drugs

4.1.5 To familiarize the trainee with the sources of information for various controlled substances

4.1.6 To familiarize the trainee with the legal aspects of controlled substances, to include scheduling in the Code of Virginia and the Federal Drug Control Act

4.2 Modes of Instruction

4.2.1 Self-directed study through reading, study questions, and practical exercises

4.3 References

4.3.1 *Drug Identification Bible,* Grand Junction, CO: Amera-Chem, Inc., various editions.

4.3.2 Goodman and Gilman's *The Pharmacological Basis of Therapeutics.* New York: Pergamon Press. 1990.

4.3.3 Shulgin, Alexander. *PIHKAL: Phenethylamines I Have Known and Loved.* Berkeley: Transform Press, 1995.

4.3.4 *Drugs of Abuse*, DEA Publication.

4.3.5 *Code of Virginia*, "The Drug Control Act" (with emphasis on § 54.1-3401; § 54.1-3443 - § 54.1-3456 and §18.2-247 – §18.2-265)

4.3.6 U.S. Controlled Substances Act*,* Title 21, Chapter 13

4.3.7 Ciolino, L. A. et al. "The Chemical Interconversion of GHB and GBL" Forensic Issues and Implications" *Journal of Forensic Sciences*, 2001, Vol. 46, No. 6, pp. 1315-1323.

4.3.8 Bommarito, C. "Analytical Profile of Gamma-Hydroxybutyric Acid (GHB*)" Journal of the Clandestine Laboratory Investigating Chemists Association*, Vol. 3, No. 3, 1993.

4.3.9 Chappell, J. S. "The Non-equilibrium Aqueous Solution Chemistry of Gamma-Hydroxybutyric Acid" *Journal of the Clandestine Laboratory Investigating Chemists Association*, Vol. 12, No. 4, 2002.

4.3.10 Inaba, D. S. and Cohen, W. E. *Uppers, Downers, All Arounders* Ashland, OR: CNS Publications, Inc.,

2000.

4.3.11 Sacco, L.N. and Finklea, K. “Synthetic Drugs: Overview and Issues for Congress”. *CRS report*. May 2016.

4.3.12 Moffat, A.C. editor *Clarke’s Isolation and Identification of Drugs.* London: The Pharmaceutical Press, 1986, pp. 423-425.

4.3.13 Nakamura, George R. and Thorton, John I. “The Forensic Identification of Marijuana: Some Questions and Answers”. *DEA* (1973), Vol. 1, pp. 102-112.

4.3.14 Waller, C.W. The Chemistry of Marijuana. Proc. *West. Pharmacol. Soc*., (1971), 14, pp. 1-3.

4.3.15 Grinspoon, L. “Marijuana” *Scientific American*, (1969), Vol. 221, No. 6, p. 17.

4.3.16 Clarke, R.C., *Marijuana Botany. An Advanced Study: The Propagation and Breeding of Distinctive Cannabis*, 1981.

4.3.17 Mechoulam, R., Marihuana Chemistry, 1970, *Science*.

4.3.18 Razdan, R.K., *Recent Advances in Chemistry of Cannabinoids, Progress in Organic Chemistry*, Vol 8.).

4.3.19 Bureau of Narcotics, *Marihuana, Its Identification*, United States Government Printing Office, Washington, 1948.

4.3.20 DFS Controlled Substances Procedures Manual

4.3.21 Elsohly, Mahmoud A. "Chemical Constituents of Marijuana", *Life Sciences*, 78 (2005), 539-548

4.3.22 Elsohly, Mahmoud A. *Marijuana and the Cannabinoids*, Humana Press, 2007, Chapters 1 and 2.

4.3.23 WHO Expert Committee on Drug Dependence Pre-Review, Isomers of THC, Section 1: Chemistry, 2018.

4.4 Assignments

4.4.1 Review of listed references

4.4.2 Study Questions

4.4.3 Practical Exercises

4.4.4 Review of Historical Aspects of Marijuana Analysis Powerpoint (available in Qualtrax)

4.5 Study Questions

4.5.1 Define the following:

- Controlled substance
- Distribution
- Manufacture
- Drug
- Narcotic drug
- Anabolic steroid
- Depressant

- Stimulant
- Alkaloid
- Cannabimimetic Agent
- Substituted Cathinone / Research Chemical
- Analog (per the Code of Virginia)
- Substantially similar (as it pertains to drug analysis)

4.5.2 Discuss how drugs are controlled in the Commonwealth. Include scheduling, the Board of Pharmacy expedited process and control dates. Where is this information found/documented?

4.5.3 List the physiological effects of the following:

- Depressant
- Hallucinogens
- Anabolic steroids
- Phenethylamines
- Opiates
- Analgesics
- Cannabis/THC

4.5.4 List the pharmacological actions of the following drug classes:

- Depressants
- Hallucinogens
- Narcotics
- Stimulants

4.5.5 Depressants

4.5.5.1 What is the difference between a sedative and a hypnotic?

4.5.5.2 What is the largest drug group within the depressants?

4.5.5.3 How are barbiturates classified?

4.5.5.4 Draw the general structure of a barbiturate.

4.5.5.5 How are most depressants illegally obtained?

4.5.5.6 Why are the benzodiazepines included with the depressants? Give their general structure.

4.5.5.7 What is chloral hydrate and how is it used?

4.5.5.8 What does synergism mean?

4.5.5.9 Explain the relationship between GHB, GBL and 1,4-butanediol.

4.5.5.10 Describe the equilibrium formed between GHB and GBL in aqueous solutions of various pH values. How does this affect the analysis?

4.5.6 Hallucinogens

4.5.6.1 What medicinal use do hallucinogens have?

4.5.6.2 From what is LSD derived?

4.5.6.3 What is the chemical name for LSD?

4.5.6.4 What is peyote? Is it controlled?

4.5.6.5 What is the scientific name for “magic” mushrooms?

4.5.6.6 What is the chemical name for MDA? For MDMA?

4.5.6.7 What is the chemical name for PCP? How are the letters of PCP derived from the chemical name?

4.5.6.8 What are common precursors and byproducts related to the manufacture of PCP?

4.5.6.9 What is the legal use of PCP?

4.5.6.10 What are the chemical names for DMT and STP?

4.5.6.11 What is the structural similarity between STP and MDA?

4.5.6.12 Describe the appearance of the *Salvia divinorum* plant. How is it scheduled?

4.5.7 Narcotics

4.5.7.1 Define a narcotic according to the Code of Virginia.

4.5.7.2 From what plant is opium obtained? How? Where is the major crop grown?

4.5.7.3 What is the definition of an opiate?

4.5.7.4 What are the two classifications of opium alkaloids and how do they differ?

4.5.7.5 How is Heroin derived from opium? Describe the degradation pathway of Heroin.

4.5.7.6 How many alkaloids are there in opium and what percentage (by weight) are they? Which is the principal constituent?

4.5.7.7 Name the principal narcotic drugs.

4.5.7.8 What is the chemical name for heroin? Street names?

4.5.7.9 Define and give examples of each:

- Natural opiate
- Synthetic narcotic
- Semi-synthetic narcotic

4.5.7.10 How are narcotics used or administered?

4.5.8 Stimulants

4.5.8.1 Name some common stimulants.

4.5.8.2 Draw the structure of phenethylamine.

4.5.8.3 What are the major uses for amphetamines?

4.5.8.4 How is the word “amphetamine” derived?

4.5.8.5 Name some amphetamine-related stimulants.

4.5.8.6 Describe three different synthesis methods for methamphetamine.

4.5.8.7 What is an anorectic drug?

4.5.8.8 What are some street names for some commonly encountered stimulants?

4.5.8.9 When is cocaine classified as a stimulant? As a narcotic?

4.5.8.10 From what plant is cocaine obtained? Where is the major crop grown? How is cocaine extracted from the leaves?

4.5.8.11 How is cocaine base produced from cocaine hydrochloride? How does “crack” differ from “freebase”? What are the differences between Cocaine Base and Cocaine Hydrochloride?

4.5.8.12 How are various stimulants used or administered?

4.5.9 Miscellaneous

4.5.9.1 What is physical dependence and how does it vary from psychological dependence?

4.5.9.2 What is meant by tolerance?

4.5.9.3 What are some common household items with a high potential for abuse?

4.5.9.4 Define the following drug actions:

- analgesic
- antipyretic
- antitussive
- tranquilizer
- anticholinergic
- vasoconstrictor
- antihelmintic
- diuretic
- bronchodilator
- antibiotic
- vitamin
- anesthetic

4.5.9.5 What is the difference between an antidepressant and a stimulant?

4.5.9.6 Name four common tricyclic antidepressants.

4.5.9.7 What is the difference between an anabolic steroid and a corticosteroid?

4.5.9.8 What is a substituted cathinone? What are some of the common/street names for these substances? How are they classified in the Code of Virginia?

4.5.10 Describe the following terms as if you were addressing a lay audience or jury panel:

- Stimulant
- Anesthetic
- Hallucinogen

- Cannabimimetic agent
- Substituted cathinone

4.5.11 Cannabis (Marijuana/Industrial Hemp)

4.5.11.1 Define the following as they pertain to (a) the Code of Virginia and (b) the Federal Controlled Substances Act:

- Marijuana
- Industrial Hemp
- Dronabinol
- Hashish
- Hash Oil (as defined prior to July 1, 2020)

4.5.11.2 What are the analytical requirements for Marijuana, Cannabis, Industrial Hemp, and Dronabinol?

4.5.11.3 What parts of the plant contain THC (including average percentage)?

4.5.11.4 Discuss the appearance of Cannabis seeds. Are they considered a positive result for any of your tests? Why/Why not?

4.5.11.5 What type of edible evidence is routinely submitted for analysis? What is the analytical scheme for each and how are the results reported?

4.5.11.6 What are the three major cannabinoids found in Cannabis? What are their structures? Are they acidic/basic, polar/non-polar? Chemically, can any of the cannabinoids break down or be converted into THC? Does THC break down?

4.5.11.7 What are the two numbering systems for cannabinoids in use today? Draw THC and show how they differ. Which is used in the Code of Virginia?

4.5.11.8 What types of isomers are delta-9-THC, delta-8-THC? Which is more stable? Why?

4.5.11.9 Define residue as it relates to the analysis of Cannabis. Outline the procedure for analyzing a smoking device suspected of containing Cannabis. Include reporting results.

4.6 Practical Exercises

4.6.1 Using the form in *Color Test / TLC Worksheet* (221-F200), start a "Drug Known" notebook by using one sheet for each drug listed in Appendix A. It is most helpful to do the tests by drug group so that differences in chemical structure can be correlated to different test results. Fill out the drug name, schedule information, pharmacological information and structure.

4.6.2 Obtain Cannabis seeds from the TC or designee. Germinate the seeds for future analysis.

4.6.3 Match the following drugs with their classification and scheduling:

Classifications: AS—Anabolic steroid D—Depressant
H—Hallucinogen N—Narcotic/Opiate
S—Stimulant

Drug	Classification	Scheduling
3,4-MDMA		
PCP		
Heroin		

Hydromorphone		
Psilocyn		
Methadone		
Pentobarbital		
Salicylamide		
Codeine		
Nandrolone Decanoate		
Methamphetamine		
Caffeine		
Diazepam		
Cocaine HCl		
Cannabimimetic Agents		
Meperidine		
Phentermine		
Methylone		
DMT		
Oxycodone		
Methylphenidate		
GBL		
LSD		
25I-NBOMe		
Furanyl Fentanyl		
Benzocaine		
Delta-9-THC		
Marijuana		
Cannabis		
Hemp		

4.7 Mode of Evaluation

4.7.1 Written Examination

5 EVIDENCE HANDLING AND REPORT WRITING

5.1 Objectives

5.1.1 For the trainee to understand the fundamentals of evidence security and report writing

5.1.2 To familiarize the trainee with LIMS

5.2 Modes of Instruction

5.2.1 Demonstration by the TC of evidence handling and report writing

5.2.2 Self-directed study through reading, study questions, and practical exercises

5.3 References

5.3.1 *Quality Manual*, Department of Forensic Science (Evidence Handling, Records and Case Files, Reporting Test Results)

5.3.2 LIMS manual dfsfile1\shared\FA(most recent version)

5.3.3 *Code of Virginia* (§ 19.2-187.01)

5.3.4 *Code of Virginia* (§ 54.1-3431)

5.3.5 Evidence Handling & Laboratory Capabilities Guide – Controlled Substances DFS website)

5.3.6 DFS Controlled Substances Procedures Manual, Reporting Guidelines Section

5.3.7 Regional Operating Procedures, Department of Forensic Science

5.4 Assignments

5.4.1 Review of listed references

5.4.2 Demonstration of proper chain of custody practices by the TC

5.4.3 Study Questions

5.4.4 Practical Exercises

5.5 Study Questions

5.5.1 Explain the chain of custody methods used by the Department, both internal and external. What is considered the “official” chain of custody?

5.5.2 Define a proper seal. How is a seal upgraded?

5.5.3 What is the proper way to mark evidence (personnel receiving evidence and examiner)?

5.5.4 Who has access to the main evidence storage vault at your laboratory? Section administrative storage (if applicable)? Your personal storage area?

5.5.5 Who has access to your work area?

5.5.6 Describe the procedures for access to your personal storage area in your absence.

5.5.7 Explain the lock box procedure.

5.5.8 What procedures are in place if LIMS goes down or is unavailable?

5.5.9 Explain how to handle evidence which also needs a latent print analysis.

5.5.10 Explain how to handle evidence which also needs a DNA analysis.

5.5.11 When batching, explain how to properly handle samples from multiple cases to prevent cross contamination.

5.5.12 Explain any special precautions that should be taken when handling evidence suspected of containing opioids.

5.5.13 Explain how Certificates of Analysis act as *prima facie* evidence.

5.5.14 How long is short term evidence storage as defined for the Controlled Substances Section?

5.5.15 What is the proper way to itemize evidence for analysis and reporting?

5.6 Practical Exercises

5.6.1 Obtain mock evidence containers from the TC or designee. Evaluate all seals to see if it meets the definition of “seal” as defined by DFS. Mark evidence at time of receipt following DFS guidelines.

5.6.2 Observe the Evidence Receiving staff during case submission and evidence transfer (to include lock box procedure)

5.6.3 Shadow an examiner during batch retrieval, logging in and batch return.

5.7 Mode of Evaluation

5.7.1 Written Examination

6 BALANCES

6.1 Objectives

6.1.1 To familiarize the trainee with the operation of laboratory balances

6.1.2 To familiarize the trainee with balance calibration and quality assurance

6.1.3 To familiarize the trainee with the recording and reporting of weights in laboratory notes and Certificates of Analysis

6.1.4 To familiarize the trainee with the theory and use of Uncertainty of Measurement

6.2 Modes of Instruction

6.2.1 Self-directed study through reading, study questions, and practical exercises

6.2.2 Presentations and demonstrations regarding use of balances by the TC or designee

6.3 References

6.3.1 Balance manufacturer's operating manuals

6.3.2 DFS Controlled Substances Procedures Manual, Weighing Practices and Quality Assurance Sections

6.3.3 DFS Controlled Substances Procedures Manual, Estimation of the Uncertainty of Measurement Section

6.3.4 NIST Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement results (intranet)

6.3.5 A Beginner's Guide to UoM (intranet)

6.4 Assignments

6.4.1 Review of listed references

6.4.2 Study Questions

6.4.3 Practical Exercises

6.5 Study Questions

6.5.1 Define the following:

- Accuracy
- Precision
- Balance
- Analytical Balance
- Certified Weight
- Tare
- Trace/Residue
- Standard Uncertainty
- Expanded Uncertainty
- Root Sum Squares
- Net Weight
- Gross Weight
- Uncertainty of Measurement

- Traceability
- Calibration
- Internal Calibration

6.5.2 Explain the quality assurance program for balances in the Controlled Substance's section. What are the two ways it can be documented?

6.5.3 If a balance falls outside established guidelines during the weekly QA, what steps must be taken before the balance may be used for case work? How and by whom are balances calibrated?

6.5.4 How and when are the accuracy and precision of the balances checked?

6.5.5 Define and compare - dynamic measurement and static measurement.

6.5.6 Describe sources of measurement uncertainty with respect to weight determination.

6.5.7 Explain the laboratory's uncertainty of measurement policy/procedure as to a jury.

6.5.8 What types of weights are used for balance QA? Are they traceable?

6.5.9 Discuss the different balances available in your laboratory including the accuracy and minimum loads for each.

6.5.10 What is the grams to ounces conversion factor used in the Cannabis analytical scheme?

6.5.11 Discuss the surrogate weight process used at your laboratory. Include what it is, why it is used and who performs the process.

6.5.12 Explain how the uncertainty for your balance is calculated.

6.6 Practical Exercises

6.6.1 Check the performance of your balances following the quality assurance plan.

6.6.2 Check the accuracy and precision of your balances.

6.6.3 Explain what an Uncertainty Budget is for a balance. Include the eight step process recommended by NIST. Do these budgets ever change?

6.6.4 Weigh the following objects. Record the weights as in case notes and designate the weight to be reported on a Certificate of Analysis, using UoM if necessary

- Ten to twenty Cannabis seeds
- Weighing paper – various sizes (Analytical Balance)
- Weigh boats – various sizes (Top Loading Balance)

6.7 Mode of Evaluation

6.7.1 Written examination

7 STEREOMICROSCOPES

7.1 Objective

To make the trainee proficient in the use of the stereomicroscopes used in the laboratory

7.2 Modes of Instruction

7.2.1 Self-directed study through reading, study questions, and practical exercises

7.2.2 Demonstrations by the TC or designee

7.3 References

7.3.1 Microscope manufacturer's operating manual

7.3.2 Saferstein, Richard, Ph.D. *Criminalistics: An Introduction to Forensic Science, Eighth Edition*. Upper Saddle River, NJ: Prentice Hall, 2004, pp. 175-176.

7.3.3 Saferstein, Richard, Ph.D., editor. *Forensic Science Handbook*. Englewood Cliffs: Prentice Hall, 1982, pp. 416-434.

7.3.4 DFS Controlled Substances Procedures Manual

7.3.5 Nakamura, G.R. "Forensic Aspects of Cystolithic Hairs of Cannabis and other plants." Journal of the AOAC, 1969, Vol. 52, No.1, pp 5-16.

7.4 Assignments

7.4.1 Review of listed references

7.4.2 Study Questions

7.4.3 Practical Exercises

7.5 Study Questions

7.5.1 Describe the principal parts of the stereomicroscope and describe the function of each.

7.5.2 How does the stereomicroscope differ from compound microscopes?

7.5.3 How is the magnification determined? What magnification ranges are used in the laboratory?

7.5.4 What is the laboratory's quality assurance procedure for the microscopes?

7.5.5 What information is gained and noted from the macroscopic and microscopic examinations of Cannabis samples?

7.5.6 Describe cystolithic hairs and glandular hairs including characteristics and locations found on Cannabis. What magnification is needed to view these hairs?

7.6 Practical Exercises

7.6.1 Record macroscopic and microscopic observations of the following:

7.6.1.1 Baking soda

7.6.1.2 Table salt

7.6.1.3 Ground Cannabis leaf material

7.6.1.4 Epsom salts

7.6.1.5 Dimethyl sulfone

7.6.2 Examine each of the following under the microscope and describe in detail. Do any give a false positive for Cannabis?

- Dry Cannabis leaf material (If the seeds germinated in Introduction to Drugs, use for this test as well as in color test and TLC modules)
- Sinsemilla
- Cannabis seeds
- Cannabis stems
- Hashish
- Concentrated Cannabis extract
- Hops
- Oregano
- Tobacco
- Sage
- Parsley
- Salvia divinorum
- Cannabimimetic Agent (non-Cannabis based)

7.7 Mode of Evaluation

7.7.1 Written examination

8 SAMPLING

8.1 Objectives

8.1.1 To familiarize the trainee with the concepts of sampling.

8.1.2 To instruct the trainee on the sampling procedures in the laboratory.

8.2 Modes of Instruction

8.2.1 Self-directed study through reading and study questions

8.2.2 Presentations and demonstrations

8.3 References

8.3.1 DFS Controlled Substances Procedures Manual, Sampling Section, Pharmaceutical Identifiers Section and Hypergeometric Table

8.3.2 Coulson, Sally A., Ph.D. *et al.,* "How Many Samples from a Drug Seizure Need to Be Analyzed?", *Journal of Forensic Sciences*, Volume 46, No. 6 (November 2001), pp. 1456-1461.

8.3.3 Colon, Maria, B.S., Rodriguez, Gloria, B.S., and Diaz, Ramon Orlando, M.S. "Representative Sampling of 'Street' Drug Exhibits", *Journal of Forensic Sciences*, Volume 38, No. 3 (May 1993), pp. 641-648.

8.3.4 Tzidony, Dov, and Ravreby, Mark. "A Statistical Approach to Drug Sampling: A Case Study", *Journal of Forensic Sciences*, Volume 37, No. 6 (November 1992), pp. 1541-1549.

8.3.5 Frank, Richard S., B.S., Hinkley, Sidney W., Ph.D., and Hoffman, Carolyn G., M.A. "Representative Sampling of Drug Seizures on Multiple Containers", *Journal of Forensic Sciences*, Volume 36, No. 2 (March 1991), pp. 350-357.

8.3.6 Shark, Robert E. "Sampling Your Drugs: A User's Guide", Virginia Bureau of Forensic Science Technical Brief.

8.3.7 Fishel, C. "Validity of Hypergeometric Sampling", Virginia Bureau of Forensic Science Technical Brief, August 29, 1988.

8.3.8 Williams, Sidney, Editor. *Official Methods of Analysis of the Association of Official Analytical Chemists, 14th edition.* Arlington, VA: Association of Official Analytical Chemists, Inc., 1984, p. 668.

8.3.9 SWGDRUG Recommendations, 2nd ed. "PART III A - Methods of Analysis/Sampling Seized Drugs for Qualitative Analysis", current version available.

8.3.10 "Guidelines on Sampling of Illicit Drugs for Quantitative Analysis" European Network of Forensic Science Institutes - Drugs Working Group, April 2014.

8.3.11 Mettler Toledo (2020). SmartCheck SLS1010S: Reference manual. Greifensee, Switzerland: Author.

8.3.12 Mettler Toledo (2021). SmartCheck: Frequently asked questions guide. Greifensee, Switzerland: Author.

8.4 Assignments

8.4.1 Review of listed references

8.4.2 Review of Net Weight Extrapolation Training Powerpoint (available in Qualtrax)

8.4.3 Study Questions

8.4.4 Complete the Good Pipetting Practices training in Qualtrax.

8.5 Study Questions

8.5.1 Define the following:

- Sampling
- Population
- Sample
- Homogeneous
- Heterogeneous
- Aliquot
- Random
- Representative
- Sampling without replacement
- Sampling with replacement
- Weight fraction

8.5.2 Define normal distribution, binomial distribution, and hypergeometric distribution. When is each correctly used?

8.5.3 What is the purpose of sampling?

8.5.4 What is “sampling error” and what effect does particle size have when sampling particulate matter?

8.5.5 What are the advantages and disadvantages of sampling?

8.5.6 What is a “composite” sample? When is it appropriate to prepare a composite sample (requirements)?

8.5.7 What criteria must be used to determine the size of the sample?

8.5.8 What are the major deciding factors in how well a sample represents a population?

8.5.9 Discuss the purpose of employing the Department’s Administrative sampling plan versus the Hypergeometric sampling plan:

- When and why would you choose to utilize the administrative sampling plan?
- When and why would you choose to utilize the hypergeometric sampling plan?
- What is the difference in the conclusion that can be drawn with the two sampling plans?
- How does the reporting differ?

8.5.10 Explain the statistical inference that can be made when the Hypergeometric sampling scheme is employed.

8.5.11 For each type of pipette available to you in your laboratory, describe what it is used for and what tips are used.

8.5.12 What is the QA/QC procedure for the pipettes? Discuss the SmartCheck QA Procedure.

8.5.13 Discuss the steps for proper pipette use.

8.5.14 Describe the sampling scheme for specimens that must be quantitated.

8.5.15 Describe the procedure for sampling and returning residues.

8.5.16 Discuss the DIRP Policy. When is it used and under what circumstances/scenarios?

8.5.17 Why would an examiner using the Department's Hypergeometric Table have to screen fifteen tamperable capsules from a population of nineteen but only twelve from a population of twenty? Use the European Network of Forensic Science Institute's Drug Working Group "Calculator for Quantitative Sampling of Seized Drugs" to justify your answer.

8.5.18 Complete the following spreadsheet with sampling scenarios:

Sample	How many sampled possession charge	How many for PWID and distribution
2 bags of off-white powder		
25 glassine packets of suspected heroin		
5 tablets marked "GG249"		
5 tablets marked "GG249" and 3 tablets marked "G3721"		
25 dolphin shaped tablets and 12 Darth Vader shaped tablets		
3 plastic bags of plant material		

8.6 Modes of Evaluation

8.6.1 Written examination

8.6.2 Mock case work

9 COLOR TESTS

9.1 Objectives

9.1.1 To familiarize the trainee with the preparation, storage, and proper handling procedures of color test reagents

9.1.2 To make the trainee proficient in the use of chemical color tests

9.1.3 To make the trainee aware of the advantages, disadvantages, and limitations of color tests

9.1.4 To make the trainee understand the theory of color tests

9.1.5 To familiarize the trainee with field test kits and their applications

9.2 Modes of Instruction

9.2.1 Self-directed study through reading, study questions, and practical exercises

9.2.2 Presentations and demonstrations

9.3 References

9.3.1 *Basic Training Program for Forensic Chemists*, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology, pp. 4-1 through 4-11

9.3.2 Moffat, A. C., editor. *Clarke's Isolation and Identification of Drugs.* London: The Pharmaceutical Press, 1986, pp. 128-147.

9.3.3 DFS Controlled Substances Procedures Manual, Color Tests Section.

9.3.4 Johns, S. H., Wist, A. A., and Najam, A. R. "Spot Tests: A Color Chart Reference for Forensic Chemists*", Journal of Forensic Sciences*, July 1979, pp. 631-641.

9.3.5 "Methods of Analysis for Alkaloids, Opiates, Marihuana, Barbiturates, and Miscellaneous Drugs." Internal Revenue Service, (Reprinted by the Bureau of Narcotics and Dangerous Drugs, U. S. Department of Justice), rev. 6-67.

9.3.6 Feigl, Fritz. *Spot Tests in Organic Analysis*. Amsterdam: Elsevier Scientific, 1966.

9.3.7 *U.S. Pharmacopeia National Formulary*, USP XX, 1980.

9.3.8 Saferstein, Richard. *Forensic Science Handbook*. Prentice Hall Regents, Englewood Cliffs, NJ; 1982.

9.3.9 Virginia Register, 6 VAC 20-220 and *Code of Virginia* § 9.1-102.

9.3.10 Kovar, K.A. and Laudszun, M. "Chemistry and Reaction Mechanisms of Rapid tests for Drugs of Abuse and Precursor Chemicals", *United Nations Scientific and Technical Notes*, February 1989. www.unodc.org/pdf/scientific/SCIE6.pdf

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9.3.12 Bailey, K. "The Value of the Duquenois Test of Cannabis - A Survey" Journal of Forensic Sciences, (l97l), 24(4), pp. 817-841.

9.3.13 Smith, R.N. “A Brief Note on the Response of Some Essential Oils and Extracts of Vegetable Origin to the Duquenois-Levine Test for Cannabis.” Journal of the Forensic Science Society, (1974), 14, pp. 191-194.

9.3.14 Pitt, C. G., Hendron, R.W., and Hsia, R.S. “The Specificity of the Duquenois Color Test for Marihuana and Hashish” Journal of Forensic Sciences, (1972), 17(4), pp. 693-700.

9.3.15 Jacobs, A.D., and Steiner, R.R. “Detection of the Duquenois-Levine chromophore in a marijuana sample”, Forensic Science International, (2014), 239, pp. 1-5.

9.3.16 Watanabe, K., Honda, G., Miyagi T., Kanai, M., et al. “The Duquenois reaction revisited: mass spectrometric estimation of chromophore structures derived from major phytocannabinoids” Journal of Forensic Toxicology, (2017), 35, pp. 185-189.

9.3.17 Forrester, D., The Duquenois Color Test for Marijuana: Spectroscopic and Chemical Studies, Volume One, 1997.

9.3.18 Schläpfer, M. “Recipe for presumptive test solutions – Cannabis Typification,” Forensisches Institut Zürich, 2017.

9.3.19 https://www.dfs.virginia.gov/field-test-kits/

9.3.20 https://www.dfs.virginia.gov/field-test-kits/field-test-kit-evaluation/preliminary-hearing-drug-field-test-kits/

9.3.21 https://www.dfs.virginia.gov/field-test-kits/field-test-kit-evaluation/marijuana-field-test-kits/

9.3.22 https://www.dfs.virginia.gov/field-test-kits/4-ap-cannabis-typification-field-tests/

9.3.23 Zumdahl, S., Chemistry, 4th Edition. pp. 967-973.

9.4 Assignments

9.4.1 Review of listed references

9.4.2 Study Questions

9.4.3 Practical Exercises

9.5 Study Questions

9.5.1 What are the recipes for each of the following color test reagents? Discuss the QA procedure for color test reagents. List the types of compounds that react with each test, and state what reaction would be observed. For those marked with an “*” note the compound used for QA:

- Marquis*
- Meckes*
- Froehdes*
- Cobalt thiocyanate*
- Ehrlich’s*
- TBPEE
- Dille – Koppanyi*
- Ferric Chloride
- Tannic Acid
- Stannous Chloride
- Sodium Nitroprusside (Feigel’s)

- Duquenois-Levine*
- 4-Aminophenol (4-AP)*

9.5.2 Describe the Duquenois-Levine (D-L) procedure. How does it differ from the Modified Duquenois Test and Rapid Modified Duquenois Test?

9.5.3 What causes the purple color obtained with the Duquenois reagent and Cannabis? What determines whether this product is soluble in the chloroform?

9.5.4 Describe the 4-AP test for typification of Cannabis. What causes either a pink or blue color result? Is this result definitive for the identification of industrial hemp and/or marijuana? For what type of Cannabis samples would this test be most appropriate?

9.5.5 Describe the mechanisms of the following color tests:

- Marquis
- Cobalt thiocyanate followed by stannous chloride/HCl
- Ehrlich's

9.5.6 Describe the difference between the terms "sensitivity" and "specificity" as they relate to color tests.

9.5.7 Define "false positive". Give three examples of false positive color tests.

9.5.8 Define "false negative". Give three examples of false negative color tests.

9.5.9 Describe the use of blanks pertaining to color tests.

9.5.10 What effect do mixtures have on color test results?

9.5.11 What effect does time have on color test results? What effect does time have on color test reagents?

9.5.12 Describe the Scott's test.

9.5.13 Describe as to a jury how a color test is performed, including the purpose and value of the test.

9.5.14 Describe the process by which field test kits are approved by DFS for law enforcement use in the Commonwealth? What does DFS approval of a field test kit mean in a legal sense? Where can one determine which field test kits have been approved by DFS?

9.5.15 An officer calls stating that the field test kit used on a submitted sample indicated the presence of heroin. Your analysis reveals no controlled substances. How might you explain this?

9.6 Practical Exercises

9.6.1 Prepare the following reagents (if used in your laboratory) and perform all necessary QA and documentation prior to use:

- Cobalt Thiocyanate with Stannous Chloride modification
- Marquis
- Meckes
- Froehdes
- TBPEE (if available)
- Ehrlich's
- Weber Test (for Hallucinogens only)
- Duquenois-Levine (D-L) (for cannabis samples/products only)
- 4-AP (for cannabis samples/products only)

9.6.2 Obtain standards (secondary, where possible) of the substances listed in Appendix A from the TC. Perform the color tests above for each substance and record in the Drug Known notebook. Some color tests may be eliminated (determined by the TC). Save these standards for use in the Thin Layer Chromatography section.

9.6.3 Perform Duquenois-Levine tests on the following (if available) and describe results. Do any give a false positive for Cannabis?

- Cannabis plant material (If seeds germinated in Introduction To Drugs Module, use plant material here)
- Hashish
- Concentrated Cannabis extract
- Patchouli oil
- Oregano
- Parsley
- Coffee
- Hops
- Tobacco
- Olivetol
- Delta-9-THC
- Cannabinol
- Cannabidiol
- Resorcinol
- Currant
- Mace
- Current Cannabimimetic Agent (chosen by TC)
- Salvia divinorum
- Dragon's blood incense (if available)

9.7 Modes of Evaluation

9.7.1 Written examination

9.7.2 Courtroom exercise (mini-mock trials)

9.7.3 Technical/Oral session(s)

10 THIN LAYER CHROMATOGRAPHY

10.1 Objective

10.1.1 To familiarize the trainee with the theory and application of thin layer chromatography in drug analysis

10.2 Modes of Instruction

10.2.1 Self-directed study through reading, study questions, and practical exercises

10.2.2 Presentations and demonstrations

10.3 References

10.3.1 *Basic Training Program for Forensic Chemists*, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology, pp. 4-39 through 4-49.

10.3.2 Moffat, A. C., editor. *Clarke's Isolation and Identification of Drugs*. London: The Pharmaceutical Press, 1986, pp. 160-177.

10.3.3 DFS Controlled Substances Procedures Manual, Thin Layer Chromatography Section.

10.3.4 Randerath, Kurt. *Thin-Layer Chromatography, Second Edition*. New York: Academic Press, 1968.

10.3.5 *Methods of Analysis for Alkaloids, Opiates, Marihuana, Barbiturates, and Miscellaneous Drugs.* Internal Revenue Service, (Reprinted by the Bureau of Narcotics and Dangerous Drugs, U. S. Department of Justice), rev. 6-67.

10.3.6 Stahl, Egon, *Thin-Layer Chromatography*, 2nd ed., Berlin: Springer-Verlag, 1969.

10.3.7 Bauer, Karin, *et al*. *Thin Layer Chromatography*, Heidelberg, Germany: EM Science, 1991.

10.3.8 Hughes, R.B., Kessler, R.R., "Increased Safety and Specificity in the Thin-Layer Chromatographic Identification of Marihuana", Technical Note, *Journal of Forensic Sciences*, 1979

10.4 Assignments

10.4.1 Review of listed references

10.4.2 Study Questions

10.4.3 Practical Exercises

10.5 Study Questions

10.5.1 Define the following:

- Chromatography
- Stationary phase
- Mobile phase
- Adsorption
- Absorption
- Elution
- Partition coefficient (K)
- Polarity
- Dipole moment

- Dielectric constant
- Visualizing reagent
- R_f value
- Solvent front
- Theoretical plate
- Resolution
- Chromophore

10.5.2 Define thin layer chromatography (TLC) including how the test is normally performed. Explain the chemical basis of TLC covering the following topics as they pertain to the analysis of controlled substances:

- Types of chromatography
- Different stationary phases
- Interactions among the stationary phase, mobile phase and solute, including consideration of equilibrium
- Influences on chromatography/separation by stationary phase thickness, temperature, humidity, molecular weight, gravity, polarity of mobile phase
- Explain any and all intermolecular forces which may be at work

10.5.3 Describe the chromatography plates used in the lab, including the purpose of each component. Why is silica generally preferred over alumina?

10.5.4 With respect to TLC plates, what causes “quenching fluorescence”? What chemical properties does a drug need to possess in order to quench fluorescence?

10.5.5 What is the general limit of detection of TLC? What factors influence this?

10.5.6 What are the recipes for each of the following TLC baths? Outline the general QA procedure for TLC baths.

- TLC1
- TLC2
- TLC3
- TLC5

10.5.7 Define elutropic series of solvents. How will the polarity of solvents change when they are mixed together?

10.5.8 Which drugs fluoresce under long wave UV? What is the difference in wavelength between short and long wave UV?

10.5.9 What types of standards are used in TLC? To what extent have they been confirmed?

10.5.10 What are the recipes for each of the following TLC visualizing reagents? For what type(s) of drugs are each utilized most effectively? Outline the general QA procedure for TLC sprays.

- Iodoplatinate
- Dragendorff
- Potassium permanganate
- Ehrlich’s
- Fluram
- Ceric sulfate
- Iodine vapors
- Ninhydrin

- Fast Blue B (include results for cannabinoids)

10.5.11 Can LSD and LAMPA be separated using TLC?

10.5.12 What TLC baths and sprays should be used in the analysis of salvinorin A?

10.5.13 Why do spots having a larger R_f value generally have larger diameters than spots with relatively low R_f values?

10.5.14 Does sample concentration have an effect on TLC migration? What causes "tailing" and "fronting" and how can they be minimized? What other factors influence an R_f value and its reproducibility? How can these factors be controlled?

10.5.15 How can the results of TLC be documented?

10.5.16 Explain as to a jury how TLC operates.

10.6 Practical Exercises

10.6.1 Prepare a TLC bath and visualizing reagent designated by the TC and perform all necessary QA and documentation prior to use.

10.6.2 Using the standards of the substances listed in Appendix A, perform TLC analysis on each. Record your results in the Drug Known notebook. Do the tests by drug group so that differences in chemical structure can be correlated to different test results. Use the TLC1, TLC2, TLC3 and TLC5 baths and the following TLC sprays (as determined by the TC):

- $KMnO_4$
- Acidified Iodoplatinate (may be acidified with an overspray)
- Ceric Sulfate
- Ehrlich's
- Dragendorff (if available)
- Fluram / Long wave UV (if available)
- FBB

10.6.3 Using the results from Section 12.6.2, answer the following questions:

- Explain the theory of using multiple TLC systems. Use examples from your data in your explanation.
- Discuss the separation effectiveness of TLC taking into account the structure of the molecule, the polarity/basicity of the solvent system and the polarity of the stationary phase. Use morphine and heroin as examples.
- The pairs Methylone/Ethylone and Morphine/Codeine both differ by only one carbon. Explain the differences between separating the two pairs.
- Which bath(s) separate the phenethylamine-type compounds the best?

10.6.4 Obtain standards of GHB, GBL and 1,4-butanediol. Perform TLC using a mobile phase of ethyl acetate and visualize using iodine vapors.

10.6.5 Obtain standards of ephedrine and pseudoephedrine from the TC or designee. Using the procedure outlined in the Procedures Manual, separate these compounds using TLC.

10.6.6 Perform TLC analysis of the following (if available) using the TLC5 and the other baths used in the laboratory. Do any give a false positive for Cannabis?:

- Known Marijuana (if seeds germinated in Introduction To Drugs Module, use for this test)

- Known Hemp
- Δ9-THC
- Δ8-THC
- Δ6a(10a)-THC (if available)
- Cannabinol
- Cannabidiol
- Concentrated cannabis extract
- Hops
- Tobacco
- Oregano
- Parsley
- Coffee
- Olivetol
- Resorcinol
- *Cannabimimetic Agent (non-Cannabis based)*

10.6.7 Obtain a known marijuana sample from the TC or designee. Extract the marijuana using hexane, methanol and chloroform and the 2% solvent system. Run each on TLC, make a color photocopy of the TLC plate and discuss the differences with the TC.

10.6.8 Obtain a sample of charred Cannabis residue from the TC or designee. Analyze using the analytical procedure listed in the Controlled Substances Procedures Manual.

10.7 Modes of Evaluation

10.7.1 Written examination

10.7.2 Court exercise (mini mock trials)

10.7.3 Technical/Oral session(s)

11 MICROCRYSTAL TESTS

11.1 Objectives

11.1.1 To familiarize the trainee with microcrystal tests for drugs

11.1.2 To make the analyst proficient in the use of microcrystal tests for the identification of dextromethorphan

11.2 Modes of Instruction

11.2.1 Self-directed study through reading, study questions, and practical exercises

11.2.2 Presentations and demonstrations

11.3 References

11.3.1 Clarke, E. G. C. *Isolation and Identification of Drugs, Volumes 1 and 2.* London: The Pharmaceutical Press, 1978, pp. 135-141.

11.3.2 Fulton, Charles C. *Modern Microcrystal Tests for Drugs*. New York: Wiley Interscience, 1969.

11.3.3 *Basic Training Program for Forensic Chemists*, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology, pp. 4-13 through 4-20.

11.3.4 DFS Controlled Substances Procedures Manual, Narcotic Methodology Section.

11.3.5 Siegel, Jay A., Ph.D. “Forensic Identification of Controlled Substances”, in Saferstein, Richard, Ph.D., editor. *Forensic Science Handbook, Volume II*. Englewood Cliffs, N. J.: Prentice Hall, pp. 68-160.

11.4 Assignments

11.4.1 Review of listed references

11.4.2 Study Questions

11.4.3 Practical Exercises

11.5 Study Questions

11.5.1 Describe the three types of microcrystal tests which may be used.

11.5.2 What are some of the advantages and disadvantages of microcrystal tests?

11.5.3 How can microcrystal tests be utilized to differentiate stereoisomers?

11.5.4 How would you document the results of microcrystal tests in your case notes?

11.6 Practical Exercises

11.6.1 Perform microcrystal tests for Dextromethorphan.

11.7 Mode of Evaluation

11.7.1 Written examination

12 GAS CHROMATOGRAPHY

12.1 Objectives

12.1.1 To familiarize the trainee with the theory and application of gas chromatography in drug analysis

12.1.2 To familiarize the trainee with the GC instrumentation and software used in the laboratory

12.2 Modes of Instruction

12.2.1 Self-directed study through reading, study questions, and practical exercises

12.2.2 Presentations and demonstrations

12.3 References

12.3.1 Moffat, A. C., editor. *Clarke's Isolation and Identification of Drug*s. London: The Pharmaceutical Press, 1986, pp. 178-200.

12.3.2 *Basic Training Program for Forensic Chemists*, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology, pp. 5-31 through 5-47.

12.3.3 DFS Controlled Substances Procedures Manual, Gas Chromatography Section.

12.3.4 Stafford, David T., Ph.D. "Forensic Capillary Gas Chromatography", in Saferstein, Richard, Ph.D., editor. *Forensic Science Handbook, Volume II.* Englewood Cliffs, N. J.: Prentice Hall, 1988, pp. 38-67.

12.3.5 Hyver, K.J., Sandra, P., editor. *High Resolution Gas Chromatography, Third Edition.* Hewlett Packard Company, 1989.

12.3.6 Rood, Dean, *A Practical Guide to the Care, Maintenance, and Troubleshooting of Capillary Gas Chromatographic Systems, 3rd ed.,* Wiley-VCH, New York, 1999.

12.3.7 Regis Chemical Company. *A User's Guide to Chromatography*. Morton Grove, IL: Regis Chemical Company, 1976, pp. 20-114.

12.3.8 Hewlett Packard and Agilent Technologies GC instrument manuals.

12.3.9 Pierce, A. E., *Silylation of Organic Compounds*, Pierce Chemical Company, Rockford, IL 1968.

12.3.10 DFS Controlled Substances Procedures Manual, Estimation of the Uncertainty of Measurement Section.

12.3.11 Shimadzu application note, GCMS-1303 Evaluation of Hydrogen as a Carrier Gas for Gas Chromatography/Mass Spectrometry

12.4 Assignments

12.4.1 Review of listed references

12.4.2 Study Questions

12.4.3 Practical Exercises

12.5 Study Questions

12.5.1 What is gas chromatography?

12.5.2 What types of information are obtained from GC?

12.5.3 Draw a schematic diagram for a GC and describe the purpose of each component.

12.5.4 Define the following terms:

- Carrier gas
- Mobile phase
- Stationary phase
- Partition
- Volatility
- Retention index
- Linear velocity
- Flow rate
- Derivatization
- Internal standard

12.5.5 Describe the solid support used in a capillary column GC system.

12.5.6 What general criteria should all stationary phases possess?

12.5.7 What general criteria should all mobile phases possess?

12.5.8 Besides the stationary phase, what factors influence column selection for a given GC application?

12.5.9 What determines the appropriate column diameter for a given GC system? The appropriate length?

12.5.10 Describe how the following concepts affect GC separation between components:

- Solubility
- Boiling point
- Intermolecular forces

12.5.11 Diagram and describe the cross-section of a capillary column.

12.5.12 What factors influence the “inertness” of a column?

12.5.13 What is the purpose of the polyimide/polyamide coating on a fused silica column?

12.5.14 What advantages does a bonded/cross-linked phase column possess?

12.5.15 What is column bleed?

12.5.16 What factors govern the operating temperature of a given GC column? What are the upper and lower temperature limits for the following liquid phases? What is the effect of operating above or below these limits?

- HP-1 (for capillary columns)
- HP-5 MS (for capillary columns)
- DB-35

12.5.17 Define:

- retention time (T_R or t_R)
- relative retention time (RRT)
- retention volume

- unretained retention time (t_m)
- corrected or adjusted retention time (t'_R or t'_R)
- phase ratio
- selectivity
- theoretical plate height /height equivalent to a theoretical plate (H or HETP)
- average linear gas velocity

12.5.18 Define partition coefficient (K)? What is it a function of? How does it relate to equilibrium? What is meant if K = 1?

12.5.19 What is the partition ratio/capacity ratio (k)? How does it relate to retention time?

- How is the # of theoretical plates related to column efficiency? Compare Gas Chromatography vs Thin Layer Chromatography.
- What is chromatographic resolution a function of? Why is resolution not the best measure of column efficiency and column performance?

12.5.20 Diagram and explain the Van Deemter plot. Why is Helium a good choice for a carrier gas?

12.5.21 What effect do the following have on retention time:

- Concentration
- Other compounds in the sample
- Free base/acid form vs. salt form

12.5.22 What should be the minimum retention time of the first eluting component in a sample of one or more components to ensure the sample has spent enough time in the liquid phase to achieve reasonable separation?

12.5.23 Discuss the sample introduction of gases, vapors, and volatile liquids into a GC. Give examples of samples that may require such analysis.

12.5.24 What is meant by flash vaporization?

12.5.25 What is the procedure for a headspace analysis?

12.5.26 What factors govern the amount of sample to be injected? How much sample/component can the average capillary column hold? What factors influence this?

12.5.27 Describe the purpose and functionality of a Merlin Microseal.

12.5.28 What are the differences and purposes of "split" and "splitless" injections ?

- Draw a diagram of the injection port and illustrate the carrier gas flow throughout for both split and splitless injections.

12.5.29 What is an injection port liner? What is it made of? Why is it used? Describe the packing process including the materials used. How are they deactivated prior to use?

12.5.30 What is a "split ratio" and how is it calculated?

- What factors govern the use of a particular split ratio (100:1 vs. 50:1)?

12.5.31 What is gas saver and how is it used?

12.5.32 What is EPC? Explain the difference between constant flow and constant pressure.

12.5.33 Why is it necessary to regulate the carrier gas flow?

- How is this done?
- What factors influence the optimum flow rate for a given carrier gas?
- If the carrier gas is too fast or too slow, how will it affect the peak shapes of your sample components?
- How will it affect the detector?

12.5.34 Discuss what a Purged Ultimate Union (P.U.U.) is and how it is beneficial. What are some of the drawbacks?

12.5.35 Discuss the Flame Ionization Detector (FID) with respect to the following:

- How does it work?
- Carrier gas requirements
- Sensitivity
- Temperature requirements
- Insensitivities
- Advantages/disadvantages with respect to organic drug analysis

12.5.36 What is “make-up” gas?

- How and why is it used?
- What determines which gas will be used as a make-up gas?

12.5.37 Explain the following statement: “response is proportional to the number of carbon atoms in the sample”.

- What type(s) of detector is this statement applicable to?
- What is meant by “mass-flow” detector?

12.5.38 What types of compounds should be included in a test mixture used to assess chromatographic performance? Why would these compounds be included and what would each be designed to evaluate?

12.5.39 What types of GCs (model, manufacturer, etc.) does the drug laboratory use?

- What types of injection ports, carrier gases, flows, columns and detectors does each GC incorporate?

12.5.40 Outline a logical troubleshooting schematic for isolating the source of a GC system problem.

12.5.41 Describe how to change the septum/Microseal on the GC.

- What are some of the problems encountered when a septum is too tight or too loose?

12.5.42 What are some of the common causes and remedies for the following GC system problems:

- No peaks
- Solvent peak only
- Baseline drift or unstable baseline
- Ghost peaks
- Tailing peaks
- Leading peaks
- Split peaks
- Baseline rise before or after a peak
- Baseline drop after a peak

- Retention time shift

12.5.43 Describe the preventative maintenance schedule and QA/QC procedures performed on the GCs.

12.5.44 Discuss the operation of an autosampler.

12.5.45 What is “needle discrimination” and how is it corrected?

12.5.46 Explain why derivatization is used for analysis. Name four common derivatizing agents used by DFS, including how they are used .

12.5.47 Describe the internal standard method of quantitation. Describe the function and acceptance criteria of the “check standard”.

12.5.48 What is the mathematical formula for calculating purity? Define each variable.

- If an amphetamine sulfate solution has a concentration of 2.4 mg/mL, what is the concentration of the base form of amphetamine in this solution?

12.5.49 Discuss when a quantitation is required for casework. Include the types of drugs DFS quantifies and how weight thresholds may relate to those drugs. Why is homogenization and choice of vessel size critical to the quantitation process?

12.5.50 If two drug compounds were to co-elute on the GC, what could be done to resolve the peaks?

12.5.51 What GC methods are available for separating THC isomers?

12.5.52 What combination of columns/methods must be used to meet the two system chromatography requirement for separating delta-8-THC, delta-9-THC and delta-6a(10a)-THC?

12.5.53 For plant material analysis, explain the procedure for the 2% THC quantitation method.

- How is the standard prepared? Why is 9:1 MeOH/CHCl3 used? Why is a steroid used as the internal standard?
- Why is the concentration of the internal standard important?
- How does 0.2 mg/mL THC standard solution represent “2% “THC?
- Explain the relationship between the area of the IS peak and that of the THC peak for the standard? For samples?
- What is the acceptable range for the 2% THC standard/IS ratio? How is it calculated?

12.5.54 Which form of THC is being measured?

12.5.55 What are control charts? What purpose do they serve? Where are they located?

12.5.56 Explain as to a jury how a GC operates.

12.6 Practical Exercises

12.6.1 Write a method for the GC which creates a program which will perform the following:

- Inlet and detector temperatures: 280°C
- Oven temperature: 150-250°C, 10°C per minute, initial hold of 2 minutes
- Total run time: 20 minutes
- Split ratio: 50:1
- Column flow rate: 1 mL/min

Now inject a mixture of cocaine and propoxyphene and see if the two compounds resolve. If not, change the method one parameter at a time until they are resolved (This can also be accomplished through discussion with your primary GC operator).

12.6.2 Discuss the peak shapes for the following scenarios (receive print outs from the TC or designee)

- Methamphetamine HCl in MeOH
- Methamphetamine base in MeOH

12.6.3 Prepare a mixture of pseudoephedrine and ephedrine, and inject on HP-1, HP-5, and DB-35 columns using the same method parameters and compare resolution. Which column provides the best separation?

12.6.4 Perform flash derivatization of Methamphetamine HCl in CHCl3 as described in the Controlled Substances Procedures Manual. Discuss peak shapes and compare to 14.6.2

12.6.5 Complete pipette training module in Qualtrax. Discuss the steps for proper pipette use.

12.6.6 Obtain two Cannabis plant material samples from the TC or designee. If seeds germinated in Introduction To Drugs Module, use sample for this test. Perform the 2% THC quantitation method per the Procedures Manual. Discuss differences in results as well as how each would be reported.

12.6.7 Obtain samples of Methamphetamine, Cocaine, and concentrated Cannabis extract (if applicable) from the TC and perform a quantitative analysis using the appropriate method in the Procedures Manual.

- Fill out an appropriate Uncertainty Budget and discuss the estimation of the uncertainty of measurement as it relates to each procedure.

12.7 Modes of Evaluation

12.7.1 Written examination

12.7.2 Court exercise (mini-mock trials)

12.7.3 Technical/Oral session(s)

13 MASS SPECTROMETRY

13.1 Objectives

13.1.1 To familiarize the trainee with the theory and application of mass spectrometry (MS) in drug analysis

13.1.2 To familiarize the trainee with the MS instrumentation and software used in the laboratory

13.2 Modes of Instruction

13.2.1 Self-directed study through reading, study questions, and practical exercises

13.2.2 Presentations and demonstrations

13.3 References

13.3.1 Moffat, A. C., editor. *Clarke's Isolation and Identification of Drugs*. London: The Pharmaceutical Press, 1986, pp. 251-263.

13.3.2 *Basic Training Program for Forensic Chemists*, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology, pp. 5-61 through 5-72.

13.3.3 Virginia Department of Forensic Science Controlled Substances Procedures Manual, Gas Chromatography/Mass Spectrometry Section.

13.3.4 Allen, A. C. et al. "The Cocaine Diastereomers", *Journal of Forensic Science*s, Vo., 26, No. 1, 1981.

13.3.5 Yinon, Jehuda. *Forensic Mass Spectrometry*. Boca Raton: CRC Press, Inc., 1987.

13.3.6 McLafferty, Fred W. and Venkataraghavan, Rengachari. *Mass Spectral Correlations, Second Edition.* Washington, D. C.: American Chemical Society, 1982.

13.3.7 McLafferty, F. W. *Interpretation of Mass Spectra, Second Edition*. Reading, MA: W. A. Benjamin, Inc., 1973.

13.3.8 Message, Gordon M. *Practical Aspects of Gas Chromatography/Mass Spectrometry.* New York: John Wiley & Sons, 1984.

13.3.9 Mills, Terry, III and Roberson, J. Conrad. *Instrumental Data for Drug Analysis, Second Edition*. New York: Elsevier, 1987.

13.3.10 Mills, Terry, III and Roberson, J. Conrad. *Instrumental Data for Drug Analysis, Third Edition*. New York: CRC Press, 2006.

13.3.11 Rösner, Peter, et al. *Mass Spectra of Designer Drugs.* Germany: Wiley-VCH, 2007.

13.3.12 Computer-based NIST library of organic compounds (NIST98.l or higher)

13.3.13 Agilent Technologies GC/MS instrument manuals

13.3.14 Agilent Technologies computer-based tutorials

13.3.15 Silverstein, R. M. *et al*. *Spectrometric Identification of Organic Compounds* New York: John Wiley & Sons, 1991, pp. 3-41.

13.3.16 Watson, J. T. *Introduction to Mass Spectrometry*, 3rd ed., New York: Lippincott, 1997.

13.3.17 Steiner, R. “Mass Spectrometry Lecture”, Virginia Department of Forensic Science, April 2000.

13.3.18 Beynon, J. et al. *The Mass Spectra of Organic Molecules*, Amsterdam: Elsevier Publishing Co., 1968. pp. 14-29.

13.3.19 Smith, R.M., The Mass Spectrum of Cocaine, *J. Forensic Sciences*, 1997, 42(3): 475-480.

13.3.20 Smith, R.M., *Understanding Mass Spectra: A Basic Approach*, 2nd ed., New Jersey: Wiley Interscience, 2004.

13.4 Assignments

13.4.1 Review of listed references

13.4.2 Study Questions

13.4.3 Practical Exercises

13.5 Study Questions

13.5.1 What is mass spectrometry? Describe the theory behind its use as an identification technique.

13.5.2 Draw a schematic diagram of a GC/MS. What is the purpose of each component?

13.5.3 Define the following terms:

- Relative abundance
- Base peak
- Molecular ion
- Precursor ion
- Product ion
- Mass/charge ratio
- Mass spectrum
- Unit mass resolution
- Normalization
- Carbocation
- Cleavage
- Dalton
- Isobaric
- Radical
- Doubly charged ion
- Calibration compound
- Torr
- Atmosphere
- Total Ion Current

13.5.4 What is the sensitivity of a GC/MS compared to color tests and TLC?

- How do the various models of GC/MS systems in your lab compare with respect to sensitivity? What factors determine this?

13.5.5 Why can column bleed cause a problem in GC/MS and how is it corrected? Septum bleed?

13.5.6 Explain the capillary direct method of sample transfer for the Agilent systems in the laboratory. What things must an interface between GC and MS accomplish?

13.5.7 Diagram and describe the components of the E.I. source for the Agilent systems in your lab. Include the following:

- Are the ions formed positive or negative?
- Do they have an even or odd number of electrons?
- What is the ionization efficiency of this technique?
- What governs the relative abundance of the ions formed?

13.5.8 What are the filaments made of??

13.5.9 What is an “ionization appearance potential” curve?

- What is the usual electron energy used in an E.I. source for ionization and why?
- What effect does variation in this energy have on ion abundance?

13.5.10 What vacuum conditions are necessary in the ionization source and the analyzing regions of a MS and why?

- Describe how a rough pump works.
- Describe how a turbomolecular pump works.
- Is it necessary that the vacuum remain constant?

13.5.11 What temperature conditions must be maintained in the ion source? Why is temperature important?

13.5.12 Describe how a quadrupole mass analyzer works.

- What factors influence the practical limits of the quadrupole as a mass filter?
- What determines whether an ion will have a stable trajectory through the quadrupoles?
- Draw a graphical representation of ion stability for ramping DC and RF voltages in a quadrupole filter.

13.5.13 Define mass resolution.

- What does a resolution of 500 mean?
- What is the resolution a function of?

13.5.14 Describe how an electron multiplier works.

- Why is it referred to as a continuous dynode?
- With what is the inner surface of the electron multiplier coated?
- Why is the electron multiplier the detector of choice?

13.5.15 What is a “high energy dynode” and how does it work?

13.5.16 Describe a triple axis detector.

13.5.17 Explain how the PBM library search routine works.

- How does the software decide which peaks to use?
- What makes a peak significant to each of these searches?
- What are the limitations of the computer library?

13.5.18 What reference spectra collections are available for your use?

- Do they consist of “normalized” data?
- Do they contain verified data?

- If not, are they still viable references for spectral comparisons?

13.5.19 Can enantiomers and diastereomers be differentiated via MS? What about positional isomers?

- Can ephedrine and pseudoephedrine be distinguished by MS?
- Obtain literature mass spectra of the cocaine diastereomers and discuss the differences

13.5.20 What requirements are necessary for an ion to be considered a molecular ion?

13.5.20.1 Define the term “logical neutral loss” and give examples.

13.5.20.2 What mass losses during fragmentation are highly unlikely?

13.5.20.3 What percentage of intensity of a molecular ion is contributed to the M+1 peak by carbon atoms?

13.5.20.4 What is the formula for calculating the number of carbon atoms in a molecule?

13.5.20.5 How can the M+1 peak be used to determine the molecular weight?

13.5.20.6 In what types of compounds is a molecular ion peak frequently not detectable?

13.5.20.7 In what types of compounds are molecular ion peaks most likely to occur?

13.5.20.8 What do the peaks occurring at higher mass numbers than the molecular ion often represent?

13.5.20.9 What is the nitrogen rule?

13.5.21 List the isotopic abundances for each of the following elements: H, C, N, O, F, Si, P, S, Cl, Br, I

13.5.22 If a molecular formula has been determined, how can the number of rings and double bonds be determined?

13.5.23 Describe how fragmentation patterns are influenced by:

- Branched carbon atoms
- Double bonds
- Rings
- Hetero-atoms
- Carbonyl groups

13.5.24 What are the M+2 (or A+2) elements?

13.5.25 What is the most desirable characteristic of mass spectra of trimethylsilyl derivatives?

13.5.26 What ions can be associated with the following m/z ratios?

- 43
- 58
- 77
- 91

13.5.27 Give examples of the following ion fragmentation mechanisms: 1) Charge-retention decomposition; 2) Charge-migration decomposition; 3) Sigma-bond dissociation; 4) Radical site initiation (alpha-cleavage); 5) Charge-site initiation (inductive cleavage); 6) Cyclic structure decomposition; 7) Radical-site rearrangement; 8) Charge-site rearrangement.

13.5.28 Define the following terms and describe how these terms relate mass spectrometry to chromatography?

- scan rate
- scan cycle time
- reset time
- a/d conversion rate
- spectral tilting
- Mass peak detect threshold
- GC peak detect threshold

13.5.29 Explain the terms “sequence file”, “sequence log”, “macro” and “data file”.

13.5.30 What is PFTBA? Why is it used for autotuning? What are the structures for the major ions found in the autotune report?

13.5.31 Explain sequencing and what its utility is. Give a few examples of macros that are used in your laboratory.

13.5.32 Describe the tuning procedure, explaining what each part of the program accomplishes. What is SIM and what is it used for?

13.5.33 Describe the preventative maintenance schedule and the QA/QC procedures performed on the GC/MS.

13.5.34 Describe the use of barcoding and how it relates to sample tracking.

13.5.35 Describe the conditions needed for using retention time data from GC/MS runs.

13.5.36 Describe the use of blanks on the GC/MS.

13.5.37 Explain as to a jury how a mass spectrometer operates.

13.6 Practical Exercises

13.6.1 Perform an autotune (ATUNE) and extraction source tune (ETUNE). Compare and contrast the tune reports, and describe what each value represents. What types of parameter values may indicate a problem with the instrument?”

13.6.2 Change the background method so that the mass detect threshold is set to zero. Run the background and discuss the different possibilities for setting the thresholds in methods for drug analysis.

13.6.3 Compare the mass spectral data for ephedrine, pseudoephedrine and methamphetamine. What are the significant differences which make these spectra unique to their parent compound?

13.6.4 Run LSD and LAMPA on a GC/MS system in your lab. Compare the mass spectra and indicate their differences.

13.6.5 Obtain unknown spectra from the TC. Using interpretive methods, give as much information about the unknown compounds as possible.

13.6.6 Create two methods using the parameters listed below. Run a cocaine standard on each method and compare the results.

13.6.6.1 Method 1

- Oven temperature: 220 – 240 ºC @ 20 ºC / minute

- Scan Range: 400 – 14 amu
- a/d = 4

13.6.6.2 Method 2

- Oven temperature: 220 – 240 ºC @ 20 ºC / minute
- Scan Range: 400 – 14 amu
- a/d = 0

13.6.7 Obtain a sample of GHB from the TC or designee. Create the silyl derivative and analyze via GC/MS using the GHB procedure in the Controlled Substances Procedures Manual.

13.6.8 Analyze a sample using various split methods commonly used in your laboratory.

13.6.9 Using a spectral interpretation software technique, such as NIST MS Interpreter program, account for the major peaks found in the following spectra: Cocaine, Heroin, Fentanyl, Methamphetamine, a current Cannabimimetic Agent and a current Research Chemical/Designer Drug.

13.6.10 Set up a sequence table on Chemstation. Print out the result in "brief" format and describe what each field represents.

13.6.11 Obtain mass spectra of the following, noting any major mass spectral differences:

- Δ9-THC
- Δ8-THC
- Cannabinol
- Cannabidiol
- Olivetol

13.7 DART-TOF Training

13.7.1 Required readings (all found in Training Manual References folder on DFS intranet)

13.7.1.1 Cody R.B. et al. Direct Analysis in Real Time (DART) Mass Spectrometry. *JEOL News* 2005; 40(1), pp. 8-12.

13.7.1.2 Tamura, J. and Osuga, J. *New Generation LC-TOF/MS* "AccuTOF".

13.7.1.3 Steiner, Larson, "Validation of the Direct Analysis in Real Time Source for Forensic Drug Screening", *J. For. Sci.*, May 2009, 54(3), 617-622.

13.7.1.4 Bennett, Steiner, "Detection of gamma-hydroxybutyric acid in various drink matrices via AccuTOF-DART", *J. Forensic Sciences*, March 2009, 54(2), 370-75.

13.7.1.5 Easter, Steiner, "Pharmaceutical Identifier Confirmation via AccuTOF-DART", *Forensic Science International*, 240(2014); 9-20.

13.7.1.6 Gross, J., "Direct analysis in real time – a critical review on DART-MS", *Analytical Bioanalytical Chemistry*, published online 15 September 2013.

13.7.1.7 Lesiak, A. et al, "Direct analysis in real time mass spectrometry (DART-MS) of "bath salt" cathinone drug mixtures", *Analyst*, 2013, 138, 3424-3432.

13.7.1.8 Lesiak, A., Shepard, J., "Recent advances in forensic drug analysis by DART-MS", *Bioanalysis*, 2014 6(6), 819-842.

13.7.2 DART-TOF Questions

13.7.2.1 Diagram and describe the following components of the AccuTOF-DART system:

- DART source
- Vacuum system
- Ion optics region
- Flight tube

13.7.2.2 Describe the positive and negative ionization processes of the DART source.

13.7.2.3 Discuss the principles of time-of-flight mass spectrometry, including how mass separation occurs. What is the resolution of the AccuTOF-DART system in your laboratory?

13.7.2.4 Describe, including advantages and disadvantages, the various ways to introduce a sample into the DART source.

13.7.2.5 Discuss how the AccuTOF-DART system is calibrated.

13.7.2.6 Discuss the spectral output of the AccuTOF-DART system and how it can be used to determine the elemental composition of an unknown.

13.7.2.7 Discuss the differentiation of empirical formula isomers.

13.7.2.8 Discuss the use of the Mass Mountaineer program in the interpretation of data from the AccuTOF-DART.

13.7.2.9 Discuss the advantages/disadvantages of there being no chromatography prior to the AccuTOF-DART analysis.

13.7.2.10 Describe the preventative maintenance schedule and the QA/QC procedures performed on the DART-TOF system.

13.7.2.11 Explain DART-TOF as you would to a jury.

13.7.3 Practical Exercises/Instrument Certification

Training Samples – The TC will provide a minimum of ten (10) training samples, which should include a minimum of three (3) “pharmaceutical identifier confirmation” samples. In conjunction with the Primary Operator, the trainee will obtain DART-TOF data on each sample, with the Primary Operator providing gradually less oversight as the trainee progresses. In order to provide the most educational experience, the ten (10) samples SHALL NOT be run in one day and should be spaced out over the course of several days. This will allow the trainee to utilize the system several different times to fully obtain the skills necessary to acquire and interpret the data. Training sample #10 should be run entirely without assistance from the Primary Operator and will be used as final certification that the trainee can fully utilize the instrument for casework, independently. Dates of completion of required readings and training samples will be kept by the TC to ensure completion of the entire set of training samples. As available, run a counterfeit tablet on the DART. Discuss what steps would be needed in your analysis with regards to sampling, analysis and reporting.

13.8 Modes of Evaluation

13.8.1 Written examination

13.8.2 Court exercise (mini-mock trials)

13.8.3 Technical/Oral session(s)

14 HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

14.1 Objectives

14.1.1 To familiarize the trainee with the theory and application of high performance liquid chromatography (HPLC) in Controlled Substances analyses.

14.1.2 To familiarize the trainee with the HPLC instrumentation and software.

14.2 Modes of Instruction

14.2.1 Self-directed study through reading, study questions, and practical exercises

14.2.2 Presentations and demonstrations

14.3 References

14.3.1 M Moffat, A.C., editor. *Clarke's Analysis of Drugs and Poisons*, 3rd edition. London: The Pharmaceutical Press, 2004 pp 500-534.

14.3.2 Smith, R. N., Ph.D. "Forensic Applications of High-Performance Liquid Chromatography", in Saferstein, Richard, Ph.D., editor. *Forensic Science Handbook*. Englewood Cliffs, N. J.: Prentice Hall, 1982, pp. 28-91.

14.4 Assignments

14.4.1 Review of listed references

14.4.2 Study Questions

14.4.3 Practical Exercise

14.5 Study Questions

14.5.1 Describe HPLC.

14.5.2 Draw a schematic diagram of a HPLC system and describe the function of each component.

14.5.3 Describe the types of pumps available in the HPLC instruments. What type of pump does your instrument have?

14.5.4 Describe the sample injection process.

14.5.5 Describe the photodiode array detector. What are its advantages? What other detectors are available for HPLC systems?

14.5.6 Why is it important to use HPLC grade solvents?

14.5.7 What types of drugs are better suited for HPLC analysis, versus analysis by gas chromatography? Give examples.

14.5.8 Define the following:

- Mobile phase
- Capacity factor
- Isocratic elution
- Gradient elution

- Normal phase HPLC
- Reverse phase HPLC
- Guard column

14.5.9 How discriminating are UV spectra?

14.5.10 Describe the use of buffers giving examples and their use for specific separations.

14.5.11 Describe how you might choose an HPLC column for analysis?

14.5.12 Describe the effect of particle size, flow rate, and column dimensions regarding separation with HPLC columns.

14.6 Practical Exercises

14.6.1 Perform a quantitative cannabinoid analysis of a sample provided by the TC or designee. The analysis should include preparing mobile phases, internal standard solutions, calibrators, controls and samples.

14.7 Modes of Evaluation

14.7.1 Written examination

14.7.2 Court exercise (mini-mock trial) (as needed)

14.7.3 Technical/Oral session(s) (as needed)

15 INFRARED SPECTROPHOTOMETRY

15.1 Objectives

15.1.1 To familiarize the trainee with the theory and application of infrared spectrophotometry in drug analysis

15.1.2 To familiarize the trainee with the FTIR and software used in the laboratory

15.2 Modes of Instruction

15.2.1 Self-directed study through reading, study questions, and practical exercises

15.2.2 Presentations and demonstrations

15.3 References

15.3.1 Moffat, A. C., *et al*., editors. *Clarke's Analysis of Drugs and Poisons*. London: The Pharmaceutical Press, 2004, pp. 328-345.

15.3.2 *Basic Training Program for Forensic Chemists*, U.S. Department of Justice, Drug Enforcement Administration, Office of Science and Technology, pp. 5-17 through 5-29.

15.3.3 DFS Controlled Substances Procedures Manual, Infrared Spectroscopy Section.

15.3.4 Suzuki, Edward M., Ph.D. "Forensic Applications of Infrared Spectroscopy", in Saferstein, Richard, Ph.D., editor. *Forensic Science Handbook, Volume III*. Englewood Cliffs, N. J.: Regents/Prentice Hall, 1993, pp. 71-195.

15.3.5 Cooper, James. *Spectroscopic Techniques for Organic Chemists*. New York: John Wiley & Sons, 1980, pp. 1-52.

15.3.6 Smith, A. Lee. *Applied Infrared Spectroscopy*. New York: John Wiley & Sons, 1979.

15.3.7 Mills, Terry, III and Roberson, J. Conrad. *Instrumental Data for Drug Analysis, Second Edition*. New York: Elsevier, 1987.

15.3.8 Mills, Terry, III and Roberson, J. Conrad. *Instrumental Data for Drug Analysis, Third Edition*. New York: CRC Press, 2006.

15.3.9 Computer-based Georgia Bureau of Investigation (Mills) library of drug compounds.

15.3.10 Silverstein, R. M. et al. *Spectrometric Identification of Organic Compounds.* New York: John Wiley & Sons, 1991.

15.3.11 Thermo Nicolet Instrument Manuals.

15.4 Assignments

15.4.1 Review of listed references

15.4.2 Study Questions

15.4.3 Practical Exercises

15.5 Study Questions

15.5.1 What is infrared spectrophotometry? Describe the theory behind its use as an identification technique

including types of information obtained and specificity.

15.5.2 Describe the electromagnetic spectrum.

- What is the upper and lower limit on the infrared region of the electromagnetic spectrum?
- What region is the most useful analytically?
- What is the standard range of most instruments?

15.5.3 Define the following terms:

- Wave
- Wavelength
- Wavenumber
- Frequency
- Dipole moment
- Overtone
- Harmonic vibration
- Combination band
- Fundamental vibration
- Interferometer
- Homonuclear
- Zero path difference

15.5.4 Draw a schematic of the FTIR and describe the function of the major components.

- Describe the different types of radiation sources for FTIR instruments.
- Describe the different types of detectors available for FTIR instruments.
- Sketch a Michaelson interferometer and describe how it works.
- What is the centerburst?
- Discuss constructive and destructive interference.

15.5.5 What is “Fourier Transform” and how does it apply to IR?

15.5.6 Explain the theory behind the Attenuated Total Reflectance (ATR) sampling unit including the differences between single-bounce and multi-bounce units.

- Describe any differences in the spectra obtained using ATR vs. regular transmittance.
- Explain the function of the ATR correction within the software including when it is permissible to use a corrected spectra in case work.
- Draw a schematic of an ATR sampling unit.

15.5.7 What is meant by the “fingerprint region” of an IR spectrum? Why is it significant?

15.5.8 Can IR differentiate optical isomers? Diastereomers? Positional isomers? Salt/Base forms?

15.5.9 Why is polystyrene used to check the function of the FTIR?

15.5.10 Why is KBr used in the preparation of solid samples?

15.5.11 What two conditions must be met in order for infrared absorption to occur?

15.5.12 What is the intensity of an IR absorption proportional to?

15.5.13 Describe the difference between data presented in transmittance, absorbance and reflectance. How are they related to each other?

15.5.14 Explain Beer's Law.

15.5.15 Describe the two basic categories of molecular vibration.

15.5.16 Describe the four types of bending.

15.5.17 What is meant by vibrational coupling?

15.5.18 Describe the differences between dispersive and non-dispersive instruments. What are the advantages/disadvantages of each?

15.5.19 Describe Hook's law. What will vibrate with higher frequency, C-H bond or C-C bond? Why?

15.5.20 What does hydrogen bonding do to the vibrational frequency of a hydroxyl or an amine group?

15.5.21 Describe the absorptions for the following groups:

- -O-H
- -N-H
- >C=O
- -C-O-
- -C-H
- -C≡N
- $-NO_2$
- Aromatic Substitutions

15.5.22 What is polymorphism and how does it influence IR spectra?

15.5.23 Describe how to prepare a KBr pellet.

15.5.24 What model IR does your laboratory use?

- What radiation sources and detectors are used in the FTIR and its attachments in your laboratory?

15.5.25 What problems are encountered in using IR as a quantitative technique?

15.5.26 What causes a sloped baseline?

15.5.27 Explain baseline correction and how it is performed.

15.5.28 What is spectral subtraction and under what conditions is it possible?

15.5.29 What are the differences between background subtraction and spectral subtraction?

15.5.30 What is the relationship between resolution and data point spacing?

15.5.31 Can a library match be used to identify a sample? Why or why not?

15.5.32 Describe how ATR analysis can be run on powders, liquids and mixtures.

15.5.33 What are the advantages/disadvantages of a GC/MS compared to an IR when used for identification purposes?

15.5.34 Describe the preventative maintenance schedule and the QA/QC procedures performed on the IR including the VAL-Q/VAL-PRO software.

15.5.35 Discuss when a salt/base form determination is required for casework.

15.5.36 Describe as to a jury how an FTIR operates.

15.6 Practical Exercises

15.6.1 Obtain the following samples from the TC or designee. Analyze via ATR and discuss the differences in the spectra: (Previously run spectra may be used if samples are not available)

- Methamphetamine HCl, Phentermine HCl, Ephedrine HCl
- Cocaine base, Cocaine HCl
- Common mixtures encountered in the laboratory

15.6.2 Obtain a mixture from the TC or designee and analyze via ATR. Using spectral subtraction determine the two components present. Devise and carry out an extraction of the two components and verify with FTIR.

15.6.3 Obtain samples from the TC or designee including procaine HCl, cocaine base/procaine mixture, Amoxicillin and gabapentin and run using the ATR.

15.7 Modes of Evaluation

15.7.1 Written examination

15.7.2 Court exercise (mini-mock trials)

15.7.3 Technical/Oral session(s)

16 PHARMACEUTICAL PREPARATIONS

16.1 Objective

16.1.1 To familiarize the trainee with the analytical procedures for pharmaceutical preparations

16.2 Modes of Instruction

16.2.1 Self-directed study through study questions, and practical exercises

16.2.2 Presentations and demonstrations

16.3 References

16.3.1 *Physician's Desk Reference.* Montvale, N. J.: Medical Economics, various editions.

16.3.2 *Identadrug*, hardcopy

16.3.3 *Drug Identification Bible.* Grand Junction, CO: Amera-Chem, Inc., various editions including CD versions.

16.3.4 DEA Logo Index, various editions.

16.3.5 Epocrates, website subscription.

16.3.6 Poison Control Center website.

16.3.7 NIH-DailyMed.

16.3.8 Drugs.com.

16.3.9 Manufacturers' websites.

16.3.10 DEA *Microgram Bulletin*, various editions (archived).

16.3.11 Moffat, A. C., editor. *Clarke's Isolation and Identification of Drugs*. London: The Pharmaceutical Press, 1986.

16.3.12 Clarke, E. G. C. *Isolation and Identification of Drugs, Volumes 1 and 2*. London: The Pharmaceutical Press, 1978.

16.3.13 Budavari, Susan, editor. *The Merck Index, Eleventh Edition*. Rahway, N. J.: Merck & Co., Inc., 1989.

16.3.14 DFS Controlled Substances Procedures Manual, Pharmaceutical Identifiers and Analysis of Pharmaceutical Injectable Dosage Forms Sections.

16.4 Assignments

16.4.1 Study Questions

16.4.2 Practical Exercises

16.5 Study Questions

16.5.1 List approved references for tablet logo identification. Is it ever appropriate to use an unlisted reference for casework?

16.5.2 What information should be recorded in the case notes to ensure proper documentation of visual examination?

16.5.3 What are the analysis and reporting requirements for tablets and capsules in Schedules II – VI? Does this change for simple possession vs. distribution?

16.5.4 What steps should be taken if the results of an analysis are inconsistent with the manufacturer's specification with regard to content? How is this reflected on your Certificate of Analysis?

16.5.5 How does the analysis of an injectable dosage form differ if tampering is suspected?

16.5.6 What are the most accurate sources for determining the schedule of a drug?

16.6 Practical Exercises

16.6.1 Obtain 5-10 unknown preparations from the TC (tablets and tamperable forms). Perform the visual examination with references from two sources. Include the schedule of each component. Discuss how analysis would differ between tamperable and non-tamperable forms.

16.7 Mode of Evaluation

16.7.1 Written examination

17 EXTRACTIONS

17.1 Objective

17.1.1 To familiarize the trainee with the sample extraction methodology

17.2 Modes of Instruction

17.2.1 Self-directed study through reading assignments, study questions, and practical exercises

17.3 References

17.3.1 Moffat, A. C., editor. *Clarke's Isolation and Identification of Drugs*. London: The Pharmaceutical Press, 1986.

17.3.2 Clarke, E. G. C., *Isolation and Identification of Drugs,* London: The Pharmaceutical Press, 1972, Vol. 1, 2.

17.3.3 Higuchi, T. et al. "Ion Pair Extraction of Pharmaceutical Amines" *Analytical Chemistry,* Vol. 39, 1967, p. 974.

17.3.4 Watson, D. G. *Pharmaceutical Analysis* New York: Churchill Livingstone, 1999, pp. 17-47.

17.3.5 Virginia Department of Forensic Science Controlled Substances Procedures Manual,

17.3.6 United Nations Office on Drugs and Crime

17.3.7 Merck Index

17.4 Assignments

17.4.1 Review of listed references

17.4.2 Study Questions

17.4.3 Practical Exercises

17.5 Study Questions

17.5.1 What is a matrix?

17.5.2 What is the difference between recrystallization and precipitation?

17.5.3 Define the following with respect to filtration:

- Supernatant
- Filtrate
- Porosity
- Retentivity
- Speed

17.5.4 Why is it necessary to have at least two test tubes in a centrifuge?

17.5.5 Define the following:

- Unsaturated solutions
- Saturated solutions

- Supersaturated solutions
- Reflux
- Azeotrope

17.5.6 What problems may be encountered if ether evaporates to dryness?

17.5.7 What is a dry extraction?

17.5.8 What effect does temperature have on a drug extraction?

17.5.9 Describe how a series of smaller volume immiscible solvent extractions is more efficient than a single extraction using the same total volume of organic solvent, using the concept of 'partition coefficient' in your description.

17.5.10 How can water be removed from organic solvents?

17.5.11 What is an emulsion? How can they be prevented and what can be done when one occurs?

17.5.12 What does "salting out" mean?

17.5.13 What does pH stand for? pK_a?

17.5.14 Describe how a pH controlled extraction works explaining equilibriums that are set up between two immiscible solvents.

17.5.15 What types of functional groups cause a compound to be acidic? Basic?

17.5.16 What does amphoteric mean?

17.5.17 Tell whether the drugs listed in Appendix A are acidic, basic, or neutral.

17.5.18 Explain the extraction scheme for morphine outlined in the Procedures Manual.

17.5.19 How does hydrogen bonding come into play in liquid-liquid extractions?

17.5.20 What is ion-pairing? Diagram how it works using equilibrium considerations.

17.5.21 What types of factors should be considered in selecting solvents to use in extractions.

17.5.22 What separation advantages does chromatography have over extraction procedures? Disadvantages?

17.5.23 Describe the acetic acid extraction of psilocybin mushrooms emphasizing areas of concern.

17.5.24 What solvent should be used to extract salvinorin A from *Salvia divinorum* and why?

17.5.25 Describe how you would extract THC from a solution that is not miscible with hexane.

17.5.26 What extraction can be used to isolate water insoluble drugs from PEG solutions?

17.5.27 What is an extraction blank/procedural blank and when should it be used?

17.5.28 Explain how you can remove residual amounts of aqueous phase suspended in the final organic fraction.

17.6 Practical Exercises

17.6.1 Obtain a mixture of Methamphetamine HCl and caffeine and outline an extraction scheme. Perform the extraction scheme and confirm the components using either GC/MS or FTIR.

17.6.2 Obtain a sample of mushrooms and a sample of psilocyn (preferably in chocolate) from the TC. If one is not available, use a standard of psilocybin.

- Perform the Weber test on each sample using both recipes listed in the Procedures Manual, which differ in concentration. Note observations and discuss the differences in the results for both recipes of the color test.

- Perform the acetic acid extraction as outlined in the Procedures Manual. Confirm the presence of psilocyn.

17.6.3 Obtain a sample of a cocaine mixture from the TC or designee. Perform a dry extraction and confirm using FTIR.

17.6.4 Obtain a sample of a food product containing THC. Perform the extraction outlined in the Procedures Manual. Confirm the presence of THC.

17.6.5 If available, perform the suggested Khat extraction on a sample of plant material. Confirm the presence of Cathinone and Cathine.

17.6.6 Obtain a sample of a controlled substance mixed with PEG. Run it on TLC and DART before the extraction and after. Compare/discuss results.

17.6.7 Obtain a sample of a Hydrocodone (or Oxycodone) and Acetaminophen tablet from the TC or designee. Place into ammonia saturated chloroform Run immediately on GC-MS. Retain sample and run again after 24-48 hours. Explain differences in spectra/results. How can this be corrected?

17.7 Mode of Evaluation

17.7.1 Written examination

18 COURTROOM TESTIMONY

18.1 Objectives

18.1.1 To familiarize the trainee with the functions of a courtroom criminal proceeding

18.1.2 To have the trainee prepare a current curriculum vitae and convey *voir dire* questioning during testimony

18.1.3 To familiarize the trainee with proper methods of presenting expert testimony during direct examination

18.1.4 To familiarize the trainee with the proper methods of defending analytical results during cross-examination

18.2 Modes of Instruction

18.2.1 Self-directed study through reading, study questions, and practical exercises

18.2.2 Observation of expert testimony

18.3 References

18.3.1 Kuzmack, Nicholas T., J.D., M.A. “Legal Aspects of Forensic Science”, in Saferstein, Richard, Ph.D., editor. *Forensic Science Handbook.* Englewood Cliffs, N.J.: Prentice Hall, 1982, pp. 1-27.

18.3.2 Shellow, James M. “The Expert Witness in Narcotics Cases”, in *Contemporary Drug Problems – A Law Quarterly*, Spring 1973, pp 81-104.

18.3.3 Travnikoff, Basil, Jr. and Kvick, Robert J. *How to Examine a Chemist in Drug Abuse Cases, First Edition*, 1971.

18.3.4 Bailey, F. L. and Rothblatt, H. B., *Handling Narcotic and Drug Cases*, Rochester, NY: The Lawyers Cooperative Publishing Co., 1972.

18.3.5 *Code of Virginia* (§ 19.2-187) and (§ 19.2-188.1).

18.3.6 DFS Subpoena Policy (101-D105).

18.4 Assignments

18.4.1 Review of listed references

18.4.2 Completion of Statement of Qualifications

18.4.3 Study Questions

18.4.4 Practical Exercises

18.4.5 Mock Trials

18.5 Study Questions

18.5.1 Discuss the role of the following during a trial:

- Expert witness
- Judge
- Prosecutor
- Defendant

- Defense counsel
- Jury

18.5.2 Define the following:

- *Voir dire*
- Direct examination
- Cross examination
- Redirect
- Chain of custody

18.5.3 Complete a Statement of Qualifications in the format provided by the TC which includes educational background and work experience.

18.5.4 Describe a typical process from arrest to arraignment.

18.5.5 Describe a typical courtroom proceeding for a trial dealing with an individual accused of possession of a controlled substance, from the time the trial begins until final verdict by the jury. Be sure to include the order in which witnesses are called, arguments by trial counsel, and introduction of physical evidence.

18.5.6 How would you describe the characteristics of an effective expert witness (both physical and professional)? Likewise, what are some of the factors which make a poor expert witness?

18.5.7 Describe the ANAB (ANSI National Accreditation Board) accreditation process and the benefits of being an accredited laboratory.

18.5.8 Discuss the importance the *Melendez-Diaz v. Massachusetts* decision played in forensic science testimony.

18.5.9 How are subpoenas received at DFS? What are the available mechanisms to legally serve a subpoena in the Commonwealth?

18.6 Practical Exercises

18.6.1 Conduct several mock trials in conjunction with the TC or designee which deal with the following aspects of testimony separately:

- *Voir dire*
- Chain of custody
- Drug analysis

18.6.2 Conduct several mock trials which will encompass all aspects of a potential trial setting. Be sure to include role players to serve as judges, attorneys, and jurors.

18.6.3 Observe examiners testify whenever possible.

18.6.4 Verbally answer the following possible direct examination questions to the TC or designee:

- What is your name?
- What is your occupation? For whom do you work?
- How long have you been so employed?
- What are your duties in this occupation?
- What education and training do you possess that qualifies you to perform your duties?
- What specific courses have you taken that are directly related to drug analysis?
- How are these courses related? For example, what did you learn in your general chemistry course that aids you in the analysis of drugs?

- Do you consider yourself an expert in the analysis of drugs?
- What is the definition of an expert witness?
- Is the university/college you graduated from accredited, and if so, by whom?
- Who conducted your training?
- What are his/ her/ their qualifications?
- What literature do you read relating to your job?
- How many analyses have you done on suspected drugs (or controlled substances)?
- Do you belong to a recognized society attesting to your qualifications as a drug chemist?
- Have you written any articles or published materials dealing with your work?
- Is your laboratory accredited? If so, by whom?
- Is there a proficiency testing procedure in place at your laboratory?

18.6.5 Review recorded mock trials of other examiners.

18.7 Mode of Evaluation

18.7.1 Passage of final mock trial

19 SPECIAL TECHNIQUES AND ANALYSES

19.1 Objective

19.1.1 To familiarize the trainee with the theory and application of the DISCOV-IR (complete if the instrument is available at your laboratory).

19.2 Modes of Instruction

19.2.1 Self-directed study through reading, study questions, and practical exercises.

19.3 References

19.3.1 Discov-IR Instrument Manual

19.4 Assignments

19.4.1 Review of listed references

19.4.2 Study Questions

19.4.3 Practical Exercises

19.5 Study Questions

19.5.1 Draw a schematic of the Discov-IR instrument and describe the function of the major components.

19.5.2 Explain the sample deposition process that is unique to the Discov-IR. What are the benefits?

19.5.3 What type of spectra are obtained from the Discov-IR? How will these spectra differ from those collected with ATR?

19.5.4 Discuss the differences between solid phase spectra and gas phase spectra.

19.5.5 Explain the operational relationship between the Discov-IR and the GC.

19.5.6 Describe how to set up a sequence including a standard, blank and sample.

19.5.7 What is the importance of depositing the sample over the same area as the blank?

19.5.8 Which instrument should be started first? Why?

19.5.9 During a Discov-IR run, where is the background used for subtraction collected?

19.5.10 How does this differ when using the “First BL” and the “Add BL” functions?

19.5.11 When would you use the “First BL” and “Add BL” functions?

19.5.12 Explain how to perform a post-run rescan of a sample. When would the use of this feature be important?

19.5.13 Describe the preventative maintenance schedule and the QA/QC procedure performed on the Discov-IR.

19.6 Practical Exercises

19.6.1 Obtain an unknown sample from the TC. Screen the sample via the normal analytical scheme and confirm using GC-Discov-IR.

19.6.2 Utilizing the report generator - create two sets of data for the standard, blank and sample.

19.6.3 Utilizing the GRAMS software – Perform a Spectral ID library search on the sample and perform peak integration and baseline correction on the standard and sample.

19.7 Mode of Evaluation

19.7.1 Written Examination

19.7.2 Court exercise

19.7.3 Technical/Oral session(s)

20 ADDITIONAL TRAINING

20.1 Review of Other Disciplines

During the course of the Training Program the trainee should spend a small amount of time with the other disciplines (latent prints, forensic biology, etc.) located within the Department. This will allow the trainee to understand how evidence is maintained for multi-sectional analysis as well as understanding the general capabilities of the other sections. These visits will be coordinated by the TC.

20.2 DEA Forensic Chemist Seminar

Upon completion of training, the trainee shall attend the DEA Forensic Chemists Seminar contingent upon resources (funding, availability). Information of current schedules can be obtained by contacting the DEA Special Testing and Research Laboratory.

20.3 Technical/Administrative Review Training

20.3.1 The following documents shall be read and discussed with the TC or designee:

- Quality Manual - Monitoring Results
- Technical Review Form

20.3.2 Practical Exercises

20.3.2.1 The trainee should document the review of at least twenty case files using the appropriate Technical Review Form. Case files should be generated by multiple examiners, if possible. The potential findings of the reviews shall be discussed with the TC. Technical Review forms generated in this capacity shall be marked as Training and retained in their Training Binder. The case files shall be technically reviewed by an authorized examiner pursuant to QM 17 prior to release.

21 CLANDESTINE LABORATORIES

21.1 Objectives

21.1.1 To familiarize the trainee with syntheses routinely used in clandestine laboratories.

21.1.2 The completion of this section is not required in order for the trainee to become a qualified examiner.

21.2 Instructions to Training Coordinators

21.2.1 This section of training may be completed as a "qualified examiner". If the training is expected to take (or once it is determined to be taking) more than a month the TC must submit regular evaluations of the chemist's progress (using the Qualtrax Workflow) to the Chemistry Program Manager and Laboratory Director. The coordinator is to discuss this evaluation with the trainee prior to forwarding it to the Chemistry Program Manager. Any relevant comments by either the trainee or coordinator are to be included with the report.

21.2.2 The "Controlled Substances Training Documentation" form (221F-201) or a MFR shall serve to document the successful completion of this module and must be forwarded to the Chemistry Program Manager for approval. This process will also prompt an update of the examiner's work authorization by the Laboratory Director.

21.3 Modes of Instruction

21.3.1 Self-directed study through reading, study questions, and practical exercises.

21.4 References

21.4.1 DFS Controlled Substances Procedures Manual, Clandestine Laboratories Section.

21.4.2 Weaver, K. and Yeung, E. *An Analyst's Guide to the Investigation of Clandestine Laboratories, 3rd edition.* Health Protection Branch, Ontario Region Health Canada, 1995.

21.4.3 *Clandestine Lab Basic Guide,* presented at the 12th Annual Clandestine Laboratory Investigating Chemists Training Seminar, 2002.

21.4.4 Ely, Roger*, et al. A Review of the Syntheses and Analyses of Phenyl-2-propanone, Amphetamine, and Methamphetamine.* Clandestine Laboratory Investigating Chemists, 1995.

21.4.5 Clandestine Laboratory Investigating Chemists monographs.

21.4.6 Strike. *Total Synthesis II*, San Antonio, TX: Panda Ink, 1999.

21.4.7 Uncle Fester. *Advanced Techniques of Clandestine Psychedelic & Amphetamine Manufacture.* Port Townsend, WA: Loompanics Unlimited. 1998.

21.4.8 Code of Virginia § 18.2-248.

21.4.9 Christian, Donnell R., Jr. *Forensic Investigation of Clandestine Laboratories*. CRC Press. 2004.

21.4.10 http://www.dfs.virginia.gov/laboratory-forensic-services/controlled-substances/meth-labs/

21.4.11 Angelos, S.A. et al. "The Identification of Unreacted Precursors, Impurities, and By-Products in Clandestinely Produced Phencyclidine Preparations", *Journal of Forensic Sciences*, 35(6), 1990, pp.1297-1302.

21.4.12 Skinner, H. F. "Methamphetamine Synthesis Via Hydroiodic Acid/Red Phosphorous Reduction of

Ephedrine", *Forensic Science International*, Vol. 48, 1990, pp. 123-134 (found in CLIC: A Review of Syntheses and Analyses of Phenyl-2-Propanone, Amphetamine, and Methamphetamine. Vol. 1).

21.4.13 Person, E.C., Knops, L.A., Northrop, D.M., "One-Pot Methamphetamine Manufacture", *Journal of the Clandestine Laboratory Investigating Chemists Association*, Vol. 14, Number 2, April 2004, p. 14-15.

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21.5 Assignments

21.5.1 Review of listed references

21.5.2 Study Questions

21.5.3 Practical Exercises

21.6 Study Questions

21.6.1 Discuss subsection J and K of § 18.2-248 in the Code of Virginia and how these correlate to a drug examiner's responsibility for handling clandestine labs. What is the significance of § 18.2-248.03?

21.6.2 Define the following terms:

- Precursor
- Byproduct
- Catalyst
- Limiting reagent

21.6.3 Explain how an analyst should sample a liquid with three layers.

21.6.4 Discuss the importance of working closely with prosecutors and officers to decide the amount of analyses necessary.

21.6.5 Review the Department's Clan Lab submission guidelines. Discuss the following:

- What items should/should not be submitted?
- What items will be analyzed?
- What weight thresholds are important in the manufacturing charges in Virginia?
- How should submitted items be packaged?

21.6.6 List chemicals and starting materials which would indicate the various syntheses of DMT and methamphetamine. What byproducts would be expected from these syntheses and why?

21.6.7 Discuss the types of analysis that may be necessary when the charge listed is Code of Virginia § 18.2-248 (J). Which compounds listed would be analyzed in the Controlled Substances section and which would be transferred to the Trace Evidence section?

21.6.8 Discuss potential hazards associated with sampling clandestine laboratory evidence. What safety measures should be used to mitigate each of the discussed hazards?

21.7 Practical Exercise (optional due to availability of reagents/starting materials and laboratory safety)

21.7.1 Shadow an examiner working on suspected clandestine lab.

21.7.2 If available/feasible, perform a synthesis procedure that is commonly encountered in clandestine laboratories (either methamphetamine or PCP is recommended).

- Take samples during the reaction process to monitor the progress.
- Determine the yield of the reaction.
- Attempt to identify all compounds in the product mixture.

21.8 Mode of Evaluation

21.8.1 Completion of the study questions

22 FORENSIC LAB SPECIALISTS

22.1 Introduction

Forensic Lab Specialists (FLS) provide important support to Forensic Scientists in the laboratory. Typically FLS perform duties including, but not limited to the following:

22.1.1 Prepare solutions, reagents and standards

22.1.2 Participate in the quality assurance/quality control program

22.1.3 Maintain inventory of expendable supplies, reagents and materials

22.1.4 Perform routine maintenance of instrumentation and equipment

22.1.5 Perform general housekeeping duties (e.g., cleaning glassware, removing sharps waste)

22.1.6 Transfer sealed evidence

22.1.7 Under close supervision, perform routine procedures in the analysis of casework.

22.2 Training Outline

22.2.1 Instruction will be provided to the FLS by directed study, demonstration by the trainer and observation of the trainee. All tasks are performed under the direction of the trainer until the training segment is completed.

22.2.2 Reference information for the topics below can be found in other sections of this manual, the Controlled Substances Procedures Manual (CSPM) and other Department manuals. The specific locations are noted by section numbers in parentheses by the topic.

22.2.3 Orientation

22.2.3.1 Introduction to the local facility, staff and how the FLS fits into the Department of Forensic Science (DFS).

22.2.3.2 Description of the FLS position and clarification of duties.

22.2.3.3 Coverage of the following:

- Quality Manual
- Controlled Substances Procedures Manual with emphasis on the Quality Assurance Section
- Controlled Substances Training Manual
- Regional Operating Procedures
- Safety Manual, to include Bloodborne Pathogen and Chemical Hygiene training
- Organizational Chart of DFS

22.2.3.4 Introduction of the technical capabilities of all the DFS laboratories and how it fits into the Virginia law enforcement system.

22.2.3.5 Introduction to LIMS.

22.2.4 Laboratory and Glassware

22.2.4.1 Objectives

22.2.4.1.1 To familiarize the FLS with the basic cleaning procedures for laboratory areas, hoods and glassware

22.2.4.1.2 To train the FLS on the proper operation of the laboratory glassware washer

22.2.4.1.3 To familiarize the FLS with the safety requirements of the laboratory and available personal protective equipment (PPE)

22.2.4.1.4 To instruct the FLS on the proper handling and maintenance of compressed gas cylinders

22.2.4.1.5 To familiarize the FLS with the proper disposal of Biohazard and Sharps waste

22.2.4.2 Mode of Instruction

Demonstrations by the TC or designee

22.2.4.3 References

22.2.4.3.1 DFS Safety Manual

22.2.4.3.2 Operations manual for glassware washer

22.2.4.4 Mode of Evaluation

Observation of the FLS by the trainer

22.2.5 Reagent Preparation

22.2.5.1 Objectives

22.2.5.1.1 To familiarize the FLS with the preparation of color test reagents and thin layer chromatography (TLC) baths and sprays

22.2.5.1.2 To familiarize the FLS with the preparation of standards and solutions

22.2.5.1.3 To familiarize the FLS with the Quality Assurance schedule and documentation

22.2.5.2 Mode of Instruction

Demonstrations by the TC or designee

22.2.5.3 References

22.2.5.3.1 *CSPM* Color Tests Section

22.2.5.3.2 *CSPM* Thin Layer Chromatography Section

22.2.5.3.3 *CSPM* Quality Assurance Section

22.2.5.4 Mode of Evaluation

Observation of the FLS by the trainer

22.2.6 Balances

22.2.6.1 Objectives

22.2.6.1.1 To familiarize the FLS with the operation of laboratory balances

22.2.6.1.2 To familiarize the FLS with balance calibration checks and quality assurance

22.2.6.2 Modes of Instruction

22.2.6.2.1 Presentations and demonstrations by the TC or designee regarding balances to include general use, leveling, cleaning and internal calibrations when necessary.

22.2.6.2.2 Presentation and demonstration regarding the quality assurance of balances

22.2.6.2.3 Study Questions (6.5.1 (except the UoM terms), 6.5.2, 6.5.3, 6.5.4, 6.5.5, 6.5.8, 6.5.9, 8.5.11, 8.5.12, and 8.5.13)

22.2.6.2.4 Complete the Good Pipetting Practices training in Qualtrax.

22.2.6.3 References

22.2.6.3.1 Balance Manufacturer's operating manual

22.2.6.3.2 *CSPM* Quality Assurance and Weighing Practices Sections

22.2.6.4 Modes of Evaluation

22.2.6.4.1 Observation of the FLS by the trainer, including quality assurance of balances

22.2.6.4.2 Completion of the study questions

22.2.6.4.3 Competency test sample. Receive a previously weighed sample from the TC or designee

22.2.7 Ordering/Stocking

22.2.7.1 Objective

To familiarize the FLS with routine ordering practices for consumable laboratory supplies

22.2.7.2 Mode of Instruction

Demonstrations by the TC or designee

22.2.7.3 Reference

DFS Administrative Policies

22.2.7.4 Mode of Evaluation

Observation of the FLS by the trainer

22.2.8 Evidence Transfer

22.2.8.1 Objectives

22.2.8.1.1 To familiarize the FLS with the fundamentals of evidence security and transfer procedures in order for the FLS to handle sealed evidence

22.2.8.1.2 To familiarize the FLS with LIMS

22.2.8.2 Modes of Instruction

22.2.8.2.1 Demonstration by the TC or designee regarding proper chain of custody and evidence handling procedures. The FLS should observe the trainer transferring evidence for a minimum of two weeks.

22.2.8.2.2 Demonstration by the TC regarding the proper use of LIMS.

22.2.8.2.3 Study Questions (see Section 5.5.1 – 5.5.5)

22.2.8.3 References

22.2.8.3.1 *Quality Manual*, Department of Forensic Science, Evidence Handling section

22.2.8.3.2 LIMS manual

22.2.8.4 Modes of Evaluation

22.2.8.4.1 Observation of FLS by trainer

The trainer should observe the FLS transferring evidence while maintaining appropriate documentation for a minimum of two weeks.

22.2.8.4.2 Written Examination

The content of the questions will be based on both the study questions and references.

22.2.9 Color Tests

22.2.9.1 Objective

To familiarize the FLS with color tests to enable them to perform quality assurance and assist examiners with casework under supervision

22.2.9.2 Mode of Instruction

Demonstration by the trainer regarding proper color test procedures

22.2.9.3 References

22.2.9.3.1 *CSPM*, Color Tests Section

22.2.9.3.2 *CSPM*, Cannabis Plant Material Section

22.2.9.4 Mode of Evaluation

Observation of FLS by trainer

22.2.10 Thin Layer Chromatography (TLC)

22.2.10.1 Objective

To familiarize the FLS with the practice of TLC to enable them to perform quality assurance and assist examiners with casework under supervision

22.2.10.2 Mode of Instruction

Demonstration by the trainer regarding proper TLC procedures

22.2.10.3 Reference

22.2.10.3.1 *CSPM*, Thin Layer Chromatography Section

22.2.10.4 Mode of Evaluation

Observation of FLS by trainer

22.2.11 Gas Chromatography (GC)

22.2.11.1 Objective

To familiarize the FLS with the practice of GC to enable them to perform quality assurance and assist examiners with casework under supervision

22.2.11.2 Mode of Instruction

Demonstration by the trainer regarding proper GC procedures

22.2.11.3 Reference

CSPM, Gas Chromatography Section

22.2.11.4 Mode of Evaluation

Observation of FLS by trainer

22.2.12 Extractions

22.2.12.1 Objectives

22.2.12.1.1 To familiarize the FLS with extraction methodologies used in standard preparation

22.2.12.1.2 To familiarize the FLS with extraction methodologies used in sample preparation

22.2.12.2 Mode of Instruction

Demonstrations by the TC or designee regarding proper extraction procedures

22.2.12.3 References

22.2.12.3.1 *CSPM*, Psilocybin and Psilocyn Methodology Section

22.2.12.3.2 *CSPM,* Cathinone Methodology Section

22.2.12.4 Modes of Evaluation

22.2.12.4.1 Observation of FLS by trainer

22.2.12.4.2 Competency test sample(s)

22.2.12.4.3 Receive a previously validated sample from the trainer for each type of extraction

22.2.13 Gas Chromatography/Mass Spectrometry (GC/MS)

22.2.13.1 Objectives

22.2.13.1.1 To familiarize the FLS with the practice of GC/MS to enable them to perform quality assurance and assist examiners with casework under supervision.

22.2.13.1.2 To familiarize the FLS with the ChemStation software.

22.2.13.2 Modes of Instruction

22.2.13.2.1 Demonstration by the trainer regarding proper GC/MS procedures

22.2.13.2.2 Demonstration of liner cleaning and preparation by the trainer

22.2.13.3 References

22.2.13.3.1 *CSPM*, Gas Chromatograph/Mass Spec Section

22.2.13.3.2 *CSPM,* Gas Chromatography Section

22.2.13.4 Mode of Evaluation

Observation of FLS by trainer

22.2.14 Fourier Transform Infrared Spectroscopy (FTIR)

22.2.14.1 Objectives

22.2.14.1.1 To familiarize the FLS with the practice of FTIR and associated accessories to enable them to perform quality assurance and assist examiners with casework under supervision.

22.2.14.1.2 To familiarize the FLS with the OMNIC software.

22.2.14.2 Modes of Instruction

22.2.14.2.1 Demonstration by the trainer regarding proper FTIR sampling procedures

22.2.14.2.2 Study questions

22.2.14.2.3 Practical exercises

22.2.14.3 Reference

22.2.14.3.1 *CSPM*, Infrared Spectroscopy Section

22.2.14.4 Study Questions

22.2.14.4.1 What is Infrared Spectrophotometry?

22.2.14.4.2 Draw a schematic of the FTIR and describe the functions of the major components.

22.2.14.4.3 What is meant by the “fingerprint region” of an IR spectrum?

22.2.14.4.4 List advantages and disadvantages of ATR versus traditional bench FTIR.

22.2.14.4.5 Describe how spectra run for an examiner are labeled.

22.2.14.5 Practical Exercises

22.2.14.5.1 Obtain the following samples from the trainer and run on the ATR accessory and using a KBr pellet. Print results according to trainer instructions including a library search.

- Cocaine base
- Cocaine HCl
- Procaine HCl
- Amoxicillin

22.2.14.5.2 Obtain the following samples from the trainer and run on the ATR accessory. Perform any clean-up procedures indicated by the trainer. Provide printed data to the trainer for evaluation of data and documentation practices.

- Gamma butyrolactone
- Ephedrine
- Pseudoephedrine
- Methamphetamine
- Sugar
- Sodium bicarbonate
- Cocaine base / procaine mixture

22.2.14.6 Modes of Evaluation

22.2.14.6.1 Observation of FLS by trainer

22.2.14.6.2 Completion of study questions

22.2.14.6.3 Competency test sample

22.2.14.6.4 Receive a previously validated sample from the TC or designee

22.2.15 Tablets and Capsules

22.2.15.1 Objective

To familiarize the FLS with available references for pharmaceutical identifiers

22.2.15.2 Mode of Instruction

Demonstrations by the TC or designee

22.2.15.3 Reference

CSPM, Pharmaceutical Identifiers Section

22.2.15.4 Mode of Evaluation

Observation of FLS by trainer

22.3 Completion of Training

22.3.1 The training will be considered complete when the FLS has completed all of the sections in the training manual, which are required by the TC, and been evaluated by the TC or his designee.

22.3.2 The checklist for the FLS training will be initialed and completed for each area assigned by the TC and any other personnel who assisted in the training in accordance with the Department Quality Manual.

22.3.3 When the training is complete, a MFR detailing the recommendation to qualify the trainee in the applicable duties will be submitted to the Chemistry Program Manager for approval. This process will also prompt an update of the FLS's work authorization by the Laboratory Director. Once approved, the TC will notify all Controlled Substances supervisors, section supervisors within their laboratory, the QA Section Supervisor and training records will then be stored in accordance with the Department Quality Manual.

22.3.4 If the FLS cannot meet the expected criteria during an expected period of time for training, steps will be taken to effect appropriate action.

Appendix A – List of Known Drugs

- Acetaminophen
- Buprenorphine
- Butalbital
- Diphenhydramine
- Ibuprofen
- Quinine
- 3,4-MDA
- 3,4-MDMA
- Alprazolam
- Amoxicillin
- Amphetamine
- Benzocaine
- Caffeine
- Cannabimimetic Agents (TC determined)
- Cocaine Base
- Cocaine HCl
- Codeine
- Dextromethorphan
- Diazepam
- Dimethyl Sulfone
- Ephedrine
- Ethylone
- Fentanyl (analogs & derivatives)
- Guaifenesin
- Heroin
- Hydrocodone
- Hydromorphone
- Ketamine
- LAMPA
- Lidocaine
- LSD
- Methadone
- Methamphetamine
- Methylone
- Methylphenidate
- Morphine
- Naloxone
- Nandrolone
- Oxycodone
- Oxymorphone
- Phencyclidine
- Phentermine
- Procaine
- Pseudoephedrine
- Psilocin
- Psilocybin
- Salicylamide
- Secobarbital
- Substituted Cathinones (determined by the TC)
- Testosterone Propionate