

# Study Guide for Drug Analysis Certification Examination

## Introduction

Your study guide consists of a Job Description, a list of Knowledge, Skills, and Abilities (KSAs), References, and a 20 Sample Question primer for the examination.

- The **Job Description** describes the education, background, training, and specific duties of an analyst in each discipline.
- The **KSAs** have ten major sections. Sections I-IX cover the core knowledge and skills expected of every forensic scientist and comprise 40% of the examination. Section X, consisting of the specific, discipline related, in-depth, upper level knowledge, skills, and abilities will make up 60% of the examination. Please note that the sub-categories listed under the capital letters in the KSAs are examples and are not meant to be all-inclusive, or to indicate that there will necessarily be a question on the examination from every sub-category.
- The **References** are broken into core references and discipline-related references. The core references are identical for all the ABC examinations. The discipline-related references are specific to each discipline.
- There are twenty **Sample Questions** to give you an idea of the range of content and difficulty that will appear on the examination. For further information, please see "Introduction to ABC Certification Examinations."

## Study Guide for Drug Analysis Certification Examination

### Job Description

A qualified forensic drug analyst must be able to:

- Perform analysis on seized illicit and pharmaceutical drugs and related materials.
- Perform qualitative analyses of evidential materials using established chemical, physical and instrumental techniques.
- Perform quantitative analysis of seized drugs using established analytical techniques.
- Develop, validate, and/or verify analytical methods to address new analytical challenges and improves upon established methods when possible.
- Maintain, optimize, calibrate, and utilize laboratory supplies, equipment, and analytical instruments.
- May provide assistance in seizure of clandestine laboratories and other drug scene investigations.
- Recognize, collect, secure, and preserve physical evidence.
- Recognize the potential for other forensic examinations in areas outside an area of specialization, prioritize the sequence of examinations, and handle evidence accordingly.
- Observe safe practices to insure the safety of analyst and co-workers.
- Engage in impartial and ethical work practices.
- Be proficient in the use and maintenance of laboratory instrumentation.
- Evaluate and interpret results of physical and instrumental analysis.
- Thoroughly and accurately produce documentation to support results and conclusions.
- Testify under oath as to analytical processes, results, and conclusions.
- Recognize and employ quality assurance measures to ensure the integrity of the analyses.

## Study Guide for Drug Analysis Certification Examination

### Knowledge, Skills, and Abilities

- I. History
  - A. Evolution of practice
  - B. Significant historical figures (e.g., Locard, Gross, Orfila, Kirk)
- II. Crime Scene Preservation
  - A. Securing
  - B. Isolating
  - C. Recording
  - D. Searching
  - E. Recognition of evidentiary value
  - F. Safety
- III. Crime Laboratory Operations-Overview
  - A. Laboratory Disciplines
    - 1. Forensic biology
    - 2. Controlled substances
    - 3. Trace analysis
    - 4. Toxicology
    - 5. Latent fingerprints
    - 6. Questioned documents
    - 7. Fire debris
    - 8. Firearms/Toolmarks
    - 9. Digital evidence
  - B. Evidence associated with each discipline
- IV. QA/QC
  - A. Accreditation, Certification, Standardization
    - 1. Laboratory accreditation
      - a. Audit trails
      - b. Accrediting bodies
      - c. ISO 17025
      - d. DAB standards
      - e. ASCLD/LAB
    - 2. Personnel certification
      - a. ABC
      - b. IAAI
      - c. IAI
      - d. ABFT
      - e. AFTE

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3. Standardization
    - a. ASTM
    - b. UN
    - c. TWG/SWG
  - B. QA/QC Application
    1. Noncompliant data
    2. Documentation evaluation
    3. Validation and verification
    4. Linearity
    5. Limits of detection
    6. Limits of quantitation
    7. Limits of reporting
    8. Negative and positive controls
    9. Calibrators
    10. Estimate of uncertainty
    11. Traceability
    12. Corrective and preventative actions
    13. Proficiency testing
    14. Confidence interval/confidence limits
  - C. Document/Data Management
    1. Databases
    2. LIMS
    3. Case document preservation/integrity
- V. Safety
- A. Chemical Hygiene
    1. Safety labeling (MSDS)
    2. Communication plans
  - B. Universal Precautions
    1. Blood-borne pathogens
    2. Personal protective equipment
  - C. Hazardous Waste/Biohazardous Waste Handling
    1. Spill control
- VI. Legal
- A. Decisions/laws
    1. Frye
    2. Daubert/Kumho
    3. Brady

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- B. Legal terms
  - 1. Chain of custody
  - 2. Discovery
  - 3. Voir dire
  - 4. Duces tecum
  - 5. Subpoena
- C. Court Testimony
  - 1. Monitoring
  - 2. Courtroom etiquette
- D. Procedural Law
  - 1. Hearings, trials, appeals
  - 2. Advocacy, burden of proof
  - 3. Subpoenas and affidavits
  - 4. Rules of evidence
- VII. Ethics
  - A. ABC Code of Professional Ethics
    - 1. Conflict of interest
    - 2. Professional integrity
    - 3. Objectivity
    - 4. Professional obligations
- VIII. Evidence Handling
  - A. Evidence Recognition and Collection
    - 1. Prioritization based on circumstance
    - 2. Sampling
    - 3. Preservation
  - B. Evidence Classes (Class/Individual)
    - 1. Exclusionary evidence
    - 2. Identification
    - 3. Direct vs. indirect evidence
    - 4. Tangible vs. latent evidence
  - C. Evidence Preservation
    - 1. Chain of custody
    - 2. Alteration/degradation
    - 3. Storage(long term/short term)
  - D. Evidence Packaging
    - 1. Proper sealing
    - 2. Types of packaging
- IX. General Science Terms and Principles
  - A. Definitions and applications
    - 1. Scientific method

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- B. General Chemistry Concepts
  - 1. Nomenclature (IUPAC)
  - 2. Type of molecules (e.g., aromatics, isoalkanes)
  - 3. Atomic, molecular weights
  - 4. Acids/bases
  - 5. Periodic Table
  - 6. Elemental composition
  - 7. Bonding
    - a. Ionic
    - b. Covalent
    - c. Hydrogen
    - d. Van der Waals
    - e. Stereoisomer
    - f. Enantiomer
- C. General Biology Concepts
  - 1. Cell structure
  - 2. Genetics
  - 3. Botany
  - 4. Characteristics of body fluids
- D. General Physics Concepts
  - 1. Energy
  - 2. Electromagnetic spectrum
  - 3. Force
- E. General Physiology and Anatomy Concepts
- F. General Statistics (S)
  - 1. Mean
  - 2. Median
  - 3. Mode
  - 4. Standard deviation
  - 5. Variability
  - 6. Population characteristics
- G. Stoichiometry
- H. Logic
  - 1. Critical thinking
  - 2. Inductive and deductive reasoning
- I. Metric System
  - 1. Metric to metric conversion
  - 2. Metric to English conversion

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- X. Forensic Science Applications for forensic drug analyst
  - A. Principles and concepts
    - 1. Drug Classes
      - a. Stimulants
      - b. Depressants/Tranquillizers
      - c. Narcotics
      - d. Hallucinogens
      - e. Steroids
    - 2. Drug Laws
      - a. Scheduling Criteria
      - b. Drug trafficking
      - c. Common Drug Schedules (i.e. Cocaine, CII)
      - d. Analogues
  - B. Types of drug evidence/composition
    - 1. Seized Drug Evidence Preservation
      - a. Illicit preparations
      - b. Pharmaceutical Preparations
      - c. Botanicals
      - d. Paraphernalia
    - 2. Production of Common Illicit Drugs
      - a. Cocaine
      - b. Methamphetamine/Amphetamine
      - c. MDMA
      - d. Heroin
      - e. PCP
      - f. LSD
      - g. Common adulterants
  - C. Evolution of the seized drug analysis
    - 1. Controlled Substances Act
    - 2. Instrumentation development
  - D. Accepted standards and practices
    - 1. SWG-DRUG Recommendations
    - 2. ASTM Standards
  - E. Results and Conclusions
    - 1. Process Analysis
    - 2. QA/QC
    - 3. Reporting
    - 4. Case Management
  - F. Analysis of Botanicals
    - 1. Cannabis
    - 2. Psilocin mushrooms
    - 3. Opium Poppy

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4. Coca leaf
5. Khat
6. Peyote
- G. Qualitative Analysis of Controlled Substances
  1. Pharmaceuticals
  2. Illicit drugs
- H. Quantitative Analysis
- I. Separation Techniques
  1. Dilute and shoot
  2. Liquid/Liquid
  3. Effects of pH and solvent polarity
  4. Solid phase extractions
  5. Prep TLC
- J. Color Tests
  1. Theory
  2. Application/Processes
    - a. Marquis
    - b. Mecke
    - c. Cobalt thiocyanate
    - d. Dille Kopannyi
    - e. p-DAB
    - f. Duquenois/Levine
    - g. Sodium Nitroprusside
    - h. Ferric Chloride
  3. Interpretation
  4. QA/QC
- K. Thin Layer Chromatography
  1. Theory
  2. Application/Processes
  3. Interpretation
  4. QA/QC
- L. Microscopy
  1. Types
    - a. Stereo
    - b. Polarizing light
  2. Uses
- M. Crystal tests
  1. Theory
  2. Application/Processes
  3. Interpretation
  4. QA/QC

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- N. Instrumentation
  - 1. Qualitative Non-structure confirming
  - 2. Structure confirming
  - 3. Qualitative vs. Quantitative applications
- O. Gas Chromatography
  - 1. Theory
  - 2. Application/Processes
    - a. Qualitative
    - b. Quantitative
  - 3. Interpretation
    - a. Qualitative
    - b. Quantitative
  - 4. QA/QC
- P. High Pressure Liquid Chromatography
  - 1. Theory
  - 2. Application/Processes
    - a. Qualitative
    - b. Quantitative
  - 3. Interpretation
    - a. Qualitative
    - b. Quantitative
  - 4. QA/QC
- Q. Ultraviolet Spectrophotometer
  - 1. Theory
  - 2. Application/Processes
    - a. Qualitative
    - b. Quantitative
  - 3. Interpretation
    - a. Qualitative
    - b. Quantitative
  - 4. QA/QC
- R. Raman Spectrometry
  - 1. Theory
  - 2. Application/Processes
    - a. Qualitative
    - b. Quantitative
  - 3. Interpretation
    - a. Qualitative
    - b. Quantitative

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- S. Mass Spectrometry
  - 1. Theory
  - 2. Application/Processes
    - a. Qualitative
    - b. Quantitative
  - 3. Interpretation
    - a. Qualitative
    - b. Quantitative
  - 4. QA/QC
- T. Infrared Spectroscopy
  - 1. Theory
  - 2. Application/Processes
    - a. Qualitative
    - b. Quantitative
  - 3. Interpretation
    - a. Qualitative
    - b. Quantitative
  - 4. QA/QC
- U. Capillary Electrophoresis
  - 1. Theory
  - 2. Application/Processes
    - a. Qualitative
    - b. Quantitative
  - 3. Interpretation
    - a. Qualitative
    - b. Quantitative
  - 4. QA/QC
- V. Nuclear Magnetic Resonance Spectroscopy (NMR)
  - 1. Theory
  - 2. Application/Processes
    - a. Qualitative
    - b. Quantitative
  - 3. Interpretation
    - a. Qualitative
    - b. Quantitative
  - 4. QA/QC

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### References

Listed below are the references for the Drug Analysis Certification Examination. Small numbers of examination questions may have been drawn from a variety of other sources including general instrumental or chemistry text. Similar information may be obtained by studying earlier or later editions of the listed works, as well as other works covering the same topics.

#### *Core*

(40% of Examination Content)

The following texts were used for the generation of test questions for the CORE knowledge. Applicants are encouraged to familiarize themselves with information provided by these texts as that information relates to the KSA (knowledge, skills, and abilities) outlined in this study guide.

*Techniques of Crime Scene Investigation*, 7<sup>th</sup> Edition, by Fisher, B.J. (Boca Raton: CRC Press, 2004) ISBN 0-8493-1691-X.

*Criminalistics, An Introduction to Forensic Science*, 7<sup>th</sup> Edition (or higher), by Saferstein, R. (Upper Saddle River, NJ: Prentice Hall, 1998) ISBN 0-13-592940-7.

*Forensic Science Handbook, Volume I*, 2<sup>nd</sup> Edition, edited by Saferstein, R. (Englewood Cliffs, NJ: Prentice Hall, 2002) ISBN 0-13-091058-9.

*Forensic Science Handbook, Volume II*, 2<sup>nd</sup> Edition, edited by Saferstein, R. (Englewood Cliffs, NJ: Prentice Hall, 2005) ISBN 0-13-112434-X.

*Forensic Science Handbook, Volume III*, edited by Saferstein, R. (Englewood Cliffs, NJ: Prentice Hall, 1993) ISBN 0-13-325390-2.

*Fundamentals of Forensic Science*, by Houck, M., Siegel, J. (Burlington, MA: Elsevier Academic Press, 2006) ISBN 0-12-356762-9.

*Forensic Chemistry*, by Bell, S., (Upper Saddle River, NJ: Pearson Prentice Hall, 2006) ISBN 0-13-147835-4.

"The Rule of Professional Conduct" supplied by the American Board of Criminalistics.  
[www.criminalistics.com](http://www.criminalistics.com)



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*ISO/IEC 17025: General requirements for the competence of testing and calibration laboratories.* International Organization of Standards, (ISO copyright office, Switzerland, 2005)

### ***Discipline-Specific*** (60% of Examination Content)

In addition to the core information provided in the text above, the following texts were specifically used for development of the discipline specific (drug analysis) portion of this exam.

*Clarke's Analysis of Drugs and Poisons*, 3rd edition, Volume 1. Edited by Moffat, A.C. Osselton, M. and Widdop, B. (Chicago: Pharmaceutical Press, 2004).

*Forensic Science Handbook, Volume I*, 2<sup>nd</sup> Edition, edited by Saferstein, R. (Englewood Cliffs, NJ: Prentice Hall, 2002) ISBN 0-13-091058-9.

Chapter 2 - Forensic Applications of HPLC and CE

Chapter 3 - Forensic Applications of Mass Spectrometry

Chapter 5 - Foundations of Forensic Microscopy

*Forensic Science Handbook, Volume II*, 2<sup>nd</sup> Edition, edited by Saferstein, R. (Englewood Cliffs, NJ: Prentice Hall, 2005) ISBN 0-13-112434-X.

Chapter 3 - Forensic Capillary Gas Chromatography

Chapter 4 - Forensic Identification of Illicit Drugs

*Handbook of Drug Analysis*, Edited by Smith F., Series Editor Jay A Siegel, (New York: Elsevier Academic Press, 2005)

### **Books**

Any collegiate level Instrumental Analysis Textbook which addresses the instrumentation detailed in the KSAs above.

Any college level Chemistry Textbook which addresses the chemistry concepts detailed in the KSAs above.

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### Sample Questions

1. Which of the following best describes the value of field kits for the chemical testing of controlled substances?
  - a. They remove the necessity for laboratory analysis.
  - b. They are presumptive tests.
  - c. They have questionable reliability.
  - d. They allow the officer to make a field identification.
2. Which of the following pairs of compounds are enantiomers?
  - a. psilocin and psilocybin
  - b. LSD and Lampa
  - c. d-cocaine and l-cocaine
  - d. phentermine and methamphetamine
3. The primary reason for proving "chain of custody" on a particular item in court is to:
  - a. Authenticate the item.
  - b. Show how many people handled the item.
  - c. Show how long it was in each person's possession.
  - d. Deter or prevent unauthorized individuals from handling the evidence.
4. Which of the following spectral regions has the highest energy?
  - a. Ultraviolet.
  - b. Infrared.
  - c. Radio.
  - d. Visible.
5. Human genomic DNA is not found in:
  - a. White blood cells.
  - b. Red blood cells.
  - c. Spermatozoa.
  - d. Epithelial cells.

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6. How will the  $R_f$  values for eluents most likely be affected if a TLC tank is not kept saturated with the developing solvent?
  - a. They will increase.
  - b. They will decrease.
  - c. They will increase or decrease unpredictably.
  - d. They will not be affected.
  
7. You receive an envelope containing a semi-automatic pistol for an operability check. You open the envelope to examine the weapon. You first remove a fully loaded magazine. The weapon is now:
  - a. Potentially still loaded and unsafe.
  - b. Unloaded and safe.
  - c. Potentially still loaded but safe.
  - d. Rendered safe because of a magazine disconnect.
  
8. If the IR absorbance spectrum for a previously unidentified drug matches that of an l-amphetamine HCL standard, which of the following would be a justifiable conclusion?
  - a. The unknown is l-amphetamine hydrochloride.
  - b. The unknown could be d-amphetamine hydrochloride.
  - c. The unknown could be l-amphetamine sulfate.
  - d. The unknown could be methamphetamine hydrochloride.
  
9. When handling biological materials, which of the following is the most reasonable approach to take?
  - a. Precautions are not normally necessary for sample handling since transmission of disease has not been shown to occur from such contact.
  - b. Precautions need only be taken when samples are in the liquid state since disease vectors are no longer viable upon drying.
  - c. Precautions should be taken regardless of the condition or the origin of the samples being handled.
  - d. Precautions need only be taken with unknown stains and liquids since preservatives and chelating agents present in reference samples will kill any communicable disease.

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10. Which of the following actions is not forbidden by the ABC Code of Professional Conduct?
- Embellishing one's qualifications when testifying.
  - Utilizing a secret method.
  - Refusing to honor a subpoena duces tecum.
  - Interpreting equivocal results based only on an employer's wishes.
11. Upon reviewing your notes for a court appearance in one week, you realize that there is a clerical error and two results have been reversed. Which of the following is the best course of action?
- Issue a corrected report including the date of the correction and testify to the error if asked.
  - Immediately notify the attorney and issue a report which makes the correction clear.
  - Immediately make an entry in your notes as to your discovery and correct it in testimony if asked.
  - Correct the error in testimony if asked, but make no additions or alterations to your notes.
12. With which one of the following drugs will the Marquis reagent *NOT* produce a colored reaction product?
- morphine
  - mescaline
  - amphetamine
  - barbiturate
13. Which one of the following reagents would be most useful for visualization and differentiation of the various cannabinoids separated from a marijuana extract on a TLC plate?
- Ninhydrin and UV light
  - Dragendorff reagent
  - Fast blue 2B
  - Floram

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14. Which one of the following terms names the functional group responsible for the absorption of ultraviolet or visible radiation?
- chromophore
  - auxochrome
  - bathochrome
  - hypsochrome
15. The term "theoretical plate" refers to which one of the following parameters in gas chromatography?
- retention time
  - polarity
  - efficiency
  - stationary phase thickness
16. 250 mg of heroin standard is dissolved in 25 mL of a solvent. 1 mL of this solution is added to 5 mL of an internal standard solution and then diluted with more solvent to a final volume of 10 mL. What is the final concentration of the heroin standard?
- 0.10 mg/mL
  - 0.25 mg/mL
  - 1.00 mg/mL
  - 2.50 mg/mL
17. What is an MSDS?
- a document of chemical safety.
  - an instrument for chemical analysis.
  - a technique for testing DNA.
  - a type of explosive material.
18. In microscopy, which one of the following terms describes the relationship between retardation and thickness?
- aberration
  - dispersion
  - scattering
  - birefringence

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19. The equivalent weight of a compound is 60. How much of this compound (in pure form) will be needed to make a 100mL solution of 0.1 N strength?
- a. 600 mg
  - b. 6.0 g
  - c. 0.06 g
  - d. 60.0 g
20. Following a liquid-liquid extraction of barbiturates will be isolated in which of the following fractions?
- a. strong base
  - b. strong acid
  - c. weak acid
  - d. weak base

**Answers can be found in the references.**