



# Study Guide for the Fire Debris Analysis Certification Examination

## Introduction

Your study guide consists of a Job Description, a list of Knowledge, Skills, and Abilities (KSAs), References, and 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 the Fire Debris Analysis Certification Examination**

### **Job Description**

A qualified fire debris analyst must be able to:

- Perform chemical analysis to determine the presence, absence, relevance, and nature of ignitable liquids and ignitable liquid residues in questioned items of evidence.
- Isolate and/or recover complex petroleum products and other ignitable liquids from matrix products.
- Interpret and compare chromatographic data generated during analysis to that of known ignitable liquids.
- Classify ignitable liquids based upon physical properties and composition.
- Identify single compounds and components of mixtures.
- 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
- Be proficient in the use and maintenance of laboratory instrumentation including gas chromatography and mass spectrometry.
- 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.
- Engage in impartial and ethical work practices.

## Study Guide for the Fire Debris 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. Non compliant 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 born pathogens
    2. Person protective equipment
  - C. Hazardous Waste/Biohazardous Waste Handling
    1. Spill control
- VI. Legal
- A. Decisions/laws
    1. Frye
    2. Daubert/Kumho
    3. Brady
  - B. Legal terms
    1. Chain of custody
    2. Discovery
    3. Voir dire

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4. Duces tecum
5. Subpoena
- C. Court Testimony
  1. Monitoring
- 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
  - 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

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6. Elemental Composition
7. Bonding
  - a) Ionic
  - b) Covalent
  - c) Hydrogen
  - d) Van der Waals
  - e) Stereoisomers
  - f) Enantiomers
- 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
  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
- X. Forensic Science Applications for Fire Debris Analysis
  - A. Principles and concepts
    1. Fire scene terminology
      - a) Flammable
      - b) Combustible
      - c) Ignitable
      - d) Flashpoint
      - e) Ignition temperature
      - f) Flashover
      - g) Flameover



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- h) Explosive limits
      - i) Etc.
    - 2. Chemistry and Physics of Fire
    - 3. Manufacture of petroleum based ignitable liquids
      - a) Terminology
      - b) Chemistry and composition of common petroleum products
      - c) Manufacturing Processes
      - d) Conversion of crude oil
      - e) Additive and dyes in petroleum based products
      - f) Transportation and distribution of petroleum products
      - g) Use of petroleum in construction and household products
    - 4. Incendiary chemicals, compounds and common initiation devices
      - a) Flares
      - b) Molotov cocktails
      - c) Vegetable oils
  - B. Types of evidence/composition
    - 1. Liquids
    - 2. Debris
    - 3. Biological
    - 4. Combustion products
    - 5. Pyrolysis products
  - C. Evolution of the discipline
  - D. Accepted standards and practices
    - 1. ASTM Fire Debris Practices
    - 2. TWG-FEX Quality Assurance Guideline
    - 3. NFPA 921
      - a) Laboratory recommendations
      - b) Evidence collection
  - E. Results and Conclusions
    - 1. Data Interpretation
      - a) Pyrolysis and combustion interferences
      - b) Common ignitable liquid – pattern recognition
      - c) Environmental/Incidental ignitable liquids
        - (1) Petroleum laced background
        - (2) Combustion products
        - (3) Naturally occurring ignitable liquid
    - 2. Reporting Results
    - 3. Case Management
  - F. Sampling – Dynamic Headspace Adsorption
    - 1. Theory

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2. Application/Processes
    - a) Tenax
    - b) Active Charcoal
  3. Interpretation/Results
  4. Advantages and Disadvantages
  5. QA/QC
- G. Sampling – Passive Headspace Adsorption
1. Theory
  2. Application/Processes
    - a) Active Charcoal
    - b) SPME
    - c) Tenax
  3. Interpretation/Results
  4. Advantages and Disadvantages
  5. QA/QC
- H. Sampling – Other techniques
1. Theory
  2. Application/Processes
    - a) Simple headspace
    - b) Solvent Extraction
  3. Interpretation/Results
  4. Advantages and Disadvantages
  5. QA/QC
- I. Gas Chromatography
1. Theory
    - a) Resolution
    - b) Flow rates
    - c) Column separation properties
    - d) Separation process
  2. Application/Processes
    - a) Injection techniques
    - b) Detectors
    - c) Column selection
    - d) Temperature Programs
  3. Interpretation/Results
    - a) Pattern recognition
    - b) ASTM Classifications



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4. QA/QC
  - a) Libraries
  - b) Reference materials
  - c) Positive/Negative Controls
  - d) Instrument maintenance
- J. Mass Spectrometry
  1. Theory
    - a) Electron impact ionization
    - b) Quadrapole vs. Ion Trap
    - c) Mass separation
  2. Application/Processes
    - a) Full Scan
    - b) Extracted ion chromatography
    - c) Selected ion chromatography
  3. Interpretation/Results
    - a) Mass spectral interpretation
      - (1) Single compound
      - (2) Class common ion (alkanes, aromatics, etc)
    - b) Pattern Recognition
      - (1) Full Scan
      - (2) Extraction ions/selected ion patterns
    - c) ASTM Classification
  4. QA/QC
    - a) Libraries
    - b) Reference Materials
    - c) Positive/Negative Controls
    - d) Instrument Maintenance
- K. Analysis Scheme
  1. Sampling plan
  2. Sequence of analyses
  3. Analysis/Instrumental Protocols



# Study Guide for the Fire Debris Analysis Certification Examination

## References

Listed below are the references for the Fire Debris 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 fire chemistry information provided in the text above, the following texts are specific to the discipline (fire debris) portion of this examination.

*NFPA 921: Guide for Fire and Explosion Investigations*, 2004 (or higher). NFPA, (Quincy, MA, 2004).

*Fire Debris Analysis*, by Stauffer, E. Dolan, J, and Newman, R. (New York: Elsevier, 2008) ISBN978-0-1-66397-1.

*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 3- Forensic Applications of Mass Spectrometry  
Chapter 9 – Arson and Explosive Investigation

*Kirk's Fire Investigation*, by DeHaan, J., 5<sup>th</sup> Edition (or higher) (Upper Saddle River: Prentice Hall, 2006) ISBN 0-13-060458-5.

*Fire Investigation*, Edited by Nic Daeid, N. (New York: CRC Press, 2004) ISBN 0-415-24891-4.

Chapter 1: An Introduction to Fires and Fire Investigation

Chapter 5: Modern Laboratory Techniques Involved in the Analysis of Fire Debris Analysis

Chapter 6: Interpretation of Laboratory Data

Chapter 7: Sources of Interferences in Fire Debris Analysis

*ASTM Annual Book of Standards*, Volume 14.02, 2006 Edition (West Conshohocken, PA: ASTM International, 2006)

E1386-00(2005) Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Solvent Extraction

E1387-01 Standard Test Method for Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography

E1388-05 Standard Practice for Sampling of Headspace Vapors from Fire Debris Samples



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- E1412-00(2005) Standard Practice for Separation of Ignitable Liquid Residues from Fire Debris Samples by Passive Headspace Concentration With Activated Charcoal
- E1413-00(2005) Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Dynamic Headspace Concentration
- E1459-92(2005) Standard Guide for Physical Evidence Labeling and Related Documentation
- E1492-05 Standard Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Science Laboratory
- E1618-06 Standard Test Method for Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography-Mass Spectrometry
- E2154-01 Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Passive Headspace Concentration with Solid Phase Microextraction (SPME)

### **Books**

Any collegiate level Instrumental Analysis and General Chemistry Textbooks that cover the instrumentation and topics outlined in the KSAs.

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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. 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.
3. Which of the following spectral regions has the highest energy?
  - a. Ultraviolet.
  - b. Infrared.
  - c. Radio.
  - d. Visible.
4. Human genomic DNA is not found in:
  - a. White blood cells.
  - b. Red blood cells.
  - c. Spermatozoa.
  - d. Epithelial cells.
5. 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.

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6. 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.
  
7. Which of the following actions is not forbidden by the ABC Code of Professional Conduct?
  - a. Embellishing one's qualifications when testifying.
  - b. Utilizing a secret method.
  - c. Refusing to honor a subpoena duces tecum.
  - d. Interpreting equivocal results based only on an employer's wishes.
  
8. 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?
  - a. Issue a corrected report including the date of the correction and testify to the error if asked.
  - b. Immediately notify the attorney and issue a report which makes the correction clear.
  - c. Immediately make an entry in your notes as to your discovery and correct it in testimony if asked.
  - d. Correct the error in testimony if asked, but make no additions or alterations to your notes



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9. Compared to glass jars or polyester bags, metal cans have which of the following advantages for packaging and storing fire debris evidence?
- I. Resistant to mechanical changes.
  - II. Easier to transport.
  - III. Resistant to corrosion.
  - IV. More likely to survive long-term storage intact.
  - V. Resistant to thermal stress during analysis.
- a. III, IV, and V
  - b. I and V
  - c. II, III, IV, and V
  - d. I, III, and IV
10. A sample collected with the assistance of a canine tests negative in the laboratory. According to NFPA 921, the canine's alert should be considered:
- a. A false positive.
  - b. Inconclusive.
  - c. Not confirmed.
  - d. Not validated.
11. The term "catalytic reforming", as it applies to the manufacture of gasoline, refers to:
- a. Converting saturated compounds to aromatic compounds.
  - b. Converting alkenes to alkanes.
  - c. Converting normal alkanes into iso (branched) alkanes.
  - d. Converting olefinic compounds to unsaturated compounds.
12. Which of the following are found in gasoline in significant quantities?
- I. Phytane.
  - II. Toluene.
  - III. Xylene.
  - IV. Ethylbenzene.
- a. I, III, and IV
  - b. II and III
  - c. II, III, and IV
  - d. I and IV



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13. Heated headspace is useful for some ignitable liquid residues, but it can provide poor recovery and discrimination of:
- Cigarette lighter fluids.
  - Light and medium petroleum distillates.
  - The less volatile components of kerosene.
  - Gasoline.
14. The **LOWEST** temperature at which a liquid gives off sufficient vapor to form an ignitable mixture with the air is called the:
- Ignition temperature.
  - Auto-ignition temperature.
  - Flash point.
  - Readily mix with air.
15. Which of the following are indicators of an incendiary fire?
- Spalled concrete.
  - Annealed metal.
  - Multiple points of origin.
  - All of the above.
16. Unprocessed crude oil consists primarily of:
- Aromatics.
  - Alkenes.
  - Isoparaffins.
  - Alkanes.
17. Which one of the following products would be expected to contain the **HIGHEST** concentration of aromatic hydrocarbons?
- Paint thinner.
  - Gasoline.
  - Kerosene.
  - Coleman fuel.

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18. The transfer of heat energy through a solid material by contact between its moving molecules is called:
- Conduction.
  - Convection.
  - Radiation.
  - Direct flame impingement
19. Which of the following classes of compounds is the **MOST** indicative of gasoline?
- Polynuclear hydrocarbons.
  - Aliphatic hydrocarbons.
  - Alicyclic hydrocarbons.
  - Aromatic hydrocarbons
20. Which of the following ASTM methods are **NOT** described as “destructive”?
- E 1385 Steam Distillation.
  - E 1386 Solvent Extraction.
  - E 1412 Passive Headspace Concentration.
  - E 1413 Dynamic Headspace Concentration.

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