Knowledge, Skills, Abilities (KSA)

AMERICAN BOARD OF CRIMINALISTICS

"Professional Competency Certification in Criminalistics"

Study Guide for the Fire Debris Certification Examination

Introduction

Your study guide consists of a Job Description, a list of Knowledge, Skills, and Abilities (KSAs), References, and a 10 Sample Question primer for the exam.

- 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 exam 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 ten **Sample Questions** to give you an idea of the range of content and difficulty that will appear on the exam. For further information, please see "Introduction to ABC Certification Examinations."

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Job Description

A qualified fire debris analyst must be able to:

- 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.
- Recognize and employ quality assurance measures to ensure the integrity of the analyses.
- 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.
- 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.
- Engage in impartial and ethical work practices.
- Engage in continuing education in the field of fire debris analysis.

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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) DNA Quality Assurance Standards (QAS)
         e) ASCLD/LAB
      2. Personnel certification
         a) ABC
         b) IAAI
         c) IAI
         d) ABFT
         e) FTCB
         f) AFTE
         g) ABFDE
         h) BFDE

i) IACIS

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/Standard Reference Material
    10. Measurement of uncertainty
    11. Traceability
    12. Corrective and preventative actions
    13. Proficiency Testing
    14. Confidence interval/confidence limits
    15. Sampling plans/sample selection

C. Document/Data Management
    1. Databases
    2. LIMS
    3. Case document preservation/integrity

V. Safety

A. Chemical Hygiene
    1. Safety labeling (SDS)
    2. Globally Harmonized Systems of Classification and Labeling of Chemicals (GHSCLC)
    3. 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
    4. Melendez-Diaz

- B. Legal terms
  1. Chain of custody
  2. Discovery
  3. Voir dire
  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
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
7. Confidence Interval
8. Bayesian Theory

G. Stoichiometry

H. Logic
1. Critical thinking
2. Inductive and deductive reasoning
3. Contextual bias

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) Explosive limits
h) 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, ignition modes and devices
    a) Flares
    b) Molotov cocktails
    c) Self heating processes

B. Types of evidence/composition
    1. Liquids
    2. Debris
    3. Biological
    4. Combustion products
    5. Products of incomplete combustion (pyrolysis products)
    6. Oils: vegetable and petroleum
    7. Multi-discipline evidence
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
        c) Canine issues
E. Results and Conclusions
    1. Data Interpretation
        a) Pyrolysis and combustion interferences
        b) Weathering effects
        c) Common ignitable liquid – pattern recognition
        d) 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
   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/process
      d) van Deemter equation
   2. Application/Processes
      a) Injection techniques
      b) Detectors
      c) Column selection
      d) Temperature Programs
   3. Interpretation/Results

a) Pattern recognition
b) ASTM Classifications

4. QA/QC
   a) Reference materials
   b) Positive/Negative Controls
   c) 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) Multiple compounds
   b) Pattern Recognition
      (1) Full Scan
      (2) Extracted Ion Chromatograms (alkanes, aromatics, etc.)
   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

References

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

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Core (40% of Exam 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, 7th Edition, by Fisher, B.J. (Boca Raton: CRC Press, 2004) ISBN 0-8493-1691-X.

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

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

Forensic Science Handbook, Volume II, 2nd 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

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 Exam 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 exam.

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NFPA 921: Guide for Fire and Explosion Investigations, 2011 (or higher) . NFPA, (Quincy, MA, 2011).

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

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

Forensic Science Handbook, Volume I, 2nd 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

Fire Investigation, Editted 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, (West Conshohocken, PA: ASTM International)

E1386 Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Solvent Extraction
E1387 Standard Test Method for Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography
E1388 Standard Practice for Sampling of Headspace Vapors from Fire Debris Samples
E1412 Standard Practice for Separation of Ignitable Liquid Residues from Fire Debris Samples by Passive Headspace Concentration with Activated Charcoal
E1413 Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Dynamic Headspace Concentration
E1459 Standard Guide for Physical Evidence Labeling and Related Documentation
E1492 Standard Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Science Laboratory
E1618 Standard Test Method for Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography-Mass Spectrometry

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E2154 Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Passive Headspace Concentration with Solid Phase Microextraction (SPME)

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

Sample Questions

1. 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.

2. Human genomic DNA is not found in:

    A. White blood cells.
    B. Red blood cells.
    C. Spermatozoa.
    D. Epithelial cells.

3. 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.

4. 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.

5. Heated headspace is useful for some ignitable liquid residues, but it can provide poor recovery and discrimination of:

    A. Cigarette lighter fluids.
    B. Light and medium petroleum distillates.
    C. The less volatile components of kerosene.
    D. Gasoline.

6. The **LOWES**T temperature at which a liquid gives off sufficient vapor to form an ignitable mixture with the air is called the:

    A. Ignition temperature.
    B. Auto-ignition temperature.
    C. Flash point.
    D. Readily mix with air.

7. Unprocessed crude oil consists primarily of:

    A. Aromatics.
    B. Alkenes.
    C. Isoparaffins.
    D. Alkanes.

8. Which one of the following products would be expected to contain the **HIGHEST** concentration of aromatic hydrocarbons?

    A. Paint thinner.
    B. Gasoline.
    C. Kerosene.
    D. Coleman fuel.

9. The transfer of heat energy through a solid material by contact between its moving molecules is called:

A. Conduction.
B. Convection.
C. Radiation.
D. Direct flame impingement

10. Which of the following classes of compounds is the **MOST** indicative of gasoline?

A. Polynuclear hydrocarbons.
B. Aliphatic hydrocarbons.
C. Alicyclic hydrocarbons.
D. Aromatic hydrocarbons