Professional Certificate in Forensic Document Examination

Ink and Paper Analysis

Aldehyde Test – a chemical assay used to detect the presence of aldehyde groups in ink solvents. Related terms: Schiff reagent, spot test. The test produces a characteristic color change when aldehydes are present, aiding in the differentiation of ink families. Practical application includes distinguishing carbon-based inks from dye-based inks in questioned documents. Challenges involve interference from paper additives that may yield false positives.

Alkaline Development – a photographic process that reveals latent impressions on paper by reacting with alkaline compounds. Related terms: ninhydrin, physical developer. Used to visualize indented writing or impressions left by a pen. Example: development of a faint imprint on a receipt to recover a signature. Limitations include the need for controlled humidity and temperature.

Atomic Absorption Spectroscopy (AAS) – an analytical technique that measures the concentration of metallic elements in ink pigments. Related terms: ICP-MS, elemental analysis. By atomizing a sample and measuring light absorption at element-specific wavelengths, AAS can identify trace metals such as copper or iron. Useful for comparing inks from different manufacturers. Challenges include the requirement for sample digestion and potential matrix effects.

Band-Pass Filter – an optical filter that transmits a specific wavelength range while blocking others. Related terms: UV filter, infrared filter. In ink analysis, band-pass filters isolate fluorescence emissions of particular dyes, enhancing contrast under microscopy. Example: using a 365 nm filter to view eosin fluorescence. The main difficulty is selecting the appropriate filter for mixed-dye inks.

Bleed-Through – the phenomenon where ink penetrates through a sheet of paper, making the reverse side visible. Related terms: ghosting, through-printing. Forensic examiners assess bleed-through to estimate writing pressure and ink type. Practical use includes detecting alterations in multi-page documents. Challenges arise when paper porosity varies, affecting the consistency of bleed patterns.

Chromatographic Mobility – the rate at which a component moves through a chromatographic medium under solvent flow. Related terms: Rf value, TLC. In thin-layer chromatography of inks, mobility values help differentiate pigments and dyes. Example: a blue ballpoint ink showing an Rf of 0.45 versus a similar hue with 0.62. Mobility can be affected by solvent composition and temperature, requiring strict standardization.

Chromatography, Thin-Layer (TLC) – a rapid, low-cost method for separating ink constituents on a silica gel plate. Related terms: mobile phase, stationary phase. TLC generates characteristic patterns that serve as “fingerprints” for ink comparison. For instance, a black ink may produce three distinct spots, whereas a counterfeit may show only two. Limitations include the need for skilled interpretation and potential overlap

of closely related dyes.

Colorimetric Analysis – quantitative assessment of ink color using spectrophotometric data. Related terms: CIE L*a*b*, spectrophotometer. By measuring reflectance across the visible spectrum, analysts can calculate precise color coordinates, facilitating objective comparison. Example: matching the L*a*b* values of a disputed signature to a known sample. Challenges involve instrument calibration and the influence of paper color.

Cross-Section Microscopy – a technique that examines a cut-through view of paper and ink layers. Related terms: embedding, polishing. Provides insight into ink penetration depth, pigment distribution, and fiber interaction. Useful for distinguishing surface-applied inks from those absorbed into the substrate. The method requires careful sample preparation to avoid distortion.

Cyanoacrylate Fuming – a physical developer that reacts with latent fingerprints on paper, releasing a white polymer. Related terms: fingerprint development, vapor deposition. While primarily used for prints, the process can also highlight ink residues on document surfaces, revealing smudges or erased marks. Application must consider paper type, as acidic papers may degrade under fumes.

Digital Image Analysis – computational evaluation of scanned document images to detect alterations, ink differences, or forgery signatures. Related terms: pixel intensity, histogram. Software can compare grayscale values across regions, flagging inconsistencies. Example: using Euclidean distance metrics to assess the similarity between two signatures. Limitations include resolution constraints and compression artifacts.

Diphenylamine Test – a colorimetric reaction that detects nitrate ions, often present in certain ink formulations. Related terms: nitrate test, spot test. A positive result yields a blue-purple coloration, assisting in classifying inks. The test is quick but may be interfered with by paper additives containing nitrogenous compounds.

Document Dating, Radiocarbon – determination of the age of cellulose fibers using ^14C decay measurements. Related terms: AMS, carbon dating. Provides a chronological framework for historical documents where ink analysis alone is insufficient. Example: dating a 19th-century letter to confirm provenance. High cost and the need for destructive sampling are primary challenges.

Document Examination, Eraser Residue – analysis of particles left after erasing ink, often revealing the original content. Related terms: powder analysis, SEM. Microscopic and spectroscopic techniques can identify the composition of eraser debris, aiding in reconstructing altered text. Difficulty lies in distinguishing intentional erasures from natural wear.

Electrostatic Detection Device (ESDD) – an instrument that visualizes indentations on paper by charging the surface and detecting variations in electrostatic potential. Related terms: Electrostatic lift, Indentation detection. Allows recovery of writing that was never inked, such as a typed draft. The technique is sensitive to humidity and paper moisture content.

Elemental Analysis, Inductively Coupled Plasma Mass Spectrometry (ICP-MS) – a high-sensitivity method for quantifying trace elements in ink pigments. Related terms: multi-element detection, isotopic ratio. Detects metals like titanium, zinc, and lead, providing a robust basis for ink comparison. Sample digestion must be thorough, and instrument cost is a limiting factor.

Elliptical Polarizer – an optical device that separates light based on polarization, enhancing contrast of birefringent ink components. Related terms: crossed polarizers, Maltese cross. When examining inks under polarized light, certain dyes produce characteristic extinction patterns useful for identification. Aligning the polarizer correctly can be technically demanding.

Embedded Ink – ink that is encapsulated within polymeric microspheres, often used in security printing. Related terms: micro-encapsulation, security features. Such inks release color only upon specific triggers (e.g., heat), providing anti-counterfeit measures. Detection may require thermal imaging or chemical activation. Analyses are complicated by the protective shell obscuring pigment spectra.

Fiber Analysis, Microscopy – examination of paper fibers to determine pulp source, manufacturing process, and potential aging. Related terms: cellulose, lignin. Fiber morphology (e.g., length, wall thickness) can distinguish wood-pulp from cotton or synthetic fibers, supporting document provenance. Sample preparation must avoid damaging the fibers, and interpretation requires expertise.

Fluorescence Spectroscopy – measurement of emitted light from ink dyes after excitation with a specific wavelength. Related terms: excitation wavelength, emission spectrum. Different dyes have unique fluorescence signatures, enabling discrimination between visually similar inks. Example: detecting a counterfeit stamp ink that lacks the expected ultraviolet emission peak. Quenching by paper additives can obscure signals.

Fourier Transform Infrared Spectroscopy (FT-IR) – a vibrational technique that identifies organic functional groups in ink binders and solvents. Related terms: absorbance bands, infrared fingerprint. FT-IR can differentiate oil-based inks from water-based inks based on characteristic peaks (e.g., C=O stretch). The method is non-destructive for thin layers but may require attenuated total reflectance (ATR) accessories for paper substrates.

Gas Chromatography-Mass Spectrometry (GC-MS) – separation of volatile ink components followed by mass analysis. Related terms: headspace analysis, solvent extraction. GC-MS provides detailed profiles of solvents, plasticizers, and low-molecular-weight dyes, supporting ink type identification. Example: detecting a unique solvent blend in a suspect pen. Sample preparation can be labor-intensive, and non-volatile pigments are not amenable to this technique.

Gel Permeation Chromatography (GPC) – size-exclusion chromatography used to assess polymeric binders in ink formulations. Related terms: molecular weight distribution, SEC. GPC separates components based on hydrodynamic volume, revealing differences in binder polymer length that can be characteristic of a particular brand. Requires dissolution of the ink in appropriate solvents, which may alter the sample.

Glossary, Forensic Document Examination – a compiled list of specialized terms used by practitioners. Related terms: terminology, lexicon. Serves as a reference for students and experts alike, ensuring consistent communication. Maintaining accuracy demands periodic updates as new technologies emerge.

Gravimetric Analysis – determination of ink concentration by measuring mass before and after solvent evaporation. Related terms: drying weight, moisture content. Useful for estimating the amount of ink deposited on a particular area. Example: comparing the gravimetric weight of a questioned signature stroke to a known sample. Accuracy is affected by ambient humidity and paper absorption.

Holographic Ink – ink containing nano-structures that diffract light to produce holographic images. Related terms: diffractive security, nano-particles. Used in high-security documents; detection often requires laser illumination and imaging. Analyzing such inks can reveal counterfeit attempts when the hologram is absent or altered. Specialized equipment and expertise are needed.

Infrared Reflectography – imaging technique that captures reflected infrared radiation to visualize hidden ink layers. Related terms: IR imaging, underdrawing detection. Certain pigments are transparent to infrared, allowing underlying text to be seen. Example: revealing erased notes beneath a later overlay. Limitations include the inability to penetrate dense pigments and the need for calibrated cameras.

Ink Aging, Oxidative Degradation – chemical changes that occur in ink over time due to exposure to oxygen, light, and heat. Related terms: photodegradation, yellowing. Aging can alter color, viscosity, and spectral properties, complicating comparison of old and fresh samples. Understanding typical aging pathways aids in interpreting differences between historical and contemporary inks.

Ink Formulation, Dye-Based – inks that rely primarily on soluble dyes dissolved in a carrier solvent. Related terms: aqueous ink, pigment ink. Dye-based inks exhibit characteristic spectral peaks and may bleed more readily into paper fibers. Example: the blue hue of a gel pen derived from a copper-phthalocyanine dye. Challenges include variability due to solvent evaporation rates.

Ink Formulation, Pigment-Based – inks that contain insoluble pigment particles suspended in a binder. Related terms: dispersions, suspension. Pigment inks are generally more resistant to fading and produce distinct scattering patterns under microscopy. Example: a black ballpoint ink containing carbon black particles. Analysis may require particle size distribution measurements.

Ink Marker, Gel Pen – a writing instrument that combines a gel matrix with dye pigments, yielding smooth flow and vivid colors. Related terms: gel formulation, viscosity. Gel pens often produce a characteristic “gel” stain observable under polarized light. Practical implications involve differentiating gel-based forgeries from traditional ballpoint forgeries. The high viscosity can hinder extraction for chemical analysis.

Ink Pen, Fountain – a writing instrument that uses liquid ink supplied from a reservoir, delivering a continuous line. Related terms: nib, capillary flow. Fountain-pen ink is typically water-based and may contain iron gall components that cause characteristic brown staining over time. Forensic relevance includes

detecting iron-gall staining patterns and assessing ink migration.

Ink Pen, Rollerball – a pen that uses a ball tip to dispense a fluid ink, often water-based and dye-rich. Related terms: ball tip, flow rate. Rollerball inks can produce vivid colors and fine lines, but also tend to feather on porous paper. Comparison of rollerball ink samples often relies on dye chromatography and fluorescence characteristics.

Ink Pen, Ballpoint – the most common writing instrument, employing a tiny rotating ball to transfer oil-based ink onto paper. Related terms: oil-based ink, viscosity. Ballpoint inks contain pigments or dyes suspended in a viscous oil, leading to characteristic smear patterns. The widespread use makes ballpoint ink comparison a frequent forensic task. Challenges include lot-to-lot variability within the same brand.

Ink Pen, Stylus – a device that writes by physically indenting the paper surface without depositing ink. Related terms: indentation, mechanical writing. While no ink is present, stylus marks can still be examined for pressure, angle, and depth, offering clues about authorship. Detection often utilizes electrostatic or oblique lighting techniques.

Ink Pen, Thermal – a printer that produces text by heating special thermochromic ink on coated paper, causing a color change. Related terms: thermal printing, heat-activated ink. Thermal inks are typically wax-based and may be identified by their unique melting points. Forensic analysis may involve differential scanning calorimetry to confirm ink type. The paper coating can interfere with standard microscopy.

Ink Pen, UV-Visible Spectroscopy – measurement of absorbance across UV and visible wavelengths to characterize ink dyes. Related terms: absorbance peak, wavelength scan. UV-Vis spectra provide a “fingerprint” for dye identification, facilitating comparison between questioned and known samples. Example: a peak at 620 nm indicating a specific red dye. Sample preparation must avoid scattering from pigment particles.

Ink Pen, Water-Based – inks that use water as the primary solvent, often containing dyes and polymers. Related terms: aqueous formulation, hygroscopic. Water-based inks dry quickly and may migrate on high-porosity papers, leaving characteristic feathering. Analysis frequently involves chromatography and drying time measurements. Their susceptibility to humidity complicates storage and transport.

Ink Pen, Xerographic – a type of ink used in laser printers where toner particles are fused to paper by heat. Related terms: toner, electrophotography. Xerographic inks are composed of polymeric particles and carbon black, producing a distinct surface texture. Microscopic examination can differentiate xerographic prints from handwritten ink. The high temperature of fusing can alter underlying paper chemistry.

Ink Pen, Z-Axis Profiling – assessment of the depth profile of ink deposits using surface-profilometry techniques. Related terms: roughness, topography. Provides quantitative data on ink thickness, useful for evaluating pressure variations in handwriting. Example: a deeper groove indicating a heavier pen stroke. Profilometers must be calibrated for soft paper surfaces to avoid damage.

Ink Saturation, Dye Load – the concentration of dye molecules within the ink solution. Related terms: concentration, molarity. High dye load produces intense coloration but may increase bleed-through. Determining saturation assists in comparing ink intensity across samples. Accurate measurement requires precise dilution and spectrophotometric analysis.

Ink Solvent, Alcohol-Based – solvents such as ethanol or isopropanol used to dissolve dyes in ink formulations. Related terms: volatility, evaporation rate. Alcohol-based inks dry rapidly and can leave a characteristic odor. Forensic relevance includes detecting residual solvent vapors with headspace GC-MS. Rapid evaporation can lead to inconsistent sample recovery.

Ink Solvent, Glycol-Based – solvents containing glycol compounds (e.g., propylene glycol) that provide slower drying times. Related terms: humectant, viscosity modifier. Glycol-based inks are common in gel pens and produce smoother flow. Their hygroscopic nature can affect long-term preservation. Analytical challenges include separating glycol from water in chromatographic runs.

Ink Viscosity, Shear-Thinning – the property of ink to decrease in viscosity under shear stress, facilitating flow through pen tips. Related terms: rheology, non-Newtonian. Shear-thinning behavior is crucial for consistent writing performance. Rheometers can quantify viscosity curves, aiding in distinguishing ink types. Temperature fluctuations can mask true rheological properties.

Ink-Paper Interaction, Absorption – the process by which ink solvent penetrates the paper matrix, depositing pigments or dyes. Related terms: capillary action, porosity. Absorption rates affect line sharpness, bleed-through, and drying time. Evaluating absorption helps in reconstructing writing pressure and tool characteristics. Highly absorbent papers may obscure fine details.

Ink-Paper Interaction, Surface Tension – the cohesive force at the ink–air interface influencing droplet formation and spread on paper. Related terms: contact angle, wetting. Low surface tension leads to broader strokes, while high tension yields finer lines. Measuring surface tension assists in predicting ink behavior on different paper grades. Additives like surfactants can modify tension unpredictably.

Lamination Detection, Infrared – use of infrared imaging to identify laminated layers that conceal underlying ink. Related terms: IR transparency, heat mapping. Laminated documents often show uniform infrared reflectance, revealing hidden text when the lamination is removed or heated. Practical application includes uncovering concealed signatures. The technique may be limited by the lamination material's opacity to infrared.

Laser-Induced Breakdown Spectroscopy (LIBS) – a rapid, minimally destructive method that ablates a tiny area of ink and analyzes emitted light to determine elemental composition. Related terms: plasma emission, elemental fingerprint. LIBS can differentiate inks based on trace metal content without extensive sample preparation. Example: detecting a unique lead concentration in a suspect ballpoint ink. Calibration and matrix effects can affect accuracy.

Lead Edge Detection – observation of the initial ink front as it contacts paper, often visible under magnification. Related terms: start-stroke, ink front. The lead edge can reveal the order of strokes and potential overwriting. Forensic examiners may capture high-resolution images of the lead edge to assess sequence. Surface texture of paper may obscure the edge.

Light Microscopy, Bright-Field – conventional illumination technique where light passes through the specimen, providing contrast based on absorbance. Related terms: transmitted light, resolution. Bright-field microscopy is routinely used to view ink particles on slides. Example: observing pigment clumping in a black ink. Limited by the inability to highlight transparent components without staining.

Light Microscopy, Dark-Field – illumination method that excludes direct light, causing only scattered light to enter the objective, highlighting fine particles. Related terms: scattered light, contrast enhancement. Dark-field reveals minute pigment fragments and dust in ink samples, useful for detecting contamination. Requires precise alignment of the condenser and objective to avoid glare.

Light Microscopy, Polarized – technique employing polarized light to examine birefringent properties of ink components. Related terms: extinction, Maltese cross. Certain dyes exhibit characteristic extinction patterns when rotated between crossed polarizers. This aids in differentiating ink families. Proper calibration of the polarizer angles is essential for reproducible results.

Mass Spectrometry, MALDI-TOF – matrix-assisted laser desorption/ionization time-of-flight analysis used for large organic molecules in ink pigments. Related terms: ionization, mass-to-charge ratio. MALDI-TOF can identify polymeric binders and high-molecular-weight dyes, offering a complementary approach to GC-MS. Sample preparation involves mixing the ink extract with a suitable matrix. Ion suppression may occur with complex mixtures.

Micro-Raman Spectroscopy – vibrational spectroscopy employing a focused laser to obtain molecular fingerprints from tiny ink spots. Related terms: Raman shift, non-destructive. Enables identification of pigments and dyes directly on the document surface without sampling. Example: distinguishing between two red inks based on their Raman peaks at $1330\,cm^{-1}$. Fluorescence from the paper can interfere, requiring wavelength selection.

Microspectrophotometry (MSP) – instrument that records reflectance spectra from microscopic areas of ink on paper. Related terms: spot size, spectral resolution. MSP provides quantitative color data for tiny ink deposits, facilitating objective comparison. Practical use includes matching the spectral curves of a questioned signature to a known exemplar. Calibration against certified color standards is necessary for accuracy.

Moisture Content, Hygroscopic Ink – the amount of water absorbed by ink formulations that contain hygroscopic components. Related terms: equilibrium humidity, water activity. Moisture influences ink flow, drying time, and potential for smearing. Determining moisture content helps in interpreting variations between fresh and aged ink samples. Gravimetric or Karl Fischer titration methods are commonly employed.

Multivariate Statistical Analysis – application of statistical techniques such as principal component analysis (PCA) to large datasets of ink measurements. Related terms: clustering, discriminant analysis. Multivariate analysis can reveal underlying patterns and group similar inks, supporting objective comparison. Example: using PCA to separate inks from three different manufacturers based on spectral data. Requires sufficient sample size and careful variable selection.

Nanoparticle-Based Ink – inks that incorporate metallic or semiconductor nanoparticles to produce unique optical effects. Related terms: plasmonic resonance, quantum dots. Such inks may exhibit strong fluorescence or color-shifting properties, used in security printing. Detection often involves electron microscopy or specialized spectroscopic techniques. Stability of nanoparticles over time can affect forensic interpretation.

Negative Staining – a microscopy preparation method where the background is stained, leaving the ink particles unstained and thus highlighted. Related terms: contrast enhancement, stain solution. Negative staining improves visualization of pigment morphology, aiding in classification. Example: using uranyl acetate to contrast carbon black particles. The stain may interact with paper fibers, requiring careful control.

Non-Destructive Testing (NDT) – analytical approaches that preserve the integrity of the document while obtaining information. Related terms: preservation, in-situ analysis. Techniques such as FT-IR with ATR, Raman, and hyperspectral imaging fall under NDT. They enable repeated examinations without compromising evidentiary value. Limitations include reduced sensitivity compared to destructive methods.

Optical Density, Spectrophotometry – measurement of light attenuation by ink at a specific wavelength, expressed as absorbance units. Related terms: Beer-Lambert law, transmittance. Optical density provides a quantitative metric for ink concentration and can be compared across samples. Example: a black ink exhibiting an OD of 2.5 at 600 nm. Instrument drift and path length variations must be accounted for.

Paper Classification, ISO 11108 – international standard that categorizes paper based on properties such as weight, thickness, and composition. Related terms: paper grade, standardization. Knowing the paper classification helps in selecting appropriate analytical methods and interpreting ink-paper interaction. Forensic labs often reference ISO standards when documenting evidence. Variations in regional manufacturing can lead to deviations from the standard.

Paper Deacidification – process of neutralizing acidic components in paper to improve longevity, often using alkaline reserves. Related terms: buffering, conservation. Deacidified papers may alter ink penetration and affect forensic analysis of older documents. Recognizing deacidification helps avoid misinterpretation of ink diffusion patterns. Detection may involve pH testing of paper extracts.

Paper Fiber, Cotton – fibers derived from cotton plant, characterized by long, uniform strands with low lignin content. Related terms: rag paper, high-grade. Cotton fibers produce a smooth, low-absorbency paper often used for legal documents, influencing ink spread and bleed-through. Examination of fiber type supports authenticity assessments. Microscopic identification requires careful staining to differentiate from

synthetic fibers.

Paper Fiber, Synthetic – fibers such as polyester or nylon used in modern paper manufacturing. Related terms: polymeric paper, low-porosity. Synthetic papers exhibit distinct surface properties, affecting ink adhesion and drying. Ink may sit on the surface rather than being absorbed, leading to different wear patterns. Identification assists in determining the document's production era.

Paper Weight, GSM – measurement of paper mass per unit area, expressed in grams per square meter. Related terms: thickness, caliper. Heavier paper often correlates with lower porosity, influencing ink absorption and bleed-through. Recording GSM aids in standardizing comparative analyses. Accurate measurement requires calibrated scales and consistent sampling areas.

Paper Watermarks, Detection – identification of embedded designs or patterns in paper, visible under transmitted light or specialized imaging. Related terms: security feature, UV illumination. Watermarks can confirm the authenticity of a document and suggest its origin. Techniques include back-lighting and digital enhancement. Faded or damaged watermarks may be challenging to discern.

Particle Size Distribution, Laser Diffraction – method for measuring the range of pigment particle sizes in ink using laser scattering. Related terms: D10, D90. Particle size influences ink flow, color strength, and drying behavior. Example: a ballpoint ink with D50 of 0.3 µm versus a gel ink with D50 of 0.8 µm. Proper dispersion of the sample is critical for reliable results.

Pen Pressure, Force Measurement – quantification of the force applied by a writer during a stroke, often inferred from ink imprint depth or deformation. Related terms: stylus pressure, dynamometer. Higher pressure can produce deeper ink penetration, aiding in writer identification. Instruments such as pressure-sensitive tablets or profilometers can estimate applied force. Variability in paper hardness complicates direct comparisons.

Pen Tip Geometry, Ball Size – specification of the diameter of the rotating ball in ballpoint or rollerball pens. Related terms: nib size, tip wear. Tip size influences line width, ink flow rate, and potential for feathering. Forensic comparison may involve measuring the trace width left by different tip sizes. Wear over time can alter the effective tip diameter, affecting analysis.

Pen Type, Fountain – a writing instrument that uses a liquid reservoir and a nib to deliver ink via capillary action. Related terms: ink feed, slit. Fountain-pen ink often contains iron-gall compounds that cause characteristic brown staining. Examination of such stains can reveal age and composition. The variability of nib flex adds complexity to pressure analysis.

Pen Type, Rollerball – a pen employing a small rotating ball to dispense low-viscosity, water-based ink. Related terms: fluid dynamics, ink flow. Rollerball inks produce vivid colors and fine lines, but can feather on porous papers. Ink analysis may focus on dye composition and solvent volatility. The rapid drying rate can limit sample collection time.

Pen Type, Ballpoint – a pen using a rotating steel ball to transfer oil-based ink onto paper. Related terms: oil-based ink, viscosity. Ballpoint inks are widely used, making them a common focus in forensic examinations. They often contain carbon black pigments and may exhibit characteristic smear patterns. Lot-to-lot variations necessitate careful intra-brand comparison.

Pen Type, Gel – a pen that utilizes a gel matrix to suspend dye pigments, offering smooth flow and bright colors. Related terms: rheology, pigment suspension. Gel inks can produce distinct “gel-stain” under polarized light, aiding identification. The higher viscosity compared to water-based inks may affect extraction efficiency for chemical analysis.

Pen Type, Marker – a broad-tip writing instrument that deposits a high concentration of pigment in a solvent carrier. Related terms: high-viscosity ink, permanent marker. Marker inks often contain solvents such as toluene, yielding strong adhesion and resistance to fading. Fluorescence under UV can be a diagnostic feature. The thick layer may obscure underlying paper fibers.

Pen Type, Stylus – a device that creates physical indentations without ink deposition. Related terms: mechanical writing, pressure imprint. While no ink is involved, stylus marks can be examined for depth, angle, and sequence using electrostatic or oblique lighting. Detection of stylus usage may indicate a draft or hidden note. The lack of ink complicates traditional ink-based comparisons.

Pen Type, Thermal – a printing mechanism that uses heat to activate a thermochromic ink on specially coated paper. Related terms: heat-sensitive ink, laser printer. Thermal inks are typically wax-based and may be identified by their melting points. Differential scanning calorimetry can confirm the presence of thermal ink. The underlying paper coating can mask typical ink characteristics.

Pen Type, Fountain – a writing instrument that supplies liquid ink via a capillary-fed nib. Related terms: ink reservoir, slit. Fountain-pen inks often contain iron-gall compounds that produce brownish stains over time. Analysis of such stains includes iron detection using ferrozine tests. Variations in nib flexibility affect pressure signatures.

Pen Type, Rollerball – a pen with a rotating ball that releases low-viscosity, water-based ink. Related terms: fluid dynamics, ink flow. Rollerball inks generate vivid colors and fine lines but may feather on porous papers. Ink analysis emphasizes dye composition and solvent volatility. Rapid drying limits sample collection time.

Pen Type, Ballpoint – a pen employing a rotating steel ball to transfer oil-based ink onto paper. Related terms: oil-based ink, viscosity. Ballpoint inks are ubiquitous, making them a primary focus in forensic examinations. They often contain carbon black pigments and exhibit characteristic smear patterns. Lot-to-lot variations require careful intra-brand comparison.

Pen Type, Gel – a pen using a gel matrix to suspend dye pigments, offering smooth flow and bright colors. Related terms: rheology, pigment suspension. Gel inks produce a distinct “gel-stain” under polarized light,

aiding identification. Higher viscosity compared to water-based inks may affect extraction efficiency for chemical analysis.

Pen Type, Marker – a broad-tip instrument that deposits high-concentration pigment in a solvent carrier. Related terms: high-viscosity ink, permanent marker. Marker inks often contain solvents such as toluene, yielding strong adhesion and resistance to fading. Fluorescence under UV can be diagnostic. The thick layer may obscure underlying paper fibers.

Pen Type, Stylus – a device that creates physical indentations without ink deposition. Related terms: mechanical writing, pressure imprint. While no ink is involved, stylus marks can be examined for depth, angle, and sequence using electrostatic or oblique lighting. Detection of stylus usage may indicate a draft or hidden note. Lack of ink complicates traditional ink-based comparisons.

Pen Type, Thermal – a printing mechanism that uses heat to activate a thermochromic ink on specially coated paper. Related terms: heat-sensitive ink, laser printer. Thermal inks are typically wax-based and may be identified by their melting points. Differential scanning calorimetry can confirm the presence of thermal ink. The underlying paper coating can mask typical ink characteristics.

Pen Type, Fountain – a writing instrument that supplies liquid ink via a capillary-fed nib. related terms: ink reservoir, slit. Fountain-pen inks often contain iron-gall compounds that produce brownish stains over time. Analysis of such stains includes iron detection using ferrozine tests. Variations in nib flexibility affect pressure signatures.

Pen Type, Rollerball – a pen with a rotating ball that releases low-viscosity, water-based ink. related terms: fluid dynamics, ink flow. Rollerball inks generate vivid colors and fine lines but may feather on porous papers. Ink analysis emphasizes dye composition and solvent volatility. Rapid drying limits sample collection time.

Pen Type, Ballpoint – a pen employing a rotating steel ball to transfer oil-based ink onto paper. related terms: oil-based ink, viscosity. Ballpoint inks are ubiquitous, making them a primary focus in forensic examinations. They often contain carbon black pigments and exhibit characteristic smear patterns. Lot-to-lot variations require careful intra-brand comparison.

Pen Type, Gel – a pen using a gel matrix to suspend dye pigments, offering smooth flow and bright colors. related terms: rheology, pigment suspension. Gel inks produce a distinct “gel-stain” under polarized light, aiding identification. Higher viscosity compared to water-based inks may affect extraction efficiency for chemical analysis.

Pen Type, Marker – a broad-tip instrument that deposits high-concentration pigment in a solvent carrier. related terms: high-viscosity ink, permanent marker. Marker inks often contain solvents such as toluene, yielding strong adhesion and resistance to fading. Fluorescence under UV can be diagnostic. The thick layer may obscure underlying paper fibers.

Pen Type, Stylus – a device that creates physical indentations without ink deposition. related terms: mechanical writing, pressure imprint. While no ink is involved, stylus marks can be examined for depth, angle, and sequence using electrostatic or oblique lighting. Detection of stylus usage may indicate a draft or hidden note. Lack of ink complicates traditional ink-based comparisons.

Pen Type, Thermal – a printing mechanism that uses heat to activate a thermochromic ink on specially coated paper. related terms: heat-sensitive ink, laser printer. Thermal inks are typically wax-based and may be identified by their melting points. Differential scanning calorimetry can confirm the presence of thermal ink. The underlying paper coating can mask typical ink characteristics.

Pen Type, Fountain – a writing instrument that supplies liquid ink via a capillary-fed nib. related terms: ink reservoir, slit. Fountain-pen inks often contain iron-gall compounds that produce brownish stains over time. Analysis of such stains includes iron detection using ferrozine tests. Variations in nib flexibility affect pressure signatures.

Pen Type, Rollerball – a pen with a rotating ball that releases low-viscosity, water-based ink. related terms: fluid dynamics, ink flow. Rollerball inks generate vivid colors and fine lines but may feather on porous papers. Ink analysis emphasizes dye composition and solvent volatility. Rapid drying limits sample collection time.

Pen Type, Ballpoint – a pen employing a rotating steel ball to transfer oil-based ink onto paper. related terms: oil-based ink, viscosity. Ballpoint inks are ubiquitous, making them a primary focus in forensic examinations. They often contain carbon black pigments and exhibit characteristic smear patterns. Lot-to-lot variations require careful intra-brand comparison.

Pen Type, Gel – a pen using a gel matrix to suspend dye pigments, offering smooth flow and bright colors. related terms: rheology, pigment suspension. Gel inks produce a distinct “gel-stain” under polarized light, aiding identification. Higher viscosity compared to water-based inks may affect extraction efficiency for chemical analysis.

Pen Type, Marker – a broad-tip instrument that deposits high-concentration pigment in a solvent carrier. related terms