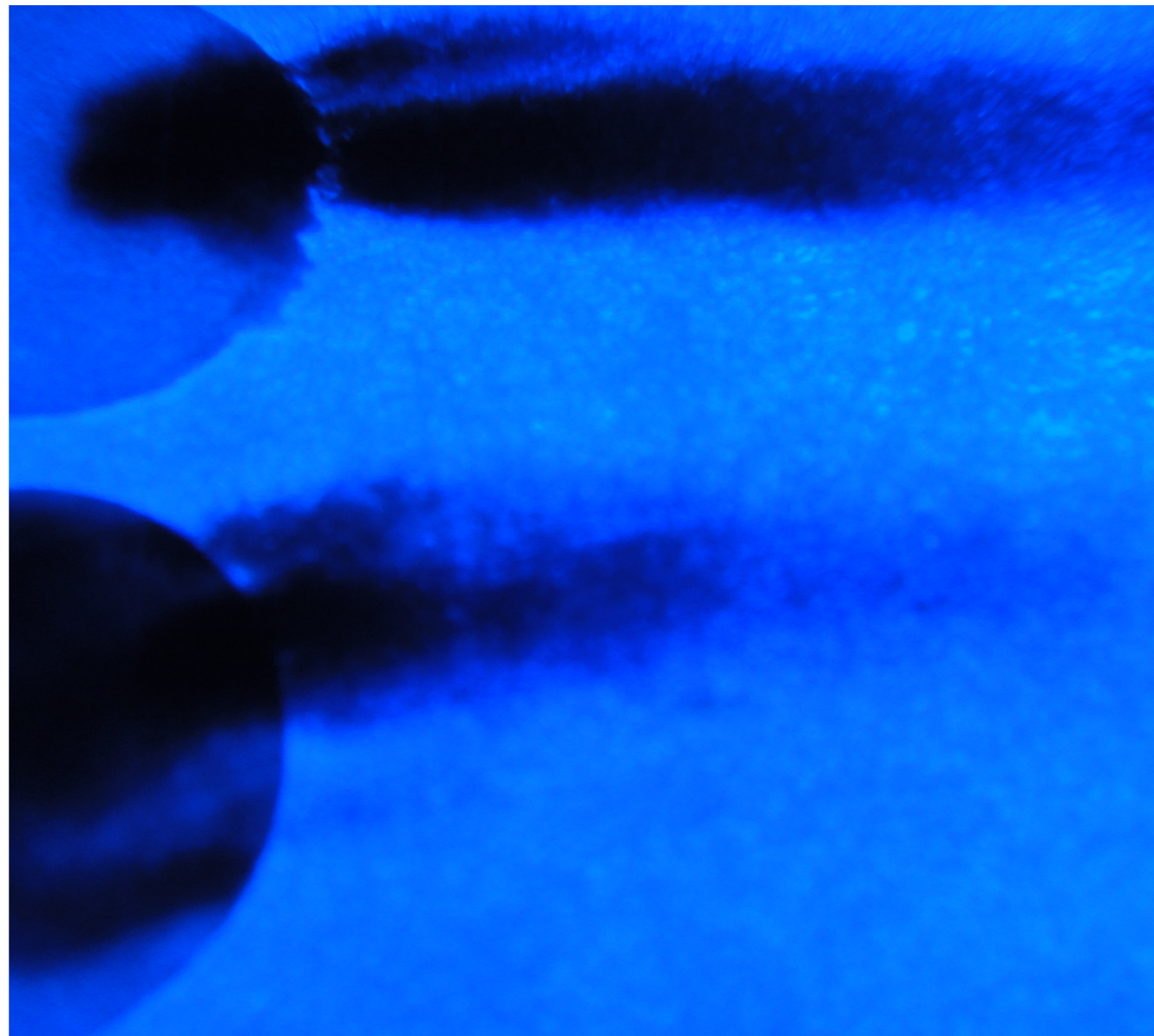


Ink Chromatography & Forensics



Ink Chromatography & Forensics

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REFERENCES



Beginning

...



MATERIALS

1. Kit Materials
2. Local Materials

KIT MATERIALS

Quantity	Description
1	Universal® brand black ink porous tip pen ACTIVITIES 1, 3
1	Universal® brand blue ink porous tip pen ACTIVITIES 1, 2,
1	Bottle, Parker® brand fountain pen ink, black ACTIVITIES 1, 3
1	Pentel® Rolling Writer® Rollerball Pen; black ink ACTIVITY 1
1	Pentel® Rolling Writer® Rollerball Pen; blue ink ACTIVITIES 1, 2
10	Vials ACTIVITIES 1, 2, 3
10	Magnifiers ACTIVITIES 1, 2, 3
10	Rulers, metric (6-inch) ACTIVITIES 1, 2, 3
1	Steel nib dipping pen ACTIVITIES 1, 3
11	EVIDENCE envelopes, 9 x 12" ACTIVITIES 2, 3
1	Flashlight / UV handheld source♦ ACTIVITIES 1, 2, 3
1	Paper punch ACTIVITIES 2, 3
1	Scissors, cuticle ACTIVITIES 1, 2, 3
1	Tweezers, fine-point ACTIVITIES 2, 3
1	Roll, transparent sticky tape ACTIVITIES 2, 3
1	Package/100, chromatography paper strips ACTIVITIES 1, 2, 3

♦ Required 4 double-A batteries; not included

CD-ROM *Ink Chromatography & Forensics*

- ACTIVITY 1 *Working with Ink Lines and a Chromatography Database*
- ACTIVITY 2 *Case of the Quivering Line*
- ACTIVITY 3 *Case of the Crossed Four*

Teacher Guide

Student Guide

Glossary

Background Information: *Chromatography of Inks & Ink Chemistry*

PowerPoint: *Ink Chromatography & Forensics* PPT and MOV

Time-Lapse Video: *Developing an Ink Chromatograph*

KIT MATERIALS (CONT)

Guides:

Guide To Writing Tools PDF
Guide To Writing Inks PDF
Writing Inks Database PDF

Folder: Images

Check

LOCAL MATERIALS

<u>Quantity</u>	<u>Description</u>
1	Bottle, water ACTIVITIES 1, 2, 3
1	Permanent marker (Sharpie® brand) ACTIVITY 1
10	Pencils ACTIVITIES 1, 2, 3
30	Sheets, copy paper (white) ACTIVITIES 1, 2, 3

Access to a computer, tablet, or iPad *

Access to a photocopier/computer scanner

Portable device cameras (optional)

* Useful but not absolutely necessary

Sharpie Blue

Sharpie Blue

F

LAMY BLUE

Fraye Blue

P-B

STEM Correlation Information



Click [HERE](#) to review a correlation of this kit with the Next Generation Science Standards.

SKILL / CONCEPT

- Experimental / Engineering Design
- Investigating
- Scientific Method
- Measurement
- Data Analysis
- Communication
- Technology

CONCEPT PRINCIPLES / KNOWLEDGE

- What is a *mixture*?
- What is a *chromatograph*?
- How chromatographs are used by scientists
- Chromatographic principles: *capillary action, solubility, affinity, adsorption, polar and non-polar substances*
- Chromatography methods & techniques
- Retention Factor (R_f) and ratios
- What is *precision*?
- What is *accuracy*?
- Inks and their composition; *ink dating, and ink tags*
- Databases and their use in forensic science
- What a standard is, and how it is useful in identifying an unknown
- How light energy (UV light) can aid in identifying ink constituents
- How forensic document examiners work to identify writing instruments, ink lines, and inks

CONSOLIDATED STEM STANDARDS

S = National Science Education Standards (NSES) - K-4, 5-8, 9-12

T = International Technology & Engineering Educators Association (ITEA) - K-2, 3-5, 6-8, 9-12

A framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (NRC; 2011) - Draft

E = Accreditation Board for Engineering and Technology (ABET) - 11-12

A framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (NRC; 2011) - Draft

M = National Council of Teachers of Mathematics (NCTM) - PreK-2, 3-5, 6-8, 9-12 Consolidated STEM Standards

SCIENCE

A.1.2 Design and conduct scientific investigations.

A.1.3 Use technology and mathematics to improve investigations and communications.

A2.1 Conceptual principles and knowledge guide scientific inquiries.

A.2.3 Scientists rely on technology to enhance the gathering and manipulation of data. New techniques and tools provide new evidence to guide inquiry and new methods to gather data, thereby contributing to the advance of science. The accuracy and precision of the data, and therefore the quality of the exploration, depends on the technology used.

E.1.1 Identify a problem or design an opportunity.

E.1.2 Propose designs – choose alternative solutions.

E.1.3 Implement a proposed solution.

E.1.4 Evaluate a proposed solution.

TECHNOLOGY

- 2.A A identification of the criteria and constraints of a product or system.
- 8.H Begin the design process ...
- 9.K Create a prototype to test a design concept.
- 11.O Refine the design.
- 11.P Evaluate the design solution.
- 11.R Communicate observations.
- 12.O Operate the system to validate the design.

ENGINEERING

- ET 1 **(Designed World)** Study of designed systems, processes, materials, and products.
 - ET1.A **(Products, Processes, Systems)**
 - ET1.B **(Nature of Technology)**
 - ET1.C **(Using Tools and Materials)**
- ET 2 **(Engineering Design)** Creative and iterative process for identifying and solving problems under constraints.
 - ET2.A **(Defining and Researching Technical Problems)**
 - ET2.B **(Generating and Evaluating Solutions)**
 - ET2.C **(Optimizing and making Tradeoffs)**
- ET3 **(Technological Systems)** Effectively using technology systems.
 - ET3.A **(Identifying and Modeling Technological systems)**
 - ET3.C **(Control and Feedback)**
- ET4 **(Interactions of technology & Society)** Decisions are affected by technology.
 - ET4.A **(Interactions of Technology & Society)**
 - ET4.B **(Interactions of Technology and Environment)**
 - ET4.C **(Analyzing issues involving Technology & Society)**

MATH

1.0 Understand: numbers, ways of representing numbers, relationships among numbers, and number systems.

2.0 Algebra: Understand numbers, ways of representing numbers, relationships among numbers, and number systems.

3.0 Geometry: Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.

4.0 Measurement: Understand measurable attributes of objects and the units, systems, and processes of measurement.

5.0 Data Analysis & Probability: Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.

6.0 Problem Solving: Build new mathematical knowledge through problem solving.

7.0 Recognize: reasoning and proof as fundamental aspects of mathematics.

8.0 Organize and consolidate: their mathematical thinking through communication.

9.0 Connections: Understand how mathematical ideas interconnect and build on one another to produce a coherent whole.

10.0 Create and use representations to: organize, record, and communicate mathematical ideas.

EXPERIMENTAL DESIGN CONSIDERATIONS

LAB OVERVIEW & LEARNING OBJECTIVES

In these guided and open investigations, students will learn about chromatographic separation techniques, especially paper chromatography; they will calculate the R_f (retention / relative mobility factor) values of several known ink 'standards;' and identify unknown ink samples through comparison with their class-created database, and critically review various documents, to solve two forensic mysteries.

- To *understand* the use of paper chromatography in forensically identifying inks
- To *determine* the R_f value of a set of standards
- To *create* an ink database
- To *practice* problem-solving skills in a forensic environment
- To *identify* an unknown ink, through comparison of its colorant constituents, in a forensic document

TEACHING STRATEGY & TIMELINES

These activities allow students to learn about the physical processes involved in mixture separation, the determination of retention factors (R_f), the use of a database, and how unknown ink characteristics can be identified and compared.

Suggested investigation order:

ACTIVITY 1 ***Working with Ink Lines and an Ink Database***

(INTRODUCTORY to INTERMEDIATE)

In this model investigation, teams are assigned a writing instrument (represented by a numbered ink sample). Each group will use the writing instrument to create various ink lines on a piece of copy paper. They will evaluate the ink line to identify the type of writing instrument and then perform a chromatographic analysis of the ink, characterize its ink constituents, and identify the ink brand using a standard ink database.

MODEL Investigation (45 minutes)

INDEPENDENT Investigation(s) (20-45 minutes)

ACTIVITY 2 ***Case of the Quivering Line*** (forensic investigation)

(INTERMEDIATE / ADVANCED)

An apparent suicide note has been found at a death scene. The death scene evidence materials have been delivered to student groups for analysis. Their tasks are:

- Does the ink line in the document match the writing instrument and its ink line?
- To complete and submit a forensic chemistry laboratory report to: Sheriff, Monroe County, New York.

INDEPENDENT Investigation (45 minutes)

ACTIVITY 3 **Case of the Crossed Four** (forensic investigation)

(INTERMEDIATE / ADVANCED)

A portion of a paper check has been sent to student groups for forensic analysis. Their tasks are:

- Determine if the dollar amount of \$4000.00 is authentic – written in the same ink or has the ink line been altered.
- To complete and submit a forensic chemistry laboratory report to: Chief of Police, Skagway, Alaska.

INDEPENDENT Investigation (45 minutes)

EXPERIMENTAL DESIGN CONSIDERATIONS

To help students effectively integrate the information they will be expected to apply in these investigations, they need to understand and discuss the following concepts before starting these lab activities. (See the *Glossary* files and power point: *Ink Chromatography & Forensics*.)

- ✓ What is a mixture?
- ✓ What is a chromatograph?
- ✓ How chromatographs are used by scientists
- ✓ Chromatographic principles: capillary action, solubility, affinity, adsorption, polar and non-polar substances
- ✓ Types of chromatography methods / techniques
- ✓ Retention factor (R_f) value
- ✓ What is precision?
- ✓ What is accuracy?
- ✓ Inks and their composition; ink dating, and ink tags

- ✓ Databases and their use in forensic science
- ✓ What a standard is, and how it is useful in identifying an unknown
- ✓ How light energy (UV light) can aid in identifying ink constituents
- ✓ How forensic document examiners work to identify writing instruments, ink lines, and inks

THE MODEL EXPERIMENT

A ‘model experiment’ provides structured guidance in a laboratory technique or protocol. In this structured (Activity 1) your students will learn how to examine ink lines and compare them to known standards to identify a writing instrument, conduct a paper chromatographic investigation of various common writing inks, and to use a created ink database in identifying them.

INDEPENDENT INQUIRY PATHS

After completing a model experiment investigation, students will gain experience in characterizing additional supplied inks (and in evaluating unknowns) – at your discretion.

In an open inquiry setting, student teams will function as “independent forensic laboratories” (Activities 2 and 3) whose task is to identify the type of writing instrument used to create the submitted document and the type of ink (and its manufacturer) used to create it as well as to submit written reports to various police agencies.

Be sure to remind your students that forensic analysis is identical to scientific inquiry – this process will help your students develop skills in communication, teamwork, critical thinking, and commitment to lifelong learning. This forensic investigation can help foster these skills.

Also remind students that an important part of becoming a forensic scientist is to learn to keep clear, concise, and accurate laboratory notes.

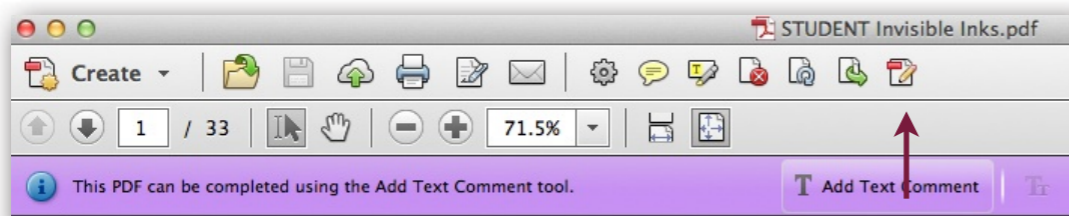
At the conclusion of the independent investigations, you may choose to conduct mock trials in which selected student groups act as “expert witnesses” to present scientific evidence while other students act as prosecutors, defendants, and jurors.

Scientific inquiry will help your students develop skills in communication, teamwork, critical thinking, and commitment to lifelong learning. This investigation can help foster these skills.

TEACHER NOTE

ADD TEXT (former Typewriter) Function in STUDENT ACTIVITY PDFs

Students can click on the icon (arrow) to add text - creating an emailable report that can be sent back to you!



KEEPING a LABORATORY NOTEBOOK

Scientific inquiry will help your students develop skills in communication, teamwork, critical thinking, and commitment to lifelong learning. This investigation can help foster these skills.

Remind students that an important part of becoming a scientist is to learn to keep clear, concise, and accurate laboratory notes. At the conclusion of the independent investigations, you might want to have students create mini-posters that showcase the results of their investigations. An organized lab notebook should demonstrate originality and reflection while serving as a record of student work.

A Laboratory Notebook should contain:

- Work group members
- Primary question (stated problem) for investigation
- Background observations and contextual information
- Hypothesis and rationale for the investigation
- Notes on Procedure / Experimental Design — strategies for testing hypothesis, using appropriate controls and variables
- Materials required
- Safety issues (or specific cautions)
- Procedure in sufficient detail so that another student group could replicate team results
- Results, including graphs, tables, drawings or diagrams, statistical analysis, and a record of digital file(s) location
- Conclusion and discussion — Was the hypothesis supported? What additional questions remain for further investigation?
- Citations for sources found through library or web research