

Forensic Science

Forensic Science

Currency

Authentication

Curriculum for
Investigative Science

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**Forensic Science Units
Art & Currency Authentication
Environmental: Soils**

Module Lesson Plans

I. Rationale

When pondering the subject of "Forensic Science", most individuals will call to mind events they have read about in the newspaper or seen on television shows like C.S. I. Las Vegas. Criminal cases involving evidence such as blood spatter, fingerprints or ballistics come to mind readily as these are the events they have been exposed to most frequently in the media. These are the topics of high profile cases. However, it is important to remember that the "sciences" we are speaking of when using the term "Forensic Science" refer to many more science disciplines than those mentioned above. In truth, any science can be translated into a Forensic Science merely by applying its' analytical findings to the law written by a governing body. And it is therefore the goal of this curriculum module to introduce students to science through the Forensic investigative techniques of science disciplines with which students might not be as familiar.

With these lessons, students will investigate the fundamental scientific concepts behind art and currency authentication, and forensic evaluation of soils. Students will identify characteristics in a given set of data, construct qualitative observations, and place information into a classification system. Students will gain experience using tools and instruments to collect evidence and practice safety procedures in all activities. In addition, students will utilize the scientific method to formulate a hypothesis, recognize variables, interpret data and arrive at a conclusion using their laboratory results.

We have designed these lesson plans to be easily modified as needed by the teacher. It is our goal that teachers can choose to present all of the material in one comprehensive package or just pull out specific activities/topics to use as mini-lessons. In all of the activities, additional suggestions and time-saving tips are included at the end.

II. Objectives

A. Cognitive objectives:

Upon completion of this module, the student will be able to:

- Understand terminology associated with art, clay media, and U.S currency and all of the vocabulary associated with the investigative examinations of each.
- Explain the historical background and relevance of Forensic Art authentication in society today.
- Understand the processes by which art /artifacts are produced.
- Understand the various processes used to authenticate art / artifacts.
- Recognize the electromagnetic spectrum.
- Distinguish among the types of EM radiation according to ranges of wavelength and frequency.
- Understand the basic physical processes that occur when different wavelengths of radiation pass or do not pass through a medium

- Describe the various methods for authenticating art /artifacts.

B. Skills and Performance objectives:

Upon completion of this module, the student will be able to:

- Produce samples of artwork and pottery based upon a given set of lab procedures.
- Exhibit the proper safety procedures when working with Ultra Violet light.
- Demonstrate the correct procedure for using a UV light source.
- Report data in an appropriate manner.
- Deduce a criminal suspect based on the authentication of samples of art /artifacts.

Currency Authentication

U.S. Currency: Do You Know Your Money Trivia?

Teachers' Key

- **Which feature on U.S. bills will vary (be changed) most frequently?**
 - changes in identity, and therefore, the signatures of the Secretary of the Treasury and the Treasurer of the United States
- **Which president is found on the U.S. \$20 note?**
 - Andrew Jackson
- **How many Federal Reserve Banks are there currently in the U.S and in what cities are they located?**
 - 12 – Boston, New York City, Philadelphia, Cleveland, Richmond, Atlanta, Chicago, St. Louis, Minneapolis, Kansas City, MO, Dallas, and San Francisco
- **Which president is found on the U.S. \$5 note?**
 - Abraham Lincoln
- **In what year was paper money as we know it first issued by the U.S. Government?**
 - 1861
- **The color of the Treasury seals on the right of all U.S. bills currently in circulation depends on which class the note belongs to....**
 - **Federal Reserve note (99% of bills in circulation today) – Green Seal**
 - **United States Note – Red Seal**
 - **Silver Certificate – Blue Seal**
- **Which president is found on the \$1 U.S. note?**
 - George Washington
- **What happens when a note bearing a serial number is mutilated in the course of manufacture?**
 - it must be replaced in the series to ensure a proper count of the notes produced; however, to produce another note with the same serial number would be very costly and time-consuming, so consequently a “star note” is substituted- it has a serial number out of sequence with the other notes in the original series, but a “STAR” is printed after the number to indicate that it is a substitute
- **Which president is found on the U.S. \$50 note?**
 - Ulysses S. Grant
- **In what year was the “Regional Seal” (on the left of all bills) depicting the Federal Reserve bank of issuance dropped in exchange for a generalized Federal Reserve seal used in conjunction with a letter and number above and to the left?**
 - 1996
- **Which president is found on the U.S \$2 note?**
 - Thomas Jefferson
- **What are the Federal Reserve codes for Dallas and New York City?**
 - K 11 and B 2
- **Which president is found on the U.S \$500 note?**
 - William McKinley
- **What has changed about the Presidential portraits with the 1996 series bills on?**
 - larger
 - slightly off-center to the left
 - more detailed

- micro-printing around the base of the frame
- **What does “FRN” stand for?**
 - Federal Reserve Note
- **What does the first letter of the serial number (located in two locations on a bill) stand for?**
 - the first letter corresponds to the serial year
 - A=1996; B=1999; C=2001; D=2003; E=2004; F=2003A; G=2004A
- **Which president is found on the U.S. \$100 note?**
 - Benjamin Franklin
- **Which fiber, known as the most widely used synthetic fiber in the U.S, is used to make the clear Security Thread that runs vertically in all paper currency after 1996?**
 - polyester
- **Which president is found on the U.S \$10 note?**
 - Alexander Hamilton
- **Which president is found on the U.S \$1000 note?**
 - Grover Cleveland
- **What does currency paper actually consist of?**
 - 25% linen and 75% cotton with small randomly dispersed red and blue fibers embedded throughout the paper
- **What is the most common type (method) of counterfeit made in the U.S?**
 - Ink Jet Produced
 - made of tiny colored dots that can be seen with a magnifying glass
 - print will run when wet
- **What is the highest denomination of paper currency now being printed?**
 - the one hundred dollar bill
- **When comparing a “suspected” bill with a genuine bill, is it best to look for similarities or differences?**
 - differences!

Currency Authentication

U.S. Currency: Do You Know Your Money Trivia?

STUDENT ACTIVITY

- Which feature on U.S. bills will vary (be changed) most frequently?
- Which president is found on the U.S. \$20 note?
- How many Federal Reserve Banks are there currently in the U.S and in what cities are they located?
- Which president is found on the U.S. \$5 note?
- In what year was paper money as we know it first issued by the U.S. Government?
- The color of the Treasury seals on the right of all U.S. bills currently in circulation depends on which class the note belongs to....
 - Federal Reserve note (99% of bills in circulation today) – _____ seal
 - United States Note – _____ seal
 - Silver Certificate – _____ seal
- Which president is found on the \$1 U.S. note?
- What happens when a note bearing a serial number is mutilated in the course of manufacture?
- Which president is found on the U.S. \$50 note?

- **In what year was the “Regional Seal” (on the left of all bills) depicting the Federal Reserve bank of issuance dropped in exchange for a generalized Federal Reserve seal used in conjunction with a letter and number above and to the left?**
- **Which president is found on the U.S \$2 note?**
- **What are the Federal Reserve codes for Dallas and New York City?**
- **Which president is found on the U.S \$500 note?**
- **What has changed about the Presidential portraits with the 1996 series bills on?**
- **What does “FRN” stand for?**
- **What does the first letter of the serial number (located in two locations on a bill) stand for?**
- **Which president is found on the U.S. \$100 note?**
- **Which fiber, known as the most widely used synthetic fiber in the U.S., is used to make the clear Security Thread that runs vertically in all paper currency after 1996?**
- **Which president is found on the U.S \$10 note?**
- **Which president is found on the U.S \$1000 note?**

- **What does currency paper actually consist of?**
- **What is the most common type (method) of counterfeit made in the U.S?**
- **What is the highest denomination of paper currency now being printed?**
- **When comparing a “suspected” bill with a genuine bill, is it best to look for similarities or differences?**

Currency Authentication

U.S. Currency: DO YOU REALLY KNOW WHAT YOUR MONEY LOOKS LIKE?

Student Discovery Activity: Teachers Guide

Purpose/Objectives: Students will...

- before any investigation of the money occurs, recall as many characteristics about U.S. bills (paper money) as possible
- make observations about paper money using the naked eye, magnifying glasses and compound microscopes
- analyze red and blue security fibers extracted from a U.S. bill
- discuss the observations made about the paper money, and the effectiveness of each viewing method used
- hypothesize the different features used by the U.S. Secret Service to detect counterfeit bills
- hypothesize which denominations of bills have the most security features built in and why?

PRE-ACTIVITY

The first part of this activity begins with the students in their lab groups recalling the many distinguishing characteristics of paper money. Students should generate a list of these characteristics on the Activity Sheet Provided. They may want to think of all bills in general, or only of a particular denomination, such as a “one dollar bill”, or a “twenty”.

In addition, there are two spaces provided in the dimensions of a U.S. bill for them to actually draw in the location of front-of-bill- and back-of-bill- features they recall. These will be shared with the entire class during the discussion after the Pre-Activity. Students may add characteristics to their list obtained from the larger group list if needed.

At the end of this introductory activity, ask the students: Now that we have generated as many identifying characteristics of the bills that we can, do you think that there are any features we have missed?

*** Note: It will be important to express to the students that getting to do these labs is a privilege. It is an expectation that all money is treated with respect and care at all times and that all money is returned to the rightful owner at the end of the labs (the teacher may provide the samples, or the students may use their own money).**

ACTIVITY: What Do You See? Part 1

Materials (per group)

- samples of U.S. paper money (different denominations) in plastic sleeves
- magnifying glasses
- compound microscopes / stereoscope
- metric ruler
- student activity sheets

At each lab station, have at least three samples of U.S. paper money, some magnifying glasses, compound microscope (you can also let the students explore with a stereoscope), and a metric ruler. Ask the students to make as many observations as they can about their money samples. Challenge them to look beyond the obvious.

Suggestions are color, texture, size, different fonts, writing styles, patterns, codes, pictures, numbers, shadowing, overlapping, seals, Latin phrases, other phraseology, American symbols, repetition of numeration (how many times does the word/number “one” appear on the bill, serial numbers, presidents, facing of presidents, signatures etc.

On their observation sheet, have the students itemize observations made with each type of viewing method. For example, they will be able to see many features such as the bust of the president with the naked eye, but would need a magnifying glass or microscope to see the microscopic words “TWENTY” around the edges of the much larger word twenty on a current series twenty dollar bill.

When the students are finished making their observations, they should answer the **Follow-Up Questions**. Use these questions to facilitate a discussion about their observations with the whole class. Have the students check off on their observation lists those features mentioned in the larger group. Students may add to their lists those features not personally observed, but mentioned by other classmates in the discussion.

ANSWERS TO FOLLOW-UP QUESTIONS:

1. Answers Will Vary
2. Answers Will Vary
3. Answers Will Vary

ACTIVITY: What Do You See? Part 2

Materials (per group)

- samples of U.S. paper money (different denominations) in plastic sleeves
- compound microscopes (a strong magnifying glass may be used)
- thumb tack, needle, **OR** razor blade (**SAFETY! You must be careful with these!**)
- small container of water
- eye dropper
- two glass slides
- two slide cover slips
- forceps
- colored pencils
- student activity sheets

*** Students Remember: The money samples belong either to the teacher or to another student. Please treat all samples with care and respect. All samples will accounted for at the end of the period.**

In this activity the students will be investigating the blue and red security fibers embedded in the paper of a U.S. bill. They will first count how many red and blue fibers they can see on one side of the bill, and then will count them on the other side. Secondly, they will gently extract some of the blue and red security fibers, will make Wet Mounts of these, and then will view these using Low and High powers on a classroom compound microscope. If your students are not familiar with Compound Microscope Lab Technique, you will need to do a lesson on this before beginning. Remind the students that extracting the fibers from the paper should not be a destructive process and that care should be taken when doing this procedure.

When the students are finished making their observations, they should answer the **Follow-Up Questions**. Use these questions to facilitate a discussion about their observations with the whole class.

ANSWERS TO FOLLOW-UP QUESTIONS:

4. Answers Will Vary
5. Answers Will Vary ; the U.S. twenties, fifties and one hundreds all have more anti-counterfeiting security features- it would cost counterfeiters more than one dollar to counterfeit one dollar bills, and still would not be very cost effective to illegally reproduce five dollar bills.

Currency Authentication

U.S. Currency: DO YOU REALLY KNOW WHAT YOUR MONEY LOOK LIKE?

Student Discovery Activity

PRE-ACTIVITY

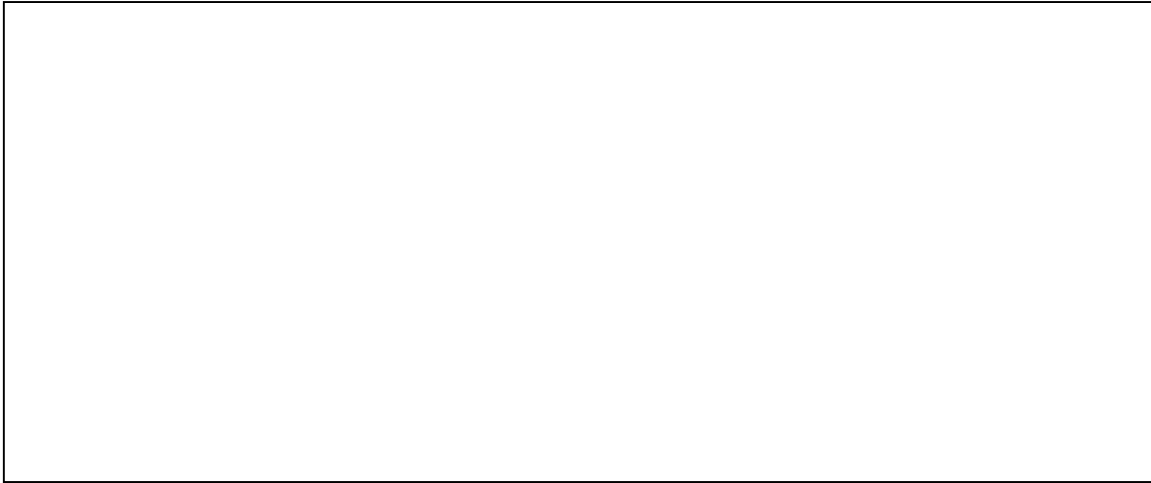
THINK ABOUT U.S. paper money! What does it actually look like? Generate a list of all of the characteristics you can remember about U.S. bills. Also, if you can, use the boxes below to signify where on the front and back of the bill you would find specific characteristics. For instance, you would draw a picture of a man in the general location of the middle of the bill on the front side.

List of Characteristics

Front of Bill

A large empty rectangular box with a black border, intended for a student to draw the front of a U.S. bill. The box is oriented horizontally and occupies a significant portion of the lower half of the page.

Back of Bill



Characteristics Added After Class Discussion

ACTIVITY: What Do You See? Part 1

Materials (per group)

- samples of U.S. paper money (different denominations) in plastic sleeves
- magnifying glasses
- compound microscopes / stereoscope
- metric ruler
- student activity sheets

**** Students Remember: The money samples belong either to the teacher or to another student. Please treat all samples with care and respect. All samples will accounted for at the end of the period.***

Procedure

At your lab table, use the above listed equipment to make observations about the bills of varying denominations. **(If you are not familiar with how to use a compound microscope, ask for assistance from your teacher.)** Record your observations in the appropriate column depending on type of viewing method used. For example, if you see something only with the microscope, record that observation in the "Microscope" column. When you complete this activity, answer the Follow-Up Questions at the end.

Naked Eye

Magnifying Glass

Microscope

FOLLOW-UP QUESTIONS

1. In the Pre-Activity, you brainstormed characteristics of U.S. paper currency. What were some of the features you discovered (that you did not include originally) in Activity Part 1?
2. In Activity Part 1, were there any features that you could not see with the naked eye? If so, what were they? Which instrument helped you to see it more clearly?
3. What feature(s) did you find to be most surprising or interesting?

ACTIVITY: What Do You See? Part 2

Materials (per group)

- samples of U.S. paper money (different denominations) in plastic sleeves
- compound microscopes
- thumb tack, needle **OR** razor blade (**SAFETY! You must be careful with these!**)
- small container of water
- eye dropper
- two glass slides
- two slide cover slips
- forceps
- colored pencils
- student activity sheets

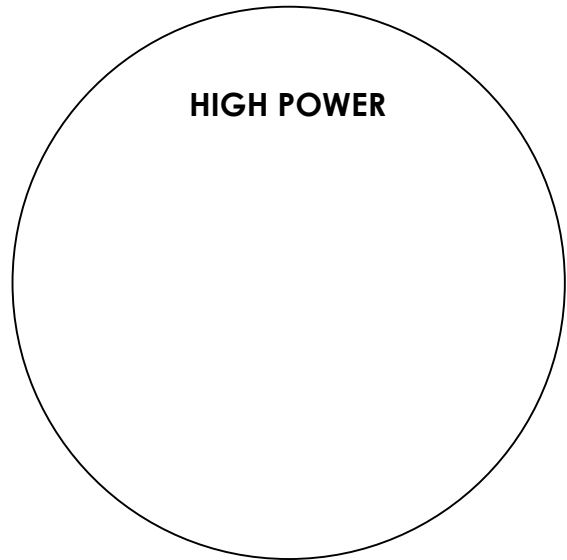
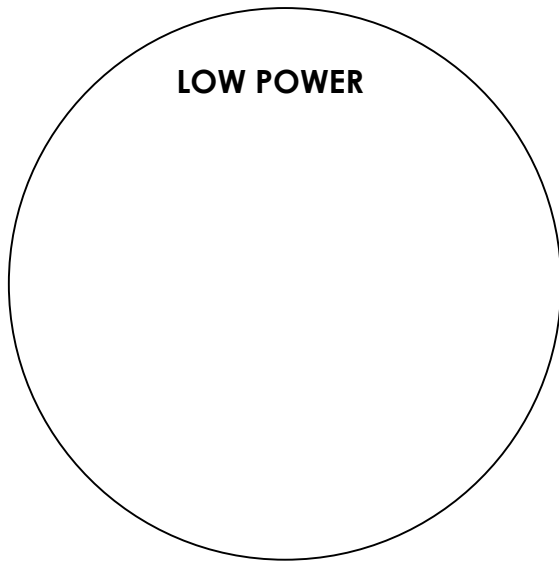
**** Students Remember: The money samples belong either to the teacher or to another student. Please treat all samples with care and respect. All samples will accounted for at the end of the period.***

Pre-Lab Questions:

- a. How many **BLUE Security Fibers** can you see on one side of your bill? _____
- b. How many can you see on the other side? _____
- c. How many **RED Security Fibers** can you see on your bill? _____
- d. How many can you see on the other side? _____

Procedure

1. Use the sharp surface of the thumb tack, needle OR razor blade to “**tease out**” one of the **RED** and **BLUE Security Fibers** from one of the bills at your lab table. Carefully lay them each on their own clean slide. **This process should not be destructive to the currency. REMEMBER – this is government property and so extra care should be taken not to make holes in the money or in any other way damage it.**
2. Add a drop of water to each of the fibers and then gently, at a forty-five degree angle, lay the cover slip down on the wet fiber. This helps to prevent air bubbles and is a process called a **Wet Mount**.
3. View each of the fibers on **Scanner, Low Power** and **High Power**. Remember to focus and center the fibers in the field of view before moving to the next lens. Using the appropriate shade of color pencil, draw **in detail** what you see on **LOW** and **High Powers**.



FOLLOW-UP QUESTIONS

1. Discuss the observations you made about the security fibers. Did they appear as you thought they would when magnified?

2. The counterfeiting of money is a problem in our society today. If you had to guess, which four or five features of the U.S paper bills do you think the government has designed in an effort to (a) make the process of counterfeiting more difficult and/or (b) help with identifying counterfeit bills?

Currency Authentication

U.S. Currency: The Science of Security Features

Student Discovery Activities: Teachers Guide

Purpose/Objectives: Students will...

- learn and be proficient with the use of the U.S.S.S currency security feature terminology in the Student Discovery Activities and in the class discussion that follows
- learn about the importance of “money” as means of exchange
- learn about the problems that can arise as a result of counterfeiting of currency
- learn about the solutions the U.S. government has created in an effort to thwart counterfeiting activities, and those measures taken by the Secret Service to aid in counterfeit currency detection

ACTIVITY 1: Do You Know Your Money?

Materials: (per group)

- laminated USSS Security Feature Terminology Sheet
 - laminated enlarged photo copies (**> 130%**) of U.S. \$1.00, \$5.00, pre-1996 \$10.00 and \$20.00 bills, and post-1996 \$10.00 and \$20.00 bills
 - real money samples in the above listed denominations in plastic sleeves
 - vis-à-vis pens of different colors
 - damp / wet paper towels
 - dry paper towels
- * This combination of denominations is optional, but will give the students examples of bills from pre- and post-1996 printing periods which will allow them to see definitive differences in features such as portrait positioning, Federal Reserve Seal Types and Optically Variable Ink (OVI).**
- * This is equal to \$66.00 and you can get these denominations at the bank ahead of time if you do not already have these bills in your possession.**

In this activity, the students in each group will first read the vocabulary words on the USSS Terminology Sheet to become familiar with them. They will then look at the real money samples and try to locate each of the individual terminology features on those samples. When they feel they have located them correctly, they can then use the vis-à-vis pens to mark their locations on the enlarged laminated replica sheets.

When all groups are finished, have members of each lab group come to the front of the class to share their results. Have them state how many of the features they believe they identified correctly.

ACTIVITY 2: How Secure Is Your Money? Let's Find Out!

Materials: (per group)

- the materials from Part 1
- USSS Counterfeit Division "Know Your Money" Mini-Poster
- USSS Counterfeit Divisions "Positions of Important Features Sheets"

The students will be comparing the USSS Security Feature Sheets to the features they labeled on the laminated copies in the previous activity. As they are finished making their comparison, have them answer the five Follow-Up Questions. These can be used in a discussion with the whole class.

FOLLOW-UP QUESTIONS:

(1) Answers will vary

(2) Answers will vary

(3) Answers will vary

(4) Answers will vary

(5) The students may mention that we have yet to talk about the Ultra Violet feature of the polyester security threads imbedded into the paper currency.

Teachers: A reminder for the kids.....

***PLEASE: At this time take a damp paper towel and clean off your laminated money sheets. Dry them off and then return ALL materials directly to the TEACHER. All materials will be accounted for before students leave the classroom. Thank You!**

ACTIVITY 3: The Color of Money

Materials: (per group)

- laminated USSS Security Feature Terminology Sheet
- USSS Counterfeit Division "Know Your Money" Pamphlet
- laminated enlarged **COLOR** photo copies (> 130%) of " **2004 and POST**" **SERIES** U.S. \$10.00 and \$20.00 and \$50.00 bills
- real money samples in the above listed denominations (**if available**) in plastic sleeves
- vis-à-vis pens of different colors
- damp / wet paper towels
- dry paper towels
- USSS Counterfeit Division "Know Your Money" Mini-Poster (may still need to have out as a resource)
- USSS Counterfeit Divisions "Positions of Important Features Sheets" (may still need to have out as a resource)

In this activity, the students will be reading about the Security Features found in the **2004 Series** paper currency with background coloring. While reading about how these features are similar or different from those found in the pre-1996 and post 1996 non-colored bills, they can look at the real samples of colored money provided and practice locating and identifying them on the laminated versions with the vis-à-vis pens provided.

(*Note: The U.S one dollar bills are not at this time slated to be updated in any fashion primarily because one dollar bills are not counterfeited very often as it is not cost efficient for counterfeiters to do so. It could cost them close to one dollar to counterfeit the bill and thus would defeat their whole purpose in increasing their spending capital. The five dollar and one hundred dollar bills will eventually be updated to match the 2004 Series complete with new background color, color-shifting ink, etc.

The students should be able to make comparisons between the bills and put their information in the table provided. Answers should be pretty consistent with the answers in the Teacher's Guide Table 1 below.

TABLE 1

	Pre-1996	1996-	2004
Background Color	Green	Green	Bkgd. color varies; also diff. col. designs
Head Size / Portrait	Small within frame/ center of bill	Big within frame / offset to left of center	Big with NO Frame / offset to left of center
Seals	Fed. Res. seal on left with LETTER in center / Dept. of Treas. Seal on right	General Fed. Res. Seal on left with numb / letter code top left / D. of Treas. Seal on right	General Fed. Res. Seal on left with numb / letter code top left / D. of Treas. Seal on right
Four Back Corners	Four denomination numbers same size	Bottom right denom. number enlarged	Bottom right denom. number enlarged
Color-Shifting Ink	none	Green to Black	Copper to Green
Serial Numbers	Bottom left / top right	Top Left / Bottom Right	Top Left / Bottom Right

FOLLOW-UP QUESTIONS

1. Ten Dollar Bill / Hamilton
2. 2004 Series
3. Copper To Green
4. Ten Dollar Bill

U.S. Currency: The Science of Security Features

Student Discovery Activities: Teachers Guide

ACTIVITY : Let's Check It Out In The UV

Purpose/Objectives: Students will...

- discuss the UV Security Thread feature manufactured into U.S. paper currency
- learn about the different types of Electromagnetic (EM) Radiation
- understand the physical process by which an object fluoresces when exposed to Ultra Violet Radiation
- be proficient with the use of a UV light source

The students should at this point realize that 1999-Post 1999 paper currency contains a Security Thread Feature. They might also realize that, depending on denomination of the money, the Security Thread will fluoresce different colors under UV light. They will be investigating this phenomenon in the lab activity.

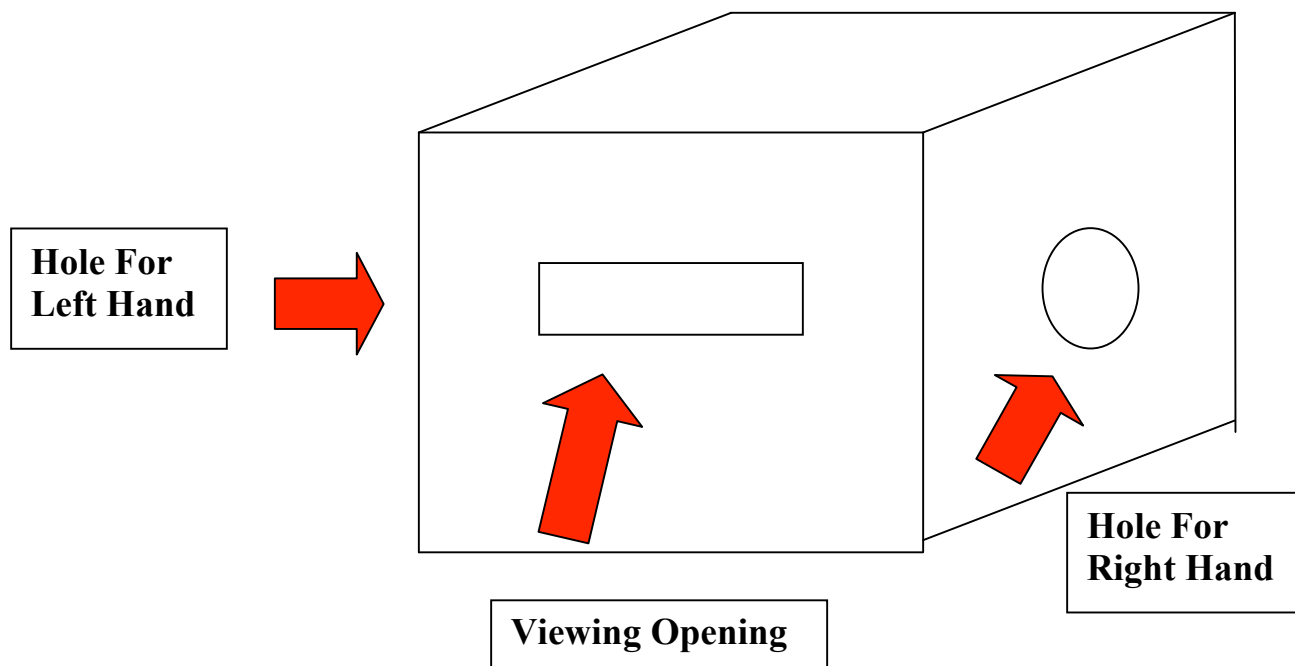
* If this Currency Authentication Module is being used independently of the Art Authentication and Clay/Mud Authentication modules, it will be necessary to, before the lab activity, discuss the Electromagnetic Spectrum with the students. (If all modules are used in the sequence provided in the binder, then this topic will have already been discussed and a simple review would suffice.) The students also need to understand the physical process occurring that causes the Security Thread to fluoresce a specific color under UV light.

Materials: (per group)

- a UV light source
- \$5.00, \$10.00 and \$20.00 bills from the **1996** style series (could have any of the following series year and still be classified as "1996" series – 1996, 1999, 2001, 2003, 2003A)
- \$5.00, \$10.00 and \$20.00 bills from the **2004** style series

The students will observe the bills held up to the normal light and then again under a UV light source. They need to be in the dark or to use a UV viewing box. They will be recording their observations in TABLE 2. When they are finished, they will write a short paragraph comparing and contrasting the pre-2004 bills with those produced in 2004. They need to include mention of **location** of Security Threads in bills of different denominations, **appearance of thread in normal light**, and **appearance of thread in UV light**.

To build a UV viewing box:



Take a middle-size cardboard box. Cut the flaps on the top off. Now turn it upside down. Cut out a little larger than fist-sized circles on two opposing sides as shown above. Next, cut out a rectangular viewing opening on the third side. Lastly, on the fourth side of the box, cut a hole in the bottom center big enough for a cord plug to fit through. The box can be lifted so that the UV light source can be on the inside of the box. Just feed the cord and plug back out through the "X" hole and plug it in the wall socket. One of the hand holes can be used to place money inside the viewing box and turn on the UV light.

SPECIAL NOTE!

In this lab activity, it will be important that the currency observed not be laminated as it could affect how the UV light source works. So this means that you will need to pay attention to the bills at each table and make sure that the kids return them all to you!

EXPANSION IDEAS:

If you can get samples of money from foreign countries, the students can see how they fluoresce under UV. For instance, the "EURO" fluoresces much more than the U.S. currency! It is very neat! If you cannot get samples, ask your students to bring some in. The kids will really enjoy this activity!

You can explain to the students that the Euro may have much more fluorescent features than the U.S. currency as the Euro is a much younger currency than ours. The creators of the Euro do not have to "hold true" to hundreds of years-old standards and traditions like our government strives to do. The U.S. government expects our currency to maintain these traditions from one series design to the next. Basically, when designing our currency, our government must make changes that will protect its viability in our economy –ie, keep it from being counterfeited- but also maintain the integrity of these traditions.....

You can also have the students "pick out" the red and blue fibers in the U.S. currency and view them with a magnifying glass or under the microscope. This will need to be supervised so that they do not end up defacing the money.

TABLE 2

TYPE / SERIES OF BILL	OBSERVATIONS
1996 + SERIES \$5.00	1. appears as vertical, type-written "USA FIVE" that repeats / cannot see edges of thread 2. security thread glows BLUE / edges of thread can be seen
1996 + SERIES \$10.00	1. appears as vertical, type-written "USA TEN" that repeats / cannot see edges of thread 2. security thread glows ORANGE / edges of thread can be seen
1996 + SERIES \$20.00	1. appears as vertical, type-written "USA TWENTY" that repeats / cannot see edges of thread 2. security thread glows GREEN / edges of thread can be seen

2004 SERIES \$5.00	1. appears as vertical, type-written “USA FIVE” that repeats / cannot see edges of thread 2. security thread glows BLUE / edges of thread can be seen
2004 SERIES \$10.00	1. appears as vertical, type-written “USA TEN” that repeats / cannot see edges of thread 2. security thread glows ORANGE / edges of thread can be seen
2004 SERIES \$20.00	1. appears as vertical, type-written “USA TWENTY” that repeats / cannot see edges of thread 2. security thread glows GREEN / edges of thread can be seen
Other Denominations/ _____	1. 2.

FOLLOW-UP QUESTIONS

1. In complete sentences, discuss the similarities and differences you observed when viewing the paper currency in the activity. You might include comparisons of: appearance of security threads in plain light, location of security threads on bills of different denominations, and comparisons of security threads under UV light. Be ready to share your answers with the class during a class discussion.

USSS Counterfeit Division:

Security Feature Terminology Sheet

- **Portrait**
- **Security Fibers**
- **Watermark**
- **Federal Reserve Indicators**
 - **Federal Reserve Seal**
 - **Issuing Federal Reserve Bank Code / Letter & Number**
- **Micro printing**
- **Low-Vision Feature**
- **Serial Numbers**
- **Color-Shifting Ink (OVI –Optically Variable Ink)**
- **Fine-Line Printing Patterns**
- **Face Plate Number**
- **Back Plate Number**
- **Series Year**
- **Check Letter / Quadrant Number**
- **Type of Note**

Important Dates in the History of Money

- **Bartering was the earliest form of exchange. Each deal would differ due to the value and needs of each party.**
- **9000-6000 B.C. – Domesticated animals were bartered or seen as a measure of wealth.**
- **1200 B.C.- Cowrie shells from the Pacific and Indian Ocean were used in China and some parts of Africa as recently as the mid-twentieth century.**
- **1000 B.C. – Bronze and copper coins with holes were used in China.**
- **500 B.C. – Lumps of silver were stamped with images of Gods and Emperors in Turkey. Later other Mediterranean empires followed suit.**
- **1118 B.C. – White deer-skin squares were decorated and used as the first notes by the Chinese.**
- **800 A.D. - First paper money was used by the Chinese.**
- **1500 A.D. – Wampum (clam shell beads) was strung together by North American Indians.**
- **1600 A.D. – The Swedish used copper money.**

- **1776 A.D. – The continental congress issued the Unites States' first paper currency that was later heavily counterfeited and ultimately became worthless.**
- **1910 A.D. – U.S. Federal Notes were issued.**
- **1996 A.D. – U.S. Bills were redesigned with additional security features.**
- **2004 A.D. – U.S Bills were redesigned yet again with even more technical security features such as background color and an improved version of the color shifting ink**

What Function Does Money Serve in Society?

The purpose of money in society is two-fold.

- money is a medium of exchange whose value is pre-determined and agreed upon by those who use it
- money is generally a non-perishable medium of exchange for goods, labor, or services
 - it can withstand the test of time
 - it is a means of storing and transferring value
 - it reduces the need to stockpile goods for trade – instead of exchanging wheat for lumber, the wheat farmer no longer has to store and haul large quantities of grain to exchange for other goods and services

So What is the Big Deal About Counterfeiting?

At an individual level, it would not seem to be much of a problem (unless YOU get stuck with a phony bill!) But on a grand scale, it could devastate an entire economy by creating inflation (devaluing the currency).

If counterfeiting were legal, everyone would print the money they wanted. This would allow people to spend more money. If everyone spent more money on goods and services, because of the laws of Supply and Demand, prices would rise because you could pay any price asked for the same goods and services. The value of labor would also be diminished as no one would need to work. Is this problematic? Who would run the companies, such as utilities plants and food processing plants that we all rely on each and every day?

Think about this! Currency is only as good as a person's trust in it! If you have been stuffing your mattress your whole life to save money, what happens now when no one wants to accept your legitimate money? And once the economy is highly inflated, what will your savings account actually buy?

Some other countries have individuals who have tried their best to counterfeit certain denominations of U.S. currency.

“A ‘**supernote**’ or ‘**superdollar**’ is a near perfect counterfeit of a U.S. banknote believed by the United States to be produced in North Korea. The United States government has outlined two reasons behind the North Korean distribution scheme: as a source of income and to undermine the U.S. economy. They have been circulating since the 1980's. The name derives from the fact that the technology incorporated to create the note exceeds the one of the original. For source article, go to the following web address:

<http://www.klas-tv.com/Global/story.asp?S=5628649>

Equipment / Materials List: The Science of Security Features

U.S. Secret Service Materials

- plastic sleeves for currency protection **(will need to order)**
- “Know Your Money” mini-posters / class set **(will need to order)**
- “Positions of Important Features” Sheets (copies included in module)
- “Know Your Money” pamphlet **(will need to order)**

Laminated Security Feature Terminology Sheets – master copy provided in module

Laminated U.S.S.S.-approved enlarged photo copies (> 130%) of the following:

- U.S. \$1.00 and \$5.00, **pre-1996** \$10.00 and \$20.00 bills, and **post-1996** \$10.00 and \$20.00 bills **(Activity 1 & 2 – The Science of Security Features)**

Real Money Samples in the following denominations:

- U.S. \$1.00 and \$5.00, **pre-1996** \$10.00 and \$20.00 bills, and **post-1996** \$10.00 and \$20.00 bills **(Activity 1 & 2 – The Science of Security Features)**

Laminated U.S.S.S.-approved enlarged COLOR photo copies (> 130%) of the following:

- U.S. \$10.00, \$20.00 and \$50.00 bills (if available) from **U.S. 2004 and post- Series** **(Activity 3 –The Science of Security Features)**

Real Money Samples in the following denominations:

- U.S. \$10.00, \$20.00 and \$50.00 bills (if available) from **U.S. 2004 and post- Series** **(Activity 3 –The Science of Security Features)**

Vis-à-vis pens

Paper Towels

Ultra Violet Light Source (see websites listed on WEB Resource Sheet that sell these)

Real Money Samples in the following denominations:

- \$5.00, \$10.00 and \$20.00 bills from the **1996 series** (could have any of the following series year and still be classified as “**1996**” series – 1996, 1999, 2001, 2003, 2003A) **(Activity 4 – The Science of Security Features)**
- \$5.00, \$10.00 and \$20.00 bills from the **2004 style series** **(Activity 4 – The Science of Security Features)**

UV Viewing Box (not needed if dark room available / instructions for building in module)

Currency Authentication

U.S. Currency: The Science of Security Features

Student Discovery Activities

Purpose/Objectives: Students will...

- learn and be proficient with the use of the U.S.S.S currency security feature terminology in the Student Discovery Activities and in the class discussion that follows
- learn about the importance of “money” as means of exchange
- learn about the problems that can arise as a result of counterfeiting of currency
- learn about the solutions the U.S. government has created in an effort to thwart counterfeiting activities, and those measures taken by the Secret Service to aid in counterfeit currency detection

ACTIVITY 1: Do You Know Your Money?

- laminated USSS Security Feature Terminology Sheet
- laminated enlarged photo copies (**> 130%**) of U.S. \$1.00, \$5.00, pre-1996 \$10.00 and \$20.00 bills, and post-1996 \$10.00 and \$20.00 bills
- real money samples in the above listed denominations in plastic sleeves
- vis-à-vis pens of different colors
- damp / wet paper towels
- dry paper towels

Procedure

- (1) With your lab partners, read through the list of terms provided on your USSS Security Feature Terminology Sheet. Familiarize yourself with these words.
- (2) At your lab station, you should find some samples of real money, and **USSS-approved** laminated copies of the same denominations of bills. Look at the real samples first. With your group members, try to locate the USSS terminology features on the actual samples of money. When you think you have located all of the features, take the vis-à-vis pens provided and circle the features or draw arrows pointing to them **on the laminated copies**.

Question: How many of the features do you feel you identified correctly on your laminated sheet? _____

- (3) When all of the groups have finished, members from each group may go to the front of the class and share their results.

ACTIVITY 2: How Secure Is Your Money? Let's Find Out!

Materials: (per group)

- the materials from Part 1
- USSS Counterfeit Division "Know Your Money" Mini-Poster
- USSS Counterfeit Divisions "Positions of Important Features Sheets"

Procedure

- (1) Use the USSS "Know Your Money" Poster and Feature Sheets to locate the features listed on your Security Features Terminology Sheet. Compare the labeled features on the USSS sheets with the features you labeled on your laminated money sheet.

FOLLOW-UP QUESTIONS:

- (1) Which of the security features were you able to originally identify correctly?
- (2) Which security features were you not able to identify correctly?
- (3) In terms of our U.S. paper currency, which security features were you unaware of (did not know was used for security) before this activity?
- (4) Of all of the security features we were familiarized with in the activity, which ones did you find interesting or intriguing?
- (5) Now, in looking at the informational posters and fact sheets provided by the US Secret Service, are there any features or interesting elements of those features that we have not yet discussed?

***PLEASE: At this time take a damp paper towel and clean off your laminated money sheets. Dry them off and then return ALL materials directly to the TEACHER. All materials will be accounted for before students leave the classroom. Thank You!**

ACTIVITY 3: The Color of Money

Materials: (per group)

- USSS Counterfeit Division “Know Your Money” Pamphlet
- laminated enlarged **COLOR** photo copies (> 130%) of “ **2004 and POST” SERIES** U.S. \$10.00 and \$20.00 and \$50.00 bills
- real money samples in the above listed denominations (**if available**) in plastic sleeves
- vis-à-vis pens of different colors
- damp / wet paper towels
- dry paper towels
- USSS Counterfeit Division “Know Your Money” Mini-Poster (may still have out as a resource)
- USSS Counterfeit Divisions “Positions of Important Features Sheets” (may still have out as a resource)
- laminated USSS Security Feature Terminology Sheet

Procedure

1. Review the features of the **2004 Series** paper currency in the USSS “Know Your Money” pamphlet provided.
2. Using the features labeled on the money samples in the pamphlet, find the same features on the real currency provided at your lab station.
3. Next, locate these features on the USSS-approved enlarged laminated copies of the currency and circle them or draw arrows with the vis-à-vis pens provided.
4. Once you are finished, you will fill out Table 1. In this table you will be comparing security features between bills of different printing series.

For example, in regard to the “Color Shifting Ink” security feature, you would say: Pre-1996 **NONE**; 1996 **green-to-black**; and 2004 **copper-to-green**. You may need to refer back to the USSS mini-poster and Positions of Features sheets from Lab Activities 1 and 2.

5. After you have completed Table 1, please answer the Follow-Up Questions.

TABLE 1

	Pre-1996	1996	2004
Background Color			
Head Size / Portrait			
Seals			
Four Back Corners			
Color-Shifting Ink			
Serial Numbers			

FOLLOW-UP QUESTIONS:

1. Which denomination of “colored-background money” has the president facing the opposite direction of all the other presidents?
2. In what printing series was the “picture frame” removed from around the head of the presidents?
3. How does the ink color shift on a 2004 bill?
4. Which 2004 bill has a yellowish background color with reddish-orange decorative images?

USSS Counterfeit Division:

Security Feature Terminology Sheet

- **Portrait**
- **Security Fibers**
- **Watermark**
- **Federal Reserve Indicators**
 - **Federal Reserve Seal**
 - **Issuing Federal Reserve Bank Code / Letter & Number**
- **Micro printing**
- **Low-Vision Feature**
- **Serial Numbers**
- **Color-Shifting Ink (OVI –Optically Variable Ink)**
- **Fine-Line Printing Patterns**
- **Face Plate Number**
- **Back Plate Number**
- **Series Year**
- **Check Letter / Quadrant Number**
- **Type of Note**

ACTIVITY 4: The Fluorescing Of Paper Currency Under UV Light

Materials: (per group)

- a UV light source
- \$5.00, \$10.00 and \$20.00 bills from the **1996** style series (could have any of the following series year and still be classified as “1996” series – 1996, 1999, 2001, 2003, 2003A)
- \$5.00, \$10.00 and \$20.00 bills from the **2004** style series

Procedure

1. Hold each of the bills up to light. See if you can locate the security threads in each bill. Record how they appear in Table 2.

2. Get in a dark place and turn on your UV light source. Run the light across each of your bills individually. Record your observations in the Table 2 below. (Your teacher may have set up a UV box that may be used in a classroom with the lights on.)

TABLE 2

TYPE / SERIES OF BILL	OBSERVATIONS
1996 + SERIES \$5.00	1. 2.
1996 + SERIES \$10.00	1. 2.
1996 + SERIES \$20.00	1. 2.
2004 SERIES \$5.00	1. 2.

2004 SERIES \$10.00	1. 2.
2004 SERIES \$20.00	1. 2.
Other /	1. 2.

FOLLOW-UP QUESTIONS

1. In complete sentences, discuss the similarities and differences you observed when viewing the paper currency in the activity. You might include comparisons of: appearance of security threads in plain light, location of security threads on bills of different denominations, and comparisons of security threads under UV light. Be ready to share your answers with the class during a class discussion.

REALLY COOL EXPANSION LAB: If your teacher has any samples available, investigate other “paper currency” from foreign countries. Examples would be the **peso**, the **pound**, the **“EURO”**, and the **yen**. Be sure to analyze all of the characteristics we investigated with U.S. money, finishing up with observations of the currency under UV light! If you have access to foreign currency, you can volunteer to bring it in to share with the class!

Currency Reproduction: U.S. And Foreign Obligations



U.S. And Foreign Currency Reproductions

Before 1984, the law forbade the use of currency reproduction in commercial advertisements (whether photographic or other likeness). Reproduction was permitted only for philatelic, numismatic, educational, or news purposes. In 1984, however, the U.S. Supreme Court held in *Regan v. Times, Inc.* that the section of law forbidding reproduction of U.S. or foreign currency was an unconstitutional restriction of free speech. The *Regan v. Times, Inc.* decision prompted the Department of Treasury to permit the reproduction of U.S. and foreign currency for any purpose if the reproduction met certain requirements.

The Counterfeit Deterrence Act of 1992 granted authority to the Secret Service (through the Department of Treasury) to permit color illustrations of U.S. currency-subject to rulemaking by the Secret Service. The final rules were issued May 31, 1996 (*Federal Register*: May 31, 1996 (Volume 61 No.106, pp.27280-27281), which amended Title 3, Chapter IV of the Code of Federal Regulations, by adding Part 411 to permit color illustrations of U.S. currency [as authorized by 18 USC, Section 504 and Treasury Directive No.15-56, 58FR48539 (9/16/93)].

The new guidelines on currency reproduction now permit the printing, publishing, and importation, and the making or importation of the necessary plates or items for such printing or publishing, of color illustrations of U.S. currency provided that all of the following criteria are met:

1. The currency reproduction is more than $1\frac{1}{2}$ the size or less than $\frac{3}{4}$ the size, in linear dimension, of the currency or any part of the currency.
2. The illustration must be one-sided.;
3. All negatives, plates, positives, digitized storage medium, graphic files, magnetic medium, and optical storage that contain an image of the illustration shall be destroyed and/or deleted or erased after their final use.

In addition, law (18 USC 475) prohibits the printing of business cards containing images of obligations or securities of the United States unless the above listed restrictions are met. Furthermore, law prohibits the stamping of advertisements onto genuine obligations.

United States Treasury Checks And Bonds

Law (18 USC 475) permits photographic or likeness of U. S. Treasury checks and bonds for any purpose provided the items meet the three tests for currency reproduction: (a) less than $\frac{3}{4}$ or greater than $1\frac{1}{2}$ times the size; (b) printed on only one side; and (c) the negatives, plates, etc. used in making the likeness are destroyed after their final use.

Coin Reproductions

Law (18 USC 504) allows for the reproduction of coins as follows:

1. Illustrations and flat images-coins may be reproduced in any size or color.
2. Genuine (raised images)-coins may be reproduced if the reproduction is (a) more than twice the diameter of a silver dollar, or (b) less than half the diameter of a dime.
3. Other requirements-such reproduction, moreover, must conform to the provisions of the Hobby Protection Act and must be marked "COPY" in the prescribed manner.

Stamps (Postage, Postage Meter, Revenue, Migratory Bird Hunting)

Law (18 USC 504) sets the following guidelines for the reproduction of stamps:

1. Canceled stamp-full color, actual size reproductions.
2. Uncanceled stamps-full color, replicated or enlarged reproductions (less than $\frac{3}{4}$ or greater than $1\frac{1}{2}$ in size).
3. Uncanceled stamps-no restrictions on black and white reproductions.

Other Common Uses

We are frequently asked about reproduction guidelines when (a) the currency or other obligation is distorted, (b) a portion of the note is used, or (c) another portrait or alternative language is substituted in place of the original.

Each of these modifications are allowed, but only when the three tests mentioned in the section (above) on "U.S. and Foreign Currency Reproductions" are met.

Electromagnetic Radiation Teachers Resource

Purpose/Objectives:

- To give the teacher a basic understanding of electromagnetic (EM) radiation

What is electromagnetic radiation?

Electromagnetic radiation can also be referred to as electromagnetic waves. Moving electrons cause electromagnetic radiation. A moving electron induces a magnetic field. If you oscillate (vibrate) an electron at any fixed frequency then the strength of the magnetic field will oscillate as well. A changing magnetic field induces an electric field. A changing electric field will also induce a magnetic field. So oscillating an electron back and forth at a given frequency will create a wave with a magnetic field and an electric field component. Those fields oscillate at the frequency at which the electron was driven. Since these two fields induce each other, the wave can move in the absence of any medium (in a vacuum). These waves come in tiny packets of energy referred to as photons.

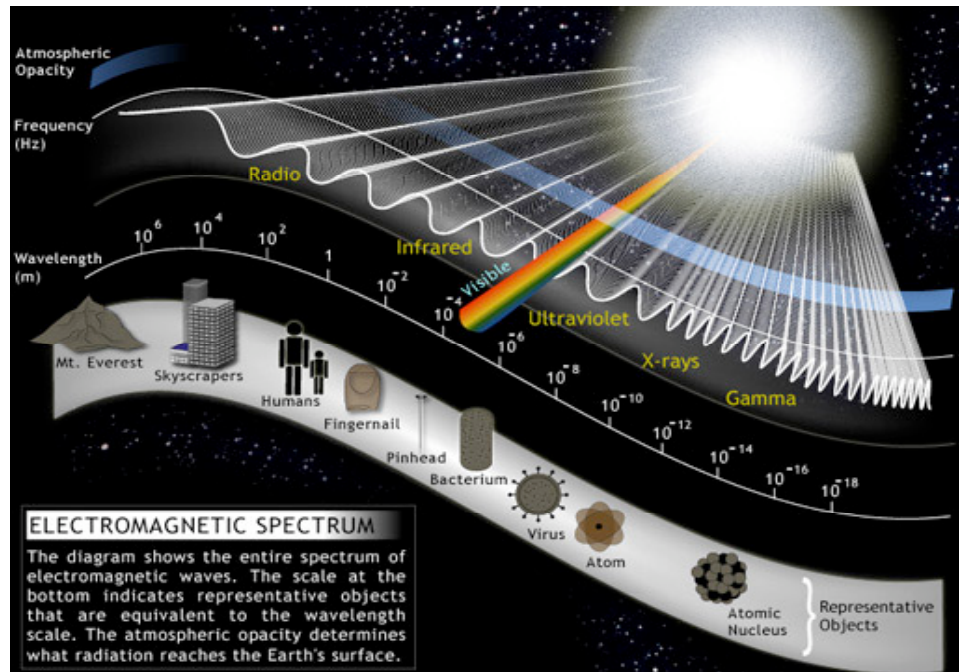
What causes electromagnetic radiation?

Anything above absolute zero in temperature gives off some type of electromagnetic radiation. More heat causes the atoms/molecules to move more rapidly. Objects with higher temperatures give off electromagnetic waves with shorter wavelengths and higher frequencies.

Alternating current is made of electrons moving back and forth at a given frequency. Various electronic devices can create electromagnetic waves of a specific frequency by utilizing these oscillating electrons. This is how many communication devices work.

What kinds of electromagnetic radiation are there?


Electromagnetic waves have many different wavelengths. They are classified in the electromagnetic spectrum. Below is the spectrum that is copyrighted by the University of California Regents. It can be found at



http://ds9.ssl.berkeley.edu/LWS_GEMS/2/em.htm.

What kinds of electromagnetic radiation are there? (Cont.)

Here is a table from <http://www.bbc.co.uk/schools/gcsebitesize/img/ph06007.gif>

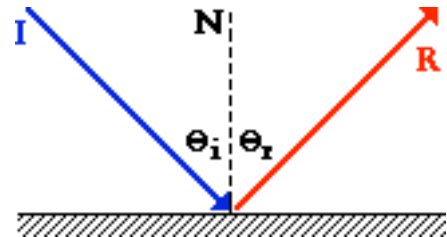
low frequency long wavelength	type of wave	typical source	example of detector	approx. wavelength	typical uses	dangers of over-exposure
	radio: lw mw vhf	electronic circuits (vibrating electrons)	aerial + electronic circuit	1 km 100 m 1 m	communications: radio, TV	(safe unless very concentrated)
	microwaves	electronic circuits; cool objects	aerial and electronic circuit	1 cm (10^{-2} m)	communications; satellites; telephony; heating water, food	burning if concentrated
	infra-red (ir)	electronic devices; warm objects; sun	electronic detectors, special film; blackened thermometer	0.1 mm (10^{-4} m)	'magic eyes' in security lighting; remote control (e.g. TV)	burning if concentrated
	light R O Y G B I V	electronic devices (LED, laser); hot objects; sun	electronic devices (LED, laser); hot objects; sun	0.001 mm (10^{-6} m)	seeing, photography	burning, blindness if concentrated
	ultra-violet (UV)	gas discharge lamps; very hot objects; sun	film	0.00001 mm (10^{-8} m)	sun-tan lamp; making ions; making vitamin D	sunburn; skin cancer
	X-rays	very fast electrons hitting a metal target	film	10^{-10} m	imaging defects in bones, hidden devices	cell destruction; cell mutation; cancer
	gamma (γ) rays	radioactive nuclei decaying	film; GM tube	10^{-12} m	medical tracers; killing cancer cells; sterilisation, imaging defects in metal	cell destruction; cell mutation; cancer
high frequency short wavelength						

These waves may seem very different but they have many shared properties. All of these waves can travel in a vacuum (no added elements needed for it to move) and travel at the speed of light which is approximately 300,000,000 m/s or 186,000 miles per second. Plus they all come from accelerating electric charges (electrons). We only detect a very small portion of the spectrum with our eyes (what is normally called light); however all of these waves can be referred to as light, because they are all the same phenomena.

What happens when electromagnetic radiation “hits” something?

Just as moving charges or atoms produce electromagnetic waves, when electromagnetic waves interact with matter they can make the atoms or molecules move. Exactly what happens depends on the wavelength of the electromagnetic wave and the electron configurations of the atoms or molecules. Here are some basic things that can happen.

Reflection—The electromagnetic wave can simply reflect off of a material. If you draw an imaginary line (N) perpendicular to the point where the EM wave strikes the reflective surface, then the angle between the incoming light (I) and that imaginary line will be the same as the angle between the reflected light (R) and that imaginary line. However, the reflected wave will be on the other side of the imaginary perpendicular line.



Transmission—(Absorption & Re-emission of the same energy)--The atom can absorb the energy of the photon and then re-emit the photon with no loss of energy. The time taken to absorb and re-emit the photons takes time. This is why light has a slower speed in transparent materials when compared to the speed of light in a vacuum. An animation of this can be found at:

<http://www.glenbrook.k12.il.us/gbssci/phys/mmedia/waves/em.html>.

Absorption & Re-emission (Different energy)--The atom or molecule being “hit” with the electromagnetic wave can absorb the energy of the photon, but emit only part of that energy back out. An example of this would be fluorescent paints. When ultraviolet light strikes the paint it emits those photons back in the visible part of the spectrum. This fluorescent material also reflects light that we normally see. So a non-fluorescent object only reflects back the light we normally see. While the fluorescent object reflects back the light we normally see plus the extra photons that were originally ultraviolet (or undetected by our human eyes). This is why fluorescent materials seem brighter than the non-fluorescent materials.

Absorption-- This can also occur where the material absorbs most of the energy of the photon and it makes the atom or molecule move faster. Heat is the measure of how fast the atoms or molecules in a substance are moving. So when the momentums of the photons are absorbed by the atom or molecule the particle start to move faster.

What are the changeable properties of electromagnetic waves?

Amplitude-- The amplitude of an EM wave has to do with the waves brightness or intensity. For light we normally see this is measured in lumens. For other types of EM waves we use watts (power) per unit area. The intensity of a wave is equal to the square of the amplitude.

What are the changeable properties of electromagnetic waves? (cont.)

Wavelength-- The wavelength is the distance between two crests (top part of) the wave. Some EM waves have wavelengths larger than football fields and even larger than Earth. And some EM waves have extremely small wavelengths even smaller than the nucleus of an atom. The wavelength is equal to the velocity (speed of the wave) divided by the frequency (how many waves pass per second) of the wave.

Frequency-- The frequency of an EM wave is the measure of how many waves pass a point in a second of time. The higher the frequency of a wave the more energy it has. The energy of a photon of an EM wave is equivalent to the frequency of the EM wave multiplied by Planck's constant (6.626×10^{-34} Joule seconds). In general higher frequencies (smaller wavelengths) are more dangerous to humans than lower frequency (longer wavelengths).

Name _____

Date _____

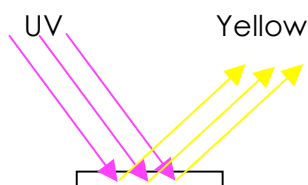
Name _____

Date _____

ULTRA VIOLET RADIATION

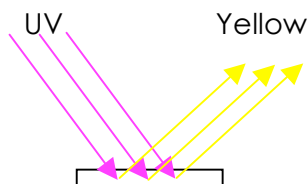
Teachers Resource

How the Money strip glows--The molecules in the strip are being "hit" with Ultra-violet (UV) electromagnetic waves. They can absorb the energy of the UV photon, but emit that energy back out in the visible (human eye can detect it).



So a non-fluorescent object only reflects back the light we normally see. The fluorescent object reflects back the light we normally see plus the extra photons that were originally ultraviolet (or undetected by our human eyes). This is why fluorescent materials seem brighter than the non-fluorescent materials.

How the stuff in the mud glows--The molecules in the mud are being "hit" with Ultra-violet (UV) electromagnetic waves. They can absorb the energy of the UV photon, but emit that energy back out in the visible (human eye can detect it).



So a non-fluorescent object only reflects back the light we normally see. The fluorescent object reflects back the light we normally see plus the extra photons that were originally ultraviolet (or undetected by our human eyes). This is why fluorescent materials seem brighter than the non-fluorescent materials.

Environmental: Soil
Pre-Activity Teachers Guide

Purpose/Objectives:

- To observe differences in inks and papers in various types of light.
- To classify and organize the observations.
- Hypothesize about what changes will occur when using UV light source.

Materials

Five different pens
Five different types of paper
Five different highlighters

Procedure

1. To avoid confusion, first label each pen and highlighter by color and/or brand name.
2. On each type of paper, make a mark with each of the pens and highlighter.
3. Label each line appropriately as well (you will have 10 marks on each paper).
4. Write down your observations of the different inks on the different papers in normal lighting conditions.
(answers will vary)
5. Using the UV light source provided, observe the marks under the UV light. *(You will need to have the lights off in the room or build the*
6. Record your observations.
(answers will vary)

Questions

1. In what ways did the appearance of the papers change, by changing the lighting?

(answers will vary)

2. In what ways did the appearance of the inks change, by changing the lighting?

(answers will vary but some of the highlighters should be much brighter under the UV light)

3. Which inks were obviously less visible in UV than under normal lighting conditions?

(answers will vary)

4. Which inks were obviously more visible in UV than under normal lighting conditions?

(Answers will vary, but some of the highlighters should be much brighter under the UV light)

5. Give your explanation for why the inks that became more visible in UV behave in that way?

(answers will vary, but the energy from the UV photons are being absorbed and re-emitted back in the visible part of the spectrum so the observer can see it)

Name _____

Date _____

Environmental: Soil Pre-Activity

Purpose/Objectives:

- To observe differences in inks and papers in various types of light.
- To classify and organize the observations.
- Hypothesize about what changes will occur when using UV light source.

Materials

Five different pens
Five different types of paper
Five different highlighters

Procedure

1. To avoid confusion, first label each pen and highlighter by color and/or brand name.
2. On each type of paper, make a mark with each of the pens and highlighter.
3. Label each line appropriately as well (you will have 10 marks on each paper).
4. Write down your observations of the different inks on the different papers in normal lighting conditions.
5. Using the UV light source provided, observe the marks under the UV light.
6. Record your observations.

Questions

1. In what ways did the appearance of the papers change, by changing the lighting?

2. In what ways did the appearance of the inks change, by changing the lighting?

3. Which inks were obviously less visible in UV than under normal lighting conditions?

4. Which inks were obviously more visible in UV than under normal lighting conditions?

5. Give your explanation for why the inks that became more visible in UV behave in that way?



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FEDERAL

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THIS NOTE IS LEGAL TENDER
FOR ALL DEBTS, PUBLIC AND PRIVATE

Rosario *Arévalo*

E:

Treasurer of the United States

SERIES
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ONE

THE UNITED STATES

IN GOD WE TRUST



ONE

1
ONE

ONE DOLLAR

FEDERAL RESERVE

THE UNITED STATES

THIS NOTE IS LEGAL TENDER
FOR ALL DEBTS, PUBLIC AND PRIVATE



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4 *Rosario Chervin*

Treasurer of the United States

ONE DOLLAR

WASHINGTON

THE UNITED STATES

IN GOD WE TRUST



FIVE DOLLARS

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FEDERAL

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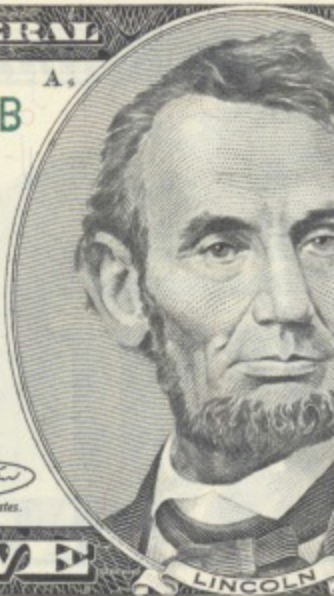
THIS NOTE IS LEGAL TENDER
FOR ALL DEBTS, PUBLIC AND PRIVATE

Rosario Marin

Treasurer of the United States.

5

FIVE



LINCOLN



100

THE UNITED STATES

IN GOD

100

ONE HUNDRED

INDEPENDENCE

100

FEDERAL RESERVE NOTE

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THIS NOTE IS LEGAL TENDER
FOR ALL DEBTS, PUBLIC AND PRIVATE

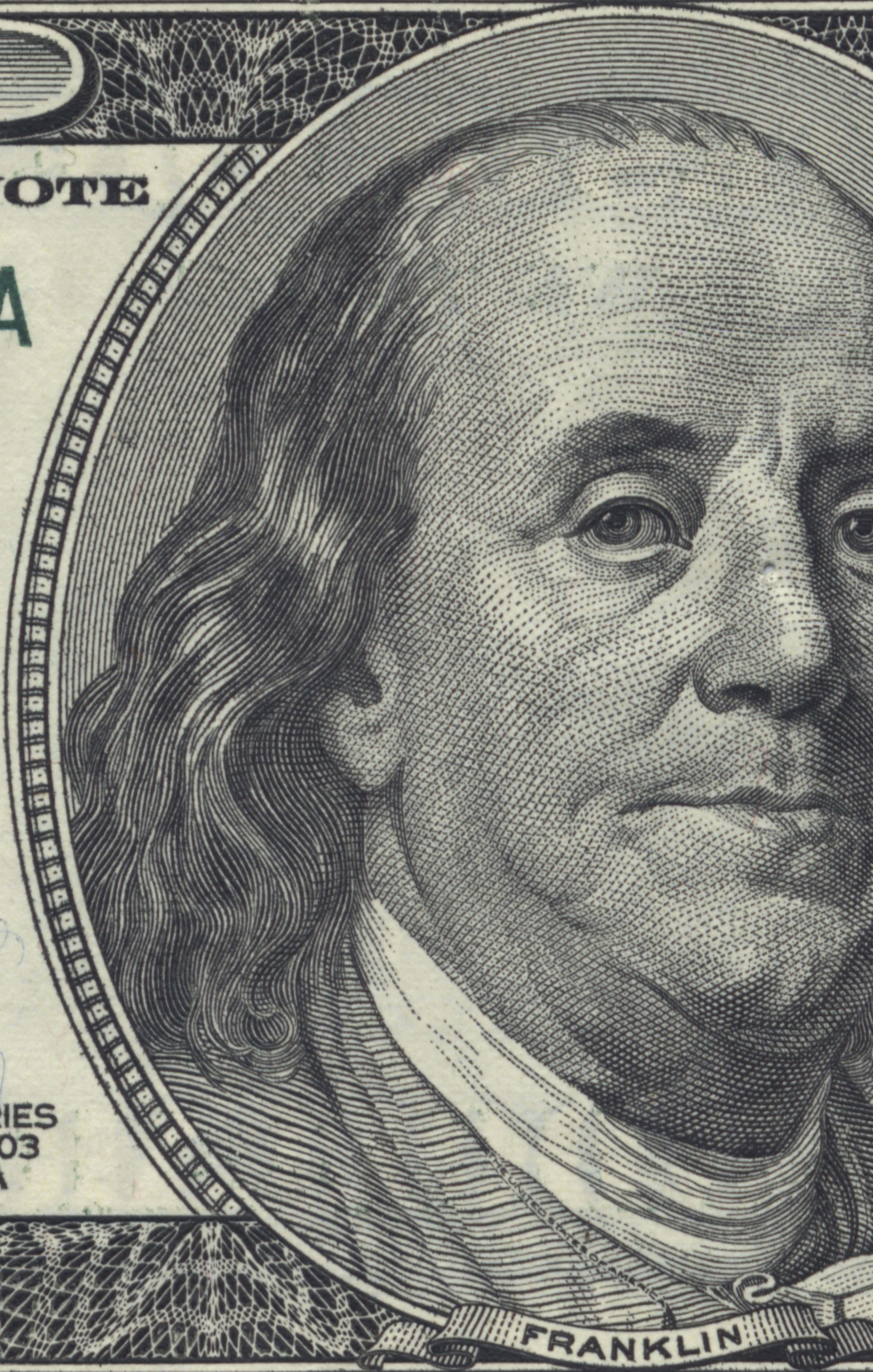
Anna Escobedo Cabral

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Treasurer of the United States.

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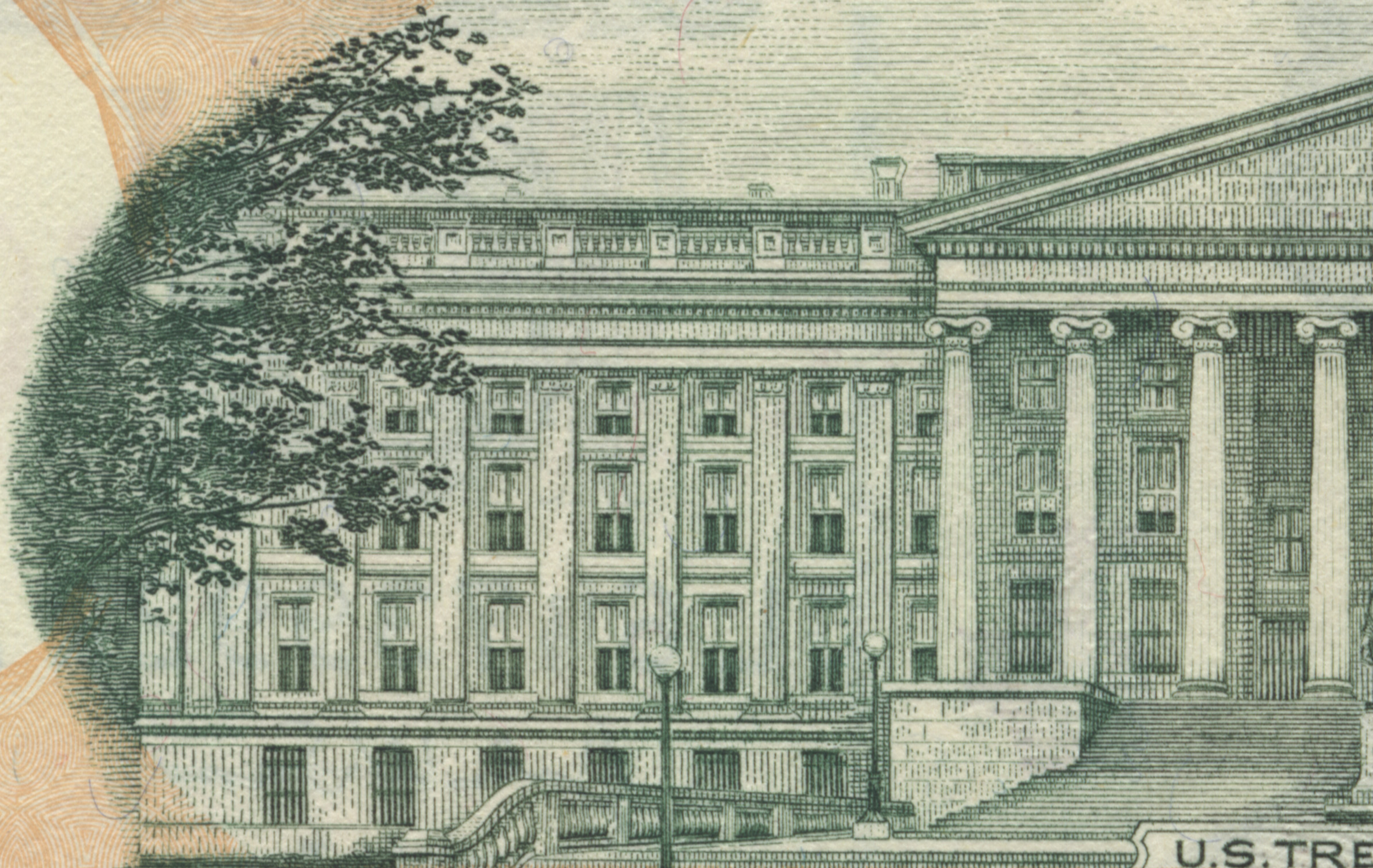
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Anne Escobedo Cabral

Treasurer of the United States.



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Rosario Marin

Treasurer of the United States.

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Francis G. ...
Anna Escobedo Cabral

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Treasurer of the United States

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