

Fluorescence of Tonic Water



Introduction

Color is a result of the interaction of light with matter. The color that a solution appears to the human eye can change depending on the nature of the light source used to illuminate it. Tonic water appears clear and colorless under normal classroom lights, but is brightly colored when exposed to an ultraviolet (black) light.

Concepts

- Fluorescence
- Absorbance
- Transmittance
- Emission

Materials

Tonic water, 500 mL
Beaker, 600-mL

Visible light source—classroom lights work well
Ultraviolet light source—black light

Safety Precautions

Do not look directly at the black light; its high-energy output can be damaging to eyes. Any food-grade item brought into the lab is considered a laboratory chemical and may not be removed from the lab and later consumed. Wash hands thoroughly with soap and water before leaving the laboratory. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Pour approximately 500 mL of tonic water into the 600-mL beaker. Observe that the tonic water is clear and colorless.
2. Turn off all the lights and completely darken the room. Turn on the black light and shine it on the tonic water. Observe that the tonic water now appears fluorescent blue in color!

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. Tonic water may be rinsed down the drain according to Flinn Suggested Disposal Methods #26b.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12

Systems, order, and organization
Evidence, models, and explanation

Content Standards: Grades 5–8

Content Standard B: Physical Science, properties and changes of properties in matter, transfer of energy

Content Standards: Grades 9–12

Content Standard B: Physical Science, structure of atoms, structure and properties of matter, conservation of energy and increase in disorder, interactions of energy and matter

Tips

- Place a white background below and behind the beaker to make the fluorescent blue color more visible.
- The tonic water does not have to be carbonated for fluorescence to occur. It will fluoresce even if it goes flat.

Discussion

Why is tonic water colorless under normal classroom lights?

Normal classroom lights give off white light, which contains all of the colors in the visible portion of the electromagnetic spectrum. The visible portion of the spectrum is only a small part of the entire spectrum spanning the wavelength region from about 400 to 700 nm. The human eye can see light and colors in this wavelength range. We see light of 400 nm as violet and 700 nm as red.

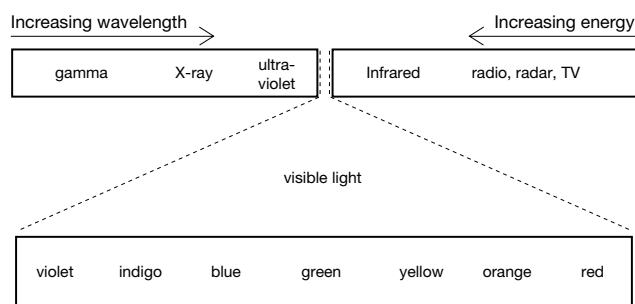
In general, solutions that are colored, such as red solutions, absorb visible wavelengths of light. They absorb some of the photons, while transmitting others. The transmitted wavelengths of light are the ones that the human eye sees. Therefore, a red solution transmits red wavelengths of light and absorbs all of the other colors, or wavelengths, of light.

A colorless solution, such as tonic water, does not absorb any of the visible wavelengths of light, but instead transmits all of the colors of visible light. When light contains all of the colors in the visible spectrum, it is called white light and it appears colorless to the human eye.

Why does tonic water appear fluorescent blue under the UV black light?

A typical black light, such as Flinn Catalog No. AP9030, gives off UVA light. This is ultraviolet light in the wavelength range from approximately 320 to 400 nm. UV light is higher in energy than visible light. The human eye cannot see light in this wavelength range. A black light must give off a little visible light in addition to the UV light, since the light appears purple to the human eye.

Tonic water appears fluorescent blue under the UV black light because it contains quinine, a substance that undergoes fluorescence when it absorbs UV light. When the UV black light is shined on the tonic water, the tonic water absorbs a photon. The energy from the photon is transferred to an electron that makes a transition to an excited electronic state. From this excited electronic state, the electron naturally wants to relax back down to the ground state. When it returns to the ground state, it emits a photon (symbolized by the squiggly arrow in the diagram to the right). This photon has a wavelength in the blue region of the visible spectrum; therefore, the tonic water appears blue. The emitted light is slightly lower in energy than the incident light due to vibrational relaxation in the excited state.



Fluorescence of Tonic Water has been expanded and developed as a Flinn Chemistry Demonstration Kit

Fluorescent Dye Kit



Catalog No.	Description	Price/Each
AP4848	Fluorescent Dye Kit	Consult Your Current Flinn Catalog/Reference Manual
AP9030	Ultraviolet Lamp, 18"	

Light up your classroom with fluorescent solutions! Under normal white light, these solutions appear colorless, yellow, orange, and pink. But, when the lights are turned off and a black light is shined on them, they glow—and with different colors! Explore the concepts of absorption and emission of light with this demonstration. Chemicals provided: quinine, fluorescein, eosin Y, rhodamine B, and ethyl alcohol solutions. Teacher Demonstration Notes provided. *Note:* A black light is needed and may be purchased separately.