

EDITORIAL: THE HINDU

GENERAL STUDIES 3: SCIENCE & TECHNOLOGY **TOPIC:** PHYSICS

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Why do clothes look dark when immersed in water?

Context: Understanding Why Materials Look Darker When Wet

- The article explores the everyday observation that materials—especially clothes—appear darker when they are wet.
- This change in appearance is explained through fundamental principles of optics: light reflection, scattering, absorption, refraction, and internal reflection.
- The topic has both conceptual value in physics and relevance for Prelims-level applicationbased questions in competitive exams.

Scientific Explanation Behind the Phenomenon

- Color Perception Mechanism:
 - An object appears a certain color because it reflects specific wavelengths of light while absorbing others.
 - For example, a red cloth appears red because it reflects red wavelengths and absorbs all others.
- Dry Surface Dynamics:
 - A dry fabric has a rough surface with many irregularities and air pockets.
 - Incident light reflects off these irregularities, and some white light also gets scattered.
 - The scattered white light gets superimposed on the colored light, enhancing brightness and making the cloth appear lighter.

• Wet Surface Dynamics:

- Water fills in the surface irregularities and replaces the air gaps between fibers.
- This reduces surface scattering and allows light to penetrate deeper into the fabric.

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- Deeper penetration increases the chances of light being absorbed by the fabric rather than reflected.
- As less light is reflected back to the eyes, the cloth appears darker.

Material-Specific Observations

P.L. RAJ IAS & IPS ACADEMY | 1447/C, 3rd floor, 15th Main Road, Anna Nagar West, Chennai-40. Ph.No.044-42323192, 9445032221 Email: plrajmemorial@gmail.com Website: www.plrajiasacademy.com Telegram link: https://t.me/plrajias2006 YouTube: P L RAJ IAS & IPS ACADEMY



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- Cotton (Loosely Packed Fibers):
 - Dry cotton has a lot of air gaps between fibers, causing significant light scattering.
 - When wet, water occupies these gaps, reducing scattering and increasing absorption.
 - This results in a noticeable darkening of appearance.
- Silk and Synthetic Fabrics (Tightly Packed, Smooth Surfaces):
 - These fabrics have fewer air gaps and smoother surfaces, even when dry.
 - They do not absorb much water, and their surface characteristics remain relatively unchanged when wet.
 - Hence, the change in appearance is minimal compared to cotton.

Optical Principles at Work

- Scattering:
 - Stronger on rough, dry surfaces due to multiple surface angles.
 - Water smooths the surface, significantly reducing scattering.
- Absorption:
 - Increased in wet fabrics because water allows light to travel deeper into the material, increasing the amount absorbed before reflection.
- Refraction and Total Internal Reflection:
 - When light transitions from air to water, it refracts (bends).
 - Some light undergoes total internal reflection within the water-cloth boundary, preventing it from escaping back to the eye.
 - Both effects contribute to the reduction in the light reflected back, making the cloth appear darker.

Conceptual and Practical Significance

- Everyday Science:
 - Helps explain a commonly observed phenomenon through core physics principles.
 - Enhances understanding of light behavior in real-life contexts.
- Relevance to Remote Sensing and Imaging:

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- In satellite imagery, wet soils or vegetation reflect differently due to similar light absorption and scattering principles.
- Useful for weather prediction, agricultural monitoring, and hydrological assessments.
- Educational Importance:
 - Useful for conceptual clarity in optics, especially for students and aspirants of competitive exams.
 - Demonstrates how theoretical knowledge of physics can explain practical situations.

Source: https://www.thehindu.com/sci-tech/science/why-do-clothes-look-dark-when-immersedin-water/article69504596.ece

