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TOOLS THAT TEACH

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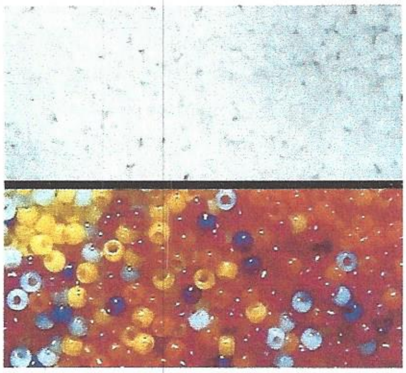

UV Beads

P3-6500

BACKGROUND:

UV Beads contain a chemical that changes color when exposed to ultraviolet light. When brought out of the UV, they will fade back to white. The beads can cycle back and forth over 50,000 times. The sun emits ultraviolet light, so exposing the beads to sunlight will cause their color to change. Students can experiment with different conditions and see which cause a color change. The ultraviolet wavelengths in sunlight cause skin to tan and burn. Students can relate the results of their experiments to the likelihood of getting sunburned in different conditions. For a more detailed explanation of how your UV beads work, see below.

EXPERIMENT IDEAS:

1. What kinds of light contain UV? Expose the beads to light from different sources, including the sun, incandescent light bulbs, fluorescent light bulbs, colored lights, and a blacklight (P2-9035).
2. Can you get sunburned on a cloudy day? Can you get sunburned in the shade?
3. How effective are different sunscreens? Coat the beads with different brands and compare the rate of color change.
4. Can UV pass through window glass? Try different types of glass, including tinted glass and car windows.
5. How much UV protection do different types of sunglasses provide?
6. How does the amount of UV from the sun compare to the UV in tanning booths?

THE CHEMISTRY OF UV-DETECTING BEADS:

UV-sensitive beads contain pigments that change color when exposed to ultra-violet light from the sun or certain other UV sources. The electromagnetic radiation needed to affect change is between 360 and 300 nm in wavelength. This includes the high-energy part of UV Type A (400-320 nm) and the low energy part of UV Type B (320-280 nm). Long fluorescent type black lights work well; incandescent black lights and UV-C lamps will not change the color of the beads.

The dye molecules consist of two large, planar, conjugated systems that are orthogonal to one another. No resonance occurs between two orthogonal parts of a molecule. When high energy UV light excites the central carbon atom, the two smaller planar conjugated parts form one large conjugated planar molecule. Initially neither of the two planar conjugated parts of the molecule is large enough to absorb visible light and the dye remains colorless. When excited with UV radiation, the resulting larger planar conjugated molecule absorbs certain wavelengths of visible light resulting in a color. The longer the conjugated chain, the longer the wavelength of light that is absorbed by the molecule. By changing the size of the two conjugated sections of the molecule, different dye colors can be produced. Heat from the surroundings provides the activation energy needed to return the planar form of the molecule back to its lower energy orthogonal colorless structure.

Although UV light is needed to excite the molecule to form the high-energy planar structure, heat from the surroundings provides the activation energy to change the molecule back to its colorless structure. If colored beads are placed in liquid nitrogen, they will not have enough activation energy to return to the colorless form.

The UV detecting beads remain one of the least expensive qualitative UV detectors available today. They cycle back and forth thousands of times.

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