

HAT Stickers

(Heat Activated Thermochromic Stickers)

Science Challenge:

Determine the effect of heat on HAT Stickers.

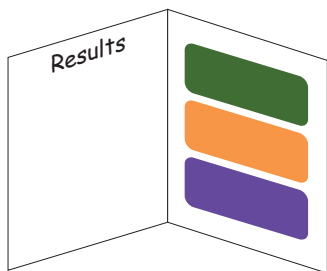
Materials:

6 in. x 4 in. (15 cm x 10 cm) white unlined index cards
per sticker tested.
HAT Stickers.

Teaching Tips:

Objective: To compare the color of the HAT Stickers at room temperature with their color when heated..

1. Give each student one index card.
2. Instruct students to make a foldable by folding the card in half with the short sides together.
3. Open the foldable and stick one of each of the stickers on the right side of the fold line.
4. Inform students that their exhaled breath is the same temperature as inside their bodies, which is about 37.0°C.
Direct students to use a straw to exhale on the stickers.



Expected Results:

5. Small circles with a different color than the unheated surface of the stickers form.

Expected Results:

As the stickers cool, the colored circles disappear and the original color of the stickers return.

Reversible Color Cycle

HAT Stickers are reversible, meaning they change color when heated and return to their original color when cooled back to room temperature.

HAT Sticker Facts:

HAT Stickers are coated with a mixture of heat activated thermochromic dye and acrylic paint. Thermochromic means a change in color due to a change in temperature.

Question:

How does temperature cause the HAT Stickers to change color?

Answer:

The changes in color due to temperature fluctuations are a result in changes in the shape of the dye molecules. At room temperature, heat activated thermochromic dye molecules have more of a planar (two-dimensional) shape. The size and shape of the molecules determine what part of visible light the molecules absorb and reflect.

Visible light, such as sunlight or indoor lighting can be separated into a spectrum of rainbow colors—red, orange, yellow, green, blue, indigo, violet.

Each light color making up visible light has a different amount of energy and when it enters your eye the message sent to your brain interprets its color. Red has the least energy and violet has the most energy.

At room temperature, the light energy reflected from the stickers is different than the light energy reflected when the sticker is heated.

Question:

Why does a mixture of thermochromic dye and paint produce a color different from that of the dye or paint?

Answer:

The mixture of dye and paint do not form a new product when mixed together. Instead, the dye molecules and paint molecules remain separate. Though separate, the two types of molecules are evenly mixed. Thus, each type of molecule affects light differently.

At room temperature, when light shines on the mixture, the molecules of dye and paint absorb parts of the visible light and reflect parts of the light. The reflected parts are seen as colors.

Question:

Since different colors of light are reflected from the stickers at room temperature, why are the stickers one color instead of multicolored?

Answer:

The colored light reflected from the dye molecules and the colored light reflected from the paint molecules enters your eyes where the two colors are added together. Thus, the stickers appear as one color instead of multicolors.

HAT Sticker Color Key:

EK 100-1	Green to Yellow	27°C
EK 100-2	Purple to Pink	27°C
EK 100-3	Orange to Yellow	27°C

Activity:**Discover How to Heat the Stickers with Friction:****Heat from Friction**

Things in motion have kinetic energy (KE). Thus if you rub your fingers back and forth against the surface of one of the HAT Stickers, your fingers have kinetic energy. The faster you move your fingers, the more kinetic energy they have.

Friction is the resistance to motion of surfaces moving against each other.

The harder you press your fingers against the sticker while rubbing, the greater the friction between your fingers and the sticker.

Friction causes some of the kinetic energy to be transformed into heat energy.

Discover for Yourself

1. Press your fingers against one of the stickers in the foldable prepared on page one.
2. Rub your fingers back and forth quickly until the sticker changes color.
3. Repeat steps 1 and 2 using the remaining two stickers.

