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# IMH TEP'S

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## LEGACY ACADEMY

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### **8.9 Mixing Colours**

Grade 8 Activity Plan

# Reviews and Updates

## 8.9 Mixing Colours

### **Objectives:**

1. To demonstrate the properties of white light; its component colors and how they can be revealed.
2. To outline the differences between additive and subtractive colour mixing.
3. To understand the colour wheel and concepts associated with it such as complimentary colours etc.

**Keywords/concepts:** rays, beams, pigment, pixels, visible light spectrum, Isaac Newton's color wheel, additive and subtractive colour mixing, primary and secondary colours, complimentary colours, speed and wavelength of light.

**Curriculum outcomes:** 209-2, 209-6, 210-11, 308-8, 308-9, 308-10.

**Take-home product:** colour wheel

Segment	Details
African Proverb and Cultural Relevance (5 min.)	"Before one has white hairs, one must first have them black." <b>Wolof, Senegal</b>
Pre-test (10 min.)	Ask probing questions on students' knowledge of colours. A little light on the psychology of colours is also appropriate.
Background (10 min.)	Explain the mixture of colours in white or colourless light. Use colour viewing box. Describe process of additive colour mixing. Demonstrate using torches and cellophane paper. Detail primary additive colours. Describe subtractive colour mixing. Demonstrate with paints. Detail primary subtractive colours.
Activity 1 (10 min.)	Describe how filters work using the colour viewing box. Also endeavour to illustrate the effect of filters on the colours of other objects around
Activity 2 (15 min.)	Using the prism and simulation link provided, demonstrate that white light is made up of other component colours.
Activity 3 (20 min.)	Using a painted or printed colour wheel, illustrate additive colour mixing.
Follow-up (10 min.)	Ask probing questions on all activities to ensure that the concepts that were introduced are well understood.
Post-test (10 min.)	Have student fill out the tables in their manual. Filling in the blanks should help in reinforcing all that has taught

**Suggested interpretation of proverb:** Life is a process, one should always endeavour to get the best out of the stage of life at which they are. As a student, it is expedient that one exploits all opportunities that are available in order to be knowledgeable at a later time in life, that's why noticeably, Grade 8 is more difficult than Grade 7. As seen in this activity, one must first acquire primary colours and mix them to get secondary colours.

## **Cultural relevance**

### **Name: Alton Liston**

A very advanced example of mixing colours would be the television. Alton Liston a native born of St Thomas, Virgin Islands was successful in his research for passing two colour television signals through a non-linear path thereby creating a coloured display. From mixing colours at a primary level Liston was able to use this simple formula additive colour mixing.

When two color television signals are transmitted over a common non-linear path, such as a transponder in a communications satellite, the two color subcarriers at slightly different frequencies intermodulate each other and produce a disturbing flickering of color on the screens of monitor of a laptop, computer or television.

## BACKGROUND INFORMATION

Essentially white light is a combination of many different colors, a continuum of wavelengths organized into "bands" which we label with names (blue, green, red etc). When equal parts of each of the three major bands are combined you get white light. White light is the sum of red, green and blue. This is additive color.

Red, green and blue are the "primary" colors of white light. All three colors will result in white, the absence of all three will produce black. When two primary colors of light are added together, you get a color that is brighter than either of its components.

These are the "additive" combinations:

Red + Green = Yellow

Red + Blue = Magenta

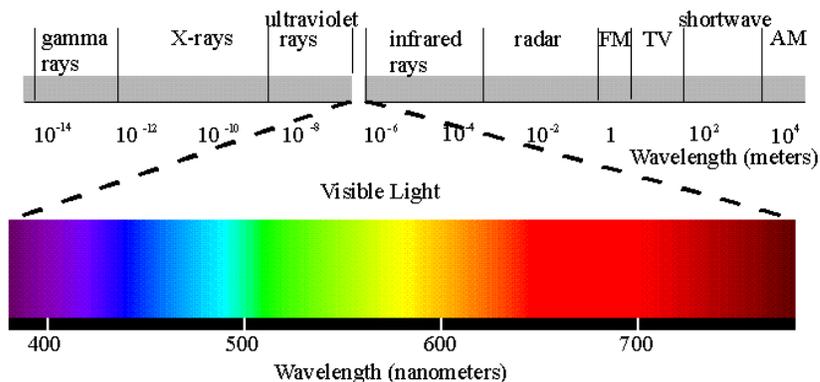
Blue + Green = Cyan

By using unequal amounts of red, green and blue light you can create new colors. Using red, green and blue, the entire spectrum of visible light can be created.

When a designer is utilizing the computer to generate digital media, colors are achieved with the additive color method. When painting, an artist has a variety of paints to choose from, and mixed colors are achieved through the subtractive color method.

Additive Color Mixing: If we are working on a computer, the colors we see on the screen are created with light using the additive color method. Additive color mixing begins with black (without light) and ends with white; as more color is added, the result is lighter and tends to white.

Subtractive Color Mixing: When we mix colors using paint, or through the printing process, we are using the subtractive color method. Subtractive color mixing means that one begins with white and ends with black; as one adds color, the result gets darker and tends to black.



## Activity 1: Filter Demo

*Purpose: To outline the differences between additive and subtractive colour mixing using filters*

*Suggested format: gather students; encourage them to participate while demonstrating.*

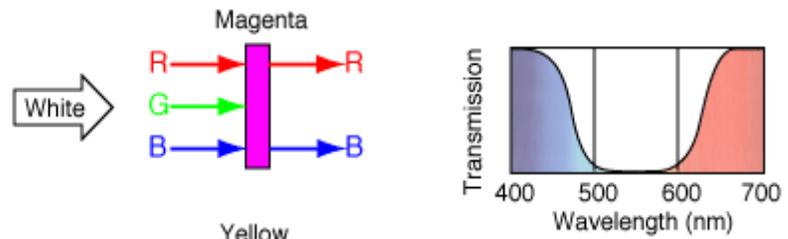
Items	Quantity (for mentor and 10 students)
Shoe Box	1
Red cellophane sheet	(height and width of shoe box)
Green cellophane sheet	(height and width of shoe box)
Scissors	1
Clear tape	1
Green Apple	2
Banana	2
Playing Card (Heart or Diamonds)	1 pack
Flashlight	1

### Procedure:

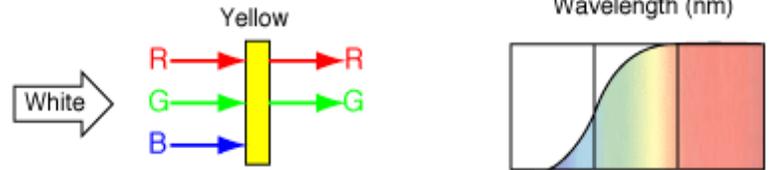
1. Make a hole on the side of the box just **enough for the flashlight** to shine through.
2. Tape the green cellophane onto the top opening of the box (lid removed). Place a green apple, banana and red coloured (diamonds or hearts) playing card inside the box. Position the flashlight so it shines inside box through the hole on the side. In a darkened room, shine the flashlight into the box.  
*Observation: the green apple looks greener, the banana has a green tinge, and the red hearts look black. This is because the filter allows only green light through. It cuts out the red light reflected from the hearts.*
3. Replace the green cellophane with red, and shine the flashlight into the box.
4. What should happen this time: the banana has a red tinge, the green apple appears dark, and the whole playing card appears red, so the hearts disappear.
5. This short activity should spark students' interest in some effects and opportunities of additive colour mixing. This can lead you into explaining subtractive colour mixing. They can also recall this information when filling out the tables in the post-test.

Primary colours: Magenta, Cyan, Yellow (Traditionally Red, Blue, Yellow)  
 Application: used in paints, inks (printer).

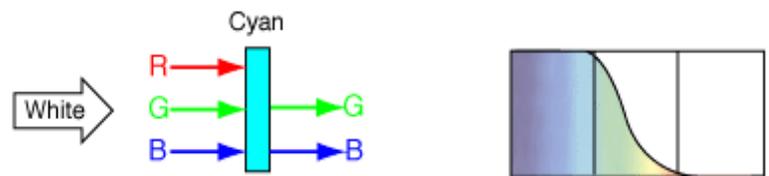
Primary magenta subtracts (absorbs) middle wavelengths (green). It reflects red and blue. Magenta does not have a single wavelength of light.



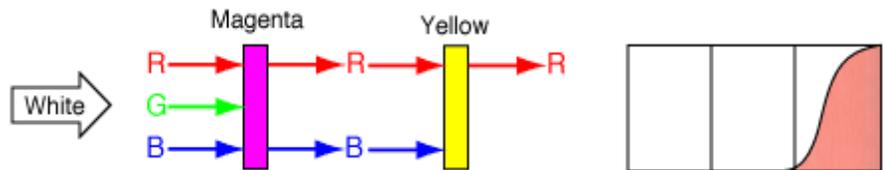
Primary yellow subtracts short wavelengths (blue). It reflects red and green.



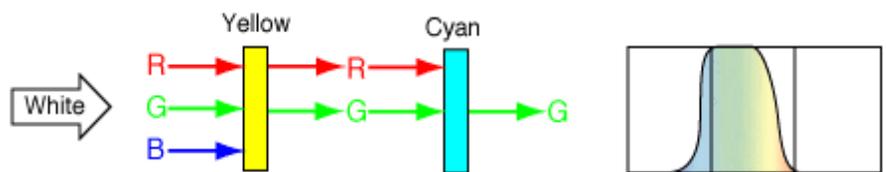
Primary cyan absorbs long wavelengths (red). It reflects green and blue.



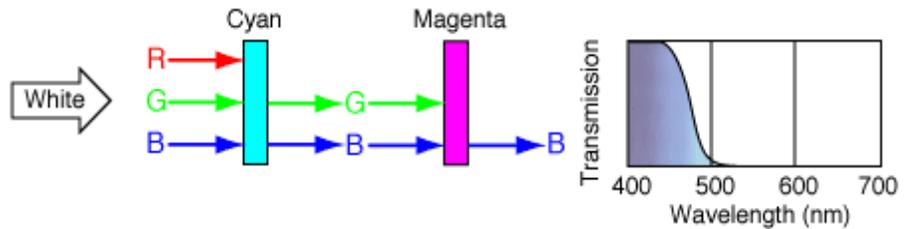
Magenta (absorbs green) and yellow (absorbs blue) reflect the colour red.



Yellow (absorbs blue) and cyan (absorbs red) reflect the colour green.



Cyan (absorbs red) and magenta (absorbs green) reflect the colour blue.



Filters act by selective absorption, the action of the idealized primary filters above is illustrated in terms of the filter's effect on white light composed of the additive primary colors red, green and blue. Note that two primary filters in succession can be used to produce each of the additive primary colors.

## Activity 2: Prisms

*Purpose: To know the properties of white light; it's component colors and how they can be revealed.*

*Suggested format: gather students; encourage them to participate while demonstrating.*

Item	Quantity (for mentor and 10students)
Flash light	1
Prism	2

### Procedure:

1. Use a flashlight (or other source of light) to shine light through the different prisms and see what results can be attained. Encourage students to experiment with different angles and if a rainbow can be made.
2. If a rainbow is observed, now try Newton's demonstration: using a second prism to turn the rainbow back into white light.

To simulate this activity using **one** prism, follow this link:

<http://phet.colorado.edu/en/simulation/bending-light>

**It does not work for two prisms.**

Download and install the software prior to afterschool session.

## Activity 3a: Colour Disk

*Purpose: To understand the colour wheel and concepts associated with it, such as complimentary colours etc.*

*Suggested format: mentor should make a color wheel beforehand. Students should not handle drills.*

Item	Quantity (for mentor and 10students)
Poster colour (red, blue, yellow)	1 each
Markers (red, blue, yellow)	11 each
USB/Battery powered fan	1

### **Procedure:**

1. Colour a circle with equal parts of red, blue and yellow (magenta, cyan and yellow) paint or markers.
2. Mount the colour disc on the shaft of the fan, making sure it is directly at the centre.
3. Turn the fan on and observe.

**It may not be possible to get the colours in their pure form; hence the colour of the spinning wheel appears a little off white.**

## Activity 3b: Additive Colour Mixing

*Purpose: To reinforce the differences between additive and subtractive colour mixing.*

*Suggested format: gather students to present while keeping interaction on.*

Items	Quantity (for mentor and 10 students)
Projector screen	1
Light board (with 3 lamp holders)	1
Flexible neck reading lamp	3 (if light board is unavailable)
Bulbs (Red, Blue & Green)	1 of each

### **Procedure:**

1. Screw three light bulbs, one of each colour into the light board. If improvising use three lamps and set them up side by side.
2. Shine the lights on a white surface. For better results, use a white projector screen.
3. Manipulate the variables and see the effects of coloured light. It may not be possible to shine the lights with enough brightness or accuracy to combine all three and obtain a white light. From the background information, students should remember if you get an equal ratio of red, green and blue light, white light can be obtained.
4. Change the angle and use the dimmers to change the brightness of each light. Place objects in front of the screen, like hands, green apples or playing cards. See what secondary colours can be created. Just be creative and encourage the students to try to explain the results you find.

**Post-Test:**

Get students try their best to fill out this table. Remind them there is a difference between additive and subtractive colour mixing. Meaning, if equal parts of the 3 primary colours are added, the outcome is different for additive (white) than it is for subtractive (black).

Colour 1	Order		Colour 2	Order	Product	Order	Type of Mixing (additive or subtractive)
Magenta	1°	+	Yellow	1°		2°	Subtractive
		+	Cyan	1°	Blue		
Cyan	1°	+		1°	Green		Subtractive
	1°	+	Blue		Magenta	2°	Additive
Green		+	Red	1°		2°	Additive
Blue	1°	+		1°	Cyan		

Colour		Colour 2		Colour 3	Product	Type of Mixing (additive or subtractive)
Magenta	+	Cyan	+		Black	
	+		+	Blue		Additive

Answer tables:

Colour 1	Order		Colour 2	Order	Product	Order	Type of Mixing (additive or subtractive)
Magenta	1°	+	Yellow	1°	Red	2°	Subtractive
Magenta	1°	+	Cyan	1°	Blue	2°	Subtractive
Cyan	1°	+	Yellow	1°	Green	2°	Subtractive
Red	1°	+	Blue	1°	Magenta	2°	Additive
Green	1°	+	Red	1°	Yellow	2°	Additive
Blue	1°	+	Green	1°	Cyan	2°	Additive

Colour		Colour 2		Colour 3	Product	Type of Mixing (additive or subtractive)
Magenta	+	Cyan	+	Yellow	Black	Subtractive
Red	+	Green	+	Blue	White	Additive

### Useful links:

- <http://hyperphysics.phy-astr.gsu.edu/HBASE/vision/filter.html#c1>  
This is the source of the image copied in the activity plan. The diagram illustrates primary colours for subtractive color mixing are cyan, magenta and yellow. It summarizes the action of primary colour filters singly and in pairs.
- <http://micro.magnet.fsu.edu/primer/java/scienceopticsu/newton/>  
This page has two prisms set as Newton did. White light is shone. One can move each prism and see how the white light reacts. This is useful, especially if one cannot recreate the demonstration with the prisms in the activity box.
- <https://micro.magnet.fsu.edu/primer/java/scienceopticsu/newton/>  
This page explains a prism and how Newton used prisms to separate white light into colours.
- <http://lucaskrech.com/blog/index.php/2010/01/22/color-theory-basics-additive-and-subtractive-color-mixing/>  
For more information on additive and subtractive colour mixing follow the link above.