3-5 years

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Science Content:
Physics: Light

Target Concepts/Skills:
Sunlight has all the colours of the rainbow, when sunlight illuminates an object, the colours that we see corresponds to the fraction of light reflected by that object

Target Age group:
3-5 years

Duration of activity:
60 minutes

Summary:
Sunlight is composed of light of every colour of the rainbow. When sunlight illuminates an object, part of this light is absorbed while the other colours are reflected. Three independent experiments are proposed, each lasting around one hour. Experiments can be pursued in sequence or in three stand-alone sessions of one hour each. These experiments include: using a prism or a CD to separate light into the spectral colours (experiment 1); With three lamps, each with a different-coloured light bulb (red, blue and green), we may obtain light that is white, yellow, magenta or light-blue (experiment 2); and not only mirrors reflect light: all the objects we see reflect some light. White reflects much light, whereas black reflects none (experiment 3).

Objective:
By the end of the activity children should be able to:

- Note that not only mirrors reflect light – but all the objects that we see also reflect light, but not all the light; and
- Appreciate and identify that the colour of each object corresponds to the portion of white light that is reflected by that object.

Resources:

- A room which can be darkened;
- CDs (these can be old/used, one for each groups of children);
- A smooth, blank wall, the surface of which cannot be glossy (if such a wall is unavailable, a large white sheet will have to be used, as a screen);
- A desk lamp with a white' light bulb, and three others equipped with red, blue and green light bulbs (if coloured light bulbs are not available, coloured plastic sheets can be used instead);
- A mirror, three squares of cardboard with about 25 cm across, a white, one red and one black.
- Small pieces (squares, circles, triangles) of coloured matte cardboard (blue, green, red, black, white).
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What is Colour?

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This project Pri-Sci-Net has received funding from the European Union Seventh Framework Programme (FP7 2007 /13) under grant agreement No.266647

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Lesson plan (with inclusion of teacher notes) - Description of activity

The activity can be carried out as a sequence of experiments or else you can choose to carry one of two of the experiments to do with the class. The experiments are described below.

1. Engage (Forming hypotheses)

You can tackle a number of questions about light and colours with the children. You can consider any of the questions below to do the inquiry activity. To introduce the context you can show a video or pictures of the rainbow. You can set any of the questions below.

- What colour is sunlight?
- Does a cardboard reflect light?
- Why do we see objects as either red or green?
- What do we see when using a red light?
- Do we see the same colour when using sunlight, an ordinary lamp in the room or a red light?

Depending on the inquiry question chosen a different experiment can be carried out.

2. Inquiry (Designing and running experiments and observations)

To answer the questions above, execute the following experiments:

Experiment 1: Separation of light
The room must be darkened. A little beam of light is allowed to come in through one of the windows. A CD is turned toward the light coming in from the window, and the results of the separation of light takes place. Closing the window completely, so as to remove all natural light from the room, we can observe the spectrum of the light emitted by different light bulbs (incandescent bulbs, fluorescent bulbs, LEDs, or coloured light bulbs).

Before the experiment, the teacher introduces the children to the topic of sunlight ("How is a rainbow formed?", "Has anyone here seen a rainbow in a place other than the sky?" "Where do the rainbow's colours come from?" "What colour is sunlight?", "Is the light from the sun the same as the light of our lamps at home?"...

Children are divided into groups. Each group is given a CD. The room is then darkened. A little beam of light is allowed to come in through one of the windows. Ask the children to turn the CD to the beam of light, and to observe the effects produced. Natural light is then sealed off completely – or as much as possible – and a source of artificial light (light bulb) is switched on; the exercise in step 3 is repeated. The lamp is switched off and a red light bulb is switched on instead. Ask the children to note what they observe. The experiment can be repeated with different sources of light. (Note: before the experiment, the teacher must have selected three sources of artificial light – light bulbs of different types, coloured light bulbs – capable of producing spectra which are clearly visible).

During the different stages of the experiment, the teacher should also ask some questions: what colours can you see on the CD? Do they see the continuous spectrum of colours? Do they see well-defined stripes of certain colours? What do they see when a coloured light bulb is used?

Experiment 2: What happens when we mix red, blue and green light?
Before starting the experiment itself, all lamps must be simultaneously directed toward the same area on a smooth, blank, so that the resulting light is white across all of the illuminated area. The coloured bulbs are then switched off. With the white' bulb on, children are asked to project shadows on the wall using their hands. The children are asked what causes the white and dark patches on the wall. The procedure is repeated with each individual coloured light bulb. Before switching on each lamp, children must be asked what they expect to happen, and what they think will be the colour of the shadows. At the end, a record is made of the colours observed. After this, all three coloured light bulbs are switch on simultaneously. The procedure is then repeated with two coloured light bulbs at a time. A record is made of the colours observed, and this is correlated to the colour of the light bulbs in use in each occasion.

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White light results from the sum of all colours. When an "ordinary" light bulb is used, the shadow projected by an intervening object is dark because the object in question bars the passage of light. Yellow-, magenta- and cyan-coloured lights can be obtained through the mixture of other two colours.

Experiment 3: Multicoloured shadows
Place some "targets" in strategic positions in the room. It is required for a child to reflect the projector light with a mirror to spot a target (the target must be placed so that it is possible to illuminate it using only the mirror, with no need to adjust or move the projector itself). Pick up a target that is closer to the focus. The mirror is oriented so as to illuminate the target well. Cover the mirror with a white cardboard and observe the target. Repeat with a cardboard with a red and black cardstock. The same projector and color filters are then used. The aim is to use three filters: one blue, one red and one green, but you can do only with a red filter and white light. (note: the projector and filters can be replaced by lamps with colored bulbs.) On the wall paste squares of white cardboard, black, blue, green and red (the cards should not be shiny).

Place the light source so that the light beam is parallel to the wall, one meter from a white wall. The focus position should be such that will be easy to bend light to the white wall using only the mirror. Stick a puppet on the wall - can be a simple small drawing (10cm) that will serve as a "target." Turn on the light focus and asked a child to "bend" the light with the mirror so that it reaches the "target" (it is usually necessary for the teacher to give a helping hand in
the beginning). Repeat the procedure, replacing the mirror by large squares (25 cm) of white, red and black cardboard.

Before each step of the experiment, ask children what they expect to observe. Before switching on the coloured bulbs, let children know which colours you are about to use, and ask them what they expect to observe. Before introducing and object between the source of light and the wall, ask children what they think the shadow will be like. During the experiment, ask children to describe what they are observing, and compare their answers with what their preliminary expectations or guesses.

3. Evaluation (Evaluating evidence)

Help the children to note and to comment on the outcomes of the experiments and to use the observations made to draw conclusions about light and colour.
With experiment 1, children should realize that light can be reflected by various surfaces.
In experiment 2, we want the children to understand the colour we see on the objects depends on the light that illuminates them.

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Teacher Notes:

The visible light emitted by the sun contains the full and continuous colour spectrum, spanning from red to violet and encompassing all intermediate colours. These colours are not simply three, five or seven – there is an infinite number of intermediate colours, each
differing gradually from the ones before and after it, in a continuous span. Using an optic prism or a simple CD we can break up natural or artificial light. Many "white" light bulbs which are considered to reproduce natural light do not contain the continuous spectrum; the spectrum of each light bulb varies depending on the process/material used for generating light (in some cases, only three colours are present – blue, green and red.

Our eyes and brain are only sensitive to three of the colours of light (red, green, blue). When the three are combined (with equal intensity) we see/perceive "white light". If we combine light of these colours in different proportions we perceive mixes like orange, pink, purple, turquoise, etc. The composition of colours can easily be assessed with resort to any drawing or painting software – all available colours correspond to different proportional variations of blue, red and green. To each available colour corresponds a three-number code – the RGB code – in which each number corresponds to the fraction (from 0 to 255) with which each colour - red (R), green (G) and blue (B) – contributes to the final colour.

When we shine red, blue and green light simultaneously on a blank wall, the wall reflects the mixture of the three colours. The three types of sensors in our eyes are simulated all at once, and our brain detects and interprets the mixture as white light. If on the wall we project only light of two colours, only two kinds of sensors and our brain will, depending on the colours in question, perceive magenta, cyan or yellow. If on the wall we project only light of two colours, only two kinds of sensors and our brain will, depending on the colours in question, perceive magenta, cyan or yellow. During this experiment, red, blue and green light bulbs are switched on and directed to the same area in a blank wall, and white light is perceived. When an object is introduced between the lamps and the wall, some of the light will be prevented from reaching the wall. Depending on the respective positions of lamps and the intervening object, a given area of the wall will remain illuminated by all three colours, while other patches will be lit only by one or two of the light bulbs – causing yellow, green, red, blue yellow, magenta and cyan patches to become visible on the wall.

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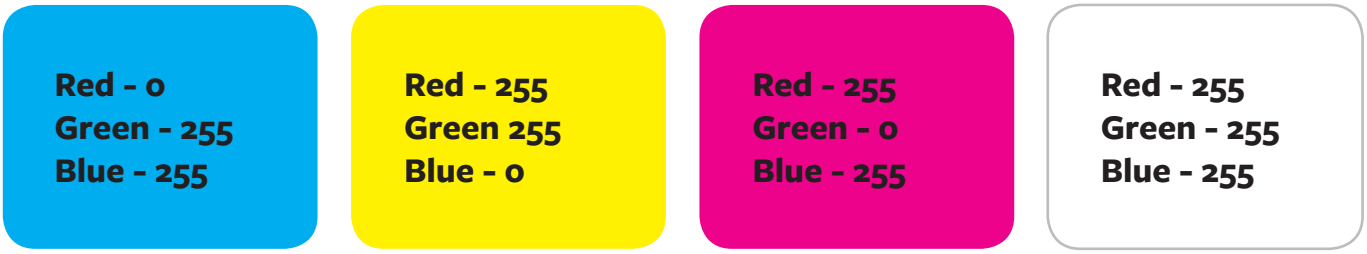

Fig 1. RGB code of the three colours

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