Let's Do
Science

Grade One

# Creating Colour

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# Creating Colour

## Before You Begin

The Creating Colour unit includes many fun, hands-on activities. Children will explore primary colours and mix them to create secondary colours and shades of colour. They will discover how colour can be transferred from one material to another by experimenting with food colouring and colours extracted from natural and manufactured objects. In the process, students learn that different materials have particular properties (such as opacity and transparency), which must be taken into account when they are used for a specific purpose.

For many children, this will be their first look through a prism. Allow children time for free exploration using the prisms. Prisms might be set on a discovery table during the unit.

Colour has a psychological impact on us. You may wish to consider with your students the effects of colour on our emotions and the use of colour in advertising or discuss ways colour-blindness affects the everyday life of people who are afflicted with this disorder.

This unit is a building block for the grade 4 unit Light and Shadows.

### Topic A: Creating Colour

(Suggested time 4-5 weeks)

Before presenting this unit, visit a paint or hardware store to collect paint strip samples. Send a letter home asking parents to help collect items on the materials list. Also request old newspapers for protecting desks and other surfaces.

Coloured cellophane or acetate filter sets can be ordered ahead of time from a science supply company. Since many of the activities in this unit require red, yellow and blue food colourings, it is worthwhile to buy them in bulk in large bottles and to refill smaller bottles.

Where materials are difficult to obtain for large numbers of children, try some of these activities at centres. A corner of the classroom can be established as an art centre, involving exploration of colours. A display of colourful prints by famous painters can be set out for students. Consider inviting an artist from the community to speak to the children. Students can learn how yarn is dyed and try a simple batik project. You can also involve your children in an investigation of how printed fabrics are made.

This unit is possibly best not taught in the beginning of grade 1. Wait until the latter part of the year when students' motor skills are better developed.

## Safety Issue

It is unsafe to shine sources of light such as that from a laser directly into an eye. The lens of the eye focuses the intense laser beam to a point on the retina, effectively overloading that portion of the eye and either temporarily or permanently damaging the eye, depending on the intensity of the laser.

# Background Information

To better understand colour and how we see colour, it is important to know a little bit more about light. Light is *radiant energy* that travels freely through space. There are many kinds of radiant energy making up the *electromagnetic spectrum* (see Fig. 1) and each has a different wavelength. Included are X-rays, ultraviolet, infrared radiation, radio waves, microwaves and cosmic radiation. We can only see a small portion of all the different kinds of radiant energy. Since we sometimes refer to other kinds of electromagnetic energy as "light" (e.g., ultraviolet light), we call the small portion of the electromagnetic spectrum that human eyes can see *visible light*.

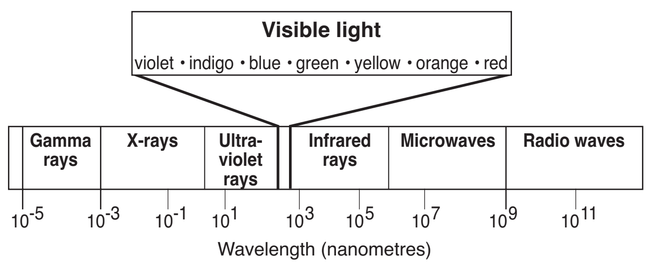


***Figure 1.***
*Electromagnetic spectrum*

# Properties of Light

The behaviour of light is both fascinating and complex. So complex in fact that two models are required to completely explain the range of observations seen by scientists studying the behaviour of light. The particle nature of light requires that light behaves as a stream of particles, called photons, that travel in straight lines while the wave nature of light insists that it is made up of transverse waves. These two apparently diverse theories are not in conflict. There is no argument that one theory is right and one theory is wrong but rather both theories are required to explain how light behaves.

Light, for all practical purposes, can be thought of as travelling in straight lines. Therefore, in teaching this concept it is appropriate to use the rule "light travels in straight lines."

What happens when light strikes an object?

When light strikes an object it will interact with the object in one of three ways, depending on the surface and the type of material the object is made of. Light may pass through the object, be reflected or be absorbed.

Objects are classified as transparent, translucent or opaque, depending on their ability to let light pass through them. *Transparent* objects allow most of the light striking them to pass through. A very small amount of the light may be reflected or absorbed. Window glass is transparent. *Translucent* objects allow some of the light striking them to pass through, while a larger portion of the light may be reflected or absorbed. *Opaque* objects do not allow any light to pass through them. The light striking an opaque object is either all absorbed or all reflected.

When light is absorbed by an object it is usually converted to heat energy. Thus a dark object sitting in the sunlight becomes warmer than the surrounding air or lighter-coloured objects.

When light strikes the surface of an object, some of the light rays may be *reflected* back into the air. Light that strikes a smooth, polished surface results in a clearly reflected image because all of the light rays are reflected. If the surface is not polished or smooth, the reflection may be less clear but still visible.

When a light beam passes through a transparent or translucent object, the light waves will be bent *(refracted)* as they move through the object. This can be seen when looking at an object through a glass of water. The light is bent because the speed of the light varies as it passes through different substances. For example, the refraction of a ray of light is shown as light is slowed down as it passes through water. This effect is demonstrated when viewing a pencil in a clear glass of water.

When light hits small particles, such as dust or smoke in the air, it *scatters* in all directions. The amount of light scattering depends on the size of the particles and the wavelength of light striking them. (See the section on colours in the sky for an explanation of scattering.)

## How Do We See?

Light is necessary for us to see. Light travels from the source (the Sun, a campfire, a room light, or a reflection from something else) onto an object, and some of this light is reflected to our eyes. Once the light has entered our eyes and been focused on the retina, complex biological processes are set into motion that create the vision or picture we see. In humans, the process of seeing results in our awareness of shades of light and dark and the perception of colour.

## Seeing Colours

Because human eyes have both light and colour receptors (most mammals have only light receptors), everything we see can be described as having a colour.

Sunlight and most other sources of white light can be separated into the colours that we know as the *visible spectrum* – violet, indigo, blue, green, yellow, orange and red. When white light passes through a prism, soap bubble or a rain drop, the wavelengths of the various colours are separated from one another because they are bent (refracted) at different angles. This produces the range of colours that we observe. Of the visible light that we see, violet has the shortest wavelength, and red has the longest (see Fig. 2).

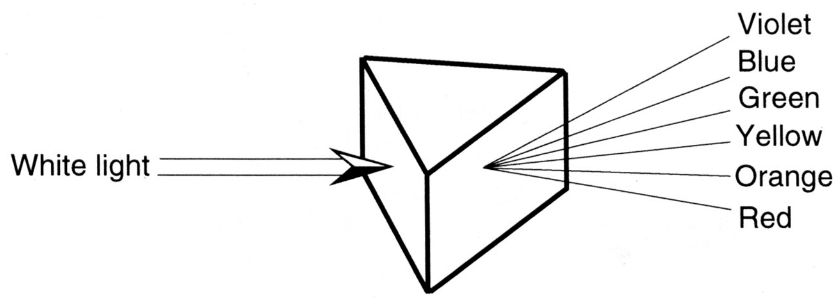


*Figure 2.*
*Passing white light through a prism to view the visible spectrum*

It is because visible light is composed of several colours that we see objects as having colour. When white light, such as sunlight, strikes an object, the different wavelengths of colour are either absorbed or reflected by the pigments on the object. The reflected wavelengths of colour converge on the retina of the eye, and the nerve impulses are sent to the brain, which are perceived as colours in our brain. There are three different colour receptors on the retina: red, blue and green. It is stimulation of combinations of the red, blue and green receptors that allows us to see all the other colours around us. Thus an object that appears red, such as an apple, reflects only red light to our eyes and absorbs all of the other colours which are contained in white light.

## Dimensions of Colour

What common vocabulary can we use to describe colour? One could say a colour is bright, flat, heavy, deep, pale or even bland. These words are part of a subjective response that develops when we begin to look at colour. In teaching about colour, however, one should have an understanding of the following terms used by artists and designers who work with colours every day.

### Hue

Most often the first reference made about a particular colour is its *hue*. When we say a book is red, we have named the hue. Hue is the difference between one colour and the next as we move around the outside of a colour wheel. Each hue represents a different wavelength of visible light.

### Value or Intensity

*Value* or *intensity* refers to the quantity of light or colour, or the brightness of the object. A colour's value is determined in relation to the amount of white, grey or black present. The more white a colour contains, the brighter it appears. A colour that has a high value is referred to as a *tint*. Darker colours contain more black and are referred to as *shades*. Colours appearing near middle grey are known as *tones*.

### Chroma Saturation

When the distinction is made between a dull colour and a richer one, it is a difference in the *chroma saturation* of the colour. In light, a colour's saturation is determined in relation to how much chroma or "colour" exists compared to "white" light. A 100% saturation contains no white.

## Mixing Colours – Light and Pigments

For many years we have been taught that the primary colours are blue, red and yellow. Actually the primary colours for pigments are cyan, yellow and magenta. The primary colours of light are red, blue and green. In creating other colours from these primary colours we have to consider different mixing techniques.

### The Additive System

In the *additive system* we work with light sources, light filters and prisms to create different colours. Variations in the amount of the primary colours of light (red, blue and green) will produce different colours. The television is an excellent example where light from glowing red, blue and green phosphors combines to make a full colour image.

If you try an exercise where you project three beams of light on a white screen—one red, one blue and one green (the three colours for which our eyes are receptors) you might be surprised at the outcome when two or more of these beams overlap. Red light plus green light results in yellow light! Add blue light to this yellow and you get white! For an effective demonstration of the additive process, the intensity of the light sources and colour saturation of the red, blue and green lights must be equal.

What is happening? In the additive colour system, you can attain any colour from red through orange, yellow and green by mixing varying intensities of red and green light. Adding the blue light completes the range of wavelengths in the colour spectrum and white light (the composite of all spectral colours) results (see Fig. 3).

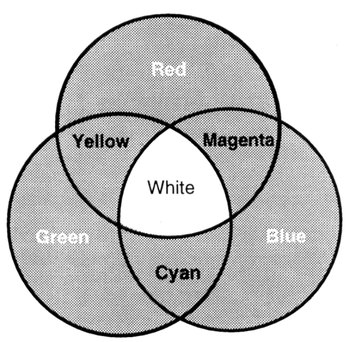


***Figure 3.***
*The additive colour stytem: mixing light*

## The Subtractive System

The process of forming colours by mixing coloured pigments describes the *subtractive system*. A colour photograph, for example, takes away or subtracts colours from the white light shining on it. Pigments in the form of a paint, ink or dye of a certain colour absorb other colour wavelengths in the white light and reflect its own colour. The three primary colours in the subtractive colour system are yellow, magenta and cyan. Yellow and magenta mix to produce red (see Fig. 4).

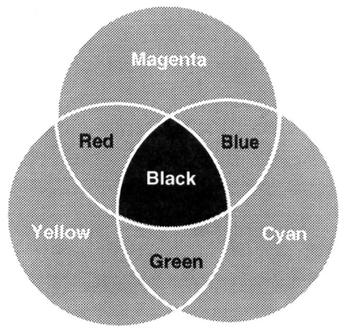


***Figure 4.***
*The subtractive colour system: mixing pigments*

*Pigments* are colouring agents such as finely ground, insoluble metallic compounds used in paints or the soluble organic molecules contained in vegetable dyes. The colour of a pigment is determined by the wavelength(s) of light that it reflects. In creating a paint or dye, the pigment is transferred to another medium like oil, wax or crayon. Many paints contain a binder—a substance that enables the paint to adhere to surfaces. Other paints such as water paints do not contain a binder and require a surface that is porous and adsorbent (adheres a thin film of liquid to the surface of a solid substance).

# Elementary Science Program of Studies

## General and Specific Learner Expectations

The following general and specific learner expectations have been taken directly from the 1996 Elementary Science Program of Studies. The specific learner expectations (SLEs) are referred to by number in the second column of the activities table.

### General Learner Expectation

Students will be able to:

Identify and evaluate methods for creating colour and for applying colours to different materials.

### Specific Learner Expectations

Students will be able to:

1. Identify colours in a variety of natural and manufactured objects.
2. Compare and contrast colours, using terms such as lighter than, darker than, more blue, brighter than.
3. Order a group of coloured objects based on a given colour criterion.
4. Predict and describe changes in colour that result from the mixing of primary colours; and from mixing a primary colour with white or with black.
5. Create a colour that matches a given sample by mixing the appropriate amounts of two primary colours.
6. Distinguish colours that are transparent from those that are not. Students should recognize that some coloured liquids and gels can be seen through and are thus transparent, and that others are opaque.
7. Compare the effect of different thicknesses of paint. Students should recognize that a very thin layer of paint, or a paint that has been watered down, may be partly transparent.
8. Compare the adherence of a paint to different surfaces; for example, different forms of papers, fabrics and plastics.
9. Demonstrate that colour can sometimes be extracted from one material and applied to another; for example, by extracting a vegetable dye or by dissolving and transferring a water-soluble paint.
10. Demonstrate at least one way to separate sunlight into component colours.

## Cross-curricular Connections

### Mathematics

- graph students' favourite colours, colour observations
- seriate samples of one colour from lightest to darkest
- sort paint chips according to various critera
- create patterns with colour
- Venn diagrams to summarize colour mixing

### Drama

- perform puppet plays where mood and setting are changed using lighting variations

### Language Arts

General outcome 1 (make observations about activities)

- vocabulary development: word sort with word wall for terms used to compare and contrast colours and distinguishing colours (SLE 1, SLE 6)

### Social Studies

- teacher outlines a map of the school, students help to make decisions about appropriate colours for the map areas and symbols

### Art

- draw the students' attention to the colourful artwork in the children's literature you are using; the concept of colour can extend to things like camouflage of animals, the uniqueness of chameleons and squids, the Northern lights, interior design or Ukrainian Easter eggs
- use a variety of media and mixed media: crayon, pastel and tissue to explore colour combinations

## Children's Alternative Frameworks

Many children have misconceptions about how colours are created. Few children realize that the mixing of primary colours (red, blue and yellow) along with black and white forms the basis for the development of secondary colours. Also, children believe that white light is colourless and is not composed of different colours. Children need experiences with light and colour to build their understanding that the mixing of coloured paints and pigments do not follow the same rules as the mixing of coloured lights.

# Activities

Classroom teachers have identified the following activities that address the Specific Learner Expectations (SLEs) in the Program of Studies. The list is not prescriptive and teachers may select activities that are most appropriate for their students.

Activities have been listed under two headings: Key Activities and Extension Activities. Key activities are supported by authorized resources and identify "powerful and practical" means for achieving learner expectations. Extension activities represent alternative ways of achieving or supporting learner expectations.

## Key Activities

| Key Activity | SLE | Print Resources | Essential Materials | Comments |
|---|---|---|---|---|
| Exploring the mixing of primary colours | 2, 4 | *Innovations in Science, Level 1, A Drop of Colour (Colour Recipes)*, p. 5<br>*Explorations in Science, Level 1, Primarily Colours (Free Exploration)*, p. 6, p. 9 | food colouring (primary colours), water, newspapers, plastic containers, eyedroppers, paper towels, cotton swabs, recipe booklets (scrap paper stapled together) | This activity will allow teachers to determine what students know about colour. You may want to have the children wear paint shirts. Children develop process skills of observing, comparing and predicting. |
| Investigating ways to make secondary colours and ways to make darker and lighter shades | 1, 4, 5 | *Explorations in Science, Level 1, Primarily Colours (Paper Towel Magic)*, p. 12 | food colouring, paper towel, newspaper, spray bottles | |
| | | *Explorations in Science, Level 1, Primary Colours (Colour Formulas)*, p. 11 | clear containers, food colouring, water, eyedroppers | |
| | | *Explorations In Science, Level 1, Primary Colours (Mixing Paints)*, p. 10<br>*Innovations in Science, Level 1, A Drop of Colour (Shades of Colour)*, p. 10 | paint (primary colours, black and white), brushes, paper, newspaper, paint shirts, containers (eyedroppers), water | Visit a paint store to see how paints are mixed by experts. |
| Describing objects in the classroom or coloured paint samples, using terms such as "lighter than," "darker than," "bluer than," "brighter than" | 1, 2 | *Innovations in Science Level 1, A Drop of Colour (Shades of Colour, Beginning the Experience)*, p. 10<br>*Innovations in Science, Level 1, A Drop of Colour (Sharing the Experience)*, p. 12 | colour booklet, pencil, various fruits and vegetables to compare colours, paint samples | Paint samples can be obtained from most hardware or paint stores. This activity can be adapted by taking the students outside to describe the colours of natural objects. |
| Matching and ordering colour samples | 2, 3 | *Innovations in Science, Level 1, A Drop of Colour (Shades of Colour, Extending the Experience)*, p. 12 | graph paper, crayons, paper squares or fabric swatches, crayons, paint | The students can make colour cards using crayons, then have a friend arrange them based upon the criteria chosen. |

| Key Activity | SLE | Print Resources | Essential Materials | Comments |
|---|---|---|---|---|
| Applying paints to various surfaces (newspaper, wet paper, fabric, milk containers) | 7, 8 | *Innovations in Science, Level 1, A Drop of Colour (Spreading Colours)*, p. 19<br><br>*Innovations in Science, Level 1, A Drop of Colour (Tie-Dye Colours)*, p. 25<br><br>*Explorations in Science, Level 1, Primarily Colours (Dyeing – Naturally)*, p. 22<br><br>*Explorations in Science, Level 1, Primarily Colours (Beautiful Batik)*, p. 24 | art paper, brushes, paint, water, containers, elastics, white pieces of cloth, ice cream pails, paper towels, natural dyes (e.g. coffee, berries, flowers) | Allow plenty of time for set up and clean up after this activity. Invite parent volunteers to assist your students. |
| Extracting colour from a variety of natural and manufactured objects and applying it to others | 1, 9 | *Innovations in Science, Level 1, A Drop of Colour (Taking Colour Out)*, p. 22<br><br>*Innovations in Science, Level 1, A Drop of Colour (Tie-Dye Colours)*, p. 25<br><br>*Explorations in Science Level 1, Primarily Colours (Dyeing - Naturally)* p. 22 | plastic glasses, water, leaves, crayons, coloured paper, flowers, coated candy, vinegar, plastic drinking cups, crepe paper in a variety of colours, hot plate, pot, wooden spoon, cotton fabric, alum, cream of tartar | Make sure the natural objects are clean. This is an ideal activity to have a parent volunteer assist the students with. |
| Viewing the visible spectrum using a prism | 10 | *Explorations in Science, Level 1, Primarily Colours (The Rainbow Connection)*, p. 18<br><br>*Innovations in Science, Level 1, A Rainbow of Colour,* p. 15 | prisms<br><br>pan, water, mirror, sunlight, white cardboard | Glass prisms can break easily if dropped. For many students this will be the first look through a prism. Allow students time for free exploration with the prisms before guiding their learning. For additional observations, teachers may want to demonstrate producing the visible spectrum using a ray box as a light source with a prism. A "rainbow" on a classroom ceiling can also be produced using an overhead projector as a light source and a clear pie plate of water as a prism. |
| Viewing materials through coloured acetate and overlaying acetate sheets to make new colours | 6 | *Innovations in Science, Level 1, A Drop of Colour (Colour Recipes, Extending the Experience, Other Activities)*, p. 8<br><br>*Explorations in Science, Level 1, Primarily Colours (Hidden Colours)*, p. 17 | acetate or coloured cellophane paper, crayons, paper (different colours of acetate are available from science supply companies) | |

# Extension Activities

| Extension Activity | SLE | Print Resources | Essential Materials | Comments |
|---|---|---|---|---|
| Creating a colour wheel | 1, 4 | | magazines, scissors, glue | Students search through the magazines for primary and secondary colours. They cut out primary colours in the shape of a circle and secondary colours in the shape of a square then glue them onto a paint pallet picture to make a colour wheel. This can be done individually or you can create a display of the whole classes' work. |
| Making water kaleidoscopes by filling a jar with water and cooking oil | 6 | *Innovations in Science, Level 1, A Drop of Colour (Spreading Colours, Extending the Experience)*, p. 21 | jars with lids (one jar per student), water, cooking oil, food colouring | Students can work in pairs because cooking oil can be expensive. |
| Observing the capillary action of paper as food colouring spreads its way across the surface | 8 | *Innovations in Science, Level 1, A Drop of Colour (Spreading Colours)*, p. 19<br>*Explorations in Science, Level 1, Primarily Colours (Coffee Filter Chromatography)*, p. 5 | food colouring, paper towels, eyedroppers, water, black felt pens (water soluble) | The word "chromatology" does not need to be used, but students do enjoy learning big words. |
| Making a colour spinning-top by poking a pencil through a cardboard disk which has been coloured | 10 | *Explorations in Science, Level 1, Primarily Colours (Spinning Colours)*, p. 13 | crayons or felts, stiff white paper like cardboard, pencil, circle tracer | Tape the coloured disk to the inside lid of a salad spinner and spin. Observe the effect. "White" light may be produced depending on colours used. |
| Using Plasticine to make three-dimensional rainbows | 1 | *Innovations in Science, Level 1, A Drop of Colour (A Rainbow of Colour, Extending the Experience)*, p. 18 | Plasticine (all colours) | This makes a good art centre activity. |
| Creating spectra using bubbles | 10 | *Explorations in Science, Level 1, Primarily Colours (Bubble Colour)*, p. 19 | bubble solution, water, containers, bubble blowing tools, glycerine, dish washing liquid, food colouring | The bubbles can be released so they land on a piece of paper. This creates interesting bubble art. |

| Extension Activity | SLE | Print Resources | Essential Materials | Comments |
|---|---|---|---|---|
| Observing and predicting what happens when looking at white light after looking intensely at a coloured circle | 4 | *Explorations in Science, Level 1, Primarily Colours (Coloured Circles)*, p. 14 | coloured markers, paper | After staring intently at the red circle, your eyes become desensitized to the colour red, so your impressions of the white circle are inaccurate. Your brain interprets what it sees as green, the complementary colour of red. |
| Observing a variety of liquids and gels and determining which are transparent and which are not | 6 | | clear containers, cooking oil, water, hair gel, liquid soaps, ketchup, jelly, etc. Student sheets with headings: "Transparent," "Not Transparent" | Each liquid and gel should be in a separate container. |
| Viewing spectra using rainbow glasses | | *Explorations in Science, Level 1, Primarily Colours (Magic Glasses)*, p. 21 | grating glasses, incandescent lights | |
| Investigating how colour protects animals | | *Explorations in Science, Level 1, Primarily Colours (Colour Camouflage)*, p. 25 | art and drawing materials | |
| Mixing and creating colours using an overhead | 4, 5 | *Innovations in Science, Level 1, A Drop of Colour (A Rainbow of Colour)*, p. 15<br>*Explorations in Science, Level 1, Primarily Colours (Projecting Colours)*, p. 160. | clear flat baking dish, water, overhead projector | Be careful not to spill water on the overhead projector. |
| Creating "rainbow milk" | 4 | *Innovations in Science, Level 1, A Drop of Colour (A Rainbow of Colour, In Action)*, p. 16 | milk, food colouring, detergent | |
| Making a wax-crayon picture, which is then washed over with a very thin layer of paint (a crayon wax resist) | 7 | | paint diluted with water, paint brushes, paper, crayons | Have the students experiment and paint over another picture with a thick layer of paint. |

## Assessment

For a broader discussion of science classroom assessment techniques see *Assessing Student Learning* in the introduction of this publication on p. 15. Good places to begin looking for the unit-related ideas are the *Explorations in Science* assessment handbooks, *Innovations in Science* teaching notes, Unit tests and Portfolio ideas, Alberta Education sample tests at **www.education.gov.ab.ca** and Alberta Assessment Consortium at **www.aac.ab.ca**

## Bibliography

de Paola, Tomie. *The Legend of the Indian Paintbrush*. New York: G.P. Putnam's Sons, 1988. ISBN 0-39921534-4.

Campbell, Steve et al. *Explorations in Science, Level 2: Assessment Handbook*. Don Mills, Ontario: Addison-Wesley, 1993. ISBN 0-201-60684-4.

Campbell, Steve et al. *Explorations in Science, Level 1, Primarily Colours*. Don Mills, Ontario: Addison-Wesley, 1992. ISBN 0-201-88137-3.

Garcia, Marcia. *The Adventures of Connie and Diego*. San Francisco, California: Children's Book Press, 1987. ISBN 0-89239028-X.

Humphrey, Margo. *The River that Gave Gifts: An Afro-American Story*. San Francisco: Children's Book Press, 1987. ISBN 0-89239019-0.

Jeunesse, Gallimard and Pascale de Bourgoing. *Colours*. New York: Cartwheel/Scholastic, 1991. ISBN 0-59045236-3.

Leonard, Marcia. *Paintbox Penguins*. Mahwah, New Jersey: Troll Associates, 1990. ISBN 0-8161716-8.

Lionni, Leo. *Little Blue and Little Yellow*. Astor Honor: I. Obolensky, 1959. ISBN 0-83923018-4.

O'Neil, Mary. *Hailstones and Halibut Bones: Adventures in Colour*. New York: Doubleday, 1989. ISBN 0-3852-4484-3.

Peturson, Rod and Neil McAllister, *Innovations in Science, Process and Inquiry, Level 1*. Toronto: Harcourt Brace & Company, Canada, 1996. ISBN 0-7747-0188-9.

*Primarily Physics*. AIMS Education Foundation, 1994 ed.

Quinlan, Patricia. *Anna's Red Sled*. Scarborough, Ontario: Annick Press, 1989. ISBN 1-55037073-1.

Richards, R. et al. *An Early Start to Science*. Hemel Hempstead, England: Simon and Schuster Education, 1987. ISBN 0-7501-0000-1.

Stinson, Kathy. *Red is Best*. Scarborough, Ontario: Annick Press, 1982. ISBN 0-92023624-3.

Stinson, Kathy. *Those Green Things*. Scarborough, Ontario: Annick Press, 1995. ISBN 1-55037377-3.

Tolley, K. *The Art and Science Connection for Primary Students*. Menlo Park, California: Addison-Wesley, 1993. ISBN 0-201-45544-7.

Troughton, Joanna. *How the Birds Changed Their Feathers*. London, England: Blackie and Son, 1976.