# Luminous Spaces (Level 3)

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| **Description** | Learners will create a model of a room that gets completely lit up by one beam of light entering through a small opening. They will achieve this by manipulating the light beam using plane and curved mirrors, as well as lenses. |
| **Leading question** | Can I light up an entire room using one thin beam of light? |
| **Subjects covered** | Science, Art & Design, Literacy |
| **Total time required** | 40-60 min a day for 5 days |
| **Resources required** | A cardboard box, colours, drinking straws, rocks, sticky tape, scissors, shiny spoons, pocket mirror, torch, old eyeglasses<br><br>Alternatives: a thick sheet of paper instead of the cardboard box |
| **Learning outcomes:** | By the end of this project, learners will be able to:<br><br>Knowledge-Based Outcomes:<br>1. Differentiate between different types of mirrors and lenses based on their structure.<br>2. Compare the interaction of light between plane and curved mirrors.<br>3. Compare the interaction of light between convex and concave lenses.<br>4. Compare the images formed due to the reflection of light in different mirrors.<br><br>21st Century Skill Outcomes:<br>1. Think critically by analysing which sequence or placement of optical devices is most conducive to illumination.<br>2. Think creatively in making miniatures of objects for the model and using lateral inversion in the model of the room.<br>3. Communicate effectively while presenting the model to their families. |
| **Previous Learning** | Light bouncing off objects and reaching our eyes helps us to see them. |
| **Supervision required** | Medium |

## Day 1 -

*Today, you will find out how light travels and start making your room model.*

| Time | Activity and Description |
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| 10 minutes | **Introduction**<br>Imagine entering a dark room full of various objects. You find a light switch and turn on a bright bulb.<br>- Will the objects in the room be visible to you before you turn on the bright bulb? Why? *(Take responses)*<br>- What happens when we turn on the bright bulb that makes it possible for us to see the objects? *(Take responses)*<br>- What if we turn on a very dim bulb instead? Will the objects be as clearly visible as in the case of a bright bulb? Why? *(Take responses)*<br><br>When a bright bulb is turned on, the light that it produces hits the objects in the room, bounces off them, and enters our eyes. This makes it possible for us to see these objects. If a dim bulb is used, the amount of light that bounces off objects and enters our eyes is much lesser, which makes objects less clear.<br><br>In this project, we will make a model of a similar dark room. We will allow only a thin beam of light to enter it. |
| 15 minutes | **Rectilinear Propagation of Light**<br>Let us first understand how light travels by performing an activity!<br>- Place a sheet of paper on the desk/ table. We will use this as the surface to glow light on during the activity.<br>- Cut out a disk of cardboard/ thick sheet of paper that matches the size of the opening at the front of the electric torch.<br>- Now cut out a small hole in the middle of the disk. Make sure that the hole is narrower than the drinking straw.<br>- Fix this disk on the opening of the torch using sticky tape.<br>- Place one end of the straw on the torch opening.<br>- Holding the torch and the straw carefully, aim the other end of the straw on the sheet of paper.<br>- Switch the torch on.<br>- Now bend the straw slightly in the middle in such a way that one group member can still blow air through it, and repeat the activity.<br><br>  |

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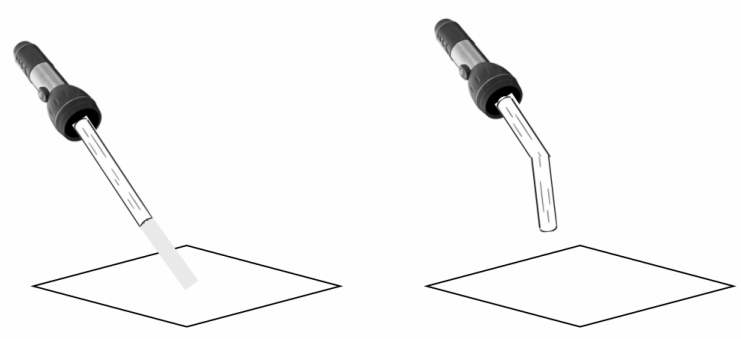
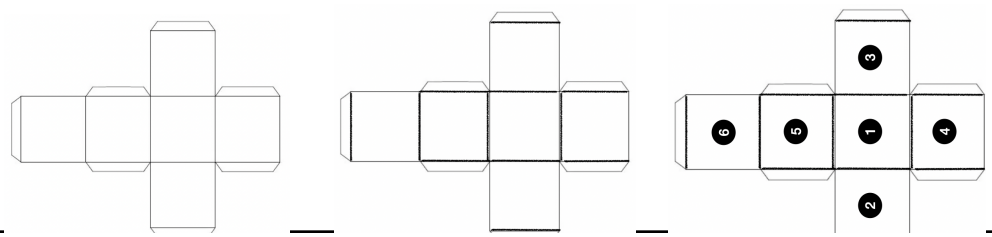
| |  <br><br>How were your observations different in the case of the bent and the unbent straws? *(Take responses)*<br>- Why do you think the observations were different?<br>- Would you be able to drink water using the bent straw? How do you know?<br>- How is the way light travels through a pipe different from water?<br><br>You could see the glow of light on the surface in the case of the unbent straw. However, you could not see the glow of light in the case of the bent straw. This happened because light could not travel through the bent straw and reach the surface. This tells us that, unlike water, light does not take turns when it travels. It travels only along a straight path.<br><br>We will use this understanding when we aim a single beam of light into our room models. |
| 15 minutes | **Making the Room Model**<br><u>Part 1: Constructing the room model</u><br>We will use a cardboard box as our room model.<br><br>***Tip**: If a cardboard box is unavailable, ask learners to follow these steps to make a box to be used as the room model using thick paper:*<br>- *Cut out 6 square pieces and 6 strips of thick paper, and organise them, as shown.*<br>- *To make sure that the room is large enough, make sure that the square pieces are at least 15 cm x 15 cm.*<br>- *Rectangular strips should be the same length as the square pieces.*<br>- *Tape each connection using one or two long pieces of tape, as shown.*<br>- *Fold 2, 3, 4 and 5 over 1, and then fold 6 to shut the box.*<br><br>*This is your room model (1 is the floor; 2, 3, 4, and 6 are the walls; and 6 is the ceiling)*<br><br>  |

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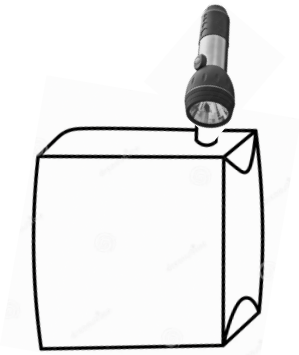
| | Step 1 Step 2 Step 3<br><br>Part 2: Making Entry for a Beam of Light<br>- Take a drinking straw and use a pencil to make a hole in the ceiling. Make sure that the hole is slightly smaller than the straw.<br>- Stick the straw through the hole. This is where the beam of light will enter your room.<br>- Close the room, switch the torch on, and aim it on the pipe so that light passes through it.<br>- Look through the door to check if only one beam is entering the room.<br>- Make any fixes if you need to.<br><br>  <br><br>Part 3: Painting Outer Walls<br>Paint your room model! You can choose to either glue pieces of paper on the outer walls or use colour. Make sure you don't end up shutting the pipe! |
| **At home activities** | Think of different objects you want in the room (a bed? a study table? a painting for one of the walls?)! Use cardboard/ paper to make tiny models of these objects and colour them as you like! |

## Day 2

*Today, you will explore how plane mirrors interact with light, identify the characteristics of images formed by them, and use your learnings to work on your room model.*

| Time | Activity and Description |
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| 10 minutes | **Reflection of Light by Plane Mirrors**<br>Glow a torch on a pocket mirror at some angle.<br>- Do you see the glow of your torch elsewhere in the room? *(Take responses)*<br>- What does this tell you about how plane mirrors behave with light? *(Take responses)*<br><br>Light bounces off or gets reflected when it hits a plane mirror. This is why it changes its path and we see a glow elsewhere in the classroom.<br><br>Now, take turns to move the torch and the mirror in such a way that you make the reflected light fall at a specific spot in the room.<br>- How did you do this? *(Take responses)*<br>- What does this tell you about how plane mirrors behave with light? *(Take responses)* |

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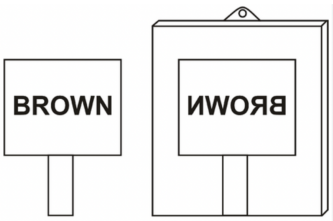
| | Light bounces off plane mirrors like a ball changing its direction after hitting a wall! |
| 15 minutes | **Characteristics of Images Formed by Plane Mirrors**<br>Look at the pocket mirror. What do you see? *(Take responses)*<br><br>You see your image in the pocket mirror because mirrors not only reflect light but also form images. Let us explore the properties of images formed by plane mirrors.<br>- Place a pocket mirror at a fixed spot on the desk/ table.<br>- Write the word BROWN on a piece of paper.<br>- Take turns to hold the piece of paper in front of the plane mirror and look into it.<br>- How does the word BROWN appear in the mirror? Where is the letter B written in the image? Where was it originally written on the paper? What happened to the letters B, R and N? Why?<br>- Did the same happen to letters O and W? Why?<br><br>  <br><br><br>The word BROWN became flipped horizontally or laterally inverted but remained upright in the mirror. This is why<br>- the letter B - originally on the left - appears to be on the right in the image.<br>- individual letters - B, R and N - got laterally inverted as well. Their left portion on the paper became the right portion in the mirror, and they looked funny! This phenomenon is called **lateral inversion**.<br>This did not happen with O and W because their left and right portions look exactly the same |
| 15 minutes | **Installing Plane Mirrors in the Room Model**<br>Based on how plane mirrors interact with light, think about how you would use plane mirrors in your room model.<br>- Try out different ways in which you would like to use one or more mirrors.<br>- Test what happens by shining a beam of light into your room model using the torch.<br>- Try to illuminate some objects that you have created so far by placing one or more mirrors in different ways.<br>- Think about ways in which you can use lateral inversion in your room in creative ways! (Can you have a painting/ writing on a wall that gets reflected in a mirror? Can you form a word with letters that do not get laterally inverted?)<br><br>Use tape to secure the arrangement in a manner that allows for easy reorganisation if necessary. |
| **At home activities** | Show your progress to a friend and ask them to help improve the arrangement to cause more illumination.<br>Find out some applications of plane mirrors in our day-to-day lives.<br>Think and list other letters that would not show lateral inversion. Test these with a plane mirror at home to check your answer! |
| **Literacy Extension (Optional)** | **Personification: A Day in the Life of a Mirror** |

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| | Personification is when we give human qualities or characteristics to nonhuman things or objects. It's like imagining that something that is not alive, such as a mirror, can think, feel, or behave like a person.<br><br>Let us read a small paragraph that personifies an eraser to understand this:<br>"The eraser was excited and waiting on the desk. It wanted to be used to fix mistakes! It imagined itself as an artist, making the pencil marks disappear. The eraser was happy to help the paper to be free from mistakes!"<br><br>Now, let us write a story titled 'A Day in the Life of a Mirror,' personifying the mirror. You can use the format given below to write your story:<br>- Introduction: Start by introducing the mirror as the main character of your story. Describe where the mirror is located, like in a bedroom or a bathroom.<br>- Appearance and Feelings: Describe what the mirror looks like. Is it big or small? Does it have a fancy frame? Imagine how the mirror might feel about itself. Does it feel proud or happy to reflect the world?<br>- Interactions: Explain how different people or objects interact with the mirror throughout the day. Maybe a child admires their reflection before school or a family member fixes their hair in front of the mirror.<br>- Emotions and Thoughts: Explore the mirror's emotions and thoughts. Does it ever feel sad when it sees someone who looks unhappy? Does it feel happy when it sees someone smiling?<br>- Conclusion: Finish the story by highlighting the mirror's role in people's lives and how it eagerly awaits the next day. |

## Day 3 –

*Today, you will explore how curved mirrors interact with light and use your learnings to work on your room model.*

| Time | Activity and Description |
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| 5 minutes | **Uses of Plane Mirrors**<br>What are some uses of plane mirrors that you found out about? *(Take responses)*<br><br>Plane mirrors are used in:<br>- Our homes: for daily activities such as checking our appearance or combing our hair.<br>- Periscopes: these are devices that allow people to see over obstacles, such as in submarines. |
| 15 minutes | **Reflection of Light by Curved Mirrors**<br>Just like plane mirrors, curved mirrors also reflect light. Let us do an activity to find out how curved mirrors behave with light!<br><br>We will use a shiny spoon as two circular mirrors for this activity.<br>- Which part of the spoon will behave like a convex mirror? *(Take responses - the portion curved outwards)* |

- Which part will behave like a concave mirror? *(Take responses - the portion curved inwards)*

***Tip**: If learners do not recall/ know the terms convex and concave mirrors, teach them to associate "con**cave**" with "a **cave** that you can enter because it curves inwards" to help them remember.*

A thin beam of light will help us understand how curved mirrors work better. Therefore, we will use the torch with its opening made smaller, which we used in the previous class.

- Place a sheet of paper at a spot on the desk/ work area. This is where we will try to reflect light during the activity.
- Hold the spoon horizontally.
- First, keep the opening of the torch about an arm's length away from the spoon. Point the light beam first towards the convex mirror and then the concave mirror.
- Now, bring the opening of the torch as close to the spoon as possible. Point the light beam again first at the convex mirror and then the concave mirror.
- In each case, make sure the reflected light falls on the paper.

***Note**: Get learners to draw the table shown below and fill in their observations and inferences in it.*

| Portion of spoon | Is the spot of reflected light wider or narrower than the torch opening? | What does it tell you about the mirror? |
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| Convex | | |
| Concave | | |

Convex mirrors usually spread out or diverge light. Concave mirrors focus or converge light. If the source of light is placed very close to the concave mirror, it diverges light.

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| 20 minutes | **Installing Curved Mirrors in the Room Model**<br>Based on how curved mirrors interact with light, think about how you would use convex and concave mirrors in your room model.<br>- Try out different ways in which you would like to use one or more mirrors.<br>- Test what happens by shining a beam of light into your room model using the torch and spoons.<br>- Try to illuminate some objects that you have created so far by placing one or more spoons in different ways.<br>- Try using curved mirrors in combination with one or more plane mirrors.<br><br>Use tape to secure the arrangement in a manner that allows for easy reorganisation if necessary. |
| **At home activities** | Show your progress to a friend and ask them to help improve the arrangement to cause more illumination.<br>Find out some applications of convex and concave mirrors in our day-to-day lives. |

## Day 4 –

*Today, you will explore how lenses interact with light and use your learnings to work on your room model.*

| Time | Activity and Description |
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| 5 minutes | **Uses of Curved Mirrors**<br>What are some uses of curved mirrors that you found out about? *(Take responses)*<br><br>Convex mirrors are used<br>- as side-view mirrors in cars because the images they form are smaller than the objects. This helps drivers to get a wider view.<br>- in street lamps because they spread out or diverge the light falling on them. This helps the light from bulbs to fall on a larger area on the street/ road.<br>Concave mirrors are used<br>- in electric torches because they focus or concentrate the light falling on them. Take a look at the torch you are using. Can you see a concave mirror behind the bulb?<br>- make-up mirrors because they form large images when objects are placed close to the mirror. This helps people see parts of their faces more closely. |
| 15 minutes | **Interaction of Light with Lenses**<br>Have you ever seen or used a pair of eyeglasses/ spectacles? How are they useful to us? *(Take responses)*<br>- Eyeglasses contain pieces of curved glass called lenses. Unlike mirrors, lenses do not reflect light and allow it to pass through them. However, they affect light in other ways.<br>- How do lenses affect light? Do all lenses affect light in the same way? Let us do an activity to find out! |

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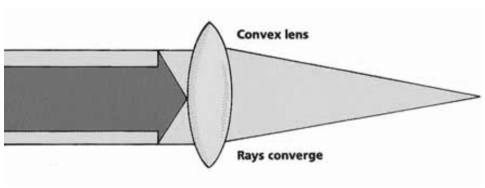
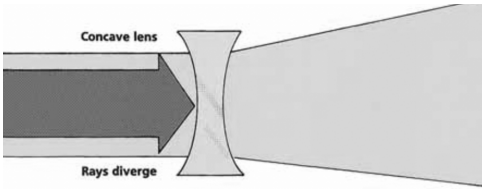
| | ***Note:*** *Demonstrate this activity to learners by following the steps below. If possible use eyeglasses with thick lenses/ high power so that light converges and diverges more clearly.*<br>● *Explain the use of resources in the demonstration:*<br>○ *Convex lens - A transparent plastic bag full of water (positive power)*<br>○ *Concave lens - A pair of near-sighted glasses (negative power)*<br>○ *Source of light - A torch*<br>● *Carry out the demonstration:*<br>○ *Convex lens*<br>■ *First hold the plastic bag full of water above a sheet of paper placed on the table.*<br>■ *Glow light on the top of the convex lens.*<br>■ *Ask learners to observe if the spot of light on the sheet of paper looks narrower or wider than the original beam of light.*<br>○ *Concave lens*<br>■ *First hold the reading glasses above a sheet of paper placed on the table.*<br>■ *Glow light on the top of one of the lenses of the reading glasses.*<br>■ *Ask learners to observe if the spot of light on the sheet of paper looks narrower or wider than the original beam of light.*<br><br>- How were the spots of light on the paper different in the two cases?<br>- What does this tell you about how concave and convex lenses behave with light?<br>- Concave lens spreads or diverges light while convex lens focuses or converges light.<br><br>  <br>  |
| 20 minutes | **Installing Lenses in the Room Model**<br>Based on how lenses interact with light, think about how you would use convex and concave mirrors in your model room.<br>- After this, test the old/ broken eyeglasses to find out if they contain convex or concave lenses, just like we did during the demonstration earlier..<br>- Based on what you find, think of different ways in which you would like to use one or more lenses.<br>- Test what happens by shining a beam of light into your model room using the torch.<br>- Try to illuminate some objects that you have created so far by placing one or more lenses in different ways.<br>- Try using lenses in combination with plane and curved mirrors.<br><br>Use tape to secure the arrangement in a manner that allows for easy reorganization if necessary. |
| **At home activities** | Show your progress to a friend and ask them to help improve the arrangement to cause more illumination. |

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| | Find out some applications of lenses in our day-to-day lives. |

## Day 5 -

*Today, you will finalise the placement of mirrors and lenses in your room model for maximum illumination, and present your models to your family.*

| Time | Activity and Description |
|---|---|
| 5 minutes | **Uses of Lenses**<br>What are some uses of lenses that you found out about? *(Take responses)*<br><br>Convex lenses are used<br>- in magnifying glasses because they make small objects appear larger.<br>- in eyeglasses for people who struggle to see objects close to them.<br>- in cameras because they focus light onto the image sensor and help capture clear and sharp photographs.<br>Concave lenses are used<br>- in eyeglasses for people who struggle to see objects far from them.<br>- in projectors in cinema halls and conference rooms because they spread light out onto big screens. |
| 15 minutes | **Model Room Completion**<br>● Finalise the positions of different objects in the room.<br>● Place the different mirrors and lenses at desired positions and test the arrangement with a beam of light. Make any changes you need to make in these positions to achieve maximum illumination.<br>● Now, use sticky tape to fix mirrors and lenses to rocks so that you can place them properly.<br>● Test again to see if everything is working properly.<br>● Make any final fixes, if needed. |
| 10 minutes | **Presentation**<br>Present your room model to your family. As you walk them through the model, explain the following:<br>- why you placed different objects at particular spots in the room,<br>- how you organised different mirrors and lenses, and<br>- how light travels through the room to illuminate different objects.<br><br>After the presentation, seek feedback on:<br>○ Two things that they admire about the project<br>○ One thing that they think you can improve in it |
| 5 minutes | **Reflection**<br>Based on your experience of working on this project, think about and share:<br>● what you did not know before working on the project, and learnt about as you worked on the project;<br>● what went well; and<br>● what you would do differently in the next project. |

<table>
<tr><td>Additional enrichment activities:</td><td>Learners can explore the characteristics of images formed by curved mirrors by performing an experiment using an object and a shiny spoon. They will place the object at different distances from the spoon and record the characteristics of the image formed in the table shown below.<br><br>
<table>
<tr><td></td><td>Distance between the object and the mirror</td><td>About 30 cm</td><td>About 20 cm</td><td>About 10 cm</td><td>About 5 cm</td></tr>
<tr><td rowspan="2">Convex</td><td>Is the image erect or inverted?</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Is the image bigger or smaller than the object?</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Concave</td><td>Is the image erect or inverted?</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Is the image bigger or smaller than the object?</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">What do you conclude from this?</td><td colspan="4"></td></tr>
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</td></tr>
<tr><td>Modifications for simplification</td><td>Learners can use only plane and curved mirrors in their model rooms.<br>Learners can organise mirrors and lenses on a flat surface and show how a beam of light gets reflected, concentrated and spread out as it interacts with each optical device.</td></tr>
</table>

## ASSESSMENT CRITERIA

A majority of my learners were able to
☐Explain how plane mirrors interact with light
☐Explain and illustrate how curved mirrors interact with light
☐Explain and illustrate how lenses interact with light
☐ Create models that appropriately use different mirrors and lenses to reflect, converge or diverge light