

# Lighting up the Shadows

YEAR 5 – PHYSICS: LIGHT



**QGC**

**FUTUREMAKERS**



**QUEENSLAND  
MUSEUM NETWORK**



**Queensland  
Government**

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## Glossary



Writing exercise



Group activity



Go! – hands on exercise



Check List



Need to know information



Watch a video



Take a photo

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Future Makers is an innovative partnership between Queensland Museum Network and Shell's QGC project aiming to increase awareness and understanding of the value of science, technology, engineering and maths (STEM) education and skills in Queensland.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of students in STEM-related subjects and careers — creating a highly capable workforce for the future.

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# Australian Curriculum Links

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## YEAR 5

### **Science Understanding**

#### **Physical sciences**

Light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080)

### **Science as a Human Endeavour**

Science involves making predictions and describing patterns and relationships (ACSHE061)

Science knowledge helps people to understand the effect of their actions (ACSHE062)

### **Science Inquiry Skills**

With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge (AC SIS064)

With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment (AC SIS065)

Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately (AC SIS066)

Represent and communicate observations, ideas and findings using formal and informal representations (AC SIS071)

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# Introduction

This learning resource consists of a number of engaging activities on the properties of light which can be completed either onsite or offsite, or in combination. Part 1 features a structured series of activities which allows students to explore exhibits focused on light in *SparkLab, Sciencentre*. These include: Mirror Mirror, Seeing Colour, Coloured Shadows and Frozen Shadows.

In Part 2, students are given the opportunity to explore the properties of light further by designing and creating their own shadow puppets on a theme or topic. Our recommended inspiration is Queensland's Biodiversity which is beautifully presented in our exhibition *Wild State*, at the Queensland Museum, South Brisbane.

## Suggested approach:

**Part 1:** Visit *SparkLab, Sciencentre* at Queensland Museum and complete Student Worksheet 1.

**Part 2:** Complete Exploring Light & Shadow - Student Worksheet 1, prior to undertaking Exploring Light with Shadow Puppets Activity, (both can be completed in the classroom).

It is recommended that **Step 2 Investigate** from Exploring Light with Shadow Puppets is completed while experiencing our exhibition *Wild State* during your visit to the Queensland Museum. This provides a memorable and highly motivational learning environment for your students.

**Part 3:** Teacher Notes, assists you in the implementation of Part 1 & 2



# Wild State as inspiration



Image: Students creating shadows on the floor of Wild State with overhead image projectors. Source: Queensland Museum Image Collection

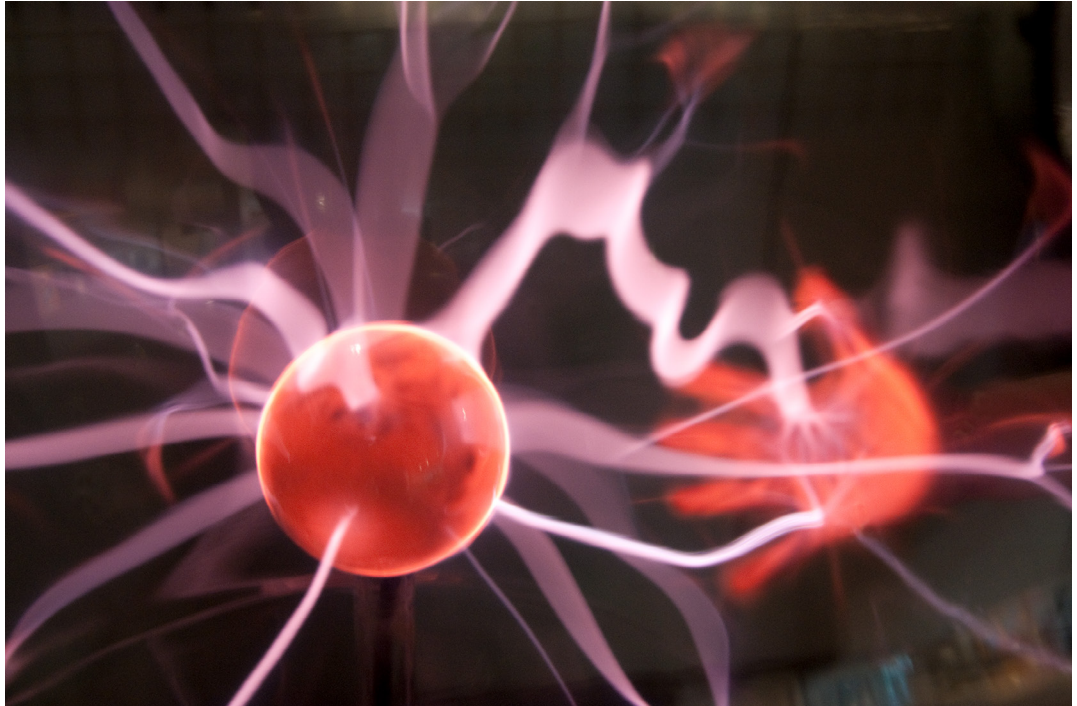
Combine your visit to the Queensland Museum with the visual feast of Queensland's biodiversity on display in our exhibition *Wild State*. *Wild State* explores the five major types of habitats in Queensland: Arid Outback, Open Forest, Rainforest, Coastal and Marine. These habitats are shaped by a number of forces, with the availability of water being the pivotal force. To survive, Australian animals have adapted to these diverse habitats which has given rise to the huge biodiversity in Queensland.

This exhibition is presented by the Queensland Museum to increase our understanding and valuing of Queensland's unique animals and habitats, encouraging all of us to take action to support a sustainable future.

The following questions may be useful in stimulating ideas for the shadow puppet presentations:

- **How have animals adapted in their habitat to survive?**
- **How do humans impact on these habitats and ultimately the animals?**
- **What is the role of water in shaping these habitats?**
- **What is the role of scientists in looking after our natural world and how can you as an individual and as a community help?**

# Part 1: Exploring Light at the *SparkLab, Sciencentre*



Source: Queensland Museum Image Collection

*SparkLab, Sciencentre* aims to inspire you to be a scientist, and to explore and discover the wonder of the world around you. The interactives and experiences help us appreciate and value that science and maths are relevant in our everyday world, and that we can apply STEM knowledge and skills to enrich and impact our lives.

## **The interactive gallery is divided into three sections:**

1. Our world and how it works
2. How do we perceive our world? Do we all perceive it the same way?
3. How can we change our world? What does this change do?



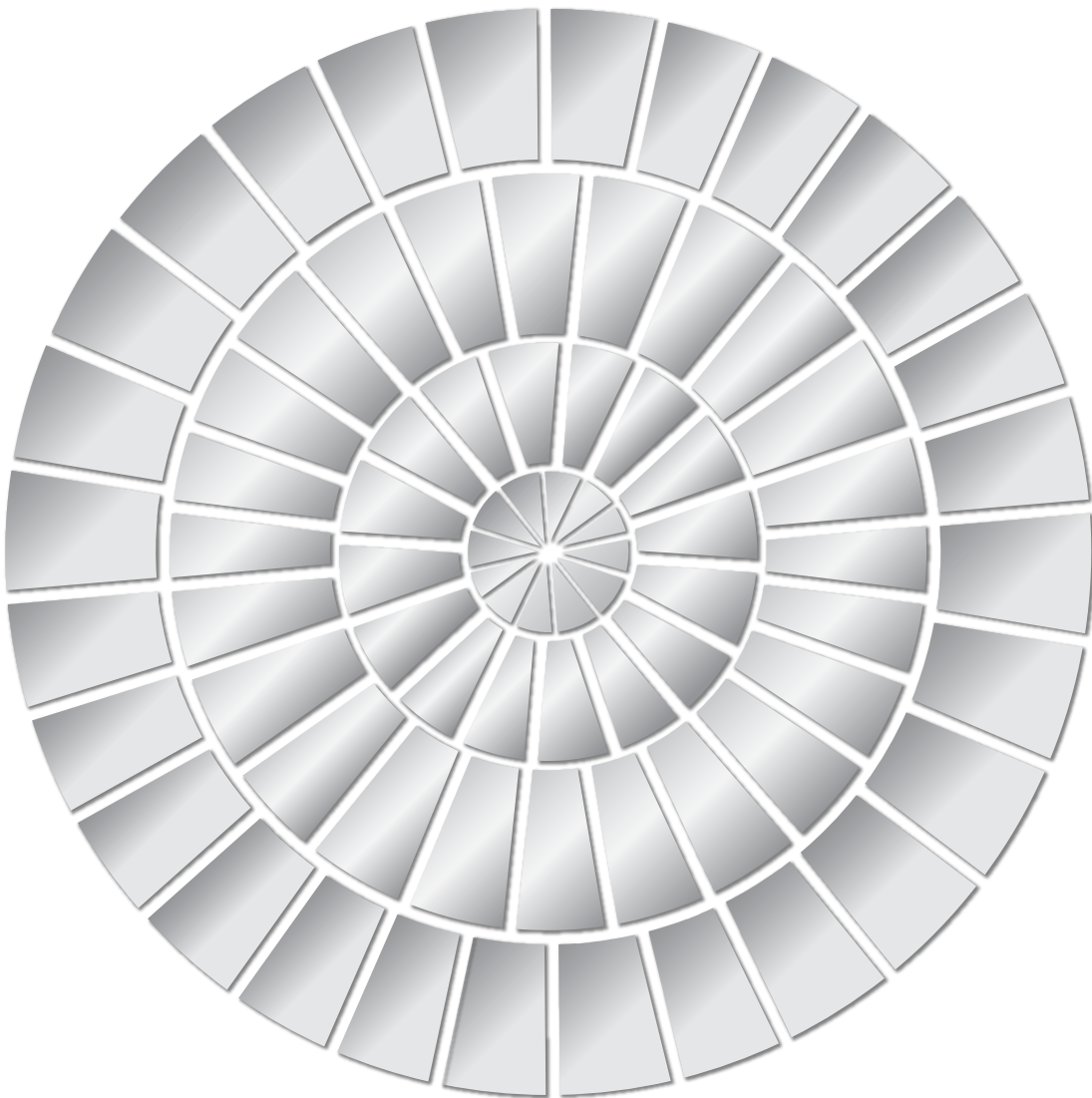
## **Task:**

Check out each of the four interactive exhibits below in any order, and discover some really amazing properties of light. Complete the relevant section on Student Worksheet 1 for each of these exhibits.

- **Mirror Mirror**
- **Seeing Colour**
- **Coloured Shadows**
- **Frozen Shadows**

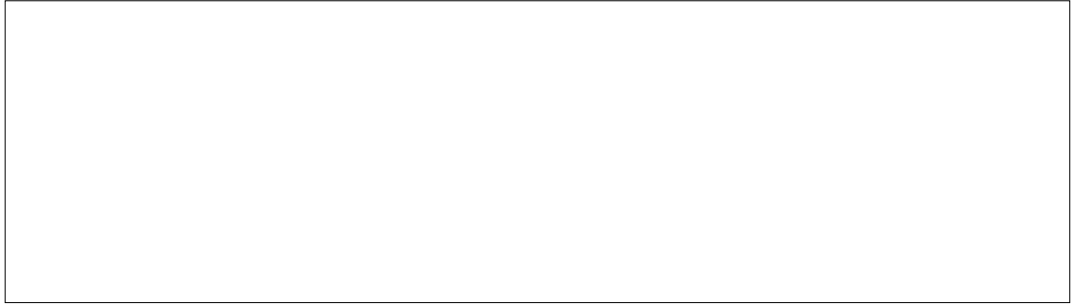
# Mirror Mirror

Mirror Mirror is made out of about 100 flat stainless-steel mirrors arranged in a curved shape. The mirrors are placed at angles so that they create an inwards curve similar to a concave mirror.

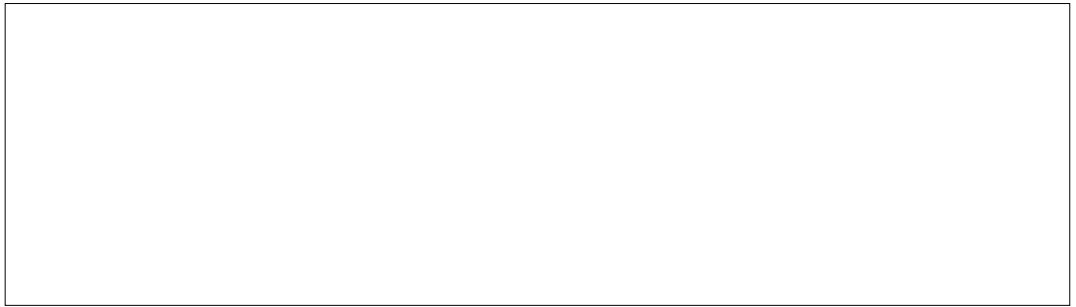


*Image: Mirror Panels. Source: Queensland Image Collection.*

1. Stand in front of the mirror with your eye level with the centre.  
Describe what you can see.



2. What happens if you stand to one side?



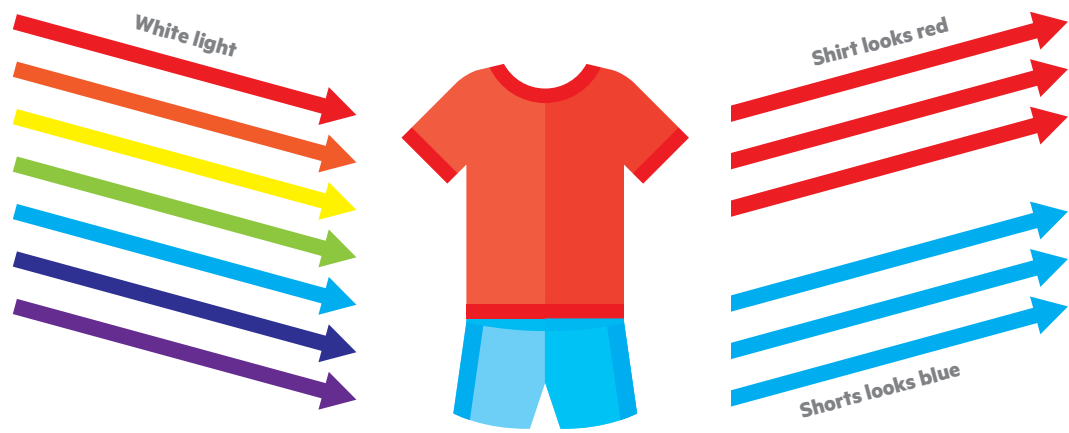


# Seeing Colour

1. Choose a variety of objects and write them in the column marked object.

Object	Red Light	Green Light	Blue Light	White Light

2. What colour do your objects appear under each of the following lights: red, green and blue? Complete the red, green and blue columns in the table above.
3. What colour do your objects appear under the white light of the torch? Complete the last column in the table.
4. How has your understanding of the colour of an object changed after experiencing the Colour Room?



Source: Queensland Museum Image Collection

# Coloured Shadows

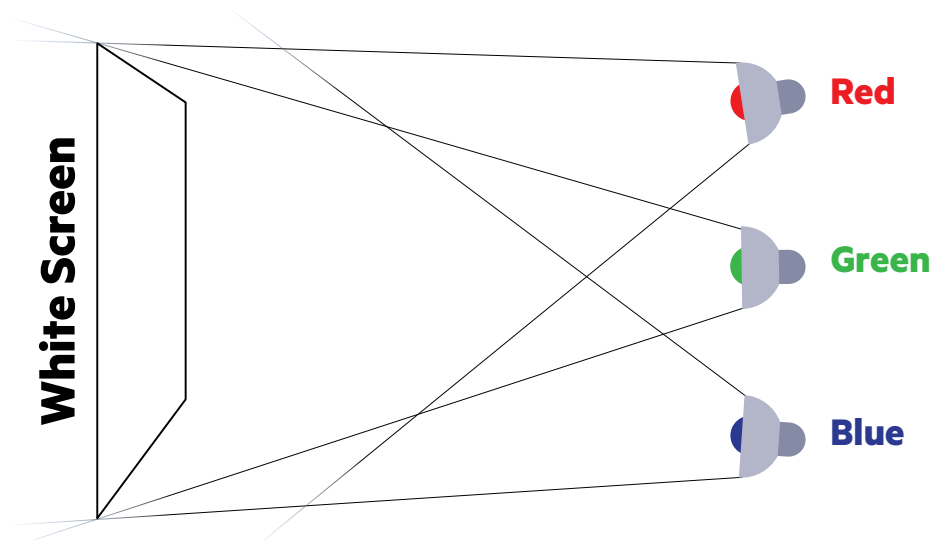
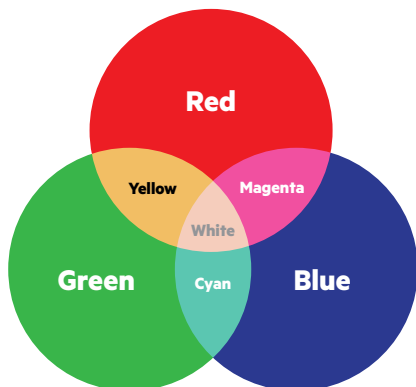
1. Position yourself in between the wall and the coloured lights. Move around and create different kinds of shadows. Describe in your own words what you see.

2. Experiment with moving closer and further away from the wall  
What happens to your shadows?

3. Complete the table below to show your understanding of what happens when coloured lights are mixed, and one or more of the coloured lights are blocked.

<b>Mixing Light</b> Red + Blue + Green = Red + Green =
<b>When you stand in front and block one or two lights, what coloured shadows will you see?</b> White – Green = White – Red =

4. Use coloured pencils to complete the following diagram on the right.



# Frozen Shadows

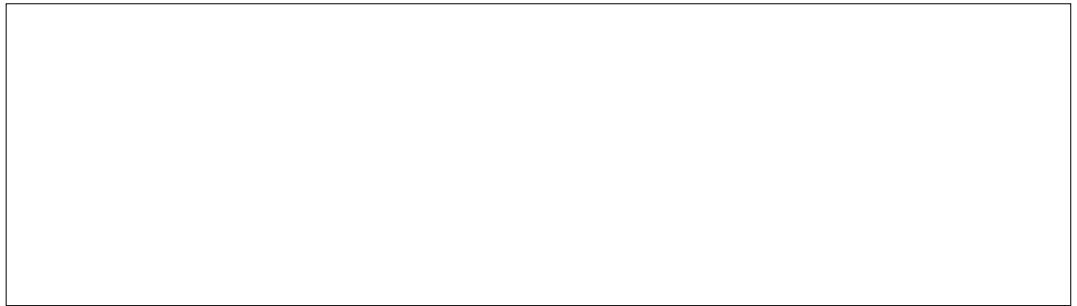


Source: Queensland Museum Image Collection.

1. In a group of three, strike a pose in front of the screen and wait for the flash of light. What do you see on the wall?

2. Do you block more light if you move closer or further away from the light?

3. How does moving closer to and further from the screen affect the size and sharpness of your shadow?



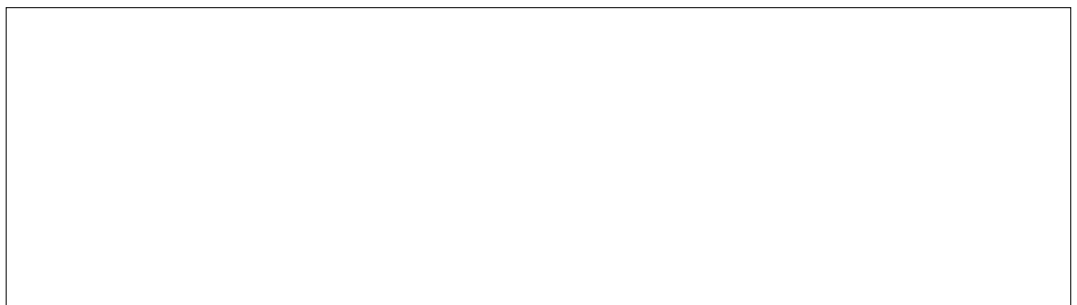
4. Strike a different pose with your group members in front of the screen. How does this affect your shadow?



5. Does this process of using light to capture an image remind you of anything? Why?



6. What is the special substance that coats the screen?



# MUSEUM PERSPECTIVES

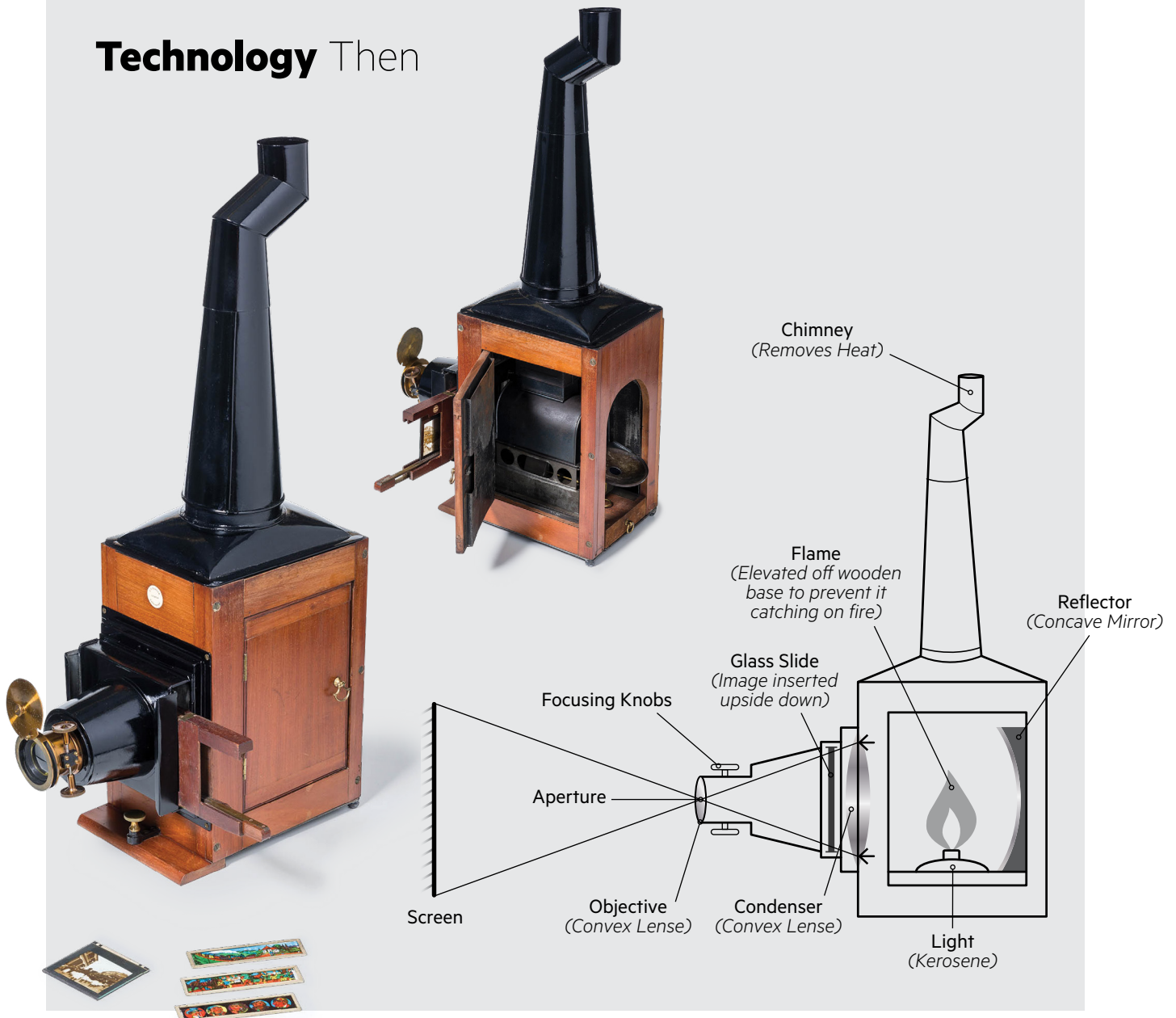
Museum objects can help us to understand how technology has changed and developed over time. Understanding the past informs the future and may provide ideas for future innovations.

Magic lanterns have been in use since the late 17th century. They project enlarged slide images onto a wall or screen. There is a concave mirror behind a light source that gathers the light and projects it through a slide with an image on it. The light rays cross an aperture (a hole or an opening through which light travels), and hit a lens which magnifies the picture for public view.

By the 20th century, most kerosene lamp magic lanterns such as this had come to be seen as children's toys, rather than serious projection equipment because of the invention of electric slide and roll-film projectors.

This object is believed to be part of the Marks collection donated to the Queensland Museum by Dr E.N. Marks. The Marks were a prominent Brisbane family who made significant contributions to the fields of science and medicine.

## Technology Then





## Technology Now



*Wild State exhibition. Source: Queensland Museum Image Collection*

## Use of Technology

### Investigation:

Have a look at the image projection used in the *Wild State* exhibition to enrich the visitor's experience. Identify what images are projected onto the floor during the 5 min presentation and what story it is telling?

How does it enrich your understanding and experience of the exhibition?

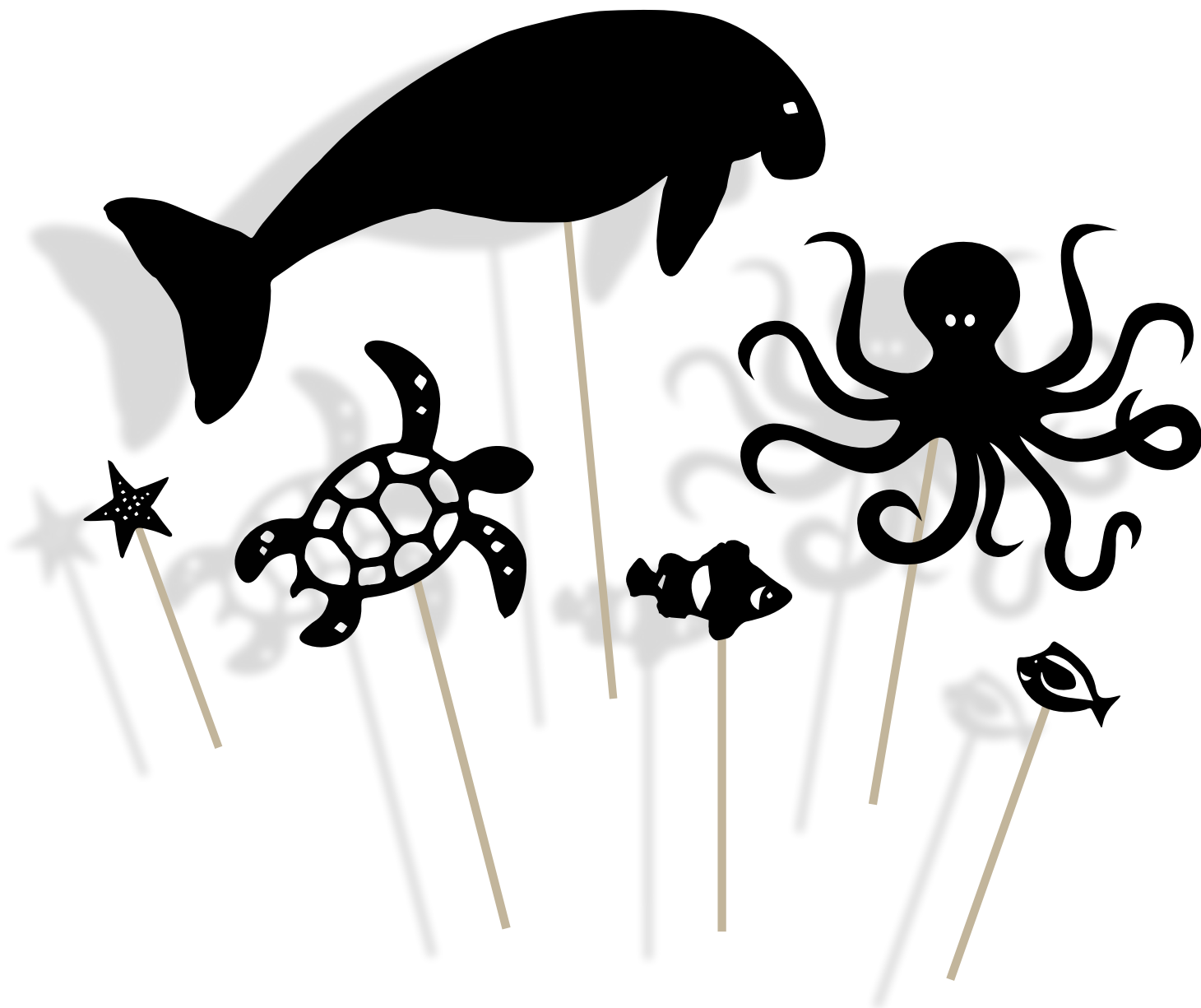
Look up and see what equipment has been used to project these images onto the floor. What is the purpose of the mirror? Why do you think it is that shape? (Devise an experiment to test your prediction and test it out once you get back to school.)

In the Marine habitat there is a more advanced *image projection system* which interacts with the visitor. What does it do?

**Further Research:**

How does this *image projection system* know where you are standing? **(CLUE: Infra-red light)**

## Part 2: Exploring Light with Shadow Puppets



This task provides you with the opportunity to extend your understanding of the properties of light which you gained from your experience in *SparkLab, Sciencentre*. You will design and create your very own shadow puppets, gaining inspiration from Queensland's unique biodiversity which is on display in our *Wild State* exhibition. You will experiment with different kinds of *transparent, translucent and opaque materials* and lighting effects, and develop a five minute shadow puppet presentation on a topic that you have learned about in *Wild State*.



## Materials

- Black Card
- Cellophane
- Various types of card, paper
- Scissors
- Craft knives
- Cutting Mats
- *Wild State* animal source material
- Wooden bamboo skewers/wire
- Tape
- Stick pins
- Translucent screen (white bedsheet)
- Frame to hang screen from
- 2-3 Light sources e.g. torches, reading lamps, fluorescent lights
- Coloured lights (red, green blue bulbs)
- Black marker pens

**This activity is divided into six stages.**



## Step 1: Investigate

**(during your visit to the Queensland Museum, South Brisbane)**

Walk through each of the five habitats on display in the *Wild State* exhibition.

As a starting point, think about the questions below and what story you could tell.

1. How have animals adapted in their habitat to survive?

2. How do humans impact on these habitats and ultimately the animals?

3. What is the role of water in shaping these habitats?

4. What is the role of scientists in looking after our natural world and how can you as an individual and as a community help?



**Visual Research** – Take photos of any animals you may need for your presentation ensuring you fill the viewfinder of your phone with the animals shape. Take photos of any written information from the exhibition that may be useful.

**Story Research** – Brainstorm any initial ideas you may have for a story. Limit the number of characters to 1 or 2 for each group member. (Your story could also include humans and their impact on the environment and animals.)



## Step 2: Develop Your Story

**(This step can be completed at the Museum or in the classroom)**

With the research you have gathered about your chosen environment, create a story that communicates how animals survive and live together in an interesting way. Use humour to make your story more memorable.





## Step 3: Design Your Shadow Puppet

(This step can be completed in the classroom)

Before you start designing your shadow puppets, watch this video:

[Puppets' shadows in a different light for kids.](#)

Richard Bradshaw got serious about making shadow puppets as a hobby while working as a teacher and he gradually became one of the world's best. His shadow puppet shows have enchanted children around Australia for generations.



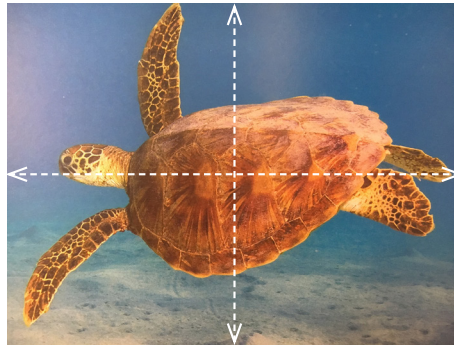
*Richard Bradshaw presenting on ABC's Play School. Source: Eileen Blumenthal.*



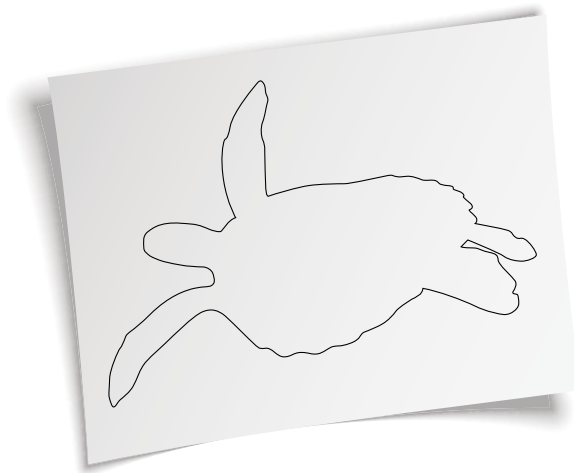
What makes a good design for a shadow puppet?

## Instructions

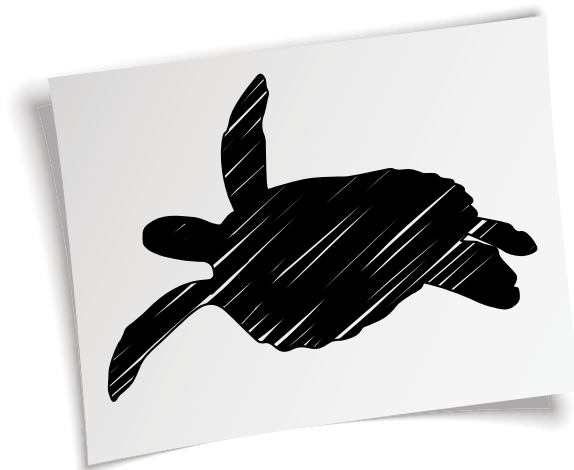
1. Download the photos you took in *Wild State* onto your computer.
2. Enlarge the photograph of the animal you would like to use for your shadow puppet so it fills as much of the space of an A4 format as possible.



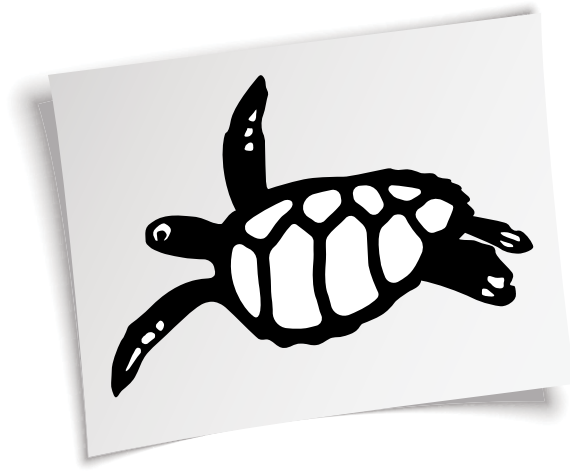
3. Print out your images in high contrast, i.e. black and white.
4. Tape the photograph of your animal to a naturally lit window. Place a second piece of A4 paper over the photograph and trace the outline of the animal



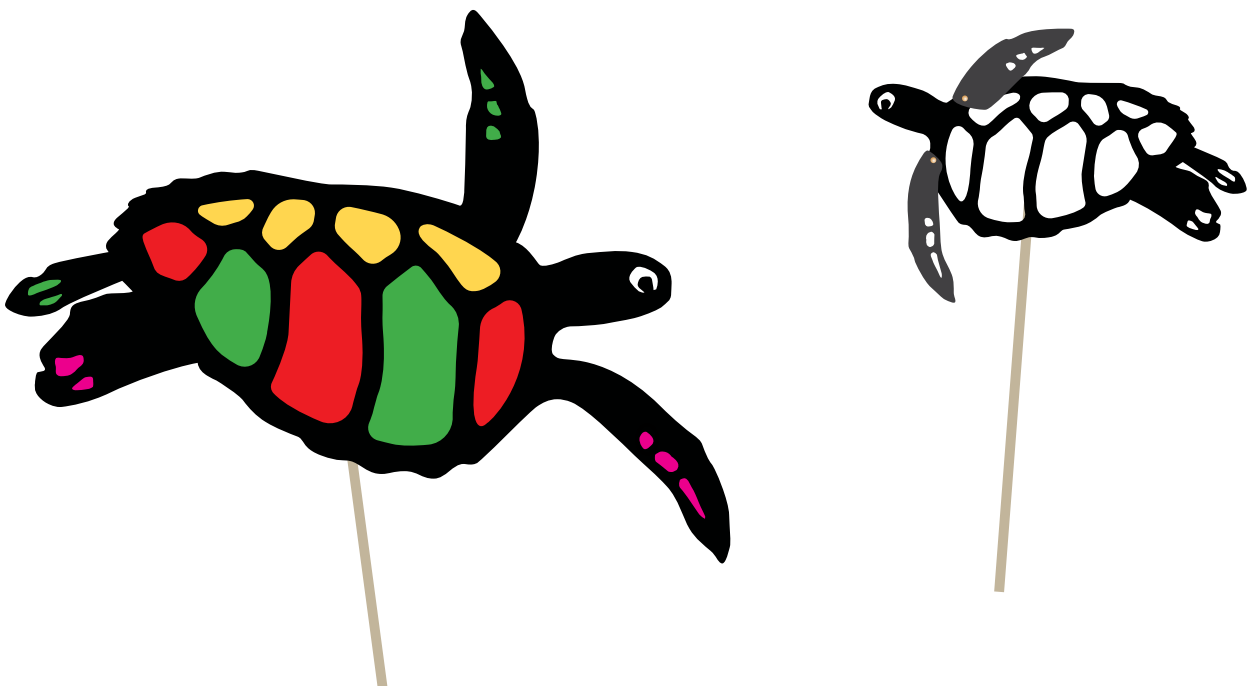
5. Fill your animal shape with solid black using a marker pen.



6. **Get creative.** Add any interior lines or shapes with a soft white pencil. At this stage you can simplify and stylise your design to enhance its effect as a shadow puppet. Shadow puppets can be very intricate; the addition of small holes allows the light to pass through and creates a more interesting design.



7. Carefully cut out all floating or interior shapes (these are the white shapes), with a craft knife. (Exercise caution if you are doing this yourself, or get an adult to help you.)
8. Cut around the outline of your animal using scissors. Use this as your template to trace your design onto other types of materials, (See Step 4: Investigate Use of Various Materials).
9. Add coloured bits of cellophane to some of the smaller shapes to add special effect when the light shines through it.
10. Will your animal or objects have any moving parts e.g. mouth or wings, joints, or legs? How will you make them move? Attach wooden skewers (or wire) to your shadow puppet and test out all moving parts. Refine your design if needed. You can also make other props for your story using the same process (e.g. objects, trees, buildings).





## Step 4: Investigate Use Of Various Materials

Using your template from Step 3, trace your finished design onto a variety of opaque, transparent and translucent materials so you can experiment with different lighting effects. These three characteristics of light will allow you to create a more interesting visual presentation.

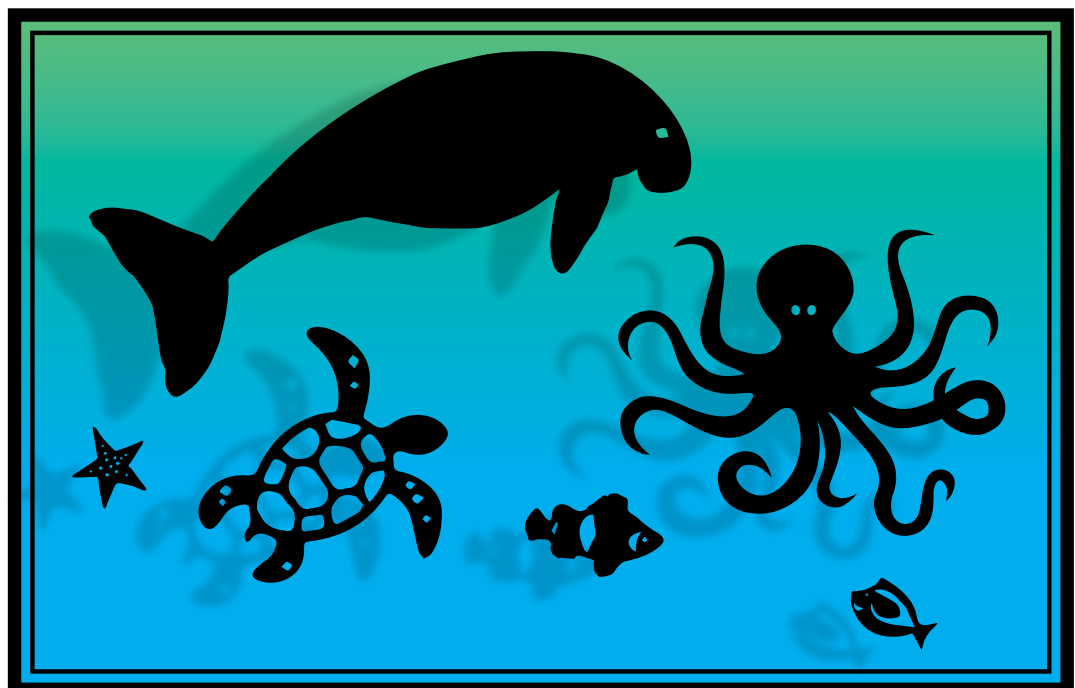
- **Opaque** materials (like black card) don't allow any light to shine through.
- **Transparent** materials (clear plastic), allows more light to shine through.
- **Translucent** materials (coloured cellophane, tissue paper), allows some light to shine through creating a more subtle effect for objects in the background.



### During this testing phase:

#### Checklist

- Move the puppet toward the light. ☐
- Move the puppet away from the light. ☐
- Add multiple puppets in front of the light to create a mega shadow. ☐
- Move the position of the light sources to either side of the puppet. ☐
- Put different colours of clear plastic in front of the light (e.g. soda bottle, lid, cellophane.) ☐
- Experiment with one light source initially. Try a second light source or even red, green or blue coloured lights. ☐
- Experiment with positioning of shadow puppet behind screen. ☐



*Use of coloured lights and shadows can greatly enhance your presentation: Source: Queensland Museum Image Collection*



## Step 5: Present your *Wild State* story using shadow puppets

- Finalise your story script and practice your presentation.
- Present your *Wild State* story using your shadow puppets.

### Reflection questions

What worked really well?

What would you change?

## Step 6: Complete Student Worksheet 2— Summary of Light & Shadows





## Student Worksheet 2— Summary of Light & Shadows

1. Using the knowledge you have gained from **Part 1: Exploring Light at SparkLab, Sciencentre** and **Part 2: Exploring Light with Shadow Puppets** draw *ray diagrams* for each of the following as a way of summarising what you have learnt about the properties of light.

1. Place an object made from an **opaque** material in the light path

Light Source 



2. Place an object made from a **transparent** material in the light path

Light Source 



3. Place an object made from a **translucent** material in the light path

Light Source 



4. Move the object **closer** to the light

Light Source 



Wall

5. Move the object **further** from the light

Light Source 



Wall

# Teacher Notes

## Part 1: Exploring Light at *SparkLab, Sciencentre*

### Mirror Mirror

- Exploring the use of mirrors to demonstrate the reflection of light
- Reflected light always leaves the reflecting surface at the same angle as it strikes the surface

Mirror Mirror is made out of 100 flat stainless-steel mirrors arranged in a curved shape. The mirrors are placed at angles so that they create an inwards curve similar to a concave mirror.

When a light ray from an object is reflected by a mirror and reaches your eye, your brain makes no allowances for the fact that this is a reflection. Instead, your brain traces the light rays back in a straight line to where they seem to be coming from. When you look into a flat mirror, you perceive a virtual image of the object that seems to come from behind the mirror.

When many flat mirrors are placed into a curved shape, light is reflected back at different angles. This means that an object can appear as a slightly different reflection in every mirror, creating the illusion of many repeated reflections. If you stand in front of the mirror with your eye level with the centre, then you'll see yourself reflected over and over again in the mirrors. If you stand to one side, your repeated image will only be visible to someone standing on the opposite side.

## Science meets Art

### Further Research:

[The Parabolic Mirror Has a Thousand Eyes, 1958-61](#). Berenice Abbot. Berenice Abbot used a mirror like this one to create her iconic photograph "A Thousand Eyes". To take this photograph she actually took a photo of her own eye first and put it on a stand at a precise location in front of a mirror. She made a swing to help her move up and down and get exactly the right spot – so that both the mirror and the stand would be in shot, and to capture the photo of her eye repeated in every individual mirror. Berenice did many experiments with photography to take scientific photographs like this one which demonstrate key principles in physics.

## Seeing Colour

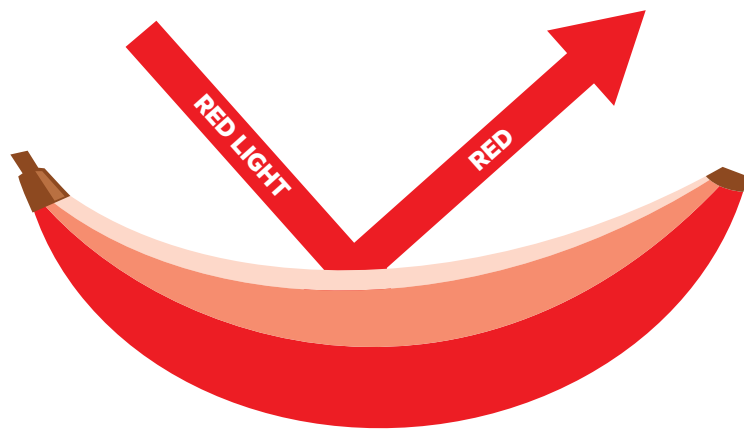
- There are many different types of light and colours of visible light
- An object's colour appears differently under the red, green and blue lights compared to how it looks under white light
- Objects that appear a certain colour are reflecting that colour of light into our eyes



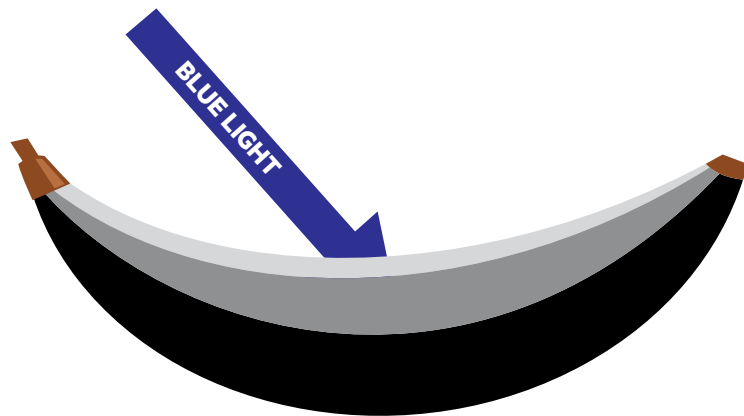
A banana appears yellow in white light because it absorbs all of the colours except yellow, which is reflected.



A yellow banana appears green under a green light. Yellow light is a mixture of red and green light so the banana reflects both red and green light.



A yellow banana appears red under a red light. Yellow light is a mixture of red and green light so the banana reflects both red and green light.



A yellow banana appears black under a blue light as all of the blue light is absorbed, so no light is reflected.

Source: Queensland Museum Image Collection

White light contains all wavelengths of visible light. Objects appear coloured because they reflect certain wavelengths of light and absorb all others. The wavelengths that are reflected reach the eye and mean we perceive the object as having that colour.

In this room the light source cycles through red, green and blue giving out one wavelength of light at a time. Objects appear different colours because they absorb some colours (wavelengths) and reflect or transmit other colours. The colours we see are the wavelengths that are reflected or transmitted.

For example, a red shirt looks red because the dye molecules in the fabric have absorbed the other wavelengths of light. Red light is the only light that is reflected from the shirt. If only blue light is shone onto a red shirt, the shirt would appear black, because the blue would be absorbed and there would be no red light to be reflected. White objects appear white because they reflect all colours. Black objects absorb all colours so no light is reflected.

By shining white light on them, visitors can reveal the colour of objects as they would usually appear.



## Coloured Shadows

— Light travels in a straight line which can be blocked to create shadows



Source: Queensland Museum Image Collection

The three primary colours of light are red, green and blue (RGB). When combined (RGB) is seen as white light. As the source positions of each colour (RGB) light are slightly different, when an object blocks the light, a range of shadows are created. A shadow against the white wall shows as a different colour depending on which colour of light has been blocked (i.e. if all light is blocked, no light reaches the wall and the shadow will appear black; if only the red light source is blocked, the green and blue light will still reach the wall and combine. Green and blue light make the colour cyan, so the shadow would be cyan). These secondary colours of light (cyan, magenta and yellow) will appear alongside the original colours of red, green and blue.

### Mixing Light

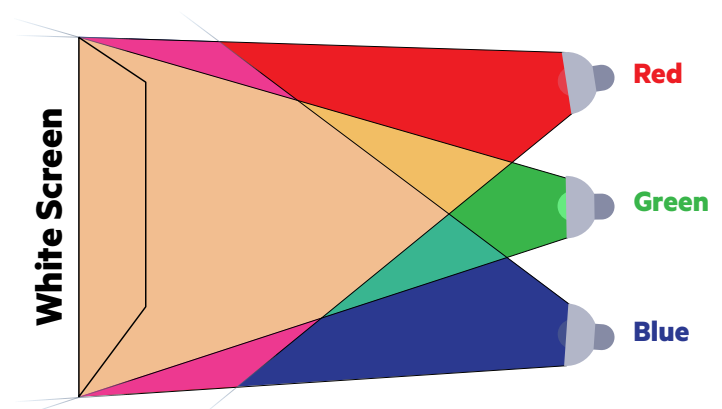
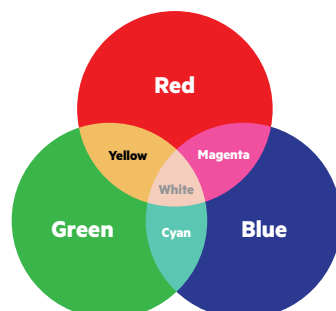
Red + Blue + Green = White

Red + Green = Yellow

**When you stand in front and block one or two lights, what coloured shadows will you see?**

White – Green = Magenta (pink)

White – Red = Cyan (greeny-blue)



Source: Queensland Museum Image Collection

## Frozen Shadows

- Light travels in a straight line which can be blocked to create shadows
- Some materials glow after being exposed to a light source



*Source: Queensland Museum Image Collection.*

If you have ever seen 'glow in the dark' stickers, toys, watches and some emergency exit signs you have seen phosphorescence in action. Phosphorescent materials absorb light energy and emit it back out (glow) over a period of time.

The screen is coated with a phosphorescent material that absorbs energy from the light and slowly releases it – seen as a green glow.

The light is blocked by your body and creates a frozen shadow.



## Part 2: Making a Screen for Shadow Puppet Presentation

To create a screen, stretch a large piece of translucent fabric (white bed sheet) taut across a sturdy frame (i.e., a cardboard box, wooden stretcher frame, or a doorframe). After you make sure there are no wrinkles in the fabric, staple the fabric to the puppeteer-side of the frame so the audience does not see the edges of the fabric. Balance your screen on L-shaped braces, or simply set the screen on a desk. Plug in a lamp behind the screen. Experiment with different light bulb wattages for the right effect based on the placement of the lamp in relation to the stage, and the size of your classroom and the screen.

## Queensland Museum

### *Wild State* Teacher Resource

[Wild State Teacher Resource \(477 KB\)](#) (PDF)

## Bibliography

Ryan, M, Czechura, G, (2016) *Wild State: Celebrating Queensland's Unique Animals and Their Habitats*. Queensland Museum: Brisbane