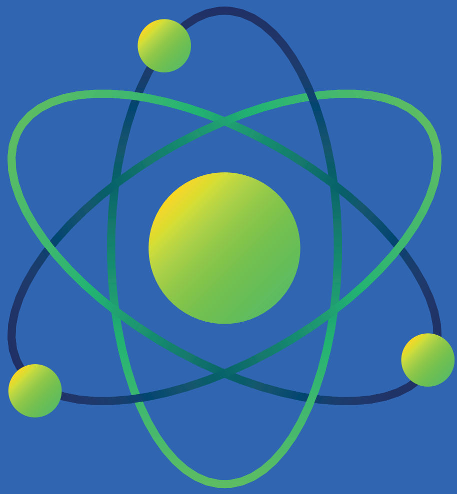
Imperial College London

LOOKING AT LIGHT



In this activity you are going to make a spectrometer.

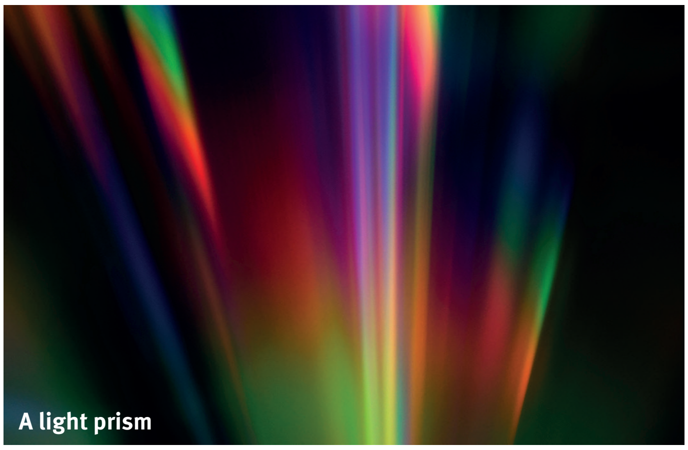
SECTION 1: INTRODUCTION

Hello, my name is Milan. I am a final year physics PhD student at the South Kensington campus. My research interest is in **atoms** and their **interactions with light**.

I got into science during early childhood when my grandparents often left nature documentaries on TV and I was encouraged to read science books. I also watched lots of Science Fiction (sci-fi) on TV and as a kid I wished sci-fi technologies were real! To see if I could make these technologies a reality I decided to study and do science, despite the fear of some sci-fi stories (like being abducted by aliens) coming true – luckily this has not happened yet!

My biggest motivation for science is about solving the mysteries and discovering the inner workings of nature. As a physicist, I am fascinated by the laws of the universe, which were not designed by any one of us, but are experienced by everyone, everywhere. Throughout my career, I have met many like-minded people, sharing our findings with each other in the hope of answering the biggest questions. For me, this sense of belonging is one of the best things about being a scientist.

I'M MILAN. NICE TO MEET YOU!



A light prism

23 12 White City Packs_LookingAtLight_TP.indd 1 14/11/2023 10:05

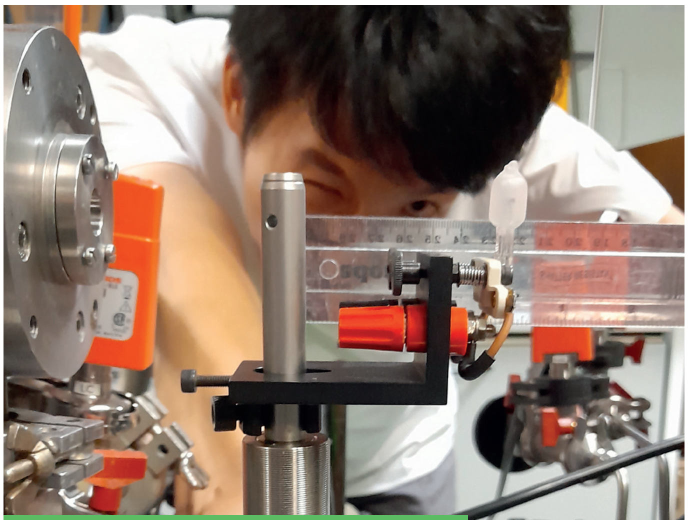
SECTION 2:
UNIVERSES BIG AND SMALL

I am an **atomic physicist** and **spectroscopist**, which means I explore data on how light interacts with atoms. As light travels through an atmosphere most of the light passes straight through, but some of the light will get absorbed and disappear when it hits the atoms in the atmosphere. **Different atoms in the atmosphere will absorb different colours**.

In my lab, there is a very expensive machine that can split any visible light into its different colours. Because the machine in my lab is very advanced, it can see the finest details of colours. If we know exactly what colours are missing, we can work out what atoms the light has passed through. This is how we know what the atmosphere of the Sun is made of!

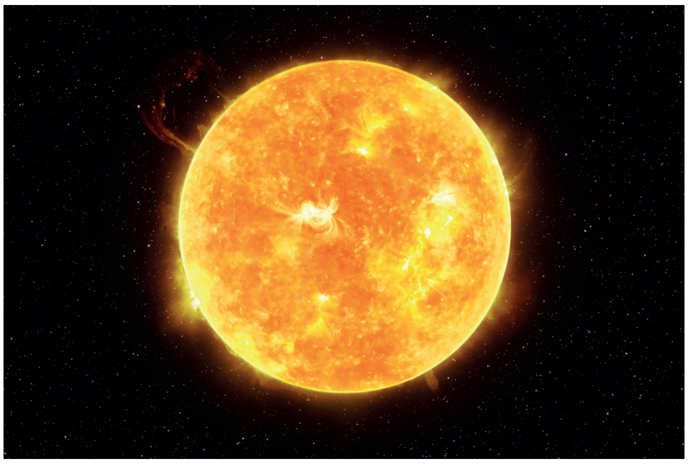
Now if we use the machine to split up the colours of other stars, we can see which colours are missing, and this will tell us which atoms are within those stars. This means we can work out which atoms are in planets or stars millions of miles away. This is called looking at the **spectra**. This is very important as we might never be able to fly to those stars directly.

The problem is, the tiny sections of missing colours are different for every single atom, their exact locations are unknown and were left to us by nature as puzzles. My job is to solve such puzzles. In my work, I picked one atom as my puzzle to solve. The choice was made for an atom with many unknown missing colours that were in


Milan researching atoms in his laboratory

urgent need by astrophysicists. This atom was double-ionised neodymium with 60 protons and 58 electrons, and it took me a whole year to measure the colours and another year to identify the important missing colours, which was done together with scientists from other countries. By learning more about how to identify different atoms we can work out what is going in other stars and see how they are made.

Once we know the exact locations of the tiny sections of missing colours and how much of the colour is actually missing, astrophysicists can perform very complex calculations to find out what stars are made of. In recent years identification of some molecules and atoms within the atmospheres of exoplanets (planets outside the solar system that orbit other stars) also became possible and which might even show us if there is life elsewhere in space!

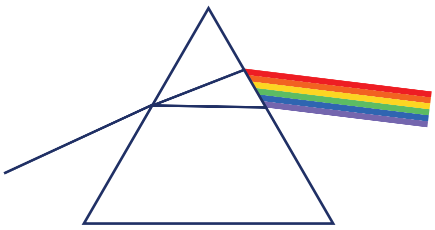


SECTION 3: LOOKING AT LIGHT

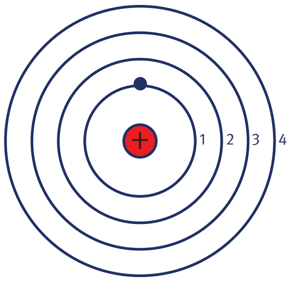
We can’t land on the Sun or other stars, and we can’t send a robot to scoop up some of the Sun and take it back to a lab. So, to find out what stars are made of, we need to find other ways to study them. The Sun is also much too bright to look at (which is why you should **never, ever look directly at the Sun, nor with a telescope**), so studying it can be tricky. One of the ways we can learn more about the Sun is by **looking at the spectra of the Sun**.

Let’s explore looking at light in more detail.

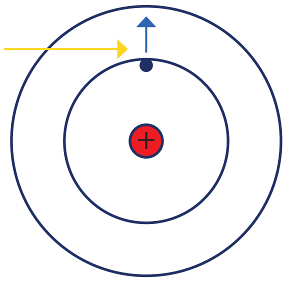
It can be a bit complicated, so don’t worry if you don’t understand every little bit!



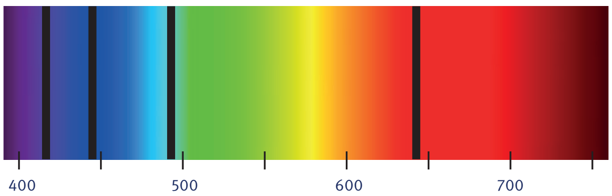
White light is made of all the colours. You can split light into different colours with a prism. Each colour of light has a different energy level, which is related to the colour’s frequency.



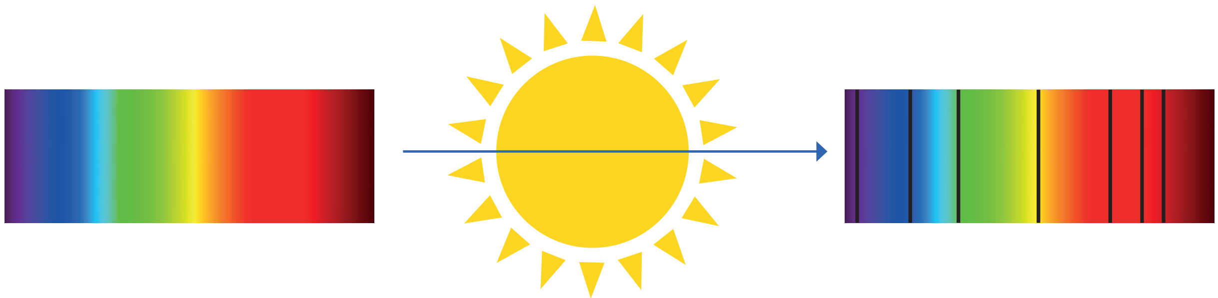
An atom consists of a **positive nucleus,** surrounded by electrons orbiting at different energy levels.



When an electron gains energy by absorbing a bit of light of a particular colour, the electron moves to a higher energy level. **Different atoms will absorb different colours.**



Because the light of a particular colour has now been absorbed it will be missing from the spectrum. If a colour is missing, we call it an **absorption spectra.**



In simple terms, **when light travels through atoms, certain colours get absorbed and disappear. If we know what light is missing, we know what atoms the light must have travelled through.**

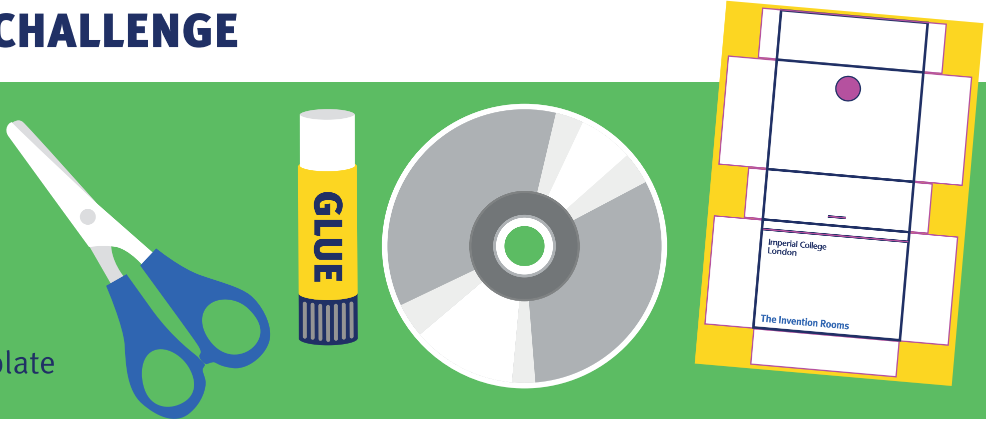
So, light created in the core of the Sun will pass through lots of atoms. The atoms will absorb bits of light. We know that when certain colours are missing, we can tell what atoms are in the Sun.

This is how we know the Sun is made mainly of Hydrogen and Helium – because the colours of light that match the energy levels in Hydrogen and Helium are missing.

SECTION 4: YOUR CHALLENGE

YOU WILL NEED

- Glue
- Scissors
- A blank CD or DVD
- Spectrometer card template



On the next page we have got a plan to make your own **spectrometer – this separates and measures light.** This is a simple version of the machine I use though the principle is the same – we split out light into its different colours and we measure this.

With this you can explore different lights and see which colours are missing. **Remember you must never look directly at the Sun** but you can use your spectrometer with the Sun or any light source.

You can use the pictures of light below to record which colours are missing by using a black pen to cross them out. For some light sources, lots of the spectrum might be missing because not all light sources produce all the colours! For example, some lamps just produce red, green and blue light, and not the colours in between. Next to the spectrum, record which light you were looking at.

Remember you must look at the reflected light through your spectrometer. Never look directly at bright lights!

Light source:

....

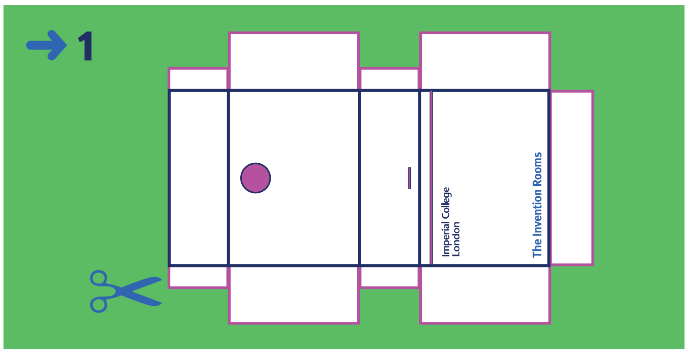
Light source:

....

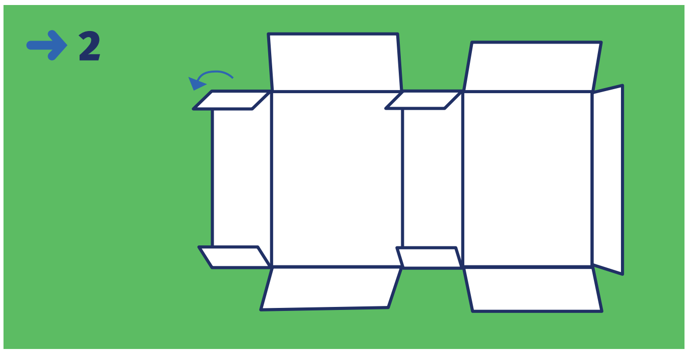
Light source:

....

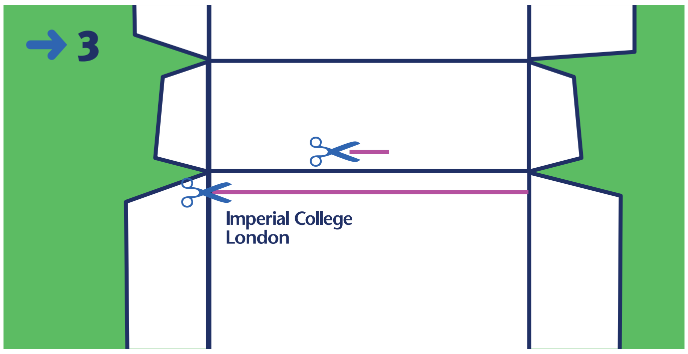
HOW TO BUILD YOUR SPECTROMETER



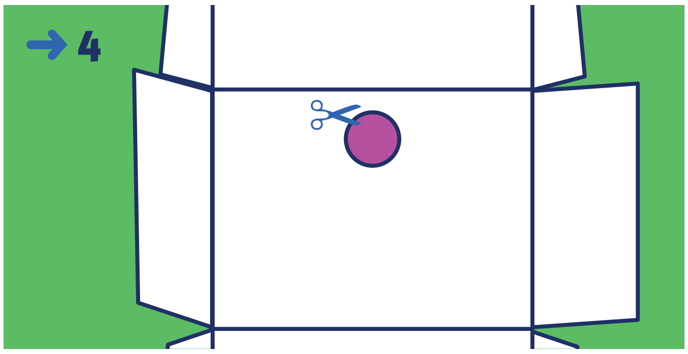
Cut out the spectroscope outline found on the last page of this pack (the **pink outer line**).



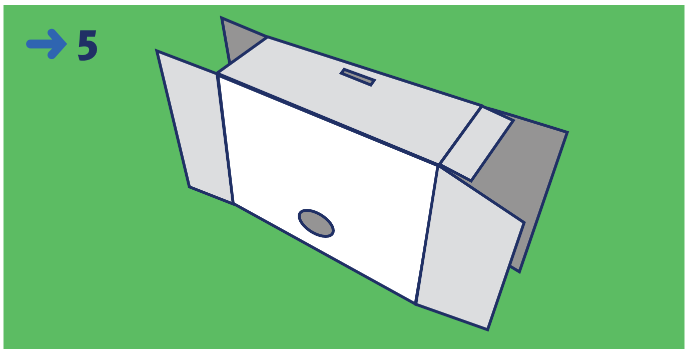
Cut along all of the **pink lines**, ensuring each tab can fold **inwards.**



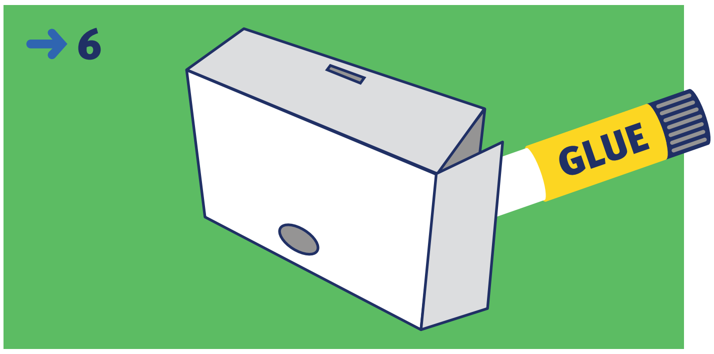
Cut out the **short pink slit** and the **long pink slit**. It may be easier to fold the paper to make the first cut. You can also use a sharp pencil to start the hole. Ask an adult to help.



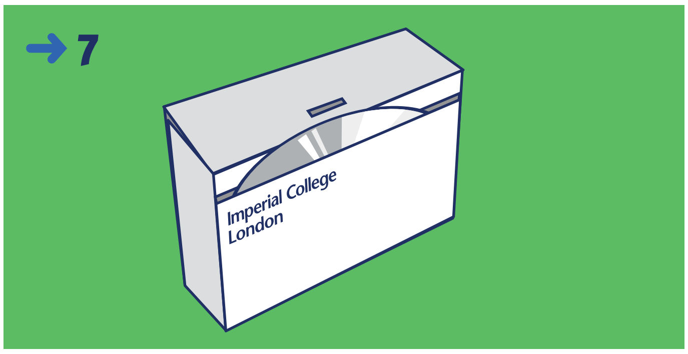
Carefully cut out the **pink circle.** Again it may be easier to fold the paper or use a sharp pencil to start the hole.



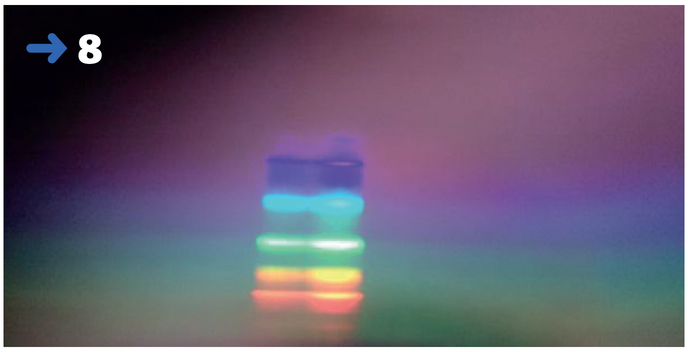
Fold along the **dark lines** to make a rectangular box.



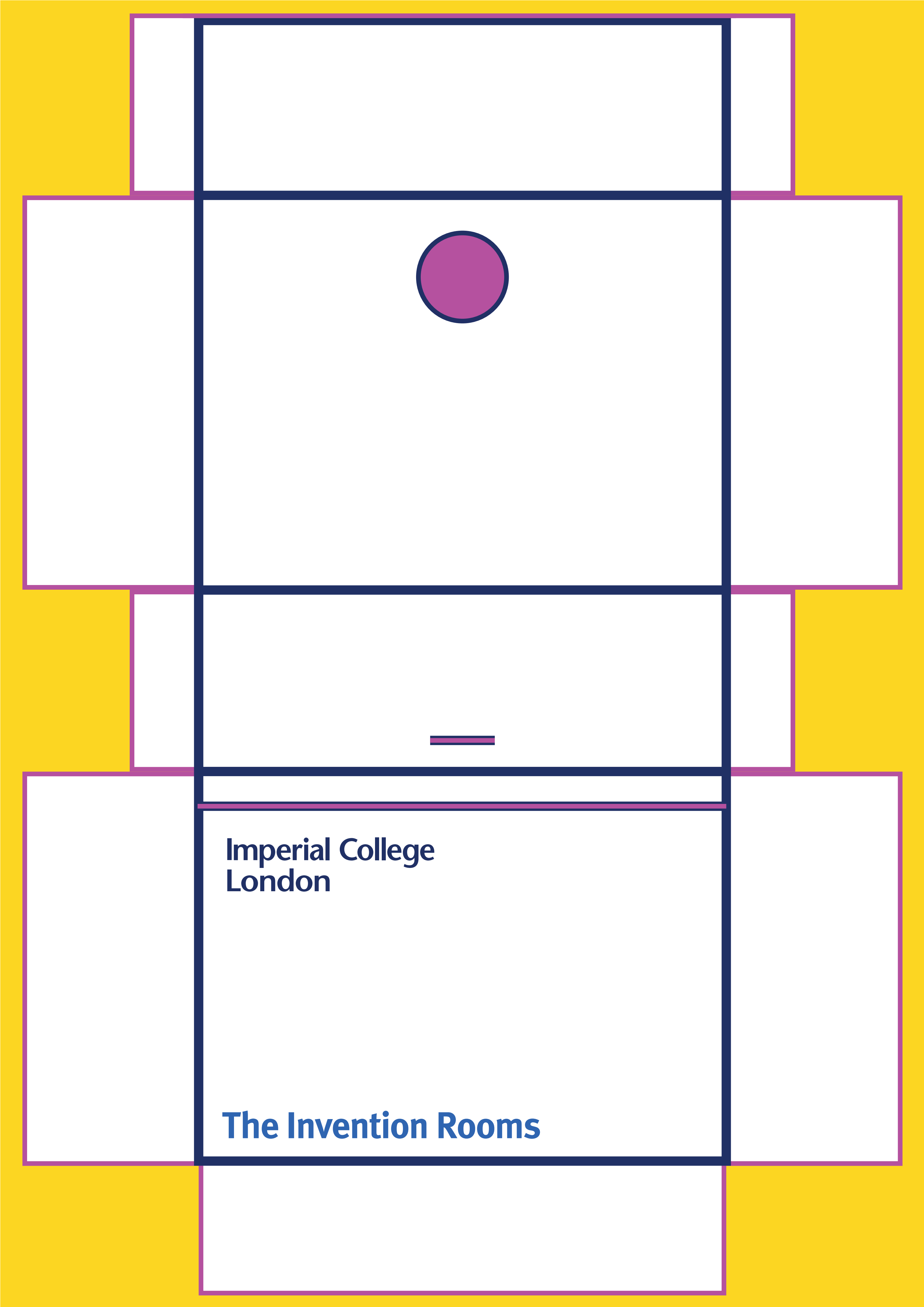
Use glue to **stick the box together** to make a sealed container.



Insert a CD or DVD into the **long slit**.



Point the small slit on the box towards the light source. Look through the **round circle** to see the emission spectra reflected off the DVD. Never look directly at the Sun!


Imperial College
London
The Invention Rooms