



# LASERS

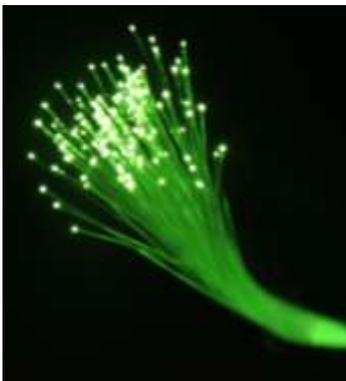


Lasers are everywhere! We could not scan our shopping at the supermarket checkout, surf the Internet or play CDs without them! Laser development is a research field in itself, but mostly people use them as tools, for example:



They can be used to create vivid and exciting light shows.

In industry, high power lasers are often used as precision cutting tools, piercing neatly through metal sheets.



Communications (phone and internet) use low power diode lasers, pulsed and sent down bundles of fibre optic cables.

Scientists of all kinds use high and low power lasers of all colours in their experiments.



**In this last picture, you can see the lasers interacting with mirrors and beam splitters.**

**This booklet contains some experiments to help you to learn what these optical components do and the tricks we can apply!**

# Safety First

Lasers are dangerous and must be treated with care. Most of the lasers that you will come into contact with (e.g. inside your CD or DVD player) are enclosed within a case to make them safe.

The beam of light that a laser unit produces, should it enter your eye, can be dangerous. This is why they come with a warning sticker...

... well perhaps not quite like the picture on the left, but usually yellow triangle with a line originating from a picture of a light source, as below.



Lasers are categorised according to how much power they emit (much like your light bulbs and appliances at home). Class 1 lasers will not burn your skin or the back of your eye (unless focussed) unlike Class 4 lasers that will blind you and drill holes into your hands. Most laser users wear special goggles and keep their hands away from the beam.

You will be using Class 1 lasers, which means that your skin is safe but that you must not look into the beam on purpose.

## Task 1:

Look at the source of your laser beam (the Sphinx). What must you do to make the laser work?

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Turn the sphinx round; can you see the safety label? Write down what warning it gives you – i.e. what must you NOT do?

.....

.....

If you are wearing jewellery on your hands/wrists or a watch, please remove it and store it safely in a pocket. Why is this important?

.....

.....

What colour is your laser beam?.....

Laser scientists attach their **optics** to special laser tables to ensure that they don't move. Tables are made of steel with holes drilled every 2.5cm.

(**Optics** is the correct term used to describe all items of equipment that the laser will reflect or interact with.)



You will be using the next best thing: a KHEt board. This is board used in the popular laser chess game of KHEt. The optics sit firmly in place within each square of the board, making them hard to tip over and ensuring good laser safety!

## Your Optical Components



*EYE OF HORUS*

Read these carefully before we meet the components individually:

**SPHINX** – This is the laser source

**PYRAMID** – This is the mirror

**ANUBIS** – This will block your beam inconveniently during some tasks!

**PHARAOH** – This is the goal, your beam will need to hit this piece in some tasks.

**EYE OF HORUS** – This is the beam splitter

## Task 2:

High Reflectors (HR) are what scientists call mirrors.

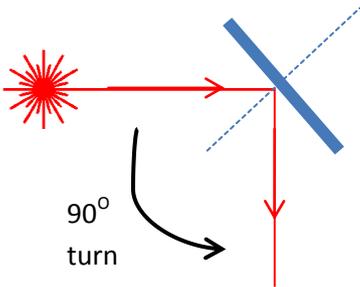
Place your laser (Sphinx) at the corner of the board with the row of RED eyes. Now place a high reflector (Pyramid) on any square with a red eye and turn your laser on. Rotate the high reflector round clockwise 4 times. What do you discover (think about angles too)?

.....  
.....

Draw what you see:



This next diagram shows how a high reflector can be used to turn the laser beam by  $90^\circ$  can you use more high reflectors to make the beam turn by  $180^\circ$  and  $270^\circ$  - draw your set ups below



## Task 3:

Beam Splitters (BS) are special mirrors.

**Remove** all your high reflectors from the board and place a beam splitter (Eye of Horus) on any square with a red eye. Turn on the laser and move the beam splitter clockwise 4 times. What do you observe?



.....  
.....

How is a beam splitter SIMILAR to a high reflector?

.....

How is a beam splitter DIFFERENT to a high reflector?



ready?!

TASK 4 cont:

Here is your challenge. Take 4 high reflectors



- 1) You must place and use 1 high reflector on *any* square containing a Red Eye at all times.

2) You may place the others wherever you choose to be able to make the laser beam hit each Pharaoh *separately*. Draw how you achieve this (remember laser lines are straight) on the grid on the previous page.

3) What is the smallest number of high reflectors that you need to hit each Pharaoh? Can you sketch this in the space below?

4) Is there a configuration that permits you to hit BOTH Pharaohs? Can you sketch this?

5) Now pick up a Beam Splitter. How can you use this to achieve question (4)? Sketch it!

### TASK 5:

You will need 6 high reflectors and 1 beam splitter:



1) Set up your board with the laser in the usual square and the Pharaoh in the square with the  as shown in the grid below.

2) You must place and use 1 high reflector on *any* square containing a Red Eye at all times.

3) You must place your remaining high reflectors on the 5 squares in the grid below. The *orientation* within each square is your *choice*.

4) Can you move your piece in (2) and rotate your pieces in (3) such that the laser hits the Pharaoh? Draw your laser's path on the grid below:

							 SPHINX
							
							 PHARAOH
							
							

## TASK 6:

The FINALE and the hardest challenge yet!

You will need 2 high reflectors, 1 beam splitter and 2 lasers:



- 1) Set up the board as below, with a laser at the diagonal corners.
- 2) Your goal, the Pharaoh, is where it was from Task 5. Leave it there!
- 3) You may place your beam splitter and your 2 high reflectors wherever you choose, but on the condition that when you turn on BOTH lasers, the Pharaoh is hit by EACH beam.

Draw where you place your optics and the route that your beam has taken on the grid below!

							 SPHINX
							 PHARAOH
 SPHINX							