Led torch or spotlight
Guide for students

## 1. First step. What we will make? (one week)

The final objective of this project is to design and make a torch or a spotlight for a concrete use. You will use a 3w Led to do it.

Search for examples of torch and spotlight applications, reflection surfaces and cases to protect the torches and spotlights components.

You must decide if you will use an ultraviolet led or not.

a) Decide what will be the use of your torch or spotlight.

b) You have two possibilities for the reflection surface: paraboloid or truncated pyramid.

Decide what will be your reflection surface and the dimensions of your torch or spotlight. Keep in mind the use of the torch or spotlight you decided previously to take this decision.
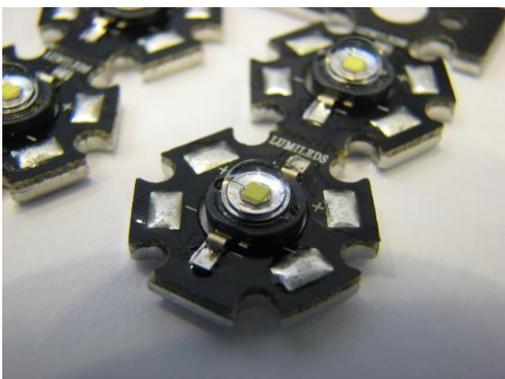
3w led. Hexagonal[1]

3w led. Ultraviolet (uv)

---

[1] *Source of images and drawings: author or Wikimedia Commons*

## 2. Second step. Theoretical background (two weeks)

You decided to use a paraboloid or a truncated pyramid to make the reflection surface.

a) If you decide to use a paraboloid

For torches and spotlights are usually used elliptical paraboloids of revolution, obtained by revolving a parabola.

i) Search for information about what curve is a parabola. Learn (or remember) the definition and properties of a parabola as a locus and the parabola as the graph of a concrete function.

ii) You received a GeoGebra file you can use to print a template (template_parabola_curve.ggb). You can change the size, the location of the focus and the form of the curve. You will use this GeoGebra file later. The template allows you to obtain a parabola to turn it around its axis.

You have to explain the process used to obtain this GeoGebra file.
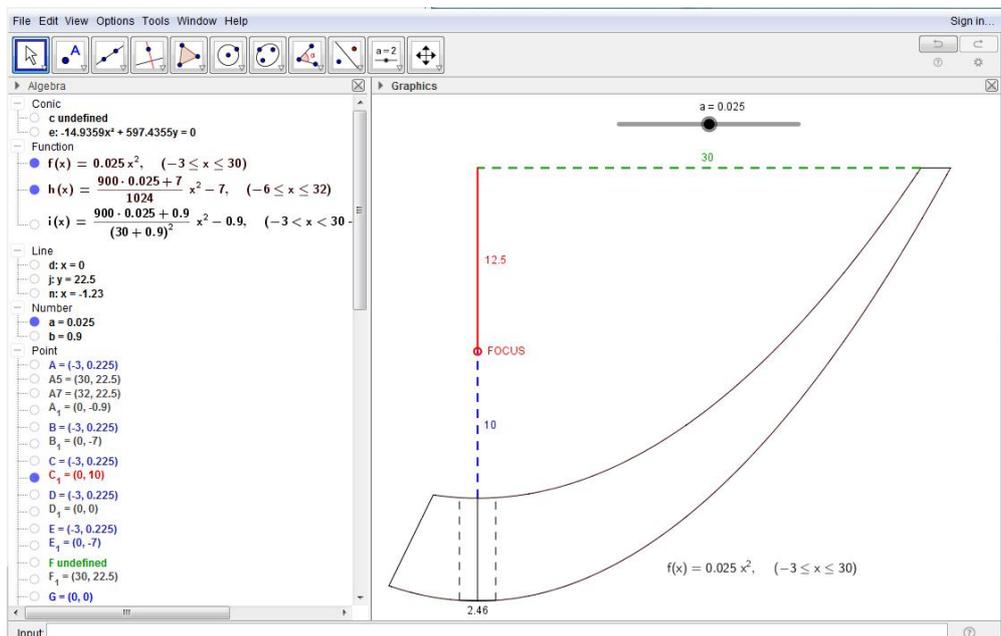
iii) You received another GeoGebra file (parabola_light_reflection.ggb).

Use this file to "model" a parabola used like a light reflector. You can change the focus situation and the curve form.
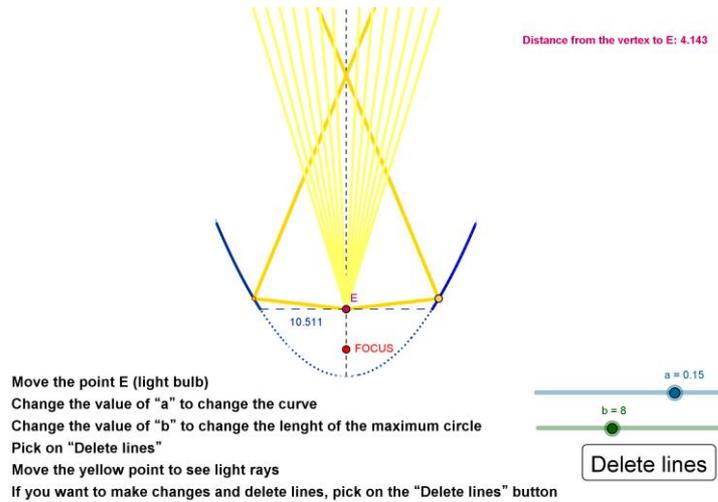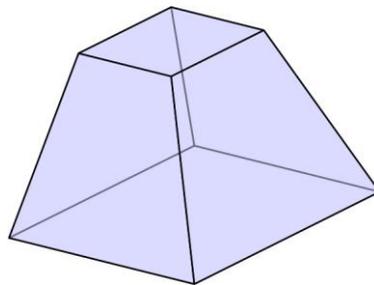
When you decide your parabola form and, therefore, your paraboloid form, you can print the template (using the file template_parabola_curve.ggb).

b) If you decide to use a truncated pyramid

i) A truncated pyramid (or pyramidal frustum) is the polyhedron obtained cutting a pyramid. To make one, you will use the plain development.
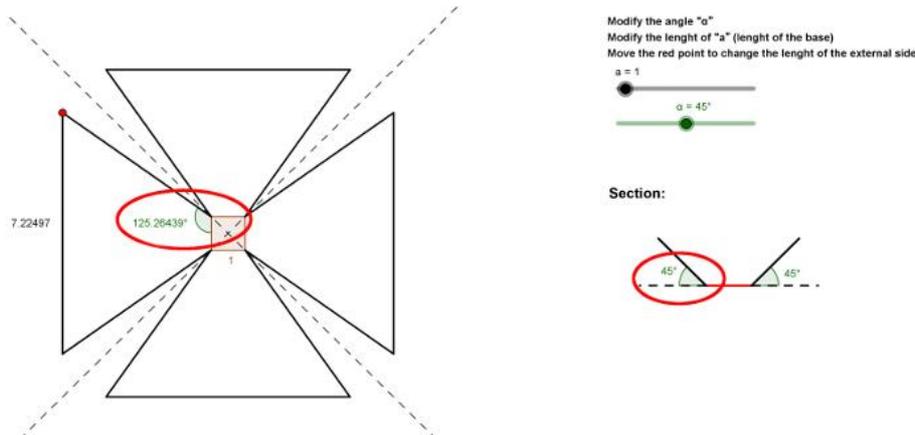

Truncated pyramid

Learn about the development of a polyhedron. In particular, what is a truncated pyramid and which is its development.

ii) You will print the development of a truncated square pyramid. You received a GeoGebra file (plain_develp_truncated_pyramid.ggb). In this GeoGebra file, you can change the inclination angle of the faces and, the base and the top side lengths.

The internal angle of a face (see the template) and the inclination angle are related. Explain what was the expression introduced in GeoGebra to do it.

iii) You will use another GeoGebra file to "model" a truncated square pyramid used like a light reflector (truncated_pyramid_light_reflection.ggb).

You can modify the shape inclination angle to observe the influence on the reflected light rays. Decide the inclination angle and the top side lengths you will use to make your truncated pyramid (using the plain_develp_truncated_pyramid.ggb GeoGebra file).
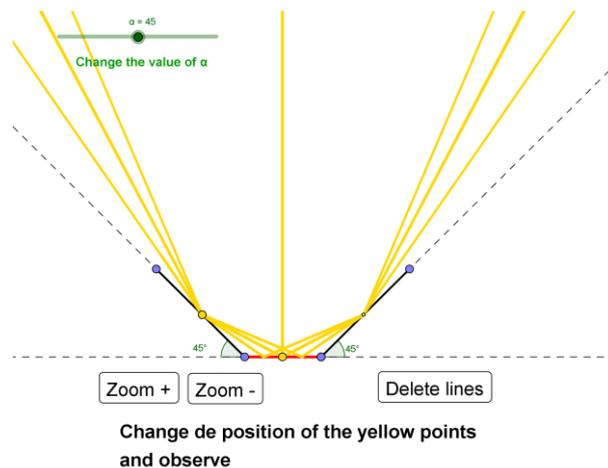
If you want use a rectangle truncated pyramid instead a square truncated pyramid, you have to modify the GeoGebra file. Print the template.

3. Third step. Making the reflection surface and mounting the led (three weeks)

i) Making the reflection surface

a) Paraboloid. Making the reflection surface

Decide the material and the system you will use to make a paraboloid.

You can use the template obtained in the previous step to generate the paraboloid rotating the curve around the axis of the parabola. Alternatively, you can decide use other system, for example, generating a 3D model and printing it to a 3D printer.

b) Truncated pyramid. Making the reflection surface

Make a truncated pyramid from the template you printed using the plain_develp_truncated_pyramid.ggb GeoGebra file.

You have to decide the faces material of your pyramid. Cut, fold and paste the faces to obtain your pyramid.

You have to obtain a reflection surface. You can use a spray or a chrome kit or search for other system.

ii) Mounting the led

Search information about the leds.

A led needs a voltage source to works. Search for the suitable voltage for the 3w led you chose to use. Read the technical information of your led, understand it, and decide what battery/batteries is the best option and what must be the configuration of the batteries if you decide to use several batteries. In addition, you have to include a current limiting resistor and a switch.
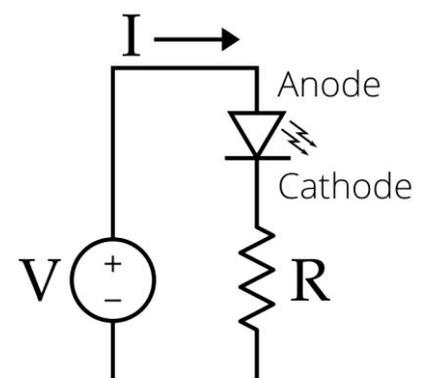
Basic scheme of a led circuit

If you decided to use an ultraviolet led, it is important you know the kind of the light the led emits. If the led emits Ultraviolet C Light (with a wavelength of 100–280nm), you have to wear glasses with UV filters and other protection for skin. Even, it is advisable you wear this protection measures if you use a Ultraviolet B led (wavelength of 280–315nm). If you want use UV-C or UV-B leds, you have to do it under teacher's supervision.

A led generate hot in his back part, so it is necessary to dissipate the heat it produces. To do so, it is necessary to paste a heatsink with a thermal compound.

Decide the kind of heatsink you want to use, the material of the heatsink (aluminium, copper or other). You can also reuse it of other electronic device or you can look for another option.
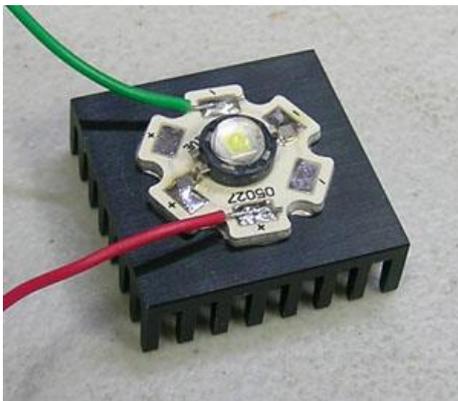
Led with a heatsink[2]

Led with a heatsink (plain heatsink)

4. Fourth step. Making the case (two weeks)

The last step is to make the case. You can design and print it to 3D printer. Other alternative is folding and pasting different pieces made with a thermofusible plastic. Remember you have to make the case with some slots for the heat output generated by the led and transmitted to the heatsink.

Keep in mind you are making a torch or a spotlight for a concrete use.

---

[2] Source of the image: http://tardhaus.com/~scolwell/LED/lamp/index.html