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PINHOLE FORMULAE

(from Ben Mossing Holsteijn 's original text)

Pinhole photography is mostly used in combination with a large or ultra-large angle of view. To calculate the focal distance, the diameter of the pinhole, etc.., the formulae to be used rely on optics, trigonometry, etc.. Below you will find the main ones, applied to a fictitious example. In this example, the aim is to build a very small camera (based on a film container, for instance.) to be used with 35mm film. What is looked for : the angle of view, the optimal pinhole diameter, and a way to calculate the correct exposure. There are of course lots of programmes who calculate this for you more or less automatically.

Angle of view (diagonal)

The formula is: α=2 x arctan (d/2f)
α = angle of view (diagonal) - d= film diagonal - f= focal distance
Note: in order to calculate the angle of view, the focal distance (distance pinhole-film plane) has to be known.

We consider that our film container has an internal diameter of 20mm.
First step is to calculate d.
We use 35 mm film, which measures 24×36 mm.
Diagonal calculation : $d = \sqrt{(24^2 + 36^2)} = 43.3$mm
Thus d/2f = 43.3/(2x20) =1.0825
Now calculate arctan of 1,0825 via button "$\tan^{-1}$" of your calculator, personal or online. The calculator has to be in d (degrees) mode.
In this case ; arctan 1.0825 = 47.27
Final step : 2 x arctan = 2 x 47.27 = **94.5°**. This is a duly wide angle camera.

Pinhole diameter

The formula is: d=c√fxl
d= pinhole diameter - c= constant = 1.9 - f= focal distance - l= wavelength of the light
The wavelength that is mostly used is the one of yellow light = 0.000550
(For use with infrared film for instance, one could use another value).

We are considering a camera with a focal distance of 20 mm.
The answer is thus: 1.9x√20×0.000550 = **0.199**

Pinhole aperture

The formula is: f/d
f= focal distance - d= pinhole diameter

We use the pinhole diameter we have calculated already : 0.199 mm.
The answer is: 20 / 0.199 = **100**

Calculating the exposure

Take a reading with the meter of your camera, or a handheld one.
Set the ISO value of the film on your meter.
Read the time corresponding to f/16. Let's suppose it is 1/15th sec.
Our pinhole is 0.199, with an f/stop value of 100.

f/stop scale:
1 – 1.4 – 2.0 – 2.8 – 4.0 – 5.6 – 8 – 11 – 16 – 22 – 32 – 45 – 64 – 90 – 128 – 181 – 256 – 312 - 512
Five steps can be counted between f/stops 16 and 100.

Let's consider now the exposure steps.
1/125 – 1/60 – 1/30 – 1/15 – 1/8 – 1/4 – 1/2 – 1 – 2 – 4 – 8 – 16 – 32 – 64 sec.

The correct exposure for our pinhole camera is 5 steps further than 1/15th, thus: ***2 sec.***