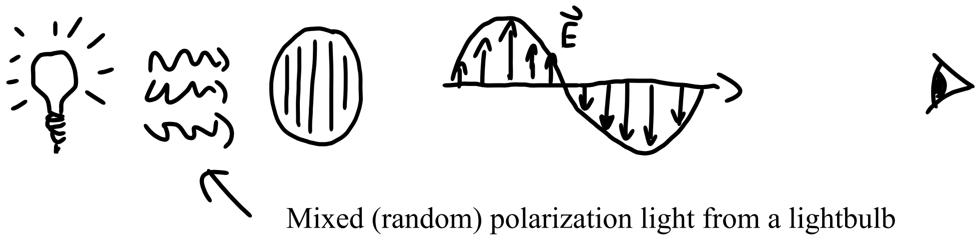
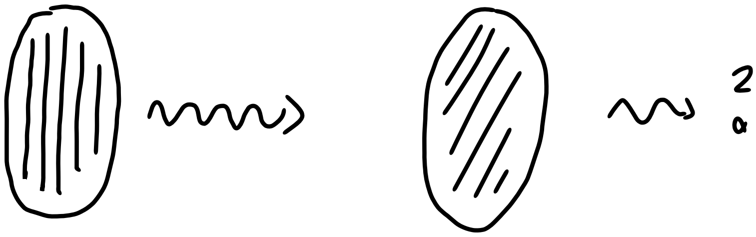
In the last lecture and in Tutorial 7, you explored what it means for light to have different polarizations.
In this lecture, we will focus on a situation in which we have a source of light with linear polarization in the vertical direction. Such source can be created by passing the light through a polarizer with its axis oriented verticaly. Or you can use a laptop screen, which produces polarized light (basically because the top layer of the screen is a polaroid sheet).

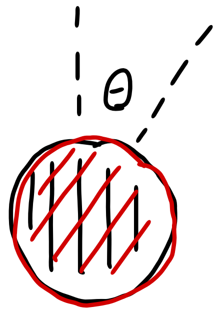


Mixed (random) polarization light from a lightbulb
pass it through a polarizer
get vertically polarized light

Now, introduce a second polarizer sheet, at some angle to the vertical:



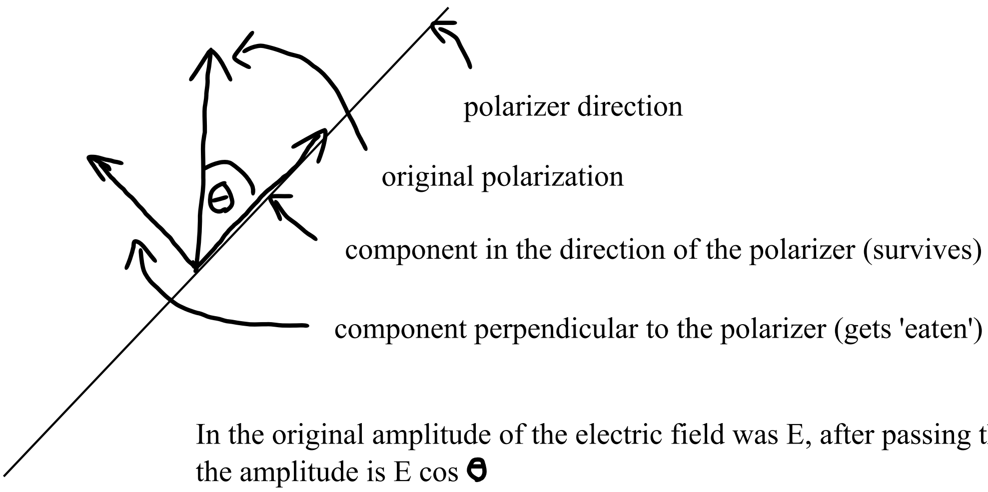
Head-on view:



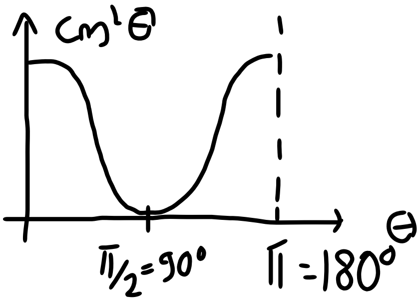
(second polarizer in red)

-> clicker question

The verticaly polarized light has a component parallel to the second polarizer proportional to $\cos\theta$:



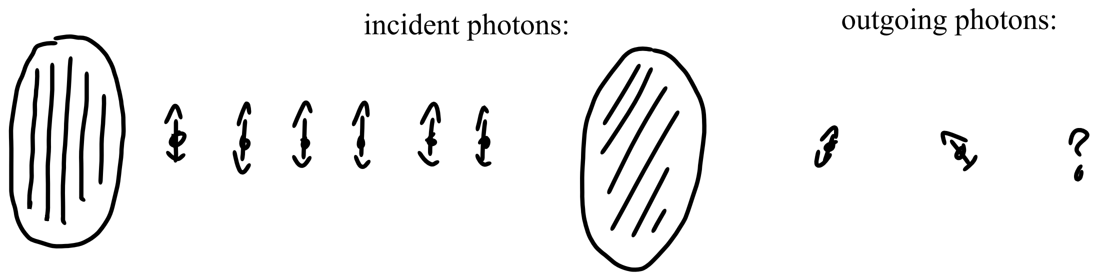
In the original amplitude of the electric field was E, after passing through the polarizer, the amplitude is $E \cos\theta$
The intensity goes like amplitude squared, so it gets diminished by $\cos^2\theta$



-> demonstrate using polaroid sheets

Now, let the angle be 45 degrees, for simplicity. The intensity goes down by a factor of 1/2.

Consider now the photon picture of this. Imagine that the initial light has very, very low intensity, so there is just a few photons at any given time. The photons must have the same polarization as the light.

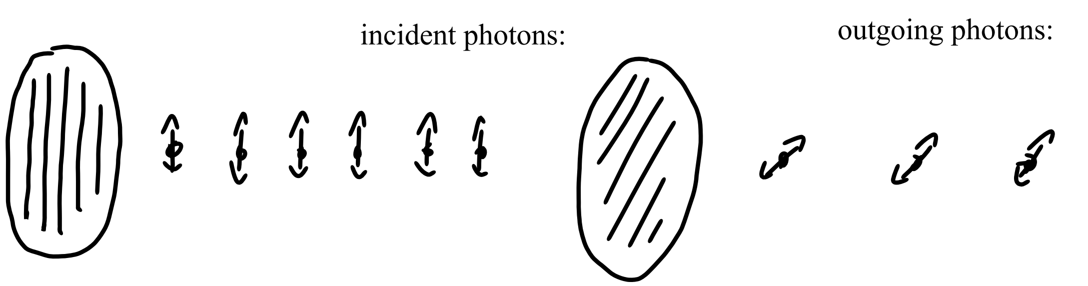


-> 4 rapid clicker questions:

Conclusion: exactly 1/2 of the photons make it through.

-> clicker question

The outgoing photons must all have 45 degree polarization, since adding third polaroid also at 45 degrees makes no difference anymore. In other words, the light which comes out of the 45 degree polaroid is polarized at that angle, and so are the photons that make it up.



This is very strange. A sequence of **identical** photons arrives at the polarizer.
Half of them get eaten, and the ones that survive have a new polarization.
Since the incoming photons are all identical, who decides what will happen to each individual photon?

A: Since all the photons are identical, there is no way to decide a priori which ones will go through.
It's random. Each photon has probablity of 1/2 of making it through.

-> clicker question

The decision for each photon is made independently - it's like a coin is tossed over and over again, once for each photon.

-> clicker question

We can compute the probability, but not the outcome for any individual photon.