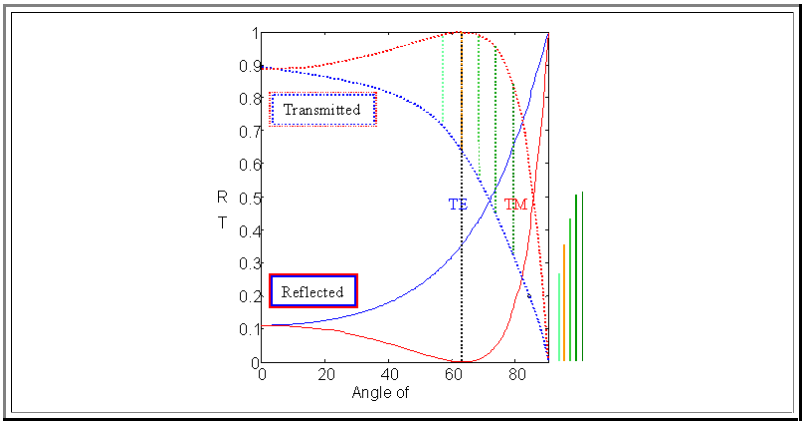
Solution to 5.2-4: Fresnel Equations and Polarization

Consider to use the Brewster angle for obtaining polarized light.
Design a polarizer from some common optical materials that works in this way . Discuss its performance.
Hint 1: Redraw the graphs for the Fresnel equations in chapter 2.2.2 for the transmitted beam.
Consider to use your design for, e.g., polarizing sun glasses.

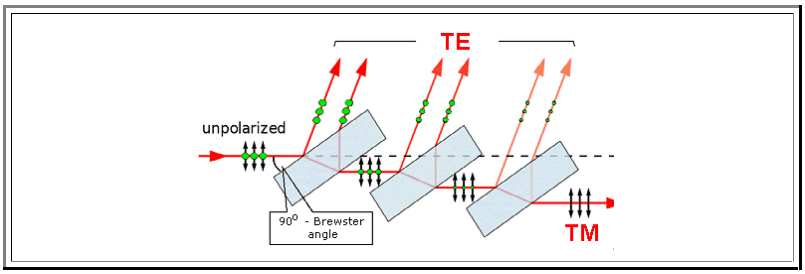
Illustration

Here is the redrawn graph:



- If we hit the surface of our ***n* = 2** material under the **Brewster angle** (about **63°**; otherwise calculate it (with some effort) from the Fresnel equations for E_{ref} **(TM) = 0**), there will be no reflection for the **TM** polarization. Reflected light thus will be fully **TE** polarized.
- That implies that *all* of the reflected light is *TE polarized*. The intensity relation between **TE** and **TM** for the *reflected* light is (nominally) something : nothing or just very large. The intensity difference is just **TE**
- The intensity difference between **TE** and **TM** for the *transmitted* light is no longer zero as for the incident light, but **TM - TE > 1**. The length of the green-yellow bars above indicates this. They are shown on the right in their length relation and one realizes that a maximum **TM - TE** occurs at angles somewhat larger than the Brewster angle.

This gives us an idea for a polarizer design:



Looks ***awkward*** because it is awkward.

- Why don't we operate in reflections? Because it is not very practical. There is very shallow incidence, and since light beams not coming form Lasers are never exactly parallel or monochromatic, there is always some "noise" in the degree of polarization. The intensity is also quite low because most of the incoming light is transmitted. Switching several Brewster polarizers in series as shown would be better (but not good). However, the beams reflected form several "mirrors" will not form a good image.
- So we look at the transmitted beam. more than three plates would then be needed to produce a decent polarization in transmission. Of course, if you intend to work in transmission, you would go off the Brewster angle a bit to optimize the **TE – TM** difference.

As far as polarizing sun glasses are concerned: forget any "Brewster" construction for obvious reasons.

- So what are Brewster polarizers good for? Well, consider that you need to polarize **far UV** light or some other weird but sometimes necessary wavelength. Than Brewster polarizers might be your *only* option!