

Lecture 27

Questions

Q1 POLARIZERS

CONSIDER THE
ARRANGEMENT OF
LIGHT & POLARIZERS
SHOWN TO THE RIGHT.

a) • By WHAT FACTOR
IS THE INTENSITY
OF LIGHT REDUCED
ON GOING THROUGH
THE 1ST POLARIZER?

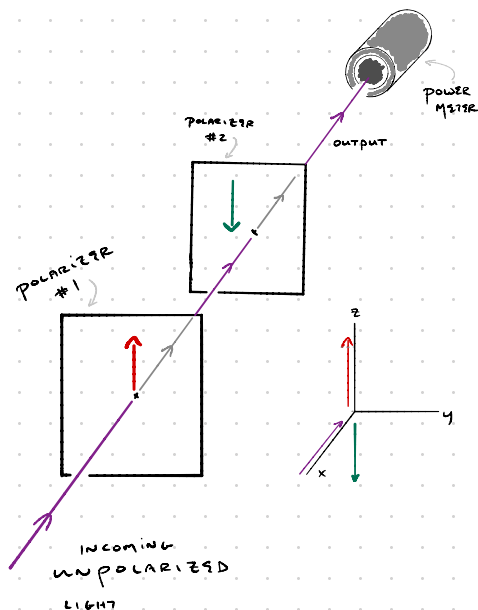
• i.e. COMPARE
POWER METER READINGS

w) :

A : POLS #1 & #2
REMOVED

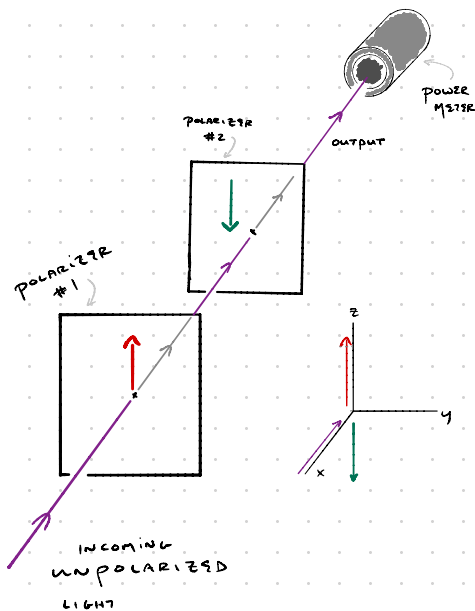
B : JUST POL #2
REMOVED

• WHAT IS I_B / I_A ?



b) (SAME SETUP)

- BY WHAT FACTOR IS THE INTENSITY REDUCED BY GOING THROUGH THE 2ND POLARIZER?



- I.E. WE NOW

TAKE POWER READING C WHERE

C : BOTH POLS IN PLACE

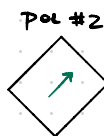
WHAT IS I_C / I_B ?

HINT: WHAT IS θ HERE IN THE CONTEXT OF MALUS' LAW?

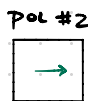
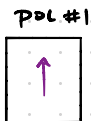
c) SAME QUESTION AS (b), EXCEPT NOW WE ROTATE θ FROM 180° TO:

(i.e. pt. (b))

(i) 45°



(ii) 90°



d) NOW SUPPOSE WE LEAVE
POLARIZERS #1 & #2

"CROSS-POLARIZED" [I.E. $\theta = 90^\circ$]

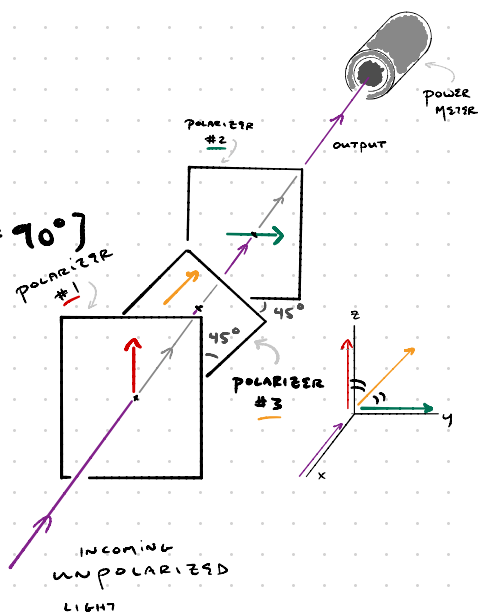
SO THAT NO LIGHT REACHES
THE POWER METER.

THEN WE ADD A 3RD
POLARIZER (#3),

ORIENTED SO THAT IT

MAKES AN ANGLE $\theta = 45^\circ$

W/ POLARIZER #1.



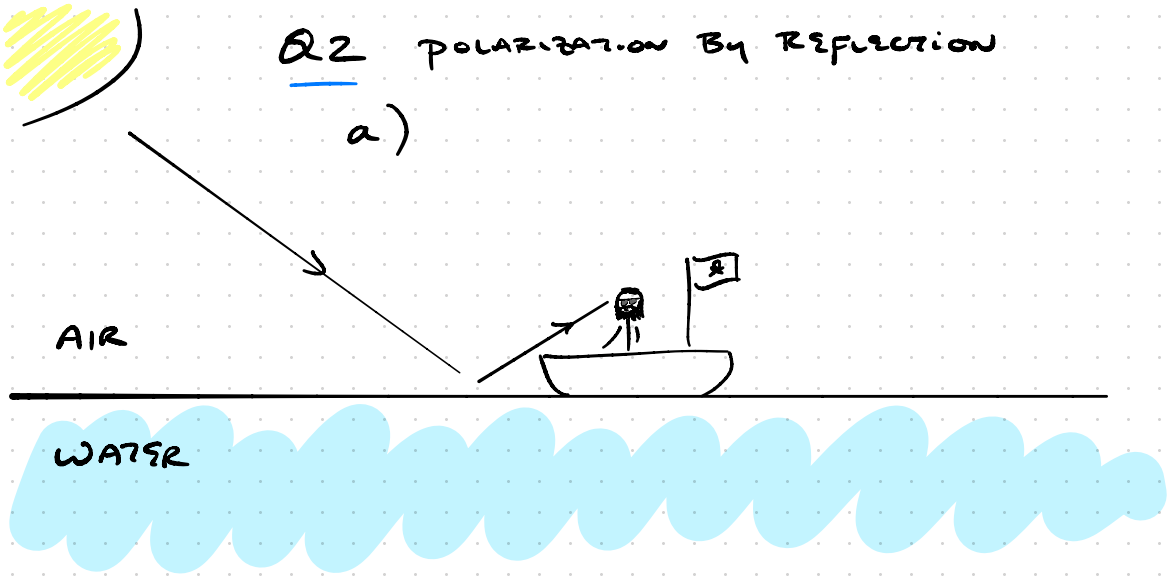
• WHAT DOES THE POWER METER READ NOW?

• SURELY ADDING ANOTHER ABSORBING
ELEMENT CANNOT INCREASE THE SIGNAL,
RIGHT?

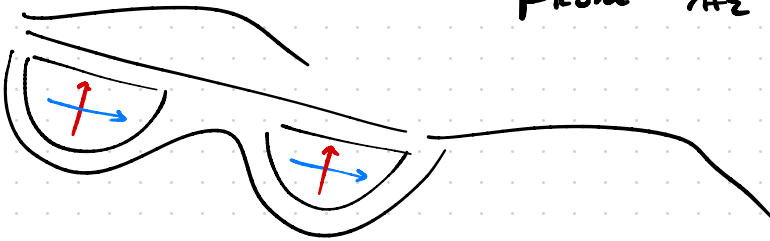
... right...?

Q2 POLARIZATION BY REFLECTION

a)



- How SHOULD THE TRANSMISSION AXIS IN THE POLARIZING LENSES OF CHRIS' SHADES BE ORIENTED TO CUT OUT THE MISERABLE GLARE FROM THE SUN?



HORIZONTAL OR VERTICAL?

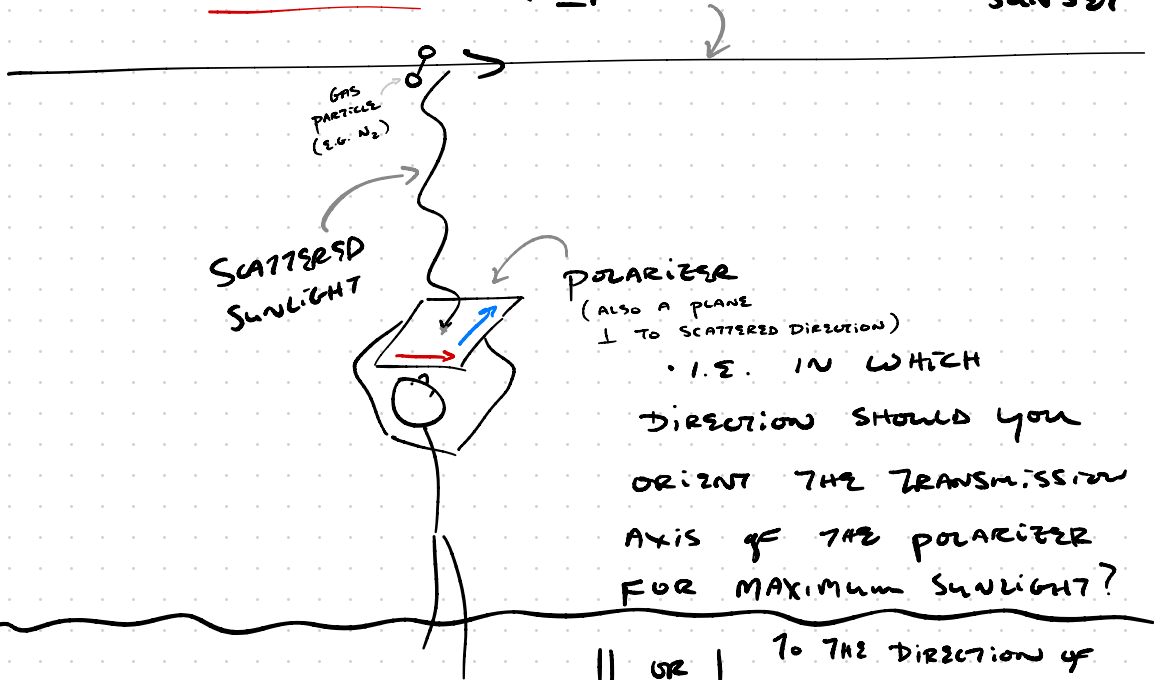
b) THE ARGUMENT ADVANCED IN THE NOTES

TO EXPLAIN BREWSTER'S ANGLE HOLDS IN

GENERAL: "THE POLARIZATION OF LIGHT SCATTERED BY AN ATOM/MOLECULE* IS GIVEN BY THE PROJECTION OF THE POLARIZATION CAUSING THE SCATTERING ONTO THE PLANE \perp TO THE SCATTERED DIRECTION."

- GIVEN THIS PRINCIPLE, IN WHAT DIRECTION DO YOU EXPECT SCATTERED SUNLIGHT TO BE POLARIZED?

DIRECT SUNLIGHT (UNPOLARIZED!) NEAR SUNRISE/
SUNSET



* OR ANY OBJECT W/ SIZE $\ll \lambda$

|| OR ⊥ TO THE DIRECTION OF DIRECT SUNLIGHT?

ANSWERS

Q1 a) w/ UNPOLARIZED LIGHT, EACH COLOR COMPONENT IS POLARIZED IN SOME RANDOM DIRECTION.

- THEREFORE, ROUGHLY SPEAKING, A GIVEN COLOR COMPONENT IS JUST AS LIKELY TO BE ABSORBED AS IT IS TO BE TRANSMITTED BY THE POLARIZER. THUS WE EXPECT HALF THE LIGHT TO TRANSMIT:

$$I_B / I_A = \frac{1}{2}$$

b) • NO CHANGE! $I_C / I_B = 1$

- REMEMBER, THE ELECTRIC FIELD @ ANY POINT IS OSCILLATING BACK & FORTH, SO LIGHT POLARIZED IN ONE DIRECTION \uparrow IS THE SAME AS LIGHT POLARIZED IN THE OPPOSITE DIRECTION \downarrow .

• IN TERMS OF MALUS' LAW: $I_C = I_B \cos^2(180^\circ) = I_B (-1)^2 = I_B$

c) MALUS' LAW INDICATES:

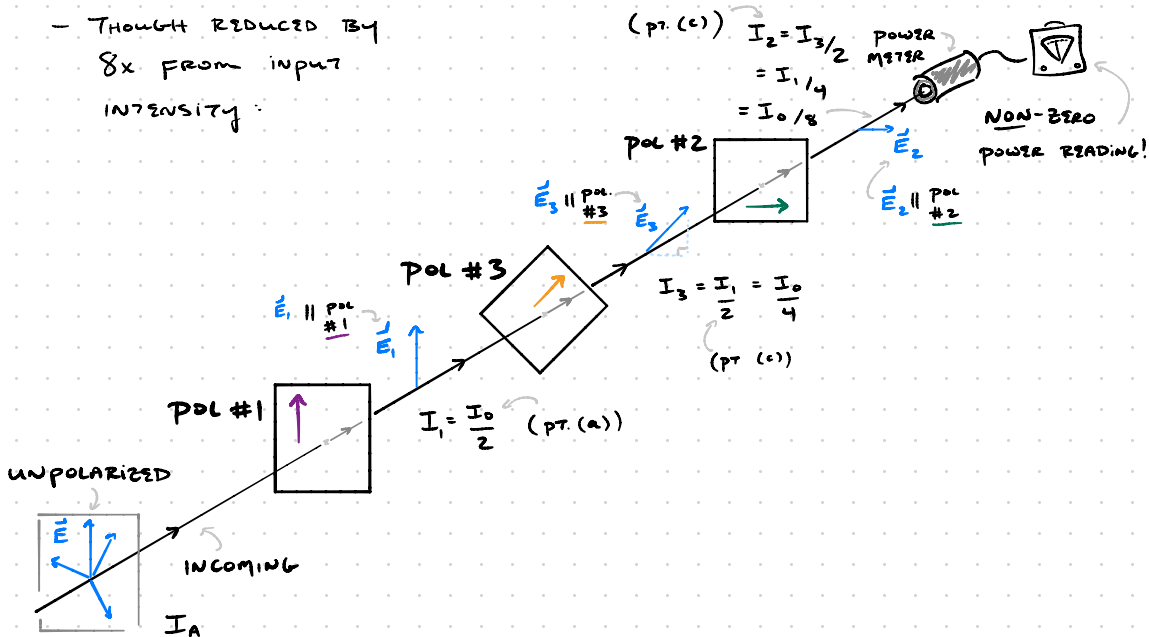
$\theta = 45^\circ : I_c = I_B \cos^2 45^\circ = I_B \left[\frac{1}{\sqrt{2}} \right]^2 = \frac{I_B}{2}$
 "CROSS POLARIZED" $\theta = 90^\circ : I_c = I_B \cos^2 90^\circ = I_B (0)^2 = 0$

\neq TRANSMISSION
 THROUGH CROSSED
 POLARIZERS!

d) INTENSITY @ POWER METER IS NON-ZERO!

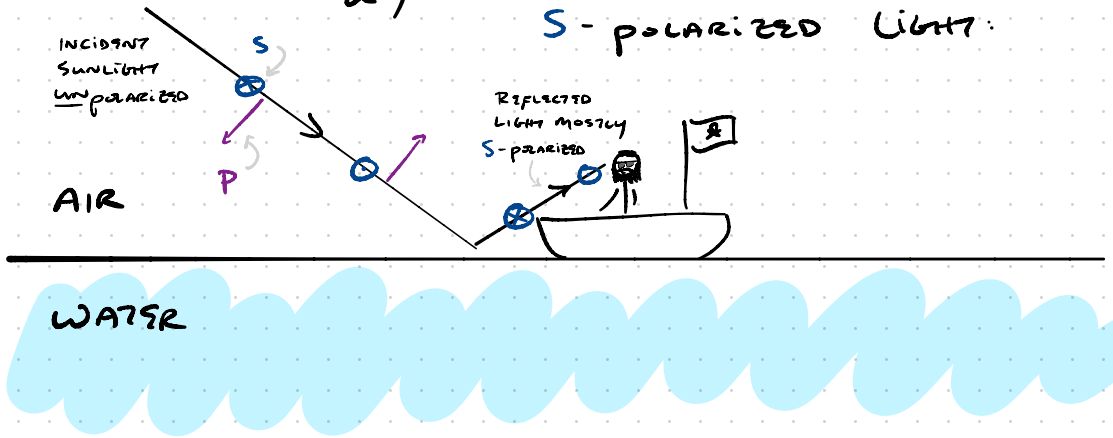
SEE YOUTUBE
DEMO!

- THOUGH REDUCED BY
 8x FROM INPUT
 INTENSITY:

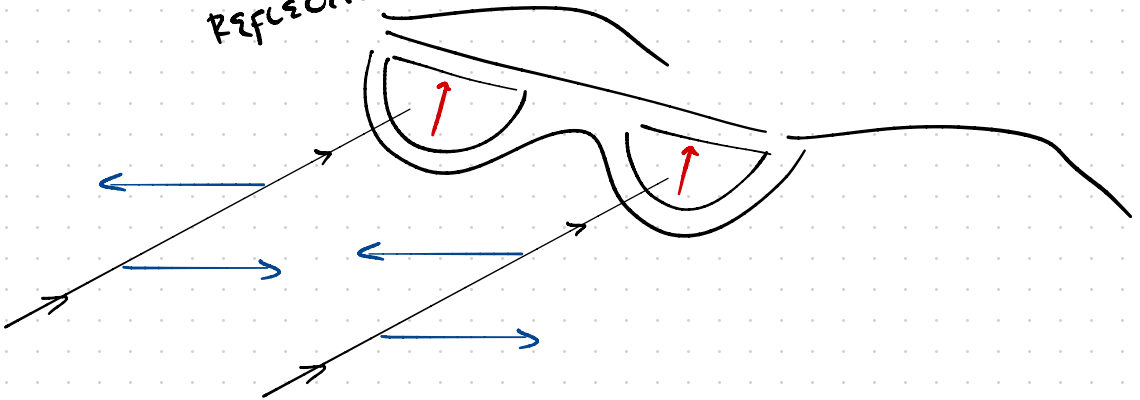


Q2

a) REFLECTION PRODUCES
S-POLARIZED LIGHT:



BLOCKS
REFLECTIONS!



To BLOCK THE REFLECTED LIGHT, WE ORIENT OUR POLARIZING LENSES TO HAVE A VERTICAL TRANSMISSION AXIS, I.E. \perp TO THE HORIZONTAL S-POLARIZED REFLECTION.

b)

• VERTICAL POLARIZATION HAS NO PROJECTION ONTO PLANE: NO LIGHT SCATTERED TO CHRIS FROM VERTICAL POLARIZATION!*

• HORIZONTAL POLARIZATION PROJECTS COMPLETELY ONTO PLANE!

(unpolarized!)
DIRECT SUNLIGHT

VERTICALLY
POLARIZED

HORIZONTALLY
POLARIZED

LIGHT
SCATTERED
FROM OVERHEAD
IS POLARIZED \perp TO

DIRECTION OF
DIRECT SUNLIGHT

POLARIZER

PLANE OF
SCATTERED
POLARIZATION

• ORIENT POLARIZER \perp
TO DIRECTION OF
DIRECT SUNLIGHT FOR
MAX TRANSMISSION

CHRIS

* IN GENERAL, "ATOMS/MOLECULES DON'T SCATTER LIGHT IN DIRECTION \parallel TO POLARIZATION"