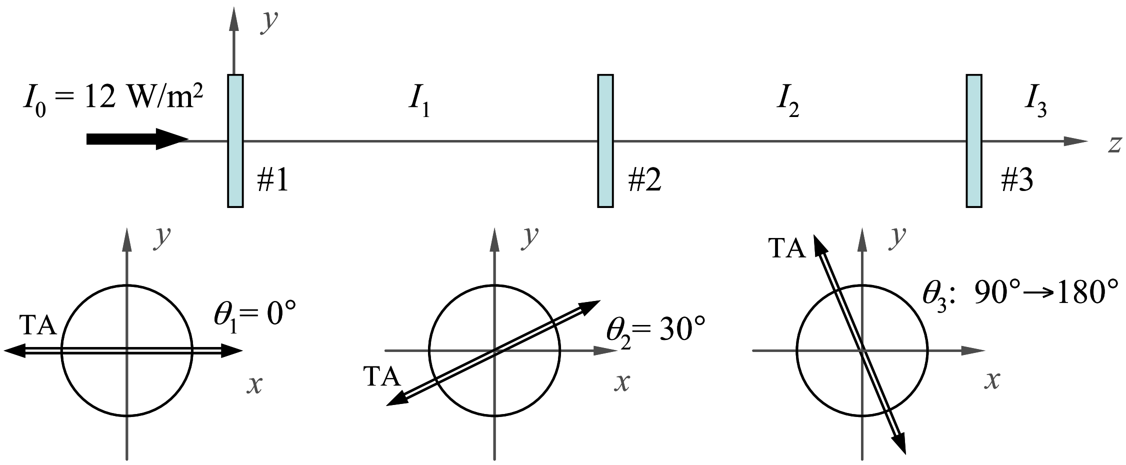
Name: ________________________ Sec. _______ **P212: Quiz 10A Week 13**

A beam of light of intensity $\boldsymbol{I_0 = 12}$ **W/m²** is incident in the $+z$ direction upon a set of three linear polarizers, each oriented perpendicular to the beam. The transmission axes (TA) of the first two polarizers make angles of $\theta_1 = 0°$ and $\theta_2 = 30°$ with respect to the x axis (see figure). The angle θ_3 of polarizer #3 can be varied from 90° to 180°.



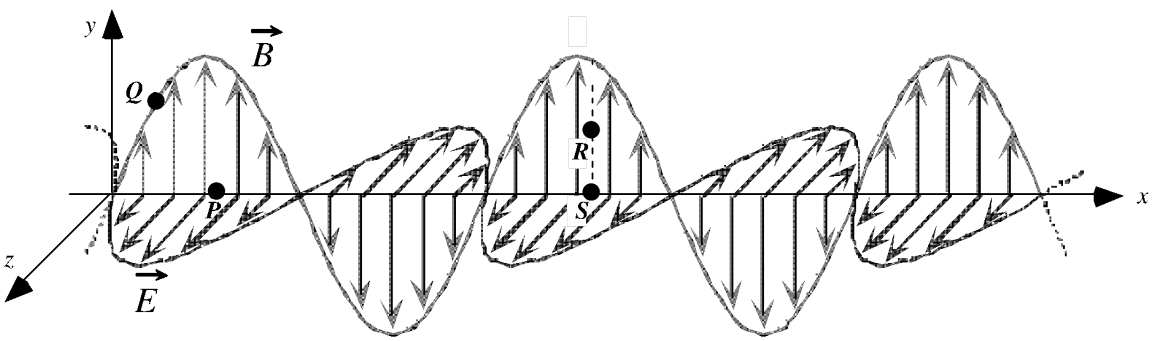
1. Calculate the intensity I_1 of the light after the first polarizer if the incident beam I_0 is linearly polarized at an angle $\theta = 25^{\circ}$ to the x-axis. **[5]**

2. The incident beam is now linearly polarized along the x-axis. Consider polarizer #3: are there any angles θ_3 between 90° and 180° for which the final intensity I_3 will be zero? If so, what are they? (There may be only one, of course, or none.) **[5]**

3. The incident beam is again linearly polarized along the *x*-axis. At what angle θ_3 between 90° and 180° will the final intensity I_3 be maximized? Determine both the angle and the maximum intensity. **[5]**

Shown below are mathematical and pictorial representations of an electromagnetic plane wave propagating through empty space. The electric field is parallel to the *z*-axis.

$$\vec{E}(x, y, z, t) = E_o \sin(kx + \omega t)\,\hat{z}$$



4. If $E_o = 125$ V/m, what is the average intensity of the plane wave? **[5]**

Q10A

1. $I_1 = I_0 \cos^2(25^\circ) = 9.86\ W/m^2$ (5)

Correct formula but numerical error (4)

Use $\sin\theta$ or $\cos\theta$ instead of $\cos^2\theta$ (2)

2. $\theta_3 = \theta_2 \pm 90^\circ = 120^\circ$ (5)

Recognize $\theta_3 - \theta_2 = 90^\circ$ but $\theta_3 \neq 120^\circ$ (3)

Use of θ_1 (-2)

Angles in addition to 120 (-2)

3. True maximum would be obtained with $\theta_3 = \theta_2 = 30^\circ$ but answer is restricted to $90 \le \theta_3 \le 180^\circ$ so the best one can do is $\theta_3 = 180^\circ$.

$I_3 = I_0 \cos^2(\theta_2 = 30^\circ)\cos^2(\theta_3 - \theta_2 = 150^\circ) = (9/16)I_0 = 6.75\ W/m^2$ (5)

Numerical error (-1)

Correct attenuation by second polarizer (2)

Observe that true maximum would require $\theta_3 = \theta_2 = 30^\circ$ (2)

Everything else correct but incorrect θ_3 (3)

4. $I = \dfrac{c\varepsilon_0 E_0^2}{2} = \dfrac{E_0^2}{2(Z_0 = 377\,\Omega)} = \cancel{74}6\ W/m^2$ (5)

20.7

Omit the ½ (-1)

Numerical error (-1)

Quadratic in E_0 but some other error in the formula (2)