P12.NP – Rayleigh Criterion and Polarization

Rayleigh Criterion:

1. What is the smallest angle that can be resolved by the Karl G. Jansky Very Large Array in New Mexico? It has a possible aperture of 42 km, and uses a wavelength of 0.6 cm.
($2x10^{-7}$ radians, or about 0.04 arc seconds (1/3600 of a degree))

2. What size radar (λ = 1.2 cm) dish could resolve an aircraft that subtends an angle of 0.14^o (Convert that angle to radians) (6.0 m)

3. A spotting telescope has an aperture of 0.102 m and uses visible light (use 550. nm as the wavelength). What is its minimum resolution angle? What minimum size object can it resolve at a distance of 400. m? ($6.58x10^{-6}$ rad, 2.63 mm)

4. Looney Tunes who deny that the moon landing ever happened say that the Hubble could have been used to take pictures of the landing stages left behind by the Apollo missions. The landing stage was 9.4 meters wide, the moon is 384.4 million meters away, and the aperture of the Hubble is 0.305 m. Use 550 nm as the wavelength. Can the Hubble resolve an object that size on the moon? (Calculate the angle the landing stage subtends, calculate the minimum angle the Hubble can resolve.) What is the minimum size it can resolve? (No, the angle is about 100x too small: $2.4x10^{-8}$ rad vs $2.2x10^{-6}$ rad. 846 m)

Polarization:

5. Vertically polarized light with an intensity of 430. W m^{-2} falls upon a perfect polarizing filter that makes an angle of 17.0^o with the vertical.
   a. What is the intensity of the light after the filter? (393 W m^{-2})
   b. At what angle would the intensity be 54.0 W m^{-2}? (69.2^o)

6. Vertically polarized light strikes a filter that makes an angle of 48.0^o with the vertical. After the filter the intensity is 102 W m^{-2}. What was the intensity before the filter? (228 W m^{-2})

7. Unpolarized light with an intensity of 200. W m^{-2} falls upon a vertical polarizer that is 100% efficient. Behind that filter is another polarizing filter that has been rotated so its plane of polarization makes a 34.0^o angle with the vertical.
   a. What is the intensity after the first filter? (100. W m^{-2})
   b. What is the intensity after the second filter? (68.7 W m^{-2})
   c. What angle of rotation would you need to reduce the transmitted intensity to 50.0 W m^{-2}? (45.0^o)

8. Unpolarized light falls on two polarizing filters that have their planes of polarization rotated 68.0^o from one another. After the two filters, the intensity is 62.0 W m^{-2}. What was the intensity before both filters? (884 W m^{-2})