Theoretical Problem 3

A detector of radiowaves in a radioastronomical observatory is placed on the sea beach at height $h = 2\,\mathrm{m}$ above the sea level. After the rise of a star, radiating electromagnetic waves of wavelength $\lambda = 21\,\mathrm{cm}$, above the horizont the detector registers series of alternating maxima and minima. The registered signal is proportional to the intensity of the detected waves. The detector registers waves with electric vector, vibrating in a direction parallel to the sea surface.

1. Determine the angle between the star and the horizont in the moment when the detector registers maxima and minima (in general form).

2. Does the signal decrease or increase just after the rise of the star?

3. Determine the signal ratio of the first maximum to the next minimum. At reflection of the electromagnetic wave on the water surface, the ratio of the intensities of the electric field of the reflected (E_r) and incident (E_i) wave follows the low:

$$\frac{E_r}{E_i} = \frac{n - \cos\varphi}{n + \cos\varphi},$$

where n is the refraction index and φ is the incident angle of the wave. For the surface "air-water" for $\lambda = 21\,\mathrm{cm}$, the refraction index $n = 9$.

4. Does the ratio of the intensities of consecutive maxima and minima increase or decrease with rising of the star?

Assume that the sea surface is flat.