Challenge 5, Optics

Submission date: 29. November

All kinds of optics *(15 points)*

Parts A, B and C are independent of each other and can therefore be solved individually.

Part A. Astronaut *(3 points)*

i. (3 pt.) An astronaut is in his spaceship in an orbit 280 km from the surface of the Earth. What is the minimum distance between two points on the Earth's surface so that he can still tell them apart (under optimal conditions)? The diameter of the pupil is 0.5 cm and the wavelength of light is 550 nm.

Part B. Coated glasses *(5 points)*

A beam of white light is shining perpendicularly on a lens (n=1.52), which is covered with a thin film of magnesium fluoride (n=1.38).

i. (3 pt.) What is the minimum film thickness at which the reflected light contains no yellow-green light of wavelength 550 nm (in air)?

ii. (2 pt.) For which minimum layer thickness (different from zero) does constructive interference result for the reflected light?

Part C. Newton's rings *(7 points)*

In 1717, Sir Isaac Newton studied an interesting phenomenon: If you approach a spherical surface to a reflecting plane surface, you observe a series of concentric rings (see figure) when you look through the glass from above. In our case, the light source is monochromatic and has a wavelength λ.

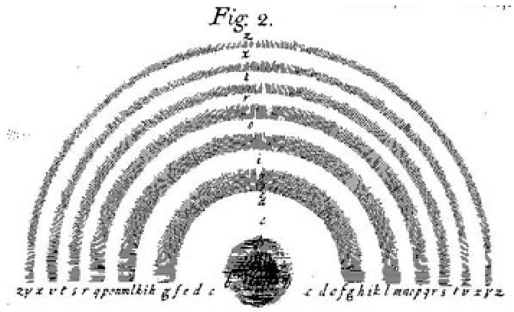

Figure 1:

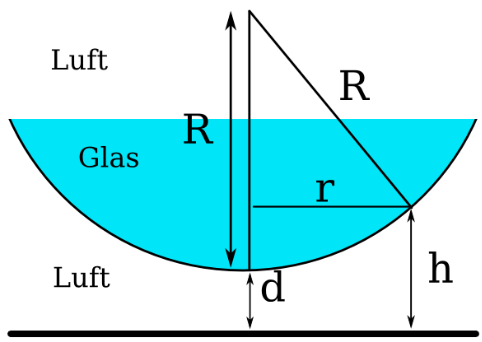

Figure 2:

i. (4 pt.) Explain why you see rings, what the conditions are for bright rings and what the conditions are for dark rings.

Having been delighted by the beauty of the rings that bear his name, Sir Isaac Newton might have wondered at what distance d the lens is from the plane surface.

ii. (3 pt.) Express d as a function of the radius R of the curved glass surface, the radius r_n of the n^{th} dark ring and the wavelength λ.