Exam #1 – Physics

Friday, October 17, 2014 **Duration: 1 h**

No documents allowed. No mobile phone. The use of not-programmable calculator is allowed. The marks will account for the justifications, the writing and the general clarity and cleanness of your papers. Indicative grading scale.

1- Lenses (11 points)

The 3 questions do not depend on each other.

During a practical, students can use an optical bench, a source of light, an object AB of height 2.0 cm (as the slide you used during the practicals), a screen and several thin lenses. They place the source and the object on the bench and want to study the lenses. The lenses will be used under paraxial conditions.

1. The first lens L_1 is placed at 15.0 cm after the object AB. A first group observes a sharp image A'B' on the screen, located at 30.0 cm after the lens.

   a. Establish the literal expression of the lens focal length f_1'. Give its numerical value.

   b. Calculate the size of the image. Is it upright or reversed? Explain.

2. A second group uses only the lens L_2. Whatever the distance between the object and the lens, and whatever the distance between the lens and the screen, they cannot observe a sharp image on the screen.

   a. What can be concluded regarding the lens L_2? Explain.

   b. From your own experience during the practicals, propose an experimental method for the observation of the image formed by L_2. Describe the method in a few sentences and use schemes to illustrate the set-up.

3. The third group uses the lens L_3, of focal length $f_3' = -10.0$ cm. They place it 5.0 cm after the object AB.

   a. Fill in the ray diagram in appendix by tracing 3 rays. From the ray diagram, determine the main characteristics of the image A'B' (position, nature, orientation and size).

   b. Bonus: the students use another lens, L_4, of focal length $f_4' = 10.0$ cm. They place it 25.0 cm after lens L_3. Complete the ray diagram and determine the position of the final image $A''B''$.

2- Snell-Descartes' laws (9 points)

A spotlight is placed on the bottom of a pool. It will be considered as a point light source (S). The spotlight emits a conical beam towards the water surface, with an apex semi-angle $\alpha = 60°$. The cone axis of symmetry is vertical (see Figure 1).

The water depth and refraction index are h = 0.80 m and $n_{water} = 1.33$, respectively.

If light detectors were placed on the bottom of the pool, they would allow the detection of 3 different areas on the pool ground (see Figure 2):

- A relatively dark disc, poorly illuminated, at the center ($R < R_{int}$);
- A very bright ring ($R_{ext} < R < R_{int}$);
- A very dark area ($R > R_{ext}$).

1. Explain clearly the difference in brightness on the pool ground, by tracing the path of the rays forming the bright ring.

2. Give the literal expressions of internal and external radiuses, R_{int} and R_{ext}, of the bright ring. Calculate the numerical values.

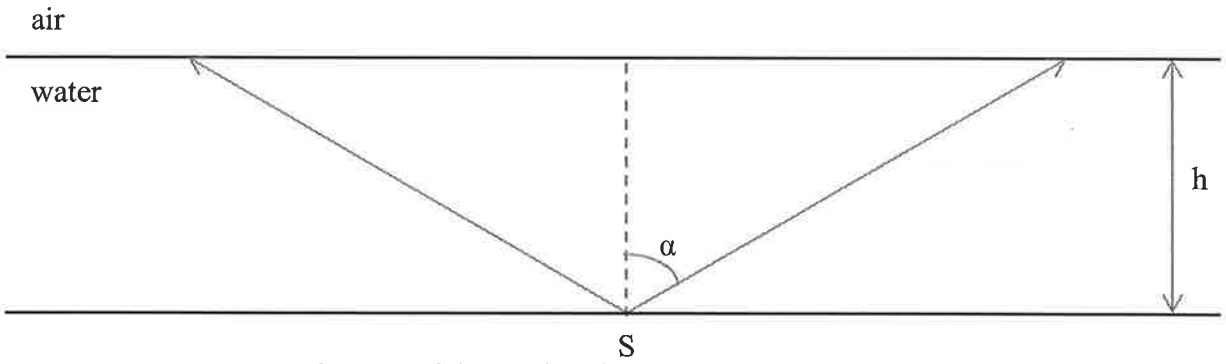

Figure 1: side view of the pool and extreme rays forming the light cone.

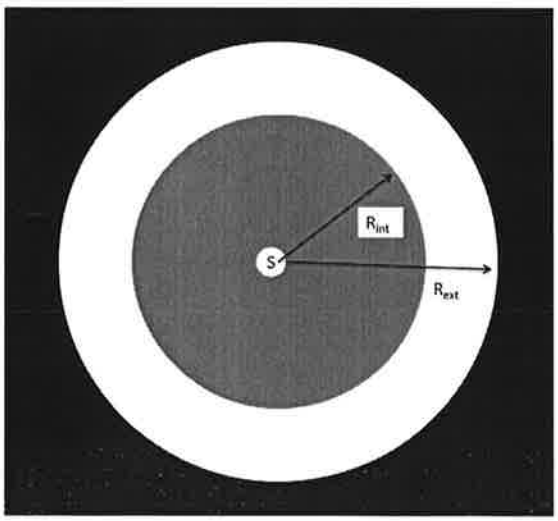

Figure 2: light collected on the pool ground: bright areas in white, poorly illuminated areas in grey and very dark areas in black.