

**State Examination Commission – Physics Higher Level, 2011**

**Question 12b**

State the laws of refraction of light. (6)

A lamp is located centrally at the bottom of a large swimming pool, 1.8 m deep.

Draw a ray diagram to show where the lamp appears to be, as seen by an observer standing at the edge of the pool. (7)

At night, when the lamp is switched on, a disc of light is seen at the surface of the swimming pool. Explain why the area of water surrounding the disc of light appears dark.

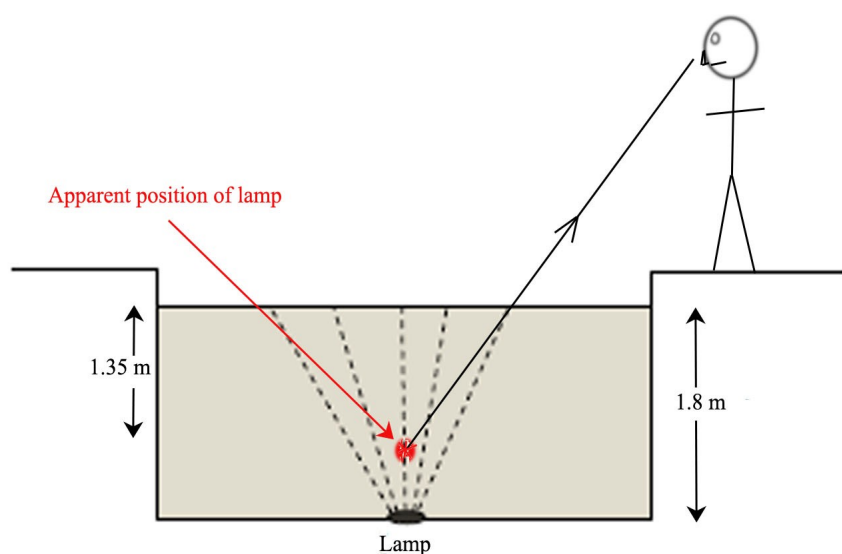
Calculate the area of the illuminated disc of water. (15)

(refractive index of water = 1.33)

State the laws of refraction of light. (6)

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$$n = \text{real depth} / \text{apparent depth}$$

$$1.33 = 1.8 / \text{apparent depth}$$

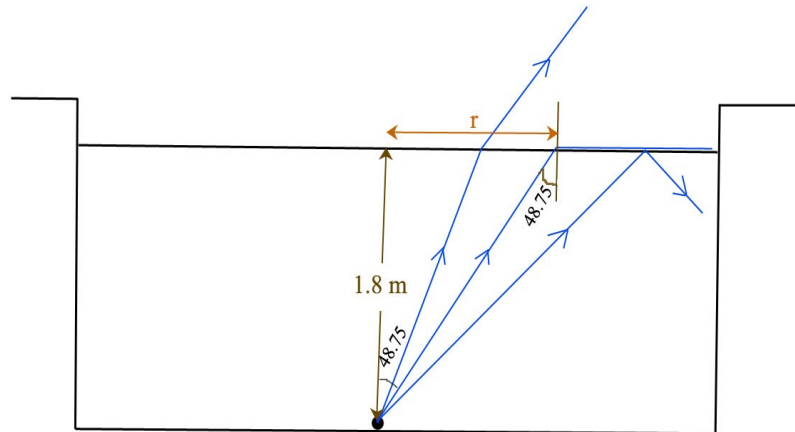
$$\Rightarrow \text{apparent depth} = 1.35 \text{ m}$$

At night, when the lamp is switched on, a disc of light is seen at the surface of the swimming pool. Explain why the area of water surrounding the disc of light appears dark.

Because no light from the lamp passes, from the water out into the air, if it strikes the water at an angle that exceeds the critical angle. This light is totally internally reflected instead.

Calculate the area of the illuminated disc of water.

(15)



$$n = 1/\sin C \Rightarrow \sin C = 1/n = 1/1.33 = 0.7519$$

$$\Rightarrow C = 48.75^\circ$$

$$\text{Now, } \tan 48.75^\circ = r/1.8$$

$$\Rightarrow r = 2.053 \text{ m}$$

$$\Rightarrow \text{area of disc} = \pi r^2 = \pi(2.053)^2 = 13.2 \text{ m}^2$$