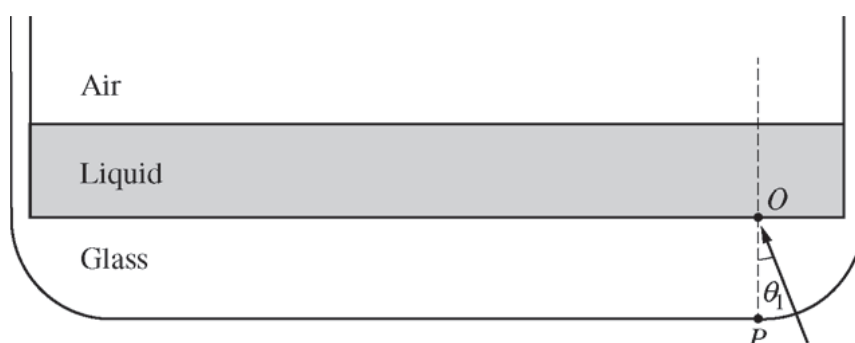


PHYSICS 2
Section II
4 Questions
Time—90 minutes

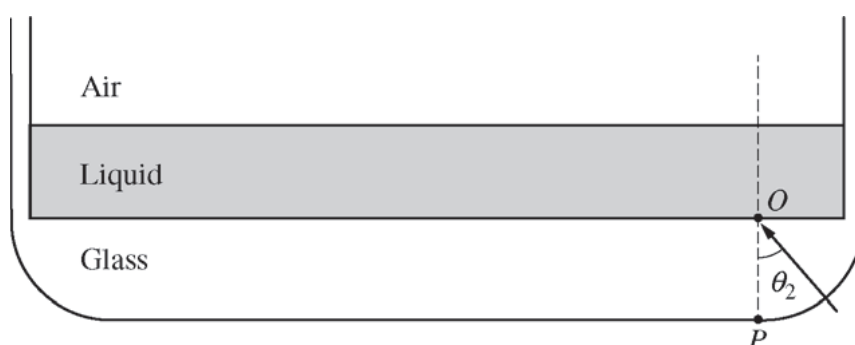
Directions: Questions 1 and 4 are short free-response questions that require about 20 minutes each to answer and are worth 10 points each. Questions 2 and 3 are long free-response questions that require about 25 minutes each to answer and are worth 12 points each. Show your work for each part in the space provided after that part.



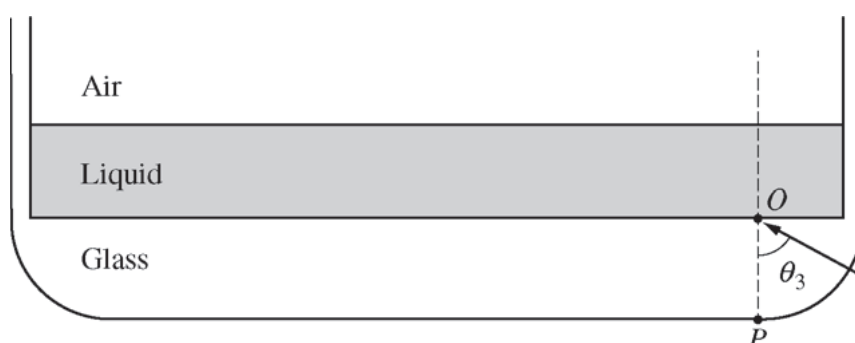
1. (10 points - suggested time 20 minutes)

The figure above shows a cross section of a drinking glass (index of refraction 1.52) filled with a thin layer of liquid (index of refraction 1.33). The bottom corners of the glass are circular arcs, with the bottom right arc centered at point O . A monochromatic light source placed to the right of point P shines a beam aimed at point O at an angle of incidence θ . The flat bottom surface of the glass containing point P is frosted so that bright spots appear where light from the beam strikes the bottom surface and does not reflect. When $\theta = \theta_1$, two bright spots appear on the bottom surface of the glass. The spot closer to point P will be referred to as X ; the spot farther from P will be referred to as Y . The location of spot X and that of spot Y both change as θ is increased.

- (a) In a coherent paragraph-length answer, describe the processes involved in the formation of spots X and Y when $\theta = \theta_1$. Include an explanation of why spot Y is located farther from point P than spot X is and what factors affect the brightness of the spots.
- (b) When θ is increased to θ_2 , one of the spots becomes brighter than it was before, due to total internal reflection.
 - i. On the figure below, draw a ray diagram that clearly and accurately shows the formation of spots X and Y when $\theta = \theta_2$.



- ii. Which spot, X or Y , becomes brighter than it was before due to total internal reflection? Explain your reasoning.
- (c) When θ is further increased to θ_3 , one of the spots disappears entirely.
 - i. On the figure below, draw a ray diagram that clearly and accurately shows the formation of the remaining spot, X or Y , when $\theta = \theta_3$.



- ii. Indicate which spot, X or Y , disappears. Explain your reasoning in terms of total internal reflection.