

Name: _____

Biology 3820
Physical Principles in Biology
Spring Semester 2011

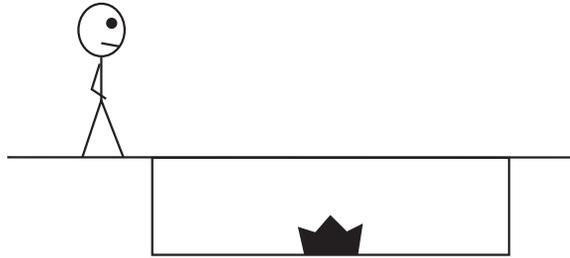
Quiz 4
8 April 2011

Please write your name on each page.

Be sure to show your work and include correct units in all of your answers!

25 points total.

1. (5 pts) In olden times, a boy was walking in the woods wishing that he could be a prince. Suddenly he came upon a pond with a golden crown at the bottom, shown below:

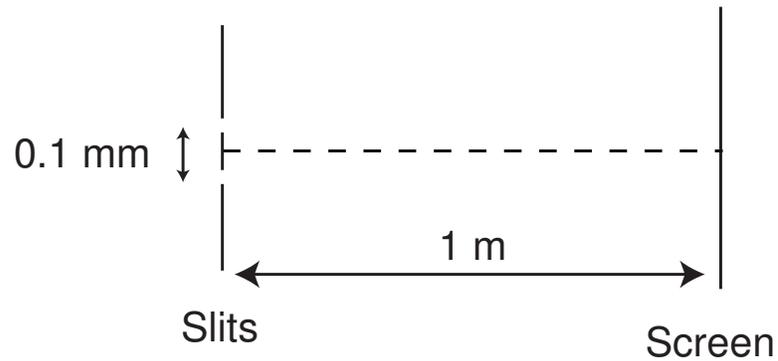


As he looked at the crown, a genie appeared and told him that he would become a prince if he could reach the crown and pull it out of the water. But, there was a catch: He had to grab the crown on his first try! Should the boy reach for the crown at the point he sees it, in front of this point or beyond the point at which the crown appears?

In answering this question, add lines to the drawing above showing the path of the light that forms the image of the crown and explain why the light takes this path. Also, carefully explain why the boy should reach for a particular point, relative to where he sees the crown.

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2. (10 pts) Suppose that you were to set up a double-slit experiment, using 600 nm light, with the dimensions indicated below:



The slits will generate an interference pattern on the screen with a bright band at the center position indicated by the dashed line.

- (a) Calculate the distance between the center position and the first bright band above the center.

- (b) Calculate the distance between the center position and the tenth bright band above the center.

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3. (10 pts) The human eye is normally filled with a clear liquid, called the vitreous humor, which has an index of refraction of about 1.34. There are certain eye pathologies for which the treatment involves removing the vitreous humor and temporarily replacing it with either a gas or a fluid, such as a saline solution, to maintain the shape of the eye and help keep the retina in place. Eventually, the body replaces the gas or artificial fluid with natural vitreous humor, and patients often recover full vision.

(a) Considering only the direct effects of replacing the vitreous humor (as opposed to other trauma on the eye), would you expect any temporary optical effects to be more severe with a gas or saline replacement? Explain your reasoning.

(b) For the case of a gas replacement of the vitreous, would you expect the focal length of the eye lens to become greater or shorter? Explain your answer with the help of a drawing.