

2008 A/L Structured Essay Question No (03)

3. (a) Two monochromatic rays of light with angles of incidence  $\theta_1 (> \theta_c)$  and  $\theta_2 (< \theta_c)$ , where  $\theta_c$  is the critical angle of glass, are falling on a glass-air interface as shown in figure 1. Complete the paths of the rays.

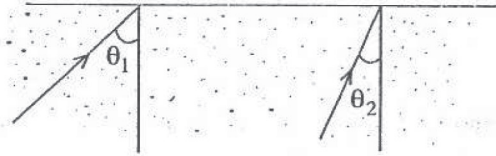


Figure 1

- (b) You are asked to determine the critical angle of glass by the method of total internal reflection. A prism is placed on a white sheet of paper, in such a way that a vertical pin ( $M$ ) is in contact with face  $AC$  of the prism as shown in figure 2. The boundaries of the faces of the prism are drawn on the paper.

- (i) In this experiment the pin  $M$  has to be placed in contact with face  $AC$ . State the reason for this.

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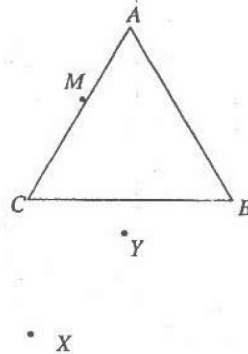


Figure 2

- (ii) When you move your eye from  $B$  to  $C$  while looking through face  $BC$  towards  $AB$  what change of the image of the pin  $M$  do you expect to observe?

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(iii) How do you detect the path of the relevant emergent ray experimentally using two other pins? The locations of the two pins are marked as  $X$  and  $Y$  in the figure 2.

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(iv) Write down the remaining steps in the order that you would follow to construct the ray diagram. Use figure 2 also to illustrate the steps in the construction of the ray diagram.

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(v) What measurement would you take from the ray diagram? Also clearly indicate it on the ray diagram.

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(c) You are asked to modify and repeat this experiment to determine the critical angle for glass – water interface by forming a thin layer of water on the surface  $AB$  as shown in figure 3.

(i) Where would be the new location of the image of pin  $M$  relative to the image obtained in part (b) above.

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(ii) Draw the new emergent ray in figure 3 relative to  $X$  and  $Y$  and label it as  $X'Y'$ .

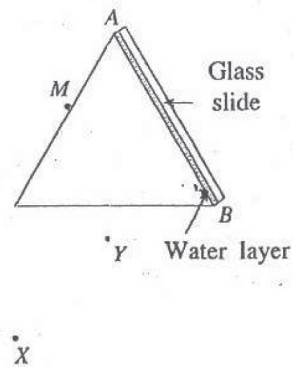


Figure 3

(d) Critical angles determined in part (b) and part (c) above are  $C_1$  and  $C_2$ , respectively. Find an expression for the refractive index of water in terms of  $C_1$  and  $C_2$ .

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