JAFFNA HINDU COLLEGE

Risk Holiday Self - Education Worksheet (2) – 2020

Grade – 12 (2021) | Physics

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INSTRUCTIONS :

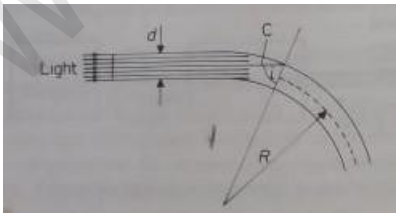
- Answer all the questions.
- Answer the questions on answer sheets only.
- Read the respective lesson units thoroughly and comprehend before you attempt answering the questions.
- File the completed answer and hand over to the class teacher when the school reopens.

1.

a) Explain in terms of a wave model how a beam of light is refracted as it crosses an interface between two transparent media. Hence derive Snell's law of refraction in terms of the speed of light in media

b) Describe the phenomenon of total internal reflection and explain what is meant by the critical angle. How is the critical angle related to the speeds of light in the media involved ?

c) A portion of a straight glass rod of diameter d and refractive index n is bent into an arc of a circle of mean radius R, and a parallel beam of light is shone down it, as shown in figure



i. Drive an expression in terms of R and d for the angle of incidence i of the central ray C on reaching the glass-to-air surface at the circular arc.

ii. Show that the smallest value of R which will allow all the light to pass around the arc given by

$$R = \frac{d(n+1)}{2(n-1)}$$

iii. Use this results to explain why glass fibres, rather than rod, are used to carry optical signals around sharp corners.

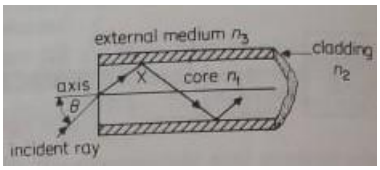
iv. A glass fibre of refractive index 1.5 and diameter 0.50mm is bent into a semi – circular arc of mean radius 4.0mm, and a beam light is shone along it.

   a. Show that no light escapes from the sides of the fibre.

   b. Shown by a suitable calculation that if the fibre is immersed in oil of refractive index 1.4 some light will escape

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2. What do you understand by angle of refraction and refractive index?
   A ray of light crosses the interface between two transparent media of refractive indices n_A and n_B . Give a formula relating the directions of the ray on the two sides of the interface. Show the angles you use in your formula on a diagram. Hence , deduce the conditions necessary for total internal reflections to take place at an interface.

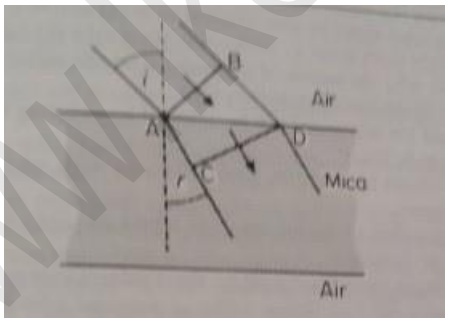


   In the simple 'light pipe' shown in figure, a ray of light may be transmitted (with little loss) along the core by repeated internal reflection. The diagram shows a cross-section through the diameter of the 'pipe' with a ray incident in that plane. The core, cladding and external medium have refractive indices n1 , n2 and n3 respectively. Show that total internal reflection takes place at X provided that the angle θ is smaller than a value θ_m given by the expression

   $\sin \theta_m = \sqrt{(n_1{}^2 - n_2{}^2)/n_3}$

   Explain why the pipe does not work for rays which $\theta > \theta_m$. (Reminder : $\sin^2 \theta + \cos^2 \theta = 1$)

3. Figure shows a wavefront of light AB arriving at the surface of a flat mica sheet. CD marks the position of the same wavefront just inside the mica



   a) Drive the result

$$n = \frac{Sin\ i}{Sin\ r} = \frac{c}{c_m}$$

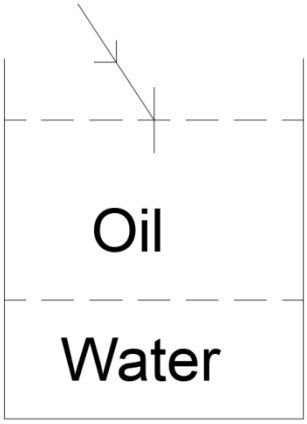
      Where n is the refractive index of mica and where c and c_m are the speed of light in air and mica respectively

   b) The thickness of the mica sheet is 4.80μm. the refractive index of mica for light of wavelength 512nm is 1.60. calculate the ratio of the thickness of the sheet of mica
      i. The wavelength of the 512nm light in air
      ii. The wavelength of the same light in mica

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4. State condition necessary for total internal reflection to occur?

A metal tank contains paraffin oil ($n_B = 1.48$) and water ($n_W = 1.33$)



i. Calculate the critical angle between the oil-water interface ?

ii. Show that total internal reflection at the interface is impossible for any ray enter the system ?

iii. If it is a glass tank instead of metal tank then show that total internal reflection is possible ?

iv. If it happening then calculate the maximum angle of incidence (θ_m) ?

v. Draw the ray diagram for $\theta < \theta_m$, $\theta > \theta_m$

vi. If the angle of incidence $\theta=60^o$, then calculate the angle of refraction in each liquid ?

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