2021 Ph H2 Q12

Section: Particles and Waves

Topic: Refraction and Dispersion

A hollow prism is filled with sugar solution. A laser beam is directed at 60° incidence. (a)(i) Calculate refractive index when angle of refraction = 40°. (a)(ii) State how the frequency of light in the solution compares with that in air. (b) Sketch path if solution is more concentrated (greater refractive index). (c) Compare paths for green and red light in concentrated solution.

Worked solution

(a)(i) Refractive index

$n = \sin(i)/\sin(r)$
$= \sin(60°)/\sin(40°) = 1.35$

Answer: 1.35

(a)(ii) Frequency of light is unchanged when crossing boundaries. So frequency in solution = frequency in air.

(b) A greater refractive index means the ray bends towards the normal. So the refracted ray inside the prism makes a smaller angle to the normal than before.

(c) Green light has a higher frequency (shorter wavelength) than red light. Refractive index increases with frequency (dispersion). Therefore, green light

refracts more strongly than red, bending further towards the normal.

Final answers

(a)(i) n ≈ 1.35

(a)(ii) Frequency unchanged

(b) Ray bends more towards normal

(c) Green light bends more than red

Revision tips

- Snell’s law: n = sin(i)/sin(r) (air → medium).
- Frequency is constant across boundaries; wavelength changes.
- Higher refractive index ⇒ ray bends towards normal.
- Dispersion: n increases with frequency, so blue/green bends more than red.
- Prisms split white light into colours due to dispersion.