

4.

(a) 2 points

The definition of the index of refraction relates the speed of light in vacuum and in glass.

$$n = \frac{c}{v}$$

Solving for v :

$$v = \frac{c}{n}$$

1 point

Substituting:

$$v = (3 \times 10^8 \text{ m/s}) / 1.60$$

$$v = 1.9 \times 10^8 \text{ m/s} \quad (\text{or } 0.625 c)$$

1 point

(b) 2 points

For the relation for the wavelength in glass and in vacuum:

$$\lambda_g = \frac{\lambda_v}{n}$$

1 point

$$\lambda_g = (700 \times 10^{-9} \text{ m}) / 1.50$$

$$\lambda_g = 4.7 \times 10^{-9} \text{ m}$$

1 point

(c) 3 points

For recognizing that the frequency of the light does not change when the light enters a different medium.

1 point

$$f = \frac{c}{\lambda}$$

1 point

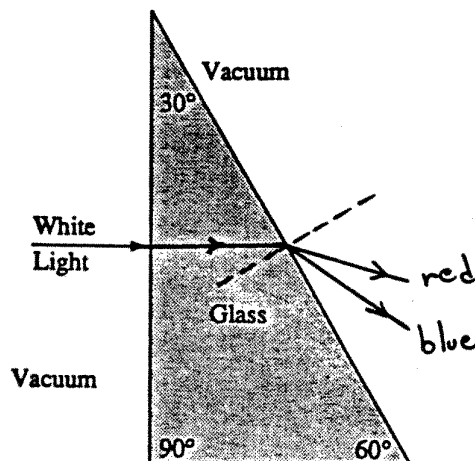
Substituting:

$$f = (3 \times 10^8 \text{ m/s}) / (700 \times 10^{-9} \text{ m})$$

$$f = 4.3 \times 10^{14} \text{ Hz}$$

1 point

4. (continued)
(d) 4 points



For indicating no refraction at the first surface 1 point

For indicating the red ray bending away from the normal at second surface (i.e. below horizontal) 1 point

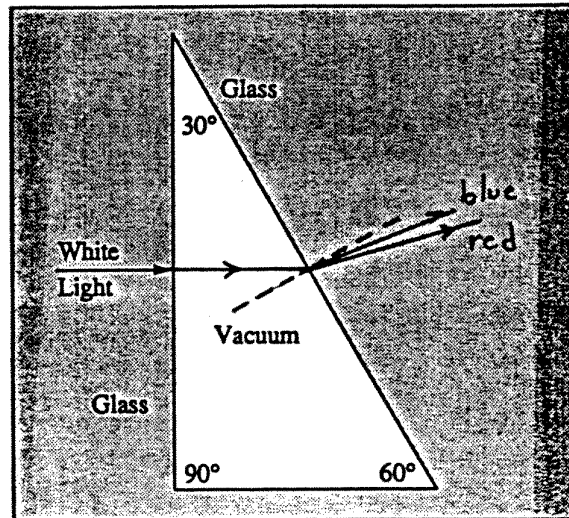
For indicating the blue ray bending away from the normal at second surface 1 point

For indicating that the blue ray bends more than the red ray. 1 point

(If refraction is shown at the first surface, the last three points may still be awarded for correctly refracting the incorrect rays at the second surface)

(If no points were earned for ray diagram, 1 point could be awarded for writing Snell's Law in either part (d) or part (e).)

4. (continued)
(e) 4 points



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| For indicating no refraction at the first surface | 1 point |
| For indicating the red ray bending toward the normal at the second surface. | 1 point |
| For indicating the blue ray bending toward the normal at the second surface. | 1 point |
| For indicating that the blue ray bends more than the red ray | 1 point |
- (If refraction is shown at the first surface, the last three points may still be awarded for correctly refracting the incorrect rays at the second surface)