

Name: _____ Section: _____ Score: _____/20

1. An **orthogonal**-triangular prism of index of refraction $n_P = 1.7$ is in an oil with index of refraction $n_O = 1.3$. With an incident angle θ as shown in the figure, the light incident from left is totally internally reflected at P. However, if you decrease this angle θ even slightly, some light can come out from P (i.e., the critical angle is realized at P).

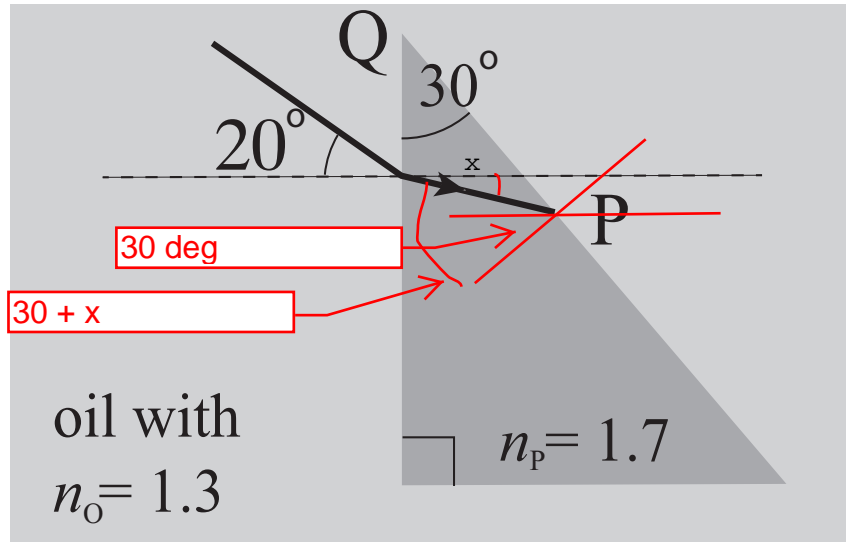
(1) The wavelength of the light in the surrounding liquid is 451 nm. What is the wavelength of the same light inside the prism? [5]

$$c = f \lambda$$

$$c = c_0/n$$

The frequency does not change in different media.

Therefore, λ in a medium is proportional to $1/n$. That is,
 $n \times \lambda$ is common to all the media. Hence,
 $1.3 \times 451 = 1.7 \times X$.
 $X = 451 \times 1.3/1.7 = 345 \text{ nm}$.



You must know that the wavelength in the prism is shorter than that in the liquid.

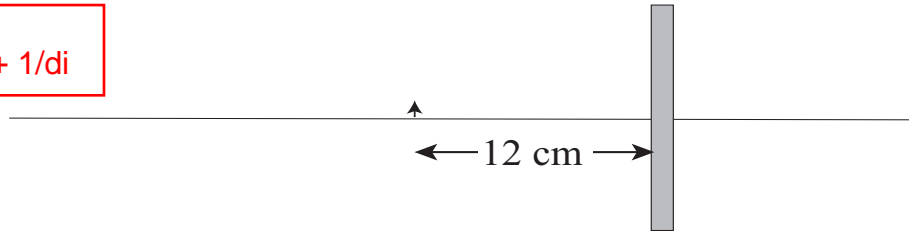
(2) Can the light come out from the prism at P? [5]

$$\text{Snell's law: } n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$1.3 \sin 20 = 1.7 \sin x \rightarrow \sin x = 0.2615 \rightarrow \theta = 15.2 \text{ deg}$
 $1.7 \sin (30 + x) = 1.7 \sin 45.2 = 1.3 \sin \theta \rightarrow \sin \theta = 0.928$.
 Therefore the light goes out.

2. 12 cm in front of a lens is a real object of height 5 mm whose image is formed 9 cm away from the lens.

$$m = -d_i/d_o$$
$$1/f = 1/d_o + 1/d_i$$



(1) What is the (absolute) size of the image? [5]

$$|m| = 9/12 = 3/4 \rightarrow (3/4) \times 5 = 3.75 \text{ mm}$$

(2) The image is actually inverted. What is the focal length of the lens? Is it converging or diverging? [5]

$$m > 0 \text{ upright}$$
$$m < 0 \text{ inverted}$$

$$m < 0 \rightarrow d_i > 0 \rightarrow d_o = 12 \text{ cm}, d_i = +9 \text{ cm}$$
$$1/f = 1/12 + 1/9 = (3+4)/36 \rightarrow f = 36/7 = 5.1 \text{ cm}$$

converging lens