Answer on Question #38975, Physics, Optics

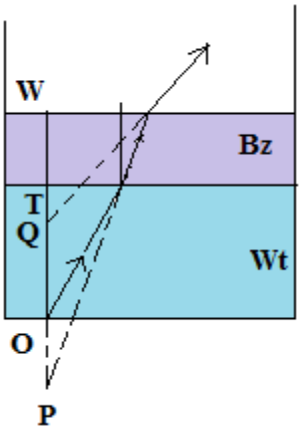
A layer of benzene (n =1.5) 12 cm thick floats on water layer (n =4/3) 8 cm thick in a vessel. When viewed from the top, the apparent depth of bottom of vessel below the surface of benzene will be

(1) 20 cm
(2) 14 cm
(3) 7 cm
(4) 21 cm

Solution:

Consider refraction through the water layer (layer 2) into the benzene layer (layer 3) first (Please see the figure). Further assume air to be the layer 1.

$n_{21} = \frac{4}{3}, \;\; n_{31} = 1.5$



The relative refractive index of the water to the benzene is

$$n_{23} = \frac{n_{21}}{n_{31}} = \frac{4}{3 \cdot 1.5}$$

OT is the real depth, after refraction through the water layer.

PT is the apparent depth after refraction through the water layer into the benzene layer.

Refractive index n = Real depth/Apparent depth.

Thus,

$$n_{23} = \frac{OT}{PT}$$

$$PT = \frac{OT}{n_{23}} = \frac{8 \cdot 3 \cdot 1.5}{4} = 9 \text{ cm}$$

Now consider refraction through the benzene layer into the air.

PW is the real depth, after refraction through the benzene layer.

QW is the apparent depth after refraction through the benzene layer into the air.

Plugging in the values in this case,

$$n_{31} = \frac{PW}{QW}$$

$$QW = \frac{PW}{n_{31}} = \frac{PT + TW}{n_{31}} = \frac{9 + 12}{1.5} = 14 \text{ cm}$$

Answer. (2) 14 cm.