P25.1 (a) From geometry, $1.25\text{ m} = d\sin 40.0°$

so $d = \boxed{1.94\text{ m}}$.

(b) $\boxed{50.0°\text{ above the horizontal}}$

or parallel to the incident ray.

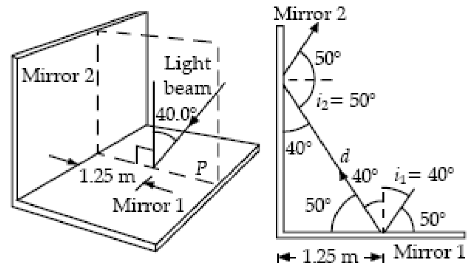

FIG. P25.1

P25.17 At entry, $n_1\sin\theta_1 = n_2\sin\theta_2$

or $1.00\sin 30.0° = 1.50\sin\theta_2$

$\theta_2 = 19.5°$.

The distance h the light travels in the medium is given by

$$\cos\theta_2 = \frac{2.00\text{ cm}}{h}$$

or $h = \dfrac{2.00\text{ cm}}{\cos 19.5°} = 2.12\text{ cm}$.

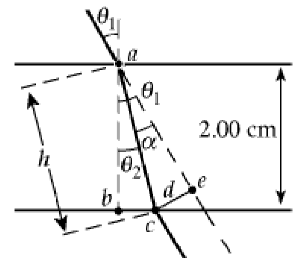

FIG. P25.17

The angle of deviation upon entry is $\alpha = \theta_1 - \theta_2 = 30.0° - 19.5° = 10.5°$.

The offset distance comes from $\sin\alpha = \dfrac{d}{h}$: $d = (2.21\text{ cm})\sin 10.5° = \boxed{0.388\text{ cm}}$.

P25.33 $\sin\theta_c = \dfrac{n_{\text{air}}}{n_{\text{pipe}}} = \dfrac{1.00}{1.36} = 0.735$ $\theta_c = 47.3°$

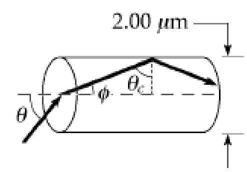

FIG. P25.33

Geometry shows that the angle of refraction at the end is

$\phi = 90.0° - \theta_c = 90.0° - 47.3° = 42.7°$.

Then, Snell's law at the end, $1.00\sin\theta = 1.36\sin 42.7°$

gives $\boxed{\theta = 67.2°}$.

The 2-μm diameter is unnecessary information.

P25.53 (a) For polystyrene *surrounded by air,* internal reflection requires

$$\theta_3 = \sin^{-1}\left(\frac{1.00}{1.49}\right) = 42.2° .$$

Then from geometry, $\theta_2 = 90.0° - \theta_3 = 47.8°$.

From Snell's law, $\sin\theta_1 = 1.49 \sin 47.8° = 1.10$.

This has no solution.

Therefore, total internal reflection $\boxed{\text{always happens}}$.

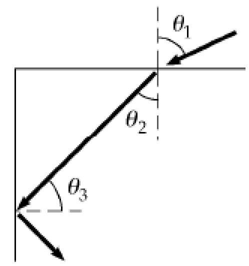

FIG. P25.53

(b) For polystyrene *surrounded by water,* $\theta_3 = \sin^{-1}\left(\frac{1.33}{1.49}\right) = 63.2°$

and $\theta_2 = 26.8°$.

From Snell's law, $\theta_1 = \boxed{30.3°}$.

(c) $\boxed{\text{No internal refraction is possible}}$

since the beam is initially traveling in a medium of lower index of refraction.