A 4.5 cm tall object is placed 26 cm in front of a spherical mirror. It is described to produce a virtual image that is upright and 3.5 cm tall.

(a) what type of spherical mirror should be used? (convex / concave)

(b) where is the image located?

NOTE: The math can tell us whether the mirror is convex / concave as well as whether the image is virtual / real; we just have to make sure to follow the sign convention

(a) CHECK SIGN OF f

GIVEN: $d_o = +26\text{cm}$, $d_i = ?$
$h_o = +4.5\text{ cm}$, $h_i = +3.5\text{ cm}$ UPRIGHT

USE MIRROR EQN & MAGNIFICATION EQN:

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

$$m = -\frac{d_i}{d_o} = \frac{h_i}{h_o} \quad h_i = +3.5\text{cm}, \quad h_o = +4.5\text{ cm}$$

$$-\frac{d_i}{d_o} = +0.778$$

$$d_i = -0.778\, d_o \quad (d_o = +26\text{cm})$$

$$\boxed{= -20.2\text{ cm}}$$

BEHIND THE MIRROR SINCE $d_i < 0$

$$f = \left[\frac{1}{d_o} + \frac{1}{d_i}\right]^{-1} = \boxed{-90.5\text{ cm}} \quad d_o = +26\text{cm}, \quad d_i = -20.2\text{ cm}$$

CONVEX MIRROR SINCE $f < 0$

A dentist uses a curved mirror to view the back side of teeth in the upper jaw. Suppose she wants an upright image with a magnification of $1.5x$ when the mirror is 1.2 cm from a tooth. Should she use a convex or concave mirror? What focal length should it have?

GIVEN: $m = 1.5$ $d_o = 1.2\text{cm}$

CONVEX OR CONCAVE MIRROR? $\longrightarrow$ CHECK SIGN OF f

$$m = -\frac{d_i}{d_o} = \frac{h_i}{h_o} = 1.5 \longrightarrow d_i = -1.5\, d_o = -1.8\text{ cm} \quad (d_o = +1.2\text{cm})$$

$$m = -\frac{d_i}{d_o} = \frac{h_i}{h_o} = 1.5 \longrightarrow d_i = -1.5\,d_o$$

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \longrightarrow f = \Big[\underbrace{\frac{1}{d_o}}_{+1.2\text{cm}} + \underbrace{\frac{1}{d_i}}_{-1.8\text{cm}}\Big]^{-1} = \boxed{+3.6\text{ cm}}$$

CONCAVE SINCE $f > 0$

A 2.0 cm tall object is placed in front of a mirror. A 1.0 cm tall upright image is formed behind the mirror, 150 cm away from the object. What is the focal length of the mirror?

NOTE: The 150 cm is the distance between the object and the image.

GIVEN: $h_o = +2\text{cm}$ UPRIGHT $h_i = +1\text{ cm}$

$d_o = ?$ $d_i = ?$

$$D = |d_o| + |d_i| = 150\text{cm}$$

$$m = -\frac{d_i}{d_o} = \frac{\overset{+1\text{cm}}{h_i}}{\underset{+2\text{ cm}}{h_o}} = 0.5$$

$$d_o = -\frac{d_i}{0.5} = -2d_i$$

$$|(-2d_i)| + |d_i| = 150\text{ cm}$$

$$|d_i| = 50\text{ cm} \longrightarrow d_i = \pm 50\text{ cm}$$

WE KNOW THE IMAGE IS BEHIND THE MIRROR, SO $d_i < 0$

$$\longrightarrow d_i = -50\text{ cm}$$

$$d_o = -2\overset{-50\text{cm}}{d_i} = +100\text{ cm}$$

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \longrightarrow f = \Big[\underbrace{\frac{1}{d_o}}_{+100\text{ cm}} + \underbrace{\frac{1}{d_i}}_{-50\text{cm}}\Big]^{-1} = \boxed{-100\text{cm}}$$

CONCAVE MIRROR