Solutions

Each answer shows the steps, then the **result**.

2.1

- thin-lens equation, with $s_o = 30$ cm and $f = 10$ cm:

$$\frac{1}{s_i} = \frac{1}{f} - \frac{1}{s_o} = \frac{1}{10\text{ cm}} - \frac{1}{30\text{ cm}} = \frac{2}{30\text{ cm}}$$

- $s_i = \mathbf{15}$ cm

2.2

- positive

2.3

- a camera, the eye, or a magnifying glass (any one)

3.1 A

- $\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}$.

3.2 B

- virtual, upright image.

3.3

(a)

- known: $s_o = 15$ cm, $f = 10$ cm (converging, so f is positive)
- thin-lens equation, rearranged for s_i:

$$\frac{1}{s_i} = \frac{1}{f} - \frac{1}{s_o}$$

$$\frac{1}{s_i} = \frac{1}{10\text{ cm}} - \frac{1}{15\text{ cm}} = \frac{3-2}{30\text{ cm}} = \frac{1}{30\text{ cm}}$$

- $s_i = \mathbf{30}$ cm

(b)

- real ($s_i > 0$)

3.4

(a)

- diverging, so $f = -15$ cm: $\frac{1}{s_i} = \frac{1}{f} - \frac{1}{s_o} = -\frac{1}{15} - \frac{1}{30} = -\frac{3}{30}$
- $s_i = \mathbf{-10}$ cm (on the same side as the object)

(b)

- $m = -\frac{s_i}{s_o} = -\frac{-10}{30} = +\mathbf{0.33}$
- upright and smaller, one third of the object's height

(c)

- the rays spread out after the lens; they only appear to come from the image, and never meet there

3.5 A

- near the centre, a thin lens acts like a thin parallel-sided slab

3.6

- rays from one point on the object actually meet at one point after the lens