

w01a — Pinhole camera: solution**Q1. Area of the image.**

Magnification for a pinhole is $m = f/Z$:

$$m = \frac{0.05 \text{ m}}{50 \text{ m}} = \frac{1}{1000}.$$

Image height = $10/1000 = 0.01 \text{ m} = 1 \text{ cm}$. Image width = $5/1000 = 0.005 \text{ m} = 0.5 \text{ cm}$.

$$\text{Area} = 1 \times 0.5 = 0.5 \text{ cm}^2 = 5 \times 10^{-5} \text{ m}^2$$

Common error: computing the area scale as $1/1000$ rather than $(1/1000)^2$. Area scales with the *square* of the magnification — the object is 50 m^2 and the image is 0.5 cm^2 , a factor of 10^6 .

Q2. When is the image blurry?

A complete answer names both competing effects:

1. **Pinhole too large** — each scene point projects to a finite disc rather than a point, so the image is blurred geometrically. Blur grows with aperture diameter.
2. **Pinhole too small** — diffraction dominates. The Airy pattern widens as the aperture shrinks, so shrinking the hole indefinitely makes things *worse*, not better.

The question stipulates the pinhole is “as small as can be without diffraction”, so the answer should focus on the remaining causes: the object being at a distance where the finite pinhole still subtends a non-negligible blur circle, motion of the object or camera during exposure, and the sensor/film plane not being at the assumed distance.

Any answer that identifies the aperture-size trade-off captures the core idea. Saying only “if the hole is too big” catches half of it: the diffraction limit matters just as much.