

# Microscopes - 2

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In *Microscope 1* we made a compound microscope with a magnification of  $2 \times 4 = \times 8$  with a single convex lens and a two-lens loupe as the eyepiece. It was shown in *Ray Diagrams* that magnification is given by the ratio of image distance over object distance ( $v/u$ ). To get more magnification with the same lenses we can lengthen the tube to increase the distance from the objective lens to the real image just below the eyepiece.



Doubling the length, doubles the ratio  $v/u$  and doubles the magnification.

## Testing the new microscope



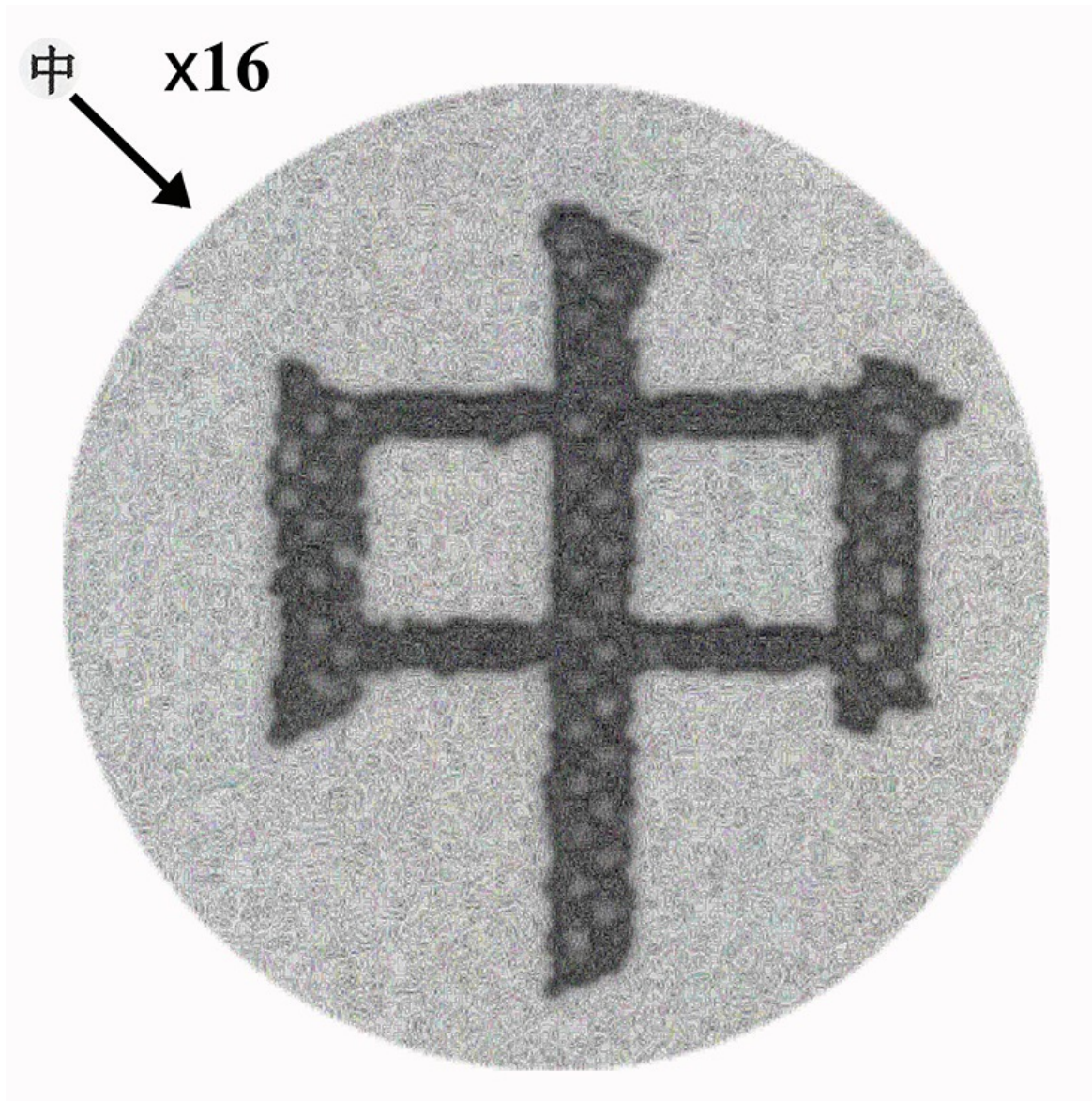
We used the same eyepiece: magnification  $\times 4$ . Object distance  $u$  and image distance  $v$  for the objective lens are marked with lines on the photo.

$$v = 4u$$

The magnification is given by  $v/u = \times 4$

The magnification of the compound microscope is now  $4 \times 4 = \times 16$



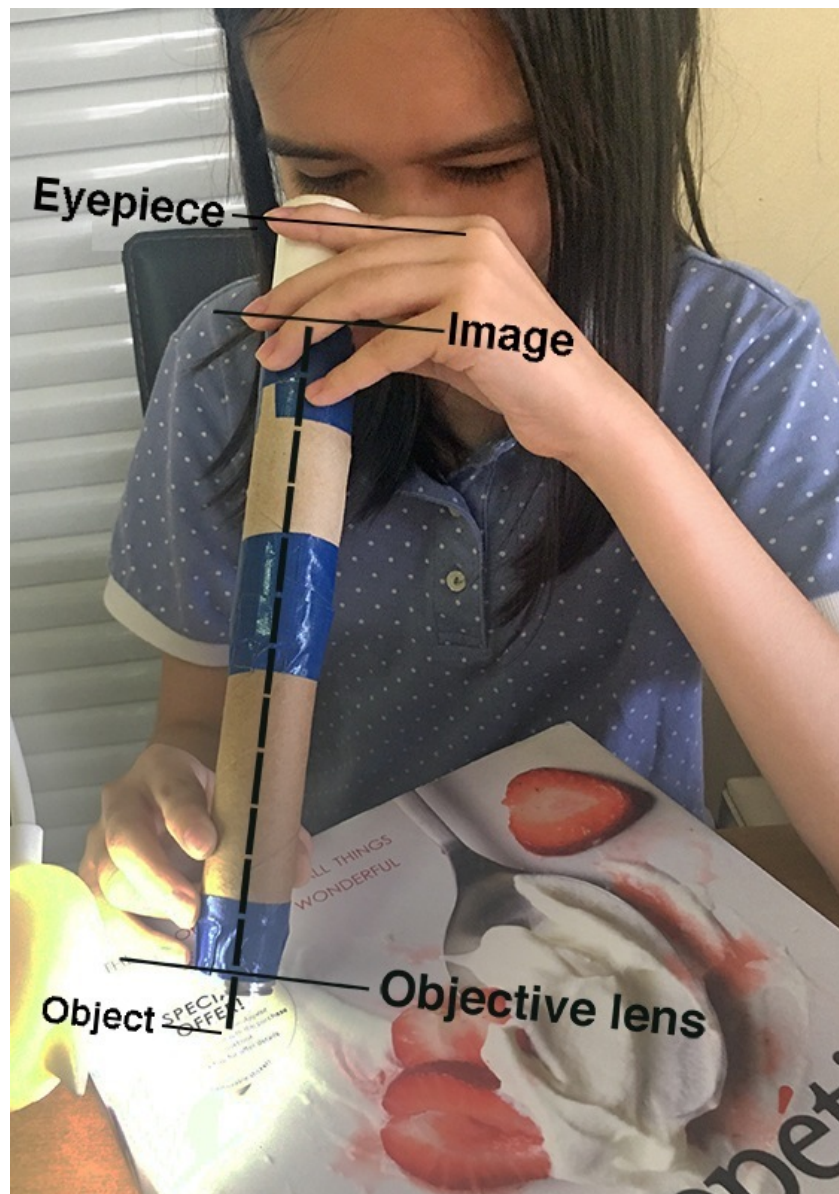


## Magnification

The magnification is doubled without appreciable loss of image quality due to using a two lens eyepiece.

The early compound microscopes used by Hooke in 1665 to draw a human flea and other small things by hand for his sensational book *Micrographie* had magnifications of 30-50 times. To increase the magnification of our microscope to x48 with the same eyepiece without lengthening it further we need to increase the ratio of  $v/u$  for the objective to 12. We need a fatter single lens objective or to maintain image quality, a two lens objective with a shorter focal length.

## Reading the fine print



Approximate object and image distances for the new two-lens objective are marked with lines on the photograph as above.

$$v = 12u$$

The magnification is given by  $v/u = \times 12$

The magnification of the compound microscope is now  $12 \times 4 = \times 48$

Note that the eye is above the eyepiece lens for comfortable viewing.



Suppose this was 1665 AD, or in Thailand, 2208 BE.



With a change of shirt and another book I might have looked like this with a Hooke-type microscope of about the same magnification, but my modern microscope has a sharper image with less distortion because we have used a compound, two-lens, objective and eyepiece.