

The Pocket Zoom Microscope

Contents:

- 9 pre-punched cardboard parts
- 3 acrylic lenses 304.OM.3, $f = +30\text{mm}$
- 1 acrylic lens 305.OM.4, $f = +49\text{mm}$
- 1 piece of clear PVC 35x59.5mm with grooving template

Instructions for assembly:

Please read the instructions fully before commencing. If you follow the instructions carefully you will be rewarded with a self-built precision instrument that can compete with much more expensive, ready-made ones. This is also thanks to Wolfgang Busch's computer-modelled spacing of the lenses.

- * Take your time, especially when waiting for the glue to dry.
- * You will need a sharp knife with a fine point (thin carpet knife, craft knife, scalpel), to cut the thin holding tabs of the pre-punched parts and a standard solvent based all purpose glue, e.g. UHU, Evo-Stik Impact, B&Q All Purpose Glue. **Do not use water-based glue:** it softens and warps the cardboard, and doesn't stick properly to the printed surfaces and lenses. Solvent based glues also dry much faster.
- * You also need a small brush to clean the parts and lenses from dust (cleanliness is essential for a good result), some sticky tape, and a black felt pen to blacken the inner edges of the blinds.
- * All grooved lines are folded backwards, away from you when looking at the black and gold printed side of the part.
- * Take care that no glue gets onto the surface of the lenses. Spare lenses are available from www.AstroMediaShop.co.uk.

Step 1: Remove the objective tube [A1] and the eyepiece tube [A2] from the cardboard, fold all grooved lines backwards, and glue each part together to form two hexagonal tubes.

Step 2: Remove the small round disc from the centre of the objective tube blind [B1], fold the six tags backwards, and blacken all edges. First without any glue, push the blind with the tags facing outwards into the end of the objective tube that has the "40x" printed next to it. The tags should be flush with the edge of the tube so that the blind sits exactly 6mm deep inside the tube. Remove the blind again, clean both parts from dust, apply a small amount of glue on the inside of the tube, and glue the blind in place. The blind improves the optical properties and the stability of the objective tube. The other end is reinforced by the objective lens.

Step 3: All 4 lenses are plane-convex: one side is flat, the other is curved outwards. Three of the lenses are equal and can be recognised by a flat rim around the curved part and two rectangular markings on that rim. These lenses have a focal length of +30mm, the fourth one has a focal length of +49mm.

Step 4: Blacken the edges of the objective blind [B2]. Carefully remove all dust from one of the $f = +30\text{mm}$ lenses and put it on your worktop with the flat surface facing down and the curved side up. Place the blind on top of the lens. Remove all dust from the $f = +49\text{mm}$ lens and put it on top of the blind with the rounded side down and the flat side facing up. Now the two lenses and the blind form a 7.5mm high stack with the objective blind in the middle (see drawing on the bottom right of the cardboard sheet). The curved sides of the lenses face inwards, the flat sides outwards. Stick small pieces of sticky tape on two or three spots on the edge of the stack to hold it together. Cut off any protruding tape.

The two lenses together form the objective of the microscope, the part that faces the object. The combination of two lenses leads to a colour correction, a single lens would produce colour fringes (chromatic aberration). The blind restricts the optical path to the centre parts of the lenses, which reduces spherical aberration and increases the sharpness of the image.

Step 5: Check again that the outer surfaces of the objective are free from dust and put it on your worktop with the $f = +30\text{mm}$ lens facing downwards and the $f = 49\text{mm}$ lens upwards. Apply a small amount of glue on the inside of the objective tube (next to the "20x"), in the middle of each of the six sides. Then push the tube over the objective until the flat surface of the bottom lens is flush with the edge of the tube. The objective is now held in place by the glue inside the tube and stabilises it.

Step 6: Clean the eyepiece tube [A2] and (very important) the other two lenses from dust, and put the lenses on your worktop with their flat sides facing down. Apply a small amount of glue to the six flat sides on the inside of one end of the eyepiece tube and push it over one of the lenses until they are flush. Do the same with the other end and the other lens. The lenses now have a distance of 20mm and together form the eyepiece, the part that faces the eye.

Step 7: Look through the eyepiece from both sides. You can see the magnified surface of the far lens, including all dust particles on it. Write an "E" onto the tube next to the lens giving the better image and through which you see less dust particles (because this will be the lens facing the eye). Next to the other lens you write an "R" onto the tube (Ramsden lens).

The combination of two equal lenses forming one colour-corrected eyepiece was invented in the 18th century by Jesse Ramsden in England.

Step 8: Blacken the edges of the two lens blinds [C1] and [C2] after removing their inner discs. Glue one of the blinds on the objective and the other on the Ramsden lens. To do this, apply a tiny drop of glue on each of the six corners and then stick the blind to tube.

The blinds prevent light entering the tubes through the openings in the corners around the lenses.

Step 9: Fold and glue the main tube [D1] to form a hexagonal tube.

Step 10: Push the eyepiece, with the "R"-side first, half into the main tube from the side that has "Hierhin kommt die Okularabdeckung" printed on it. Then apply some glue onto the outside of the other half of the eyepiece and push it fully home until the edges of both tubes are flush. Take special care that no glue reaches the lens itself.

Step 11: Push the opening of the main tube onto the end of the objective tube that holds the objective tube blind. Remove the disc from the eyepiece cover [D2] and fold all six tabs backwards. Then glue the cover over the eyepiece. It is best to apply glue only to the tabs.

Step 12: Fold the main tube sleeve [D3] into a six-sided ring and glue it onto the other end of the main tube.

Step 13: Put the 35 x 59.5mm piece of PVC film onto the grooving template (Nut-Schablone) and groove the film along the dashed lines, using a blunt knife or an empty ball pen. If necessary, you can secure the film with a piece of sticky tape. Fold the film into a hexagonal tube and glue it together with clear sticky tape. Then push this tube onto the end of the objective tube. If it slides on too easily, you can squash the tube a bit before fitting it.

This PVC tube forms an adjustable stand that is put over the object you want to observe. You can then shine a light onto the object through the transparent sides.

Congratulations! Now your Pocket Zoom Microscope is finished.

How to use your Microscope:

First push the objective tube fully in (20x magnification) and pull the PVC stand out a bit. Now stand the microscope over an object and shine a strong light onto it. Look through the eyepiece and adjust the height of the PVC stand until the image is as sharp as possible. For higher magnifications (up to 40x) pull the objective tube partly out and adjust the stand again. The higher the magnification, the closer the objective has to be to the object.