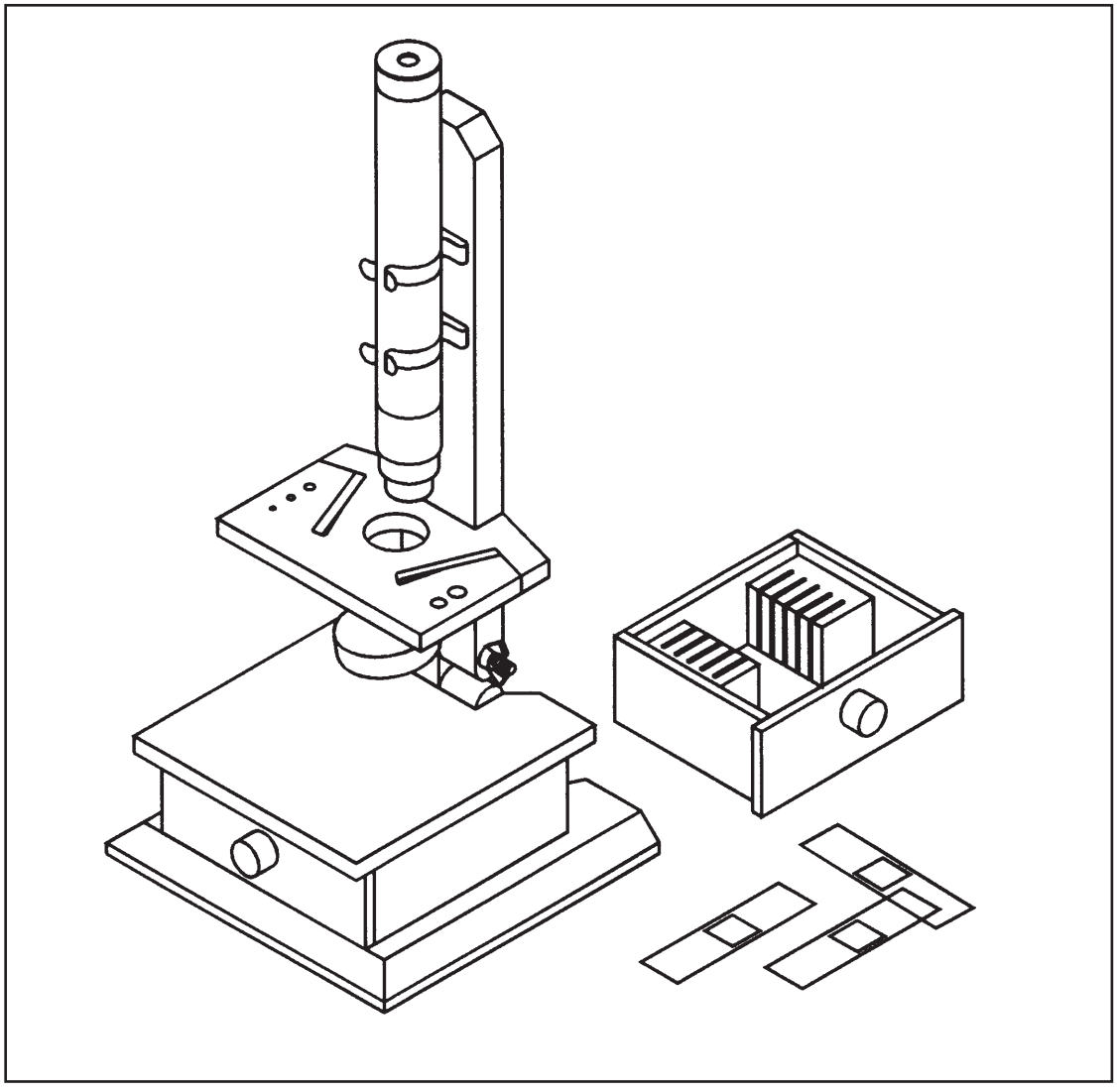
OPITEC

Hobbyfix

115.040

Microscope



Please Note

The OPITEC range of projects is not intended as play toys for young children.They are teaching aids for young people learning the skills of Craft, Design and Technology.These projects should only be undertaken and tested with the guidance of a fully qualified adult. The finished projects are not suitable to give to children under 3 years old. Some parts can be swallowed. Dan- ger of suffocation!

1. Product information:

Article: Useable product

Suitability: Key Stage 4 13-16 years

2. Material informations:

2.1. Material: Pine softwood
Gabon plywood, multi-layered

Working: All wood can be planed,(except plywood) sawn, shaped and sanded

Joining: PVA glue or screws

Finish: Wax (fluid or solid)
Wood paint (undercoat and top coat / spray paint)
Staining (coloured and water soluable finished with varnish)

2.2. Material: Aluminium (non ferrous metal)

Working: Mark out with a scriber.
Saw to length with a fine hackskaw, remove any burr with a file.

Joining: By clamping

Finish: No special finish required other than a clear lacquer spray.

2.3. Material: Plastic sheet (clear)

Working: Cut with scissors or a modelling knife.

Finish: None necessary

2.4. Material: Card tube

Working: None, the tube is pre-prepared

Joining: Glue

Finish: The ends are painted black (Edding felt tip pen)

3. Tools:

Sawing Use a **fret saw** for all rounded shapes and a straight backed saw for other work.

Note! Fret saw blades must be inserted with the teeth facing forward.

Hold the work securely on a sawing board.

The **Puk-saws** in our catalogue, are ideal for sawing dowel and small strips.

3. Tools:

Files: Choose the correct shaped file for the work in hand..

Note! Files will only cut on the forward stroke.

Sanding: Use a block and glasspaper for finishing all flat surfaces.

Drilling: Use a handrill or pillar drill

Note! Take note of the safety precautions when drilling.
(all long hair to be tied back, no loose clothing or jewelry to be worn and wear safety glasses)

Ensure that you choose the correct size drill bit and that it is sharp.
Secure all work to be drilled in a machine vice.

Holding: We recommend clamping the work..

Note! G clamps or similar are best for holding the parts whilst the glue is drying.

Cutting: Use a sharp modelling knife.

Note! use a safety ruler where possible to stop the knife from slipping in use.

A special tube cutting tool can be used on the aluminium. Be careful to remove any sharp burr with a file.

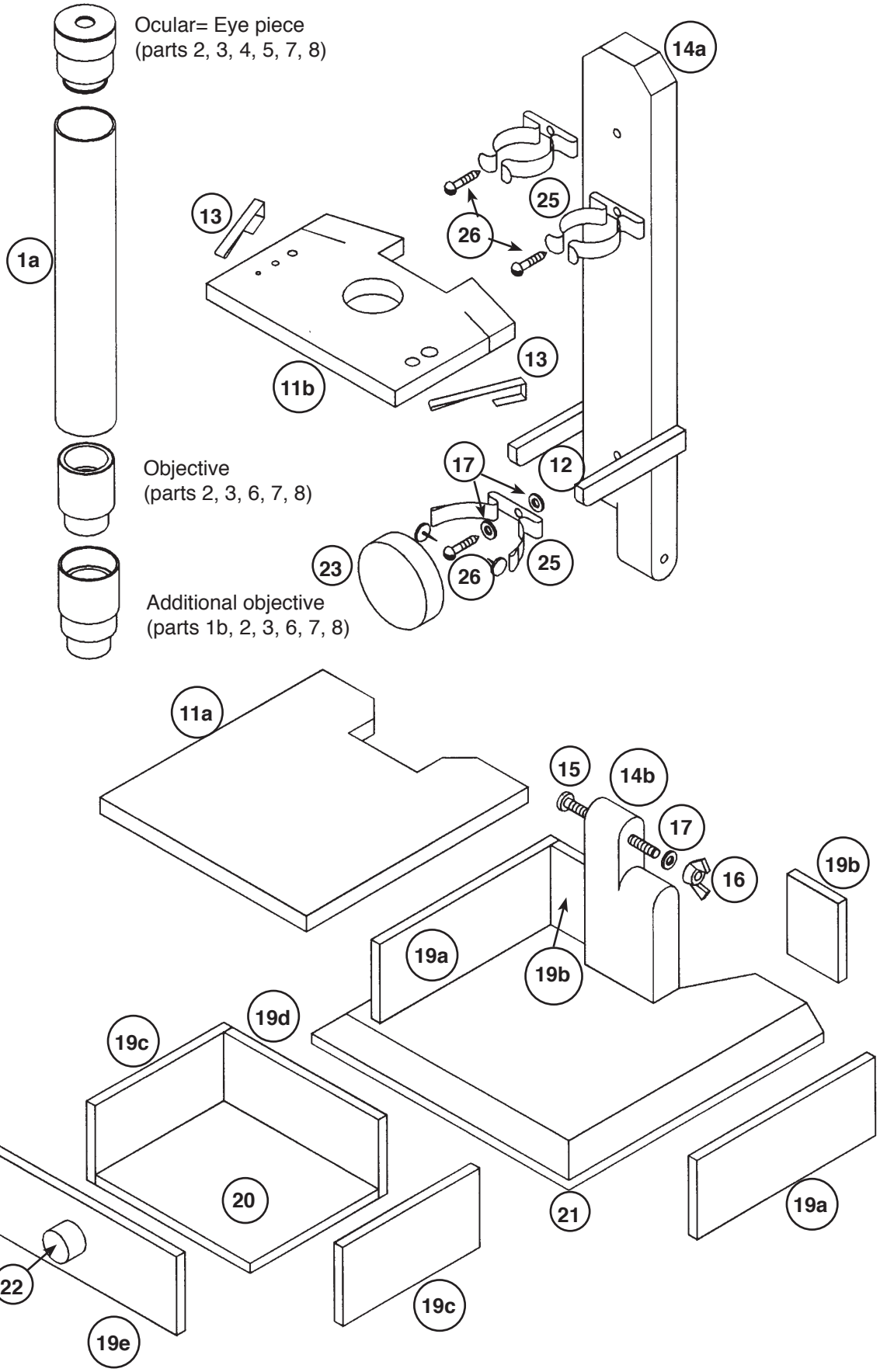
. 4. Parts list

Part	Material	Quantity	Diagram / N°	Size
Optic:				
Tube	Aluminium	1	 1a 1b	ø 23/25 x 200 mm
Lens holder	Card tube	3	 2	16,5 x 17,9 x 2,3 mm
Objective holder	Card tube	3	 3	22,0 x 23,0 x 2,5 mm
Aperture	PVC	1	 4	25/8 x 1 mm
Aperture	PVC	3	 5	17,7/8 x 1 mm
Aperture	PVC	4	 6	17,7/4 x 1 mm
Lens	Acrylic	4	 7	long. focale = +30 mm

4. Parts list:

Part	Material	Quantity	Diagram. / N°	Size
Optic:				
Paper	Black paper	1	8	see page 21 of instruction
Sliders	Plastic sheet	2	9	0,5 x 120 x 120 mm
Covers	Plastic sheet	1	10	0,3 x 150 x 210 mm
Microscope-Stand				
Table Drawer Lid	Plywood	1	11a 11b	8 x 120 x 200 mm
Table support	Pine	1	12	5 x 10 x 150 mm
Spring band	Brass	1	13	0,3 x 5,5 x 150 mm
Upright arm	Pine	1	14a 14b	15 x 40 x 350 mm
Machine screw	Steel	1	15	M 4 x 50 mm
Wing nut	Steel	1	16	M 4
Washer	Steel	3	17	M4
Screws	Steel	2	18	3 x 30 mm
Drawer/ carcass	Pine	3	19a 19b 19c 19d 19e	5 x 40 x 250 mm
Drawer base	Plywood	1	20	5 x 110 x 110 mm
Base	Pine	1	21	15 x 150 x 150 mm
Drawer handle	Pine	1	22	ø 15 mm
Mirror/tube holder				
Disc	Pine	1	23	ø 40 mm
Drawing pins	Steel	2	24	
Spring clips	Steel	3	25	27 - 32 mm
Screws	Steel	3	26	3 x 16 mm

5. Exploded drawing:



6. Planning and Making overview:

6.1 Planning stage
6.2 Preparation of individual parts
6.3 Making the eye piece (ocular)
6.4 Making the objectives
6.5 Assembly of the microscope optic stage
6.6 Making the object slides and covers
6.7 Making the base table
6.8 Making the base and drawer
6.9 Making the upright arm
6.10 Making and assembling the mirror
6.11 Assembly of the, upright arm, table and tube
6.12 Testing and evaluation

6.1. Planning stage:

Planning an making this microscope is best carried out in two stages:

- Making the optics
- Making the holder

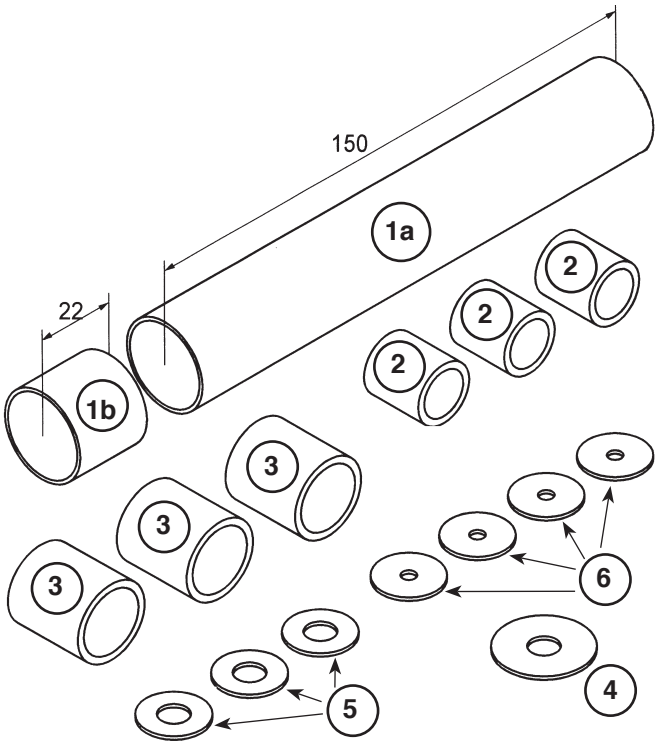
The optical parts need to be made in a clean and as dust free environment as possible eg. not in the same room as sawing, drilling, sanding and cutting are taking place at the same time.

It does not matter which step is carried out first. For group work it may be better to have one team making the optic and another the holder and base. This way the necessary tools can be used in an optimal way.

6.2. Preparation:

6.2.1. Start by measuring and cutting one length 150 mm (1a) and one of 22 mm (1b) from the aluminiun tube, using a fine bladed hacksaw. Make sure that the ends of the cuts are straight and burr free by rubbing them on a sheet of fine emery cloth. The tubes can be polished later to a high shine with metal polish.

6.2.2. Colour the ends (the cut section) of the 6 card tubes (2/3) with a black felt tip pen. Also blacken the 8 aperture rings (4, 5, 6) to minimise reflecting light in the tube.



6.3. Making the eyepiece (ocular):

The eyepiece or ocular is the upper lens part of the microscope, through which the eye looks. (oculus is the Latin word for eye)

6.3.1. Take one of the card tube lens holders (2) and glue a disc (5) on each end.

6.3.2 Then glue a lens (7) to one end of the tube, exactly in the middle of the disc. The flat side of the lens must face into the tube.

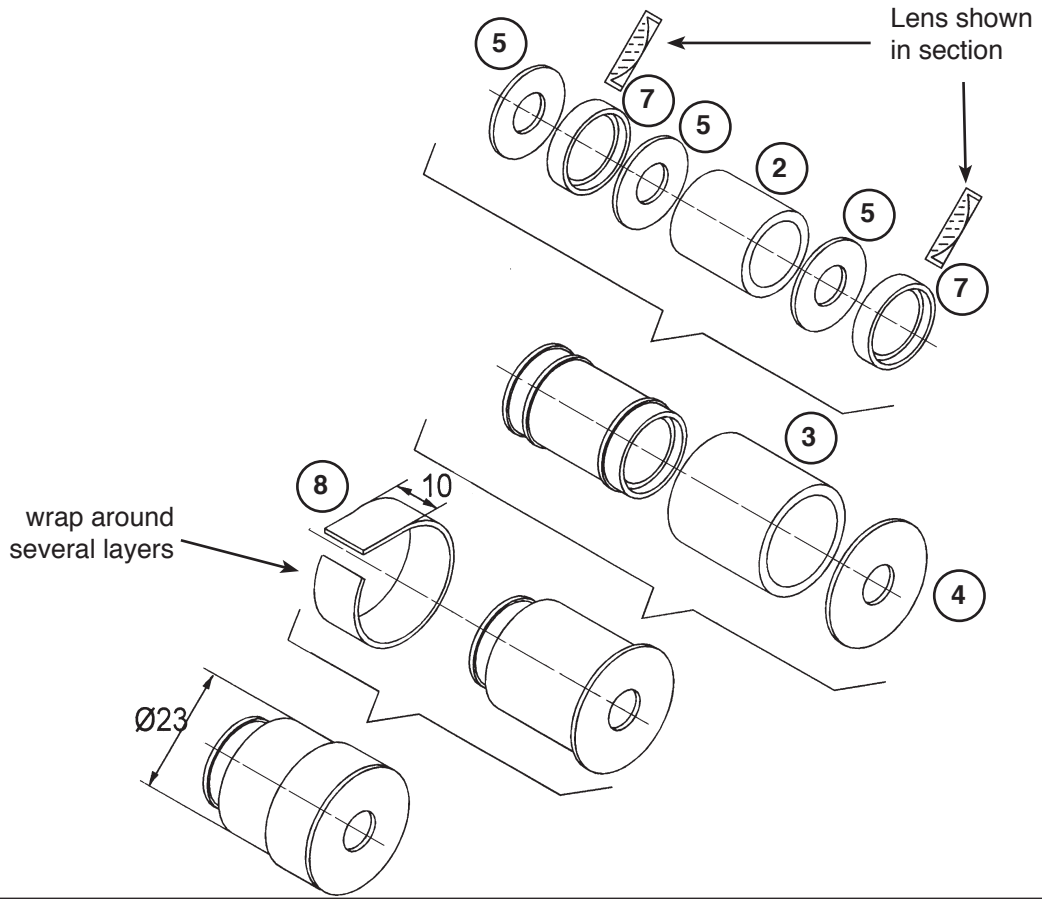
Attention: The lenses must be dust free. You must also make sure that there is no glue on the middle of the lens. Apply glue to the outside edge of the disc, ensure that there are no threads of glue across the middle by pushing a pencil through the hole in the disc. Press the lens in position so that it does not move.

Tip: In case this lens gets damaged you can change it for another (all four lenses are indentical) Then of course a lens will be missing from another stage. Extra lenses (No 839.052) can be ordered from Opitec

6.3.3. On the opposite end of the tube (2), glue another lens (7) to the disc (5) this time ensuring that the rounded part faces inwards to the tube. Both lenses are facing in the same direction. Add a further disc (5) centrally on top of this lens..

6.3.4.Now insert the completed lens holder (2) into the eyepiece (3) with the lens without the extra disc on top facing forward. Push it in until it is level with the top of the tube. Glue the lens holder in position and finally glue on the large eyepiece disc (4)

6.3.5. Cut out a strip of black paper (8, 10mm wide) wrap and glue it around the end of the ocular tube (3) next to the large disc (4). Continue winding it around until the paper strip is the same diameter as the disc.(4) Once this stage is complete, insert the ocular tube (3) into the aluminium tube. The end where the black paper strip is, will remain outside. Once you are satisfied that it fits, remove the tube (3) again.



6.4. Making the objectives:

The objective is the lower lens part of the microscope and is the lens which is aimed at the specimen which is to be observed.

6.4.1. Take one of the two remaining lens holder tubes (2) and glue a disc (6) (with a 4mm dia hole) to one end of the tube.

6.4.2. Glue a lens (7) directly in the middle of the disc (6) making sure that the flat side faces into the tube. Remember to glue carefully, so that no trace of glue is on the lens centre.

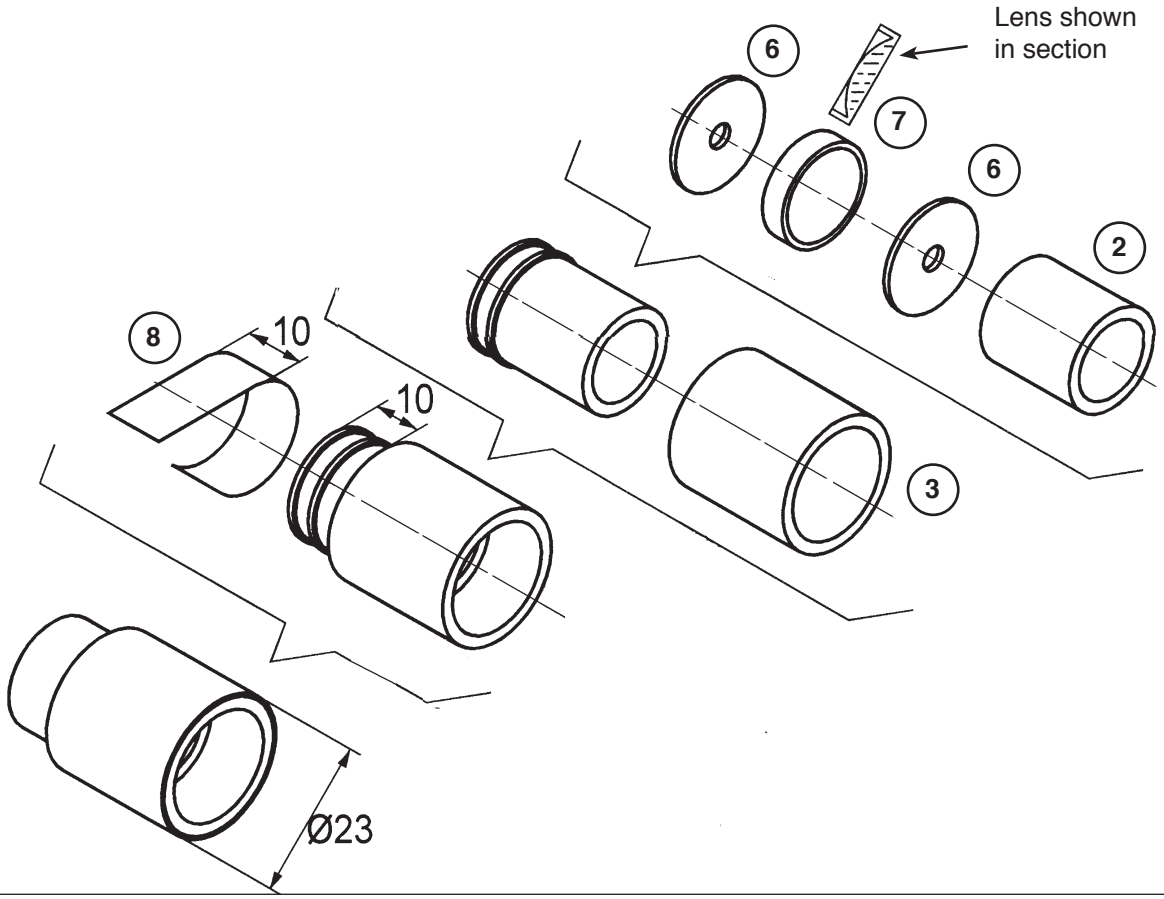
6.4.3. Once this is dry, place a second disc (6) over the top of the lens and glue it in position. The lens is now sandwiched between two discs and can only be seen through the 4mm dia holes.

6.4.4. Now take one of the two remaining objective holder tubes (3) and insert the objective lens (2) with the open end into the tube (3). Push it in and leave 10mm standing proud at the end. This measurement includes the lens and the two discs. Finally glue the lens holder in this position into the objective holder.

6.4.5. So that the lenses are covered from the side, cut a strip 10 x 60 mm of the black paper (8). Wrap it around just once, otherwise it will make the end to thick and difficult to attatch to the extra objective at a later stage.

6.4.6. With the remaining materials: 1 lens holder (2), 1 lens (7), 2 discs (6) and 1 objective holder tube (3) construct the same objective again exactly as described in steps 6.4.1 - 6.4.5. (see also page 10) This makes an additional objective, which can be added to the main objective and will double the maginification. (see diagram 3)

6.4.7. Now you can test your work by inserting the objective (with or without the extra objective) into one end of the aluminium tube. Insert it only 12 mm in, so that exactly 10mm protrudes. If you now insert the ocular tube into the other end of the aluminium tube, you can begin to see the quality of the magnification. For example on a well illuminated piece of printed paper. Now you can also check to see if any threads of glue are across the lens, which are often not noticed during the construction stage.



6.5. Assembly of the microscope objective stage:

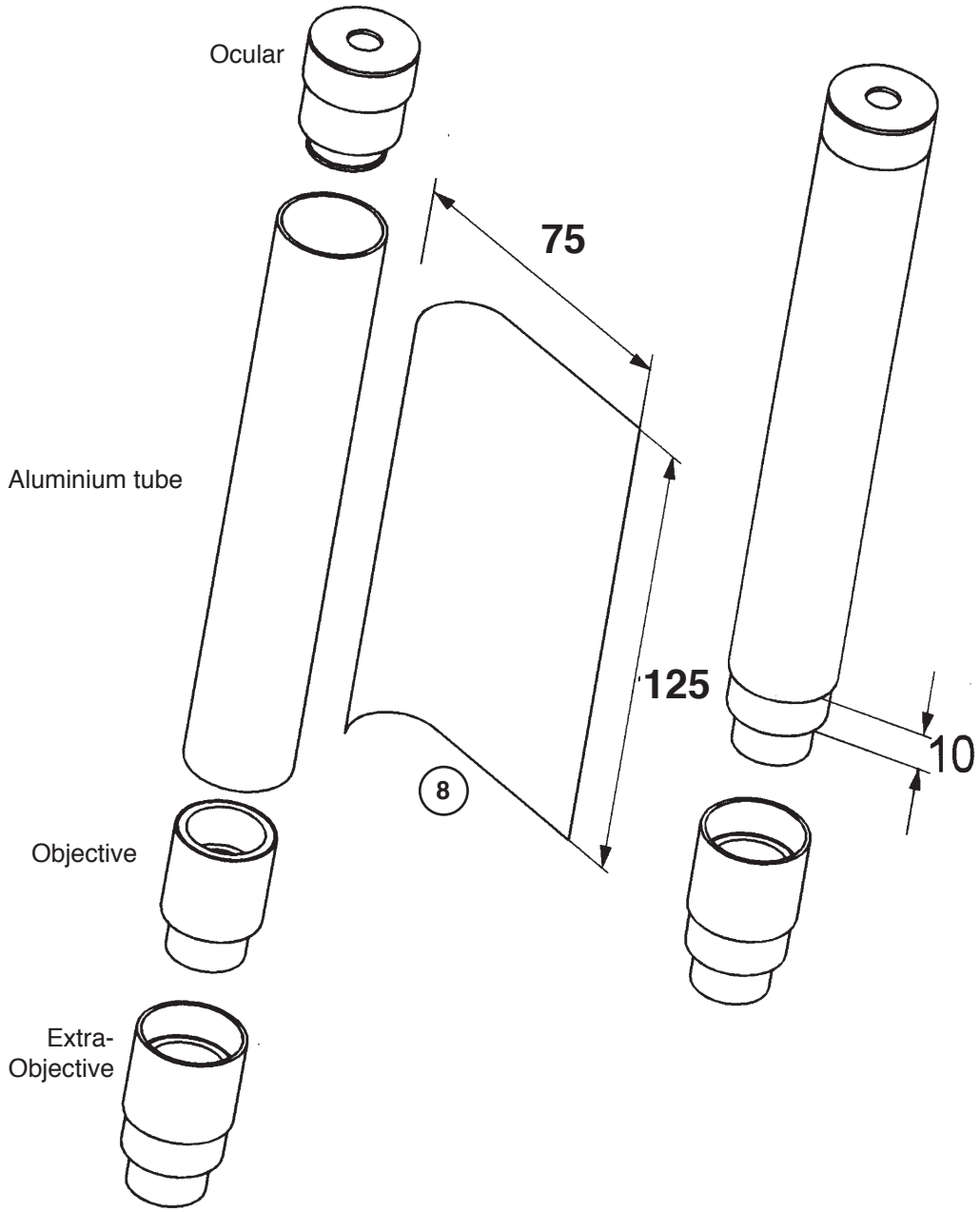
Important: all parts (tube, paper strips, ocular and objective) should be as dust free as possible. Wipe them with an anti- static cloth such as supplied free by opitcians for cleaning glasses.

6.5.1. Once tested the ocular tube can be glued to one end of the aluminium tube.

6.5.2. Cut out the black paper strip (8) 75 x 125mm and wrap it with the black side innermost around a pencil, so that when the pencil is removed, the paper curls itself into a tube. Insert the curled paper into the aluminium tube, so that it uncurls inside, to produce a black lining. This stops the reflection inside the tube and improves the clarity of the magnification.

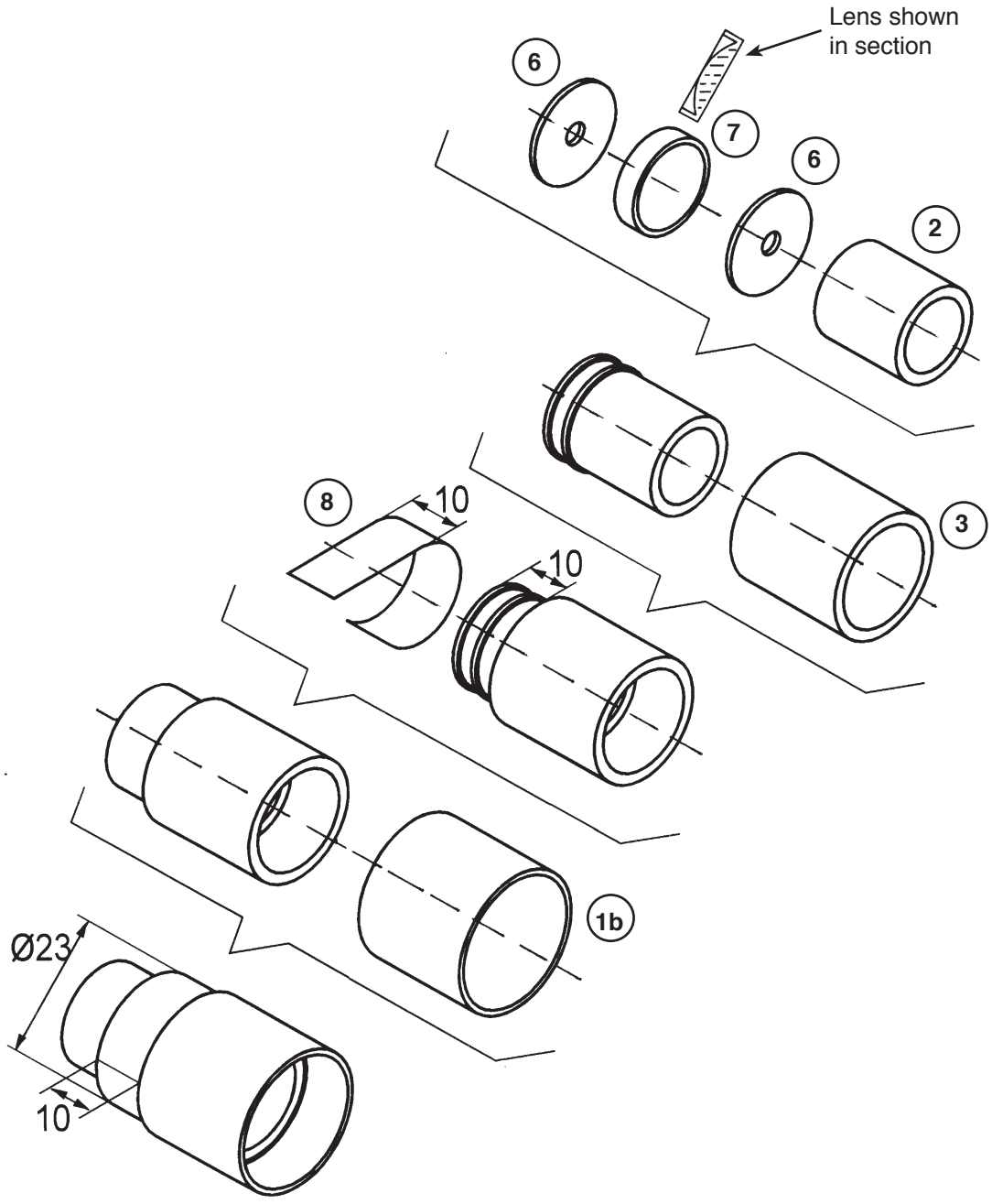
6.5.3. Insert the objective into the other end of the tube, ensuring that the lens holder stands 10mm proud and glue into position.

Note: Before the final glue is dried, check once more that you can see through the tube and there are no traces of glue on the lenses.



6.5. Assembly of the microscope objective stage:

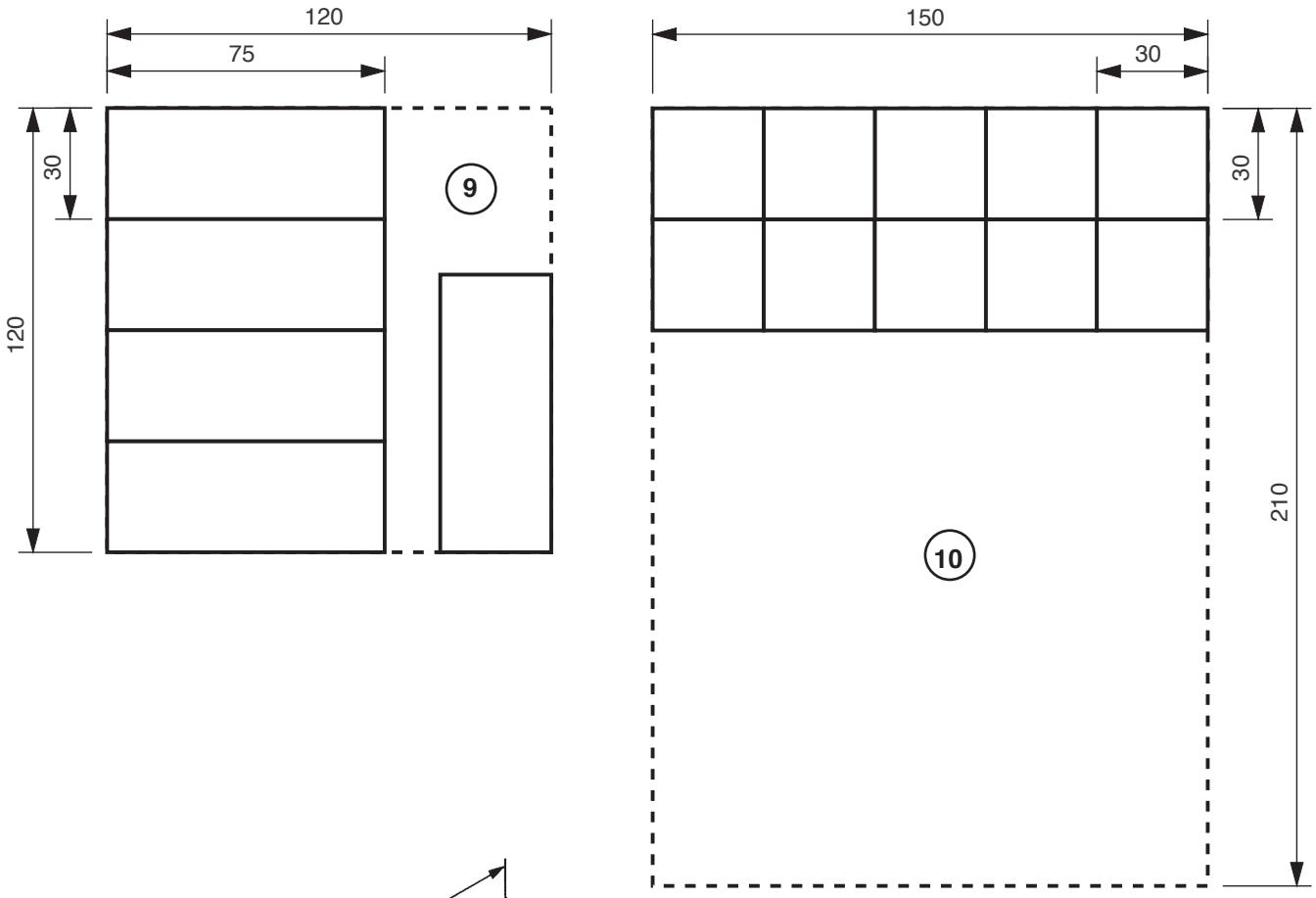
6.5.5. The additional objective lens is glued into the 22 mm long aluminium ring (1b) just like the main objective into the longer aluminium tube. This must also be inserted so that it stands 10mm proud at the end. When this extra objective lens is pushed on to the main objective, the aluminium ring connects directly to the main aluminium tube. When the extra lens is not in use it can be stored in the drawer.

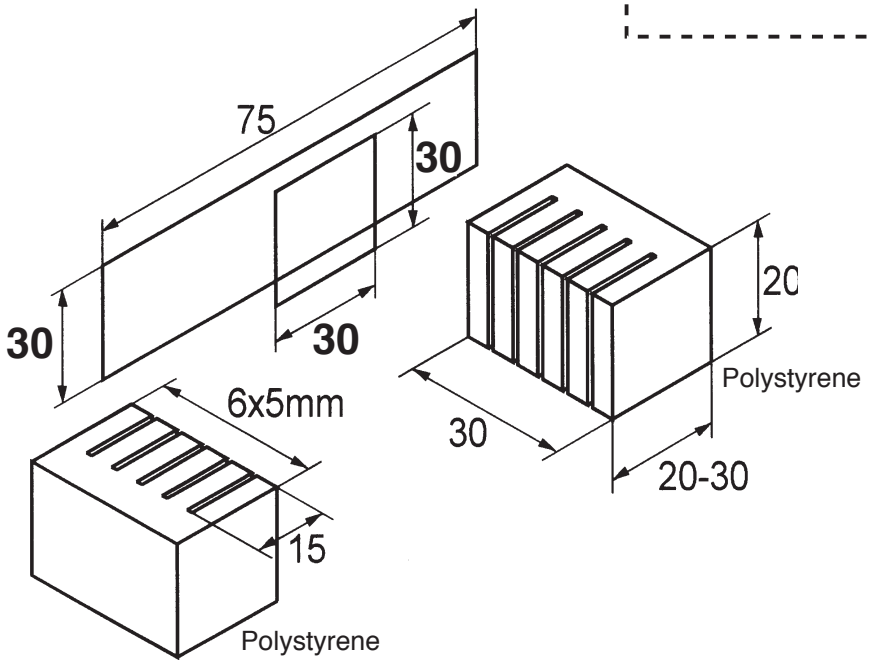


6.6. Making the objective slides and covers:

6.6.1. The two 0.5 mm thick plastic sheets (9) are marked out and cut into single pieces, each 30 x 75mm, this should produce 10 slides, which are the object carriers. The objects to be studied could include: pollen, insects drops of pond water, hair etc. The slides are best stored in the drawer and in held apart by polystyrene blocks with slots. The slots are easily cut with a heated knife blade (use a candle).

6.6.2. From the 0.3 mm thick plastic sheet (10) mark out and cut 10 squares 30 x 30 mm. These are the slide covers that hold the object, to be studied, in place. There is enough plastic sheet for spares.



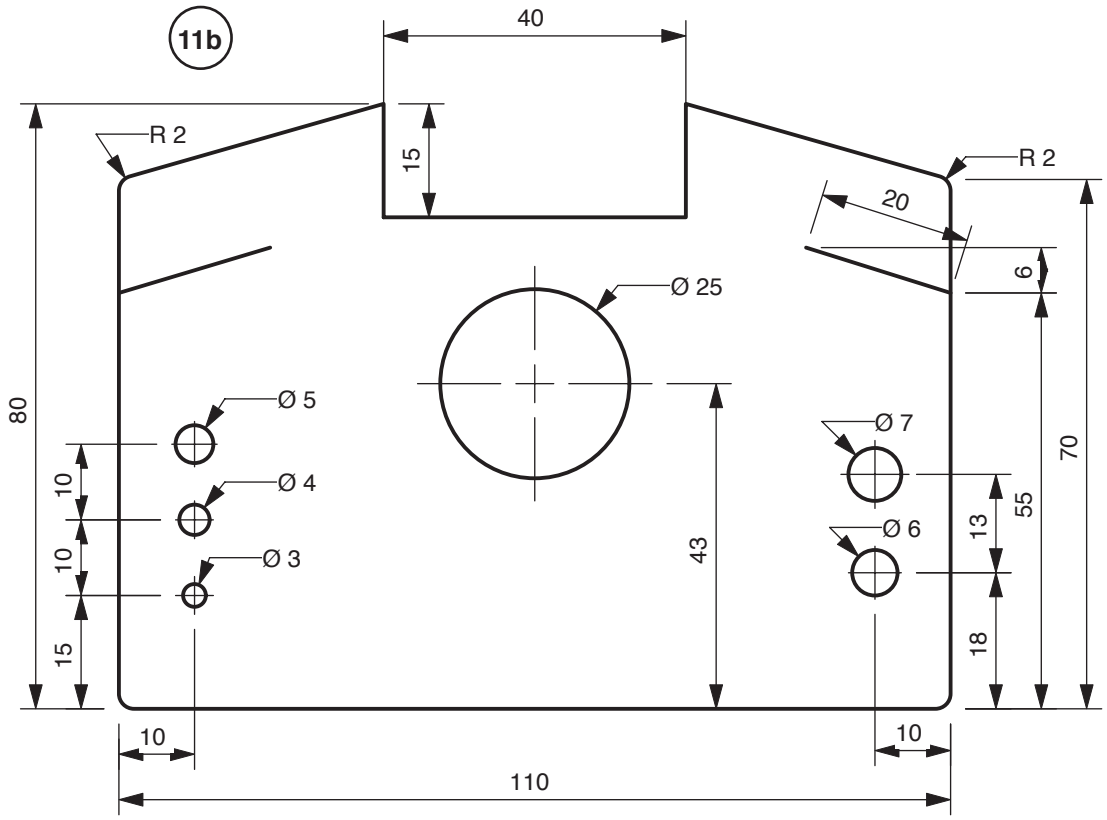


6.7. Making the base table:

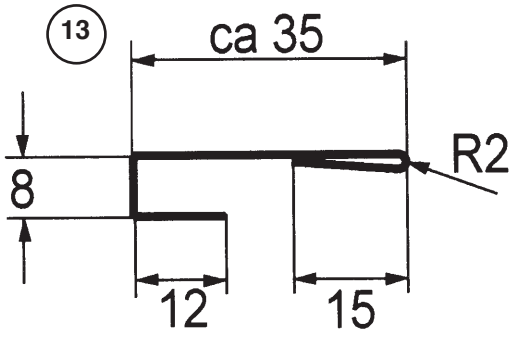
6.7.1. The table top:

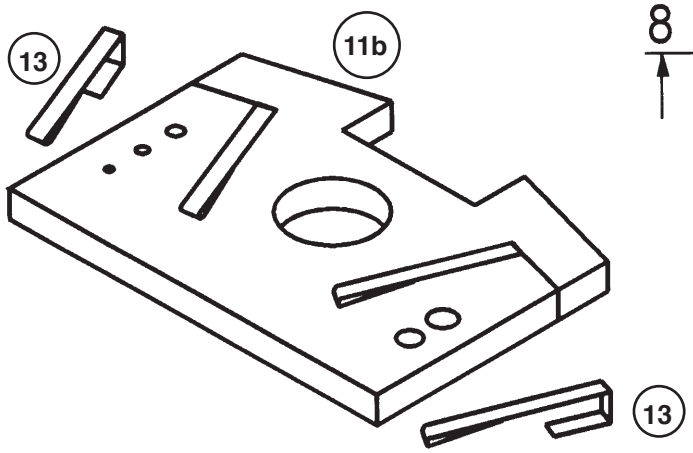
Mark out the shape of the table on to the plywood (11) sheet 8 x 120 x 200 mm. Saw out the shape (11b), sand the edges etc. (keep any remaining plywood offcuts) use a forstner bit for the large hole 25 mm dia, the other holes can be drilled with normal bits. A fine saw can be used for the two 20 mm long cuts to hold the spring clips (13).

If you wish you can leave out the smaller holes on the edge, although they will be helpful to hold small plants or thin pieces of material. A description of how to prepare slides is given on page 21. The bronze spring band slide holders (13) 0.3 x 5.5 x 150 will need to be cut into two 70 mm lengths and bent as shown in the pattern.



Spring clip



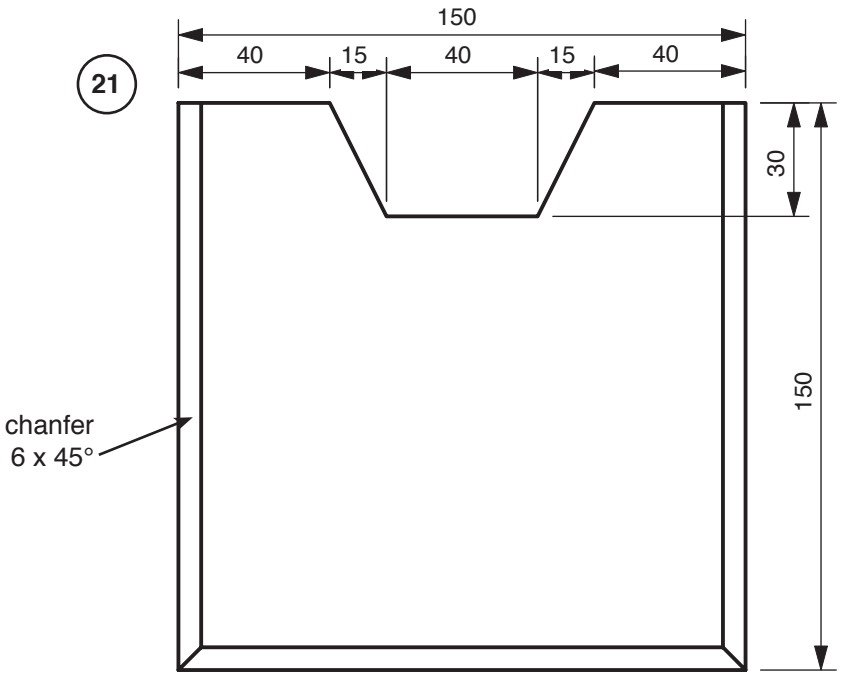


6.8. Making the base, sides and drawer:

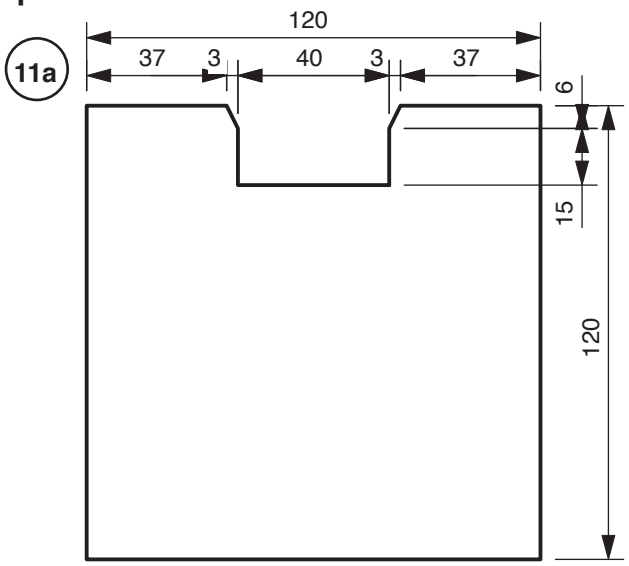
6.8.1. Base and top of drawer carcass:

Mark out the base on the 15 x 150 x 150 mm pine wood (21). Cut out and chamfer the sides at 45 degrees. Use the remainder of the plywood (11) to make the carcass top (11a)

Base



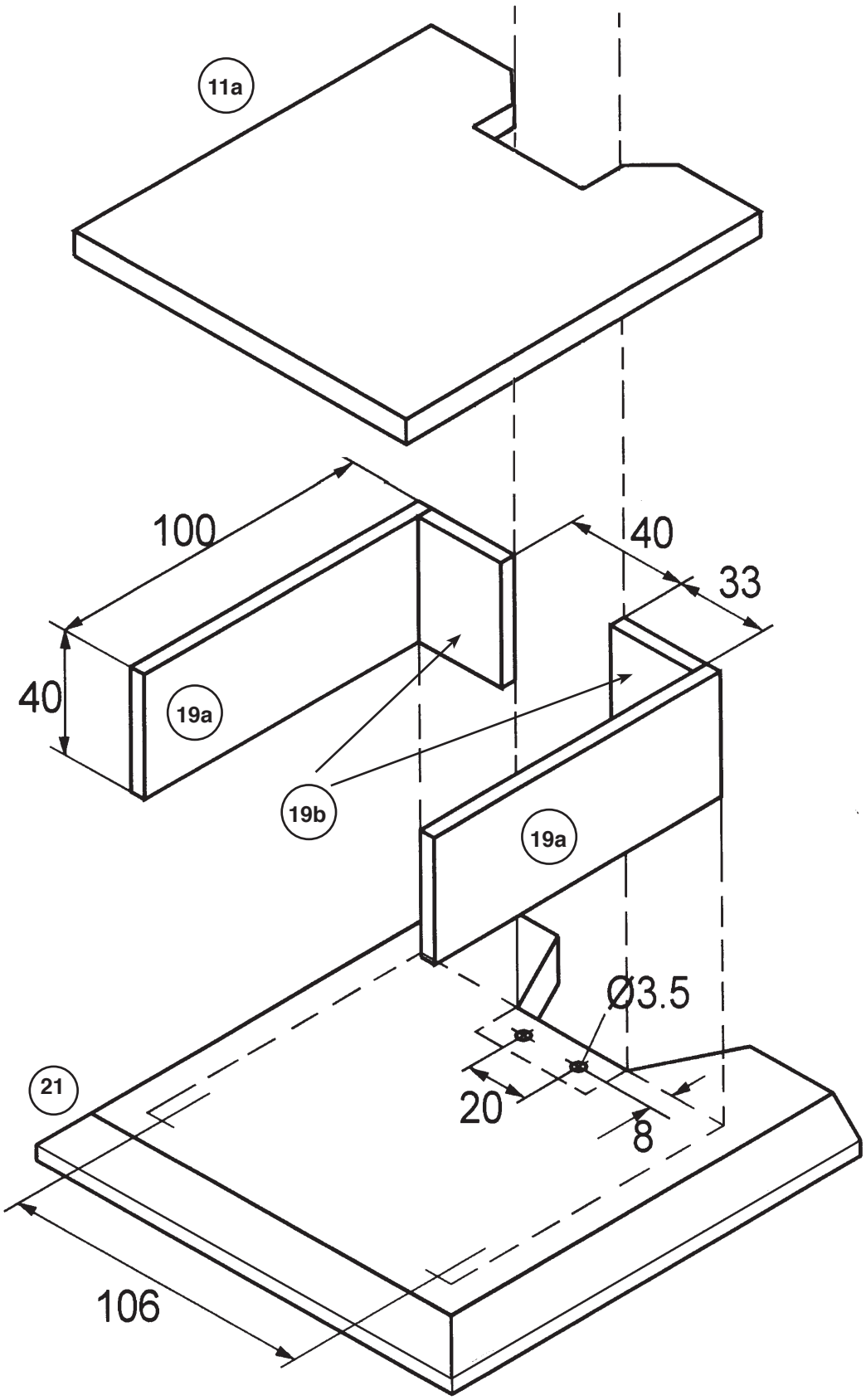
Drawer carcass top



6.8. Making the base, sides and drawer:

6.8.2. Drawer carcass:

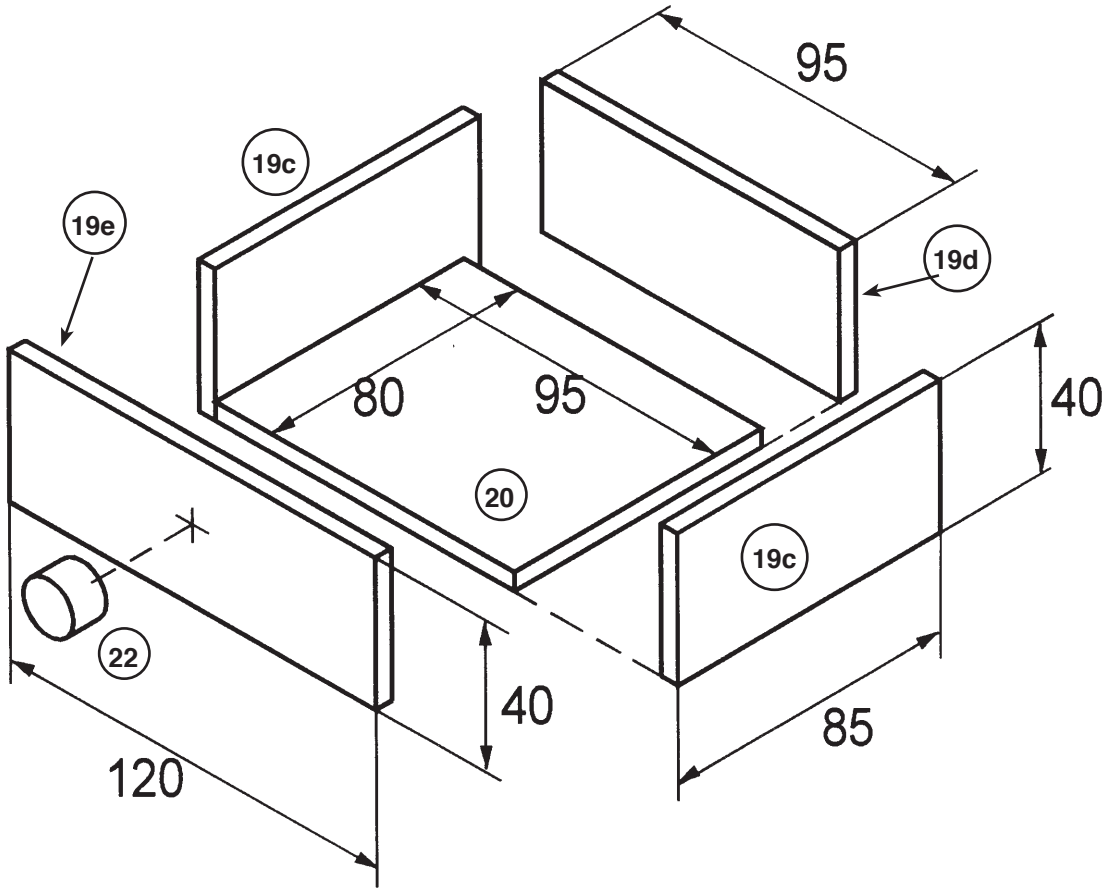
Use the pine strips (19) mark out two lengths (19a) each 5 x 40 x 100 mm and two lengths (19b) each 5 x 40 x 33 mm, these form the drawer carcass. Drill the 3.5 mm dia holes in the base (21) as shown for fixing the microscope upright arm. Assemble and glue the drawer carcass together (11a,19a,19b, 21) as shown.

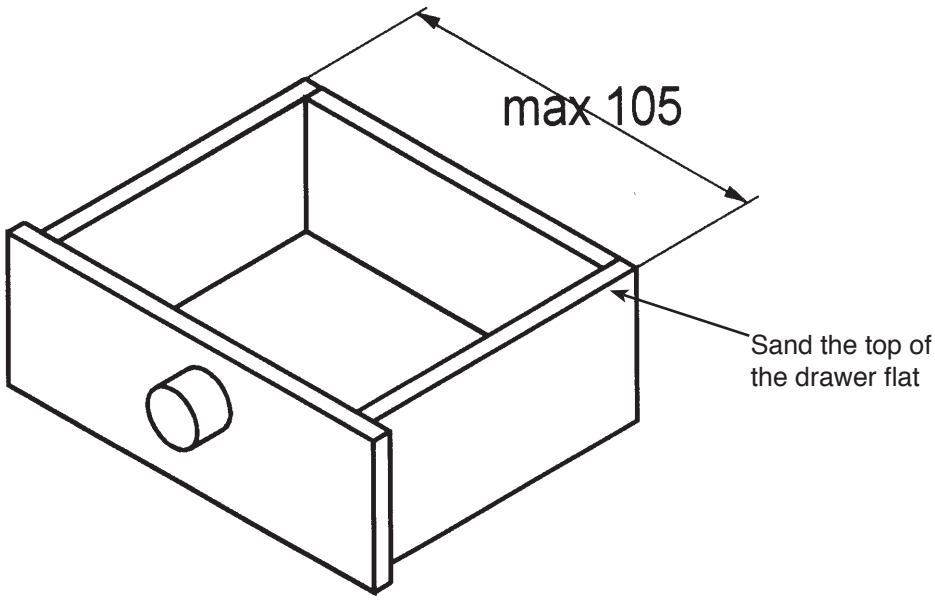


6.8. Making the base, sides and drawer:

6.8.3. Drawer:

Mark out and saw the drawer base from the plywood sheet (20) 5 x 110x 110 mm to the size of 5 x 80 x 95 mm. Finish the edges with glasspaper. Use the remaining pine strips (19) cut two lengths (19c) each 5 x 40 x 85 mm and one length (19d) 5 x 40 x 95mm and a further strip (19e) 5 x 40 x 120 mm. These will form the sides of the drawer. Assemble and glue together as shown in the diagram. Finish the top of the drawer by rubbing it on a sheet of glaspaper so that the it is level and will slide easily into the drawer carcass. For the handle,# use the wooden disc (22) and glue it centrally to the drawer front.

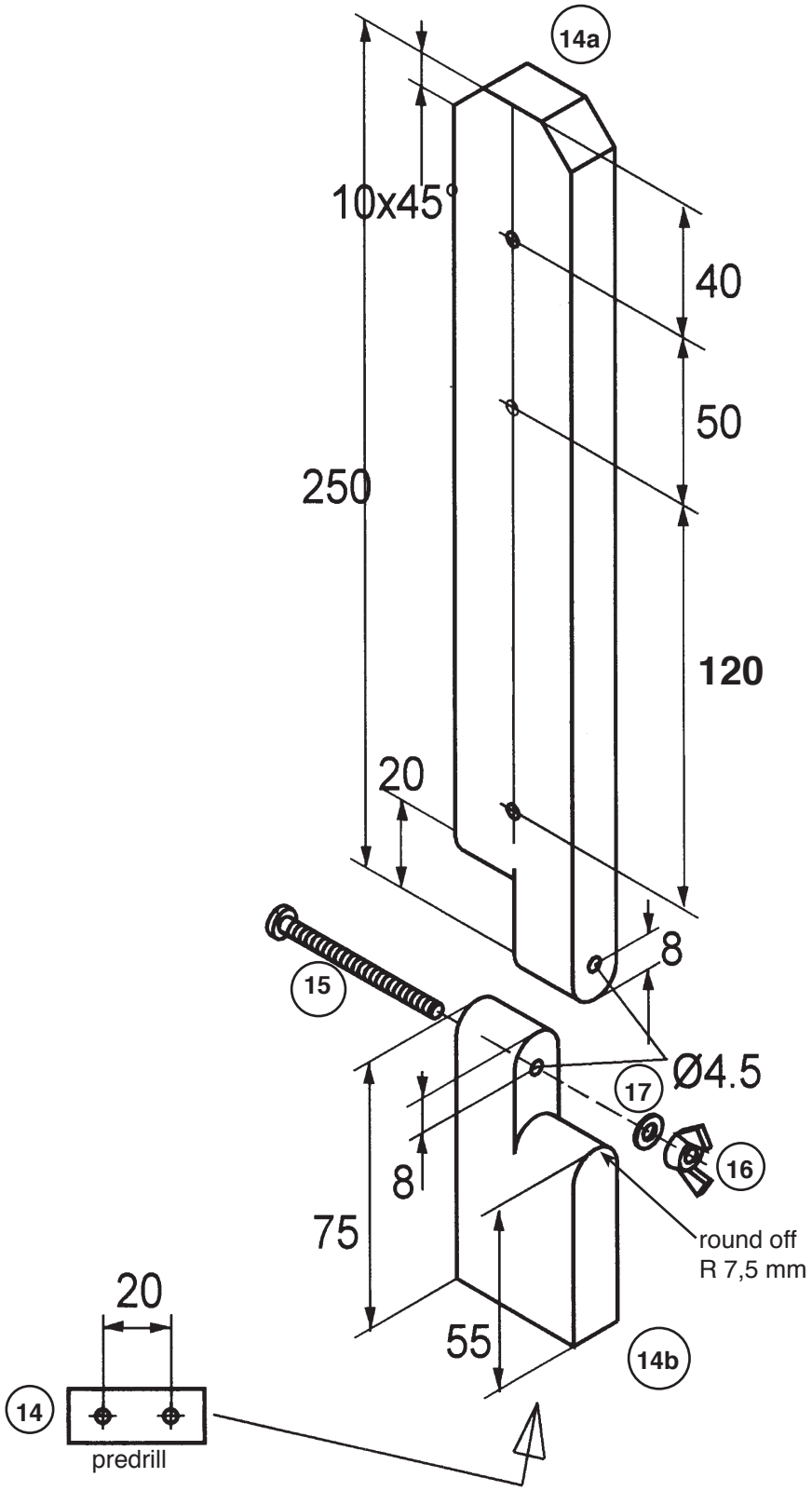




6.9. Making the microscope upright arm:

6.9.1. Mark and saw a length of 250 mm from the pine strip (14) this will serve as the microscope upper arm (14a). One end needs to be cut at 45 degrees and the other end rounded. It is sufficient to round only the longer part of the joint, through which the 4.5 mm dia hole is to be drilled. Mark out and drill the 3 holes, each 1.5 mm dia, to hold the mirror / tube clips as shown. Use the remainder of the pine strip (14) to make the lower part (14b) of the upright. This piece is 75 mm long and must be shaped and rounded and drilled to form the joint as shown. Drill two 1.5 mm dia holes in the bottom of the lower joint for fixing it to the base at a later stage.(14) Assemble the joint using the set screw (15), washer (17) and wing nut (16) and make sure that it moves freely.

Note! all the 1.5 mm dia holes are blind and not drilled all the way through



6.10. Making the mirror:

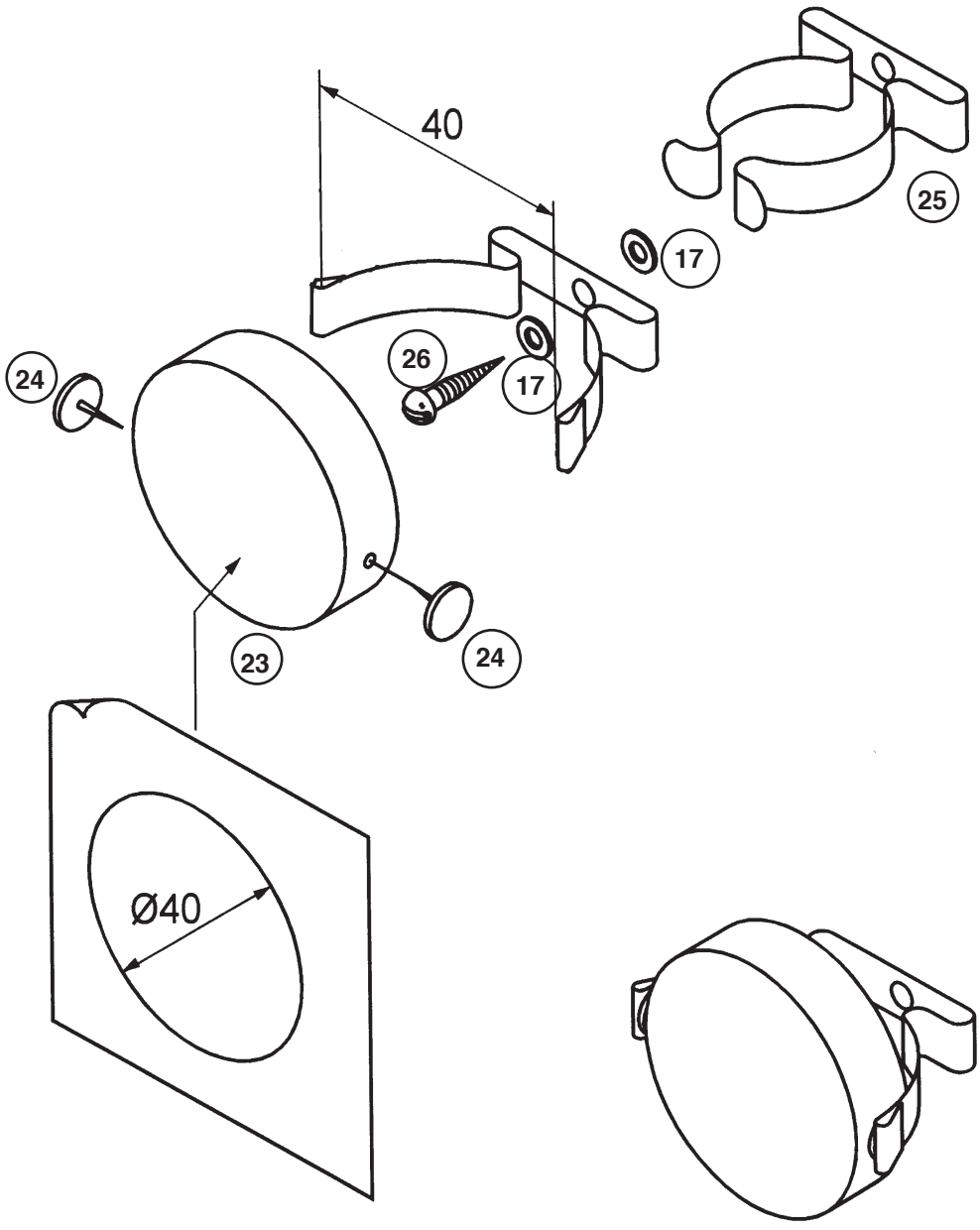
6.10.1. The holder:

Take the spring clip (25) and bend the ends back carefully, with a pair of pliers, to the shape as shown in the diagram. Glue a drawing pin (24) to the inside of each arm of the spring clip (use a hot glue gun or a two component glue) so that the points face inward. When fixing the spring clip to the upright microscope arm (first hole from the bottom), insert the fixing screw (26) with a washer (17) into the spring clip and add a further washer (17) between the back of the clip and the upright arm of the microscope. The washers should ensure that it will turn easily.

6.10.2. The mirror:

Cover one side of the 40mm pine disc (23) with a circle of aluminium cooking foil (not included), gluing it on with the shiny side uppermost. Other reflective materials, such as mirror card can also be used (order No 874.539). Use a pointed holemaker to make two small holes, one on either side of the wooden disc (23) so that it can be set into the spring clip between the two drawing pins. The mirror should turn on the pin axis as well as the screw axis and so move in any direction.The mirror serves to reflect light through transparent objects.

The way this mirror is mounted, is called a 'Cardan fixing', after the Italian Geronimo Cardan who worked out this principle in 1545.



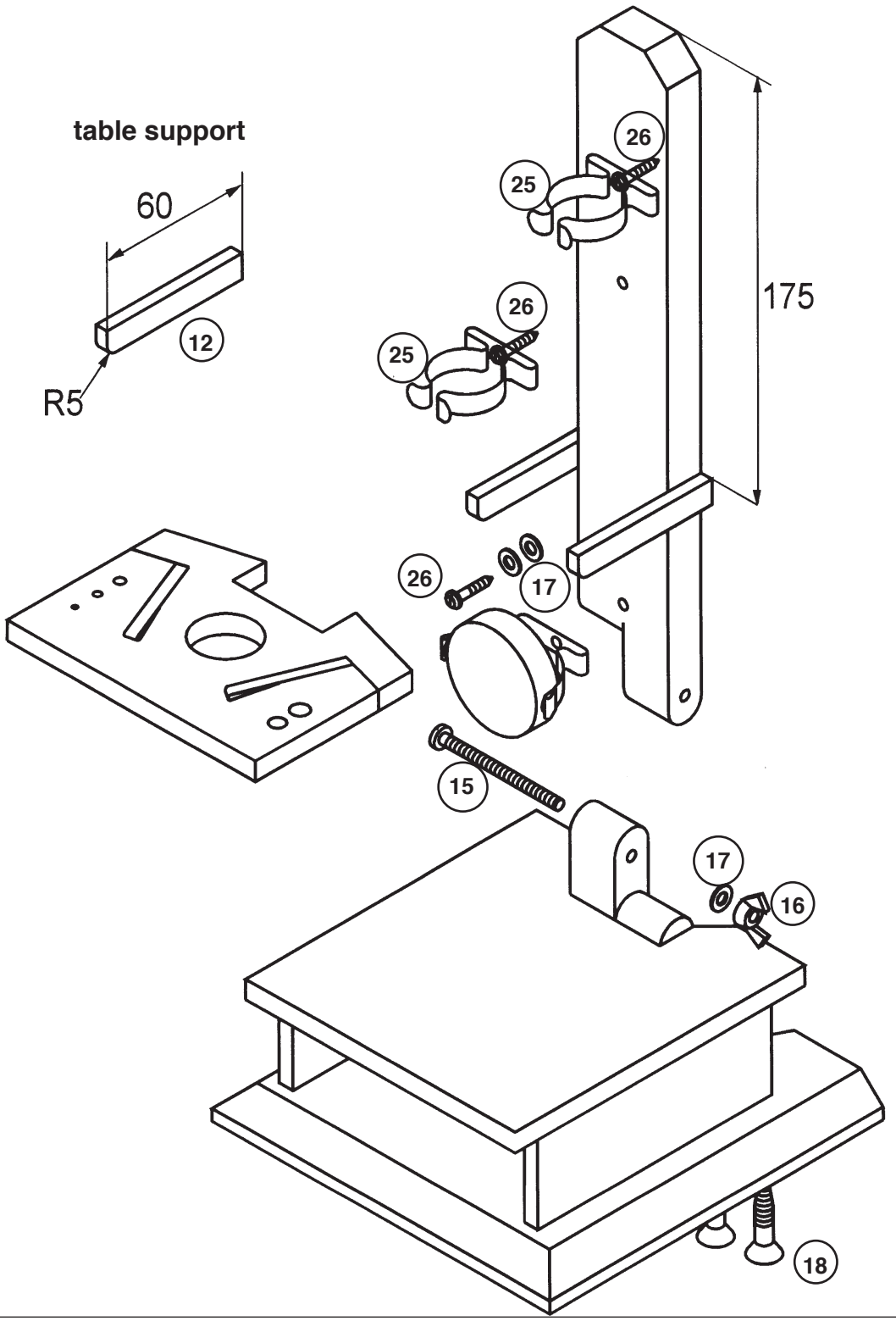
6.11. Assembling the microscope upright arm, table and tube fixing:

6.11.1. Mount the two remaining spring clips (25) on the upright arm as shown with screws (26)

6.11.2. Mark and cut out the two table supports 5 x 10 x 60mm from the pine strip (12) 5 x 10 x 150 mm. Round off the front ends and glue them to the upright arm.(see diagram)

6.11.3. Glue the lower part of the upright arm into the slot in the drawer unit and fix with 2 screws (18) to the base from underneath.

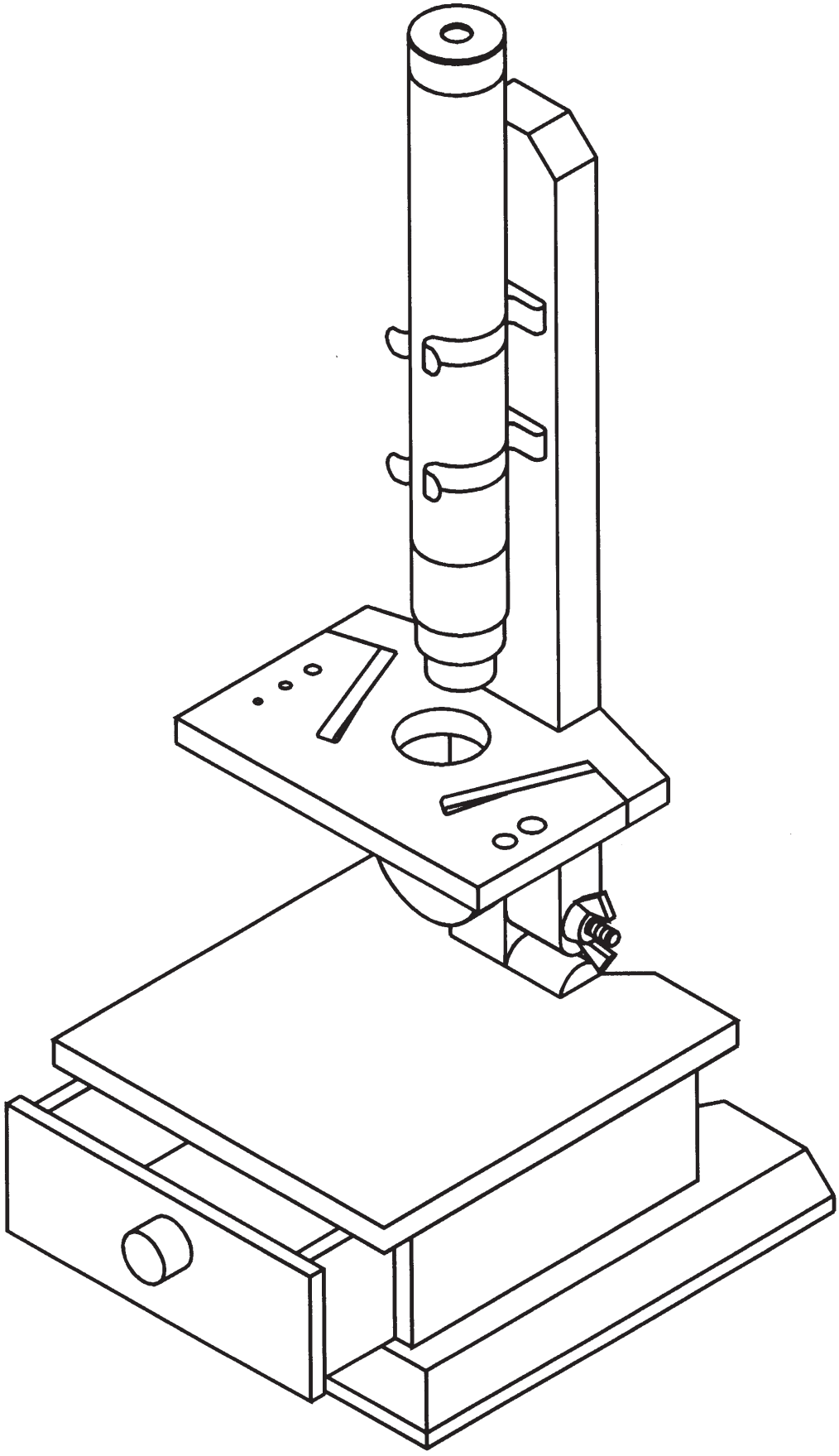
6.11.4. Glue the microscope table to the support arms and the upright arm. Join the upper and lower parts of the upright arm together with the set screw (15), as described in step 6.9.1



6.12. Testing and evaluation:

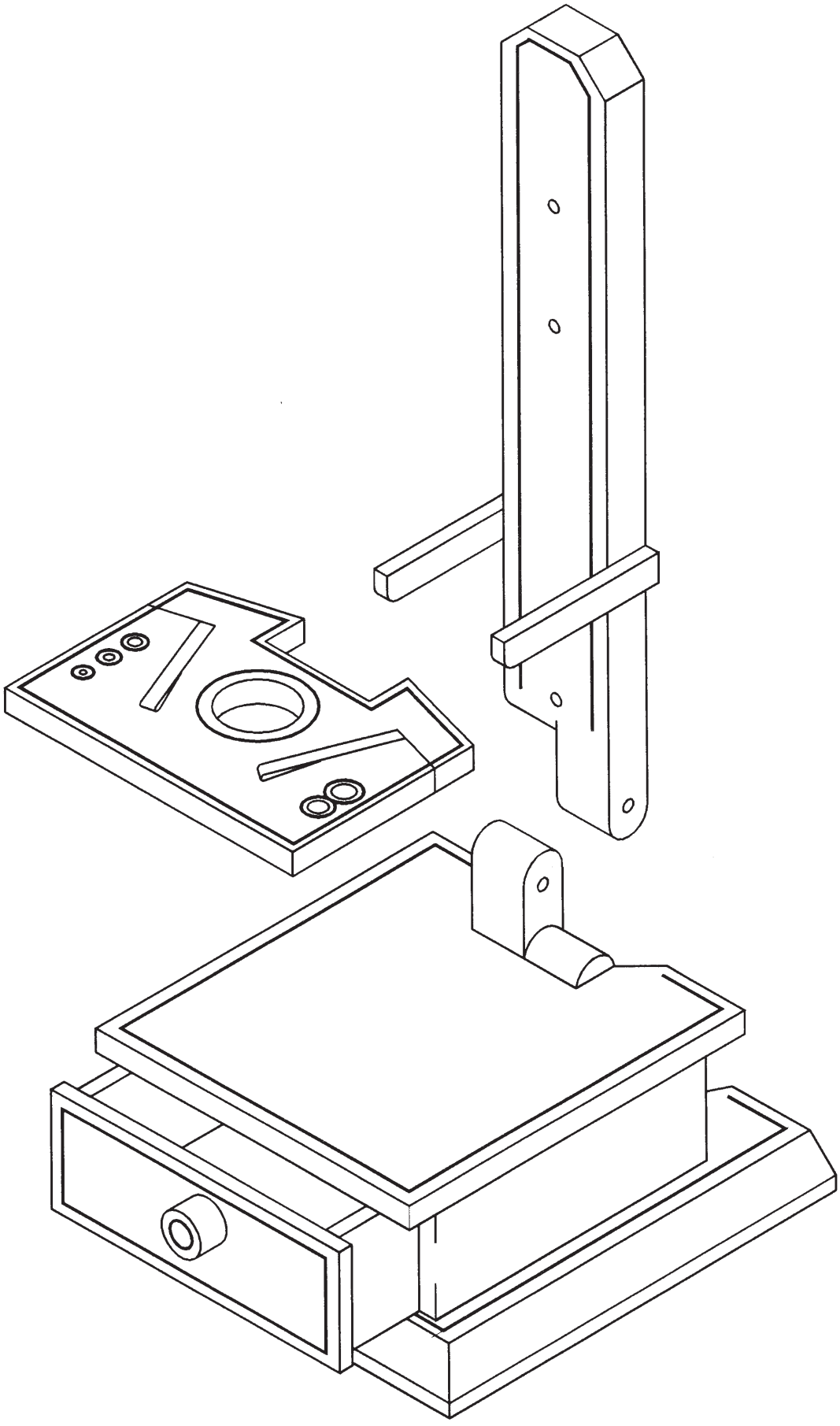
Insert the microscope tube into the spring clips. Place a slide and sample in the carrier and adjust the height of the tube by turning it, until you can see a sharp image appear.

Tip: Non transparent samples must be lit from above with a torch or table lamp.



7. Decoration and finish:

You can paint and decorate the finished project with any design / colour you wish or use a clear varnish and black lines (Edding felt tip pen) as suggested in the drawing.



7. Decoration and finish:

To prepare your slides, it helps to have a sharp knife for cutting sample sections of flower stems etc. You can make a sharp knife from a razor blade

Note: This should only be carried out and used with an adult present!

Cover one side of the blade with a thick layer of masking tape, so that you cannot cut yourself. Or you can fix the razor blade to a strip of wood or use a scalpel. You then thread from underneath, the stem of any plant you wish to observe, through the smallest possible of the holes in the microscope table. Then run the knife blade flat along the stem until the top of the stem is smoothly cut. Push the stem up a fraction more and repeat the movement with the knife. You should now have a thin cross section of the stem on your knife blade. Transfer this small section on to a slide, add a small drop of water and then a cover glass. This process needs a lot of practice in order to achieve a really thin sections of stems / carrots etc. Further information can be gained from Science books or from your Biology teacher.

8. Paperstrips: