

# The Magnetic Compass

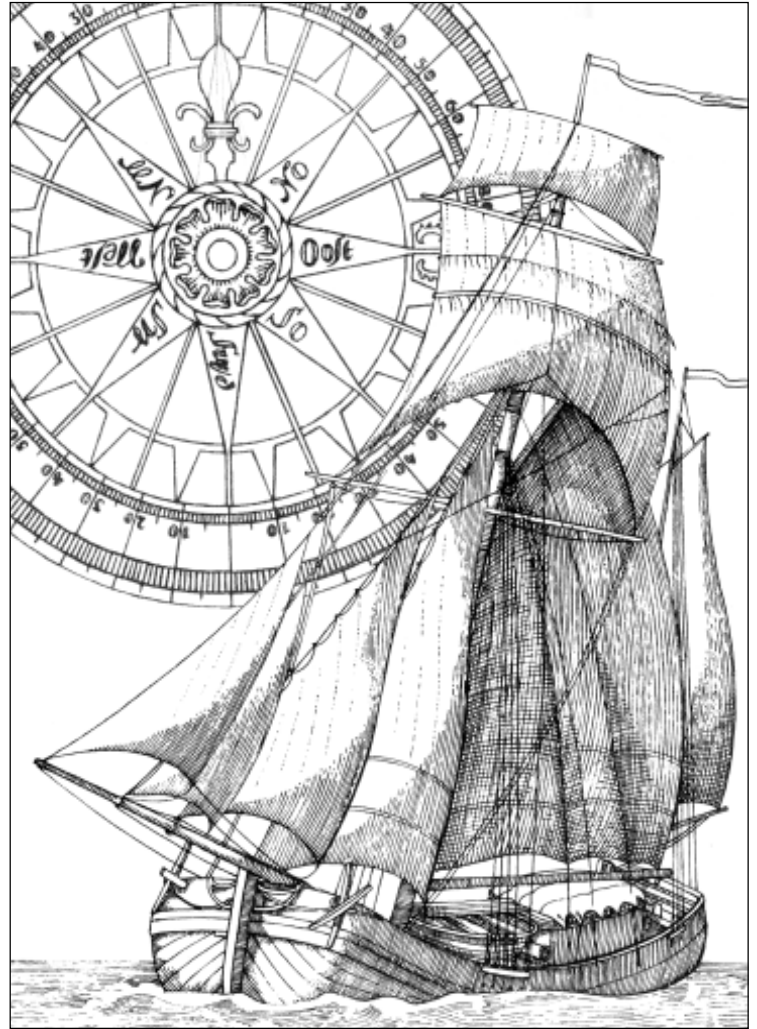
The first compass ever to be used for determining the course of a ship was a needle rubbed with a magnetic stone. The needle was located inside a piece of straw and floated in a dished filled with water. We probably owe this invention to a Chinese, perhaps also to a Scandinavian. The pivoted compass needle has been in use since the year 1200. In Italy a hundred years later, the first ship compasses with a rotating full compass rose instead of a plain needle were used for the first time.

Natural magnets consisting of magnetite (magnetic iron ore) were known in the Greek antique. The most well-known place to find them was the city Magnesia at the Meander river in Asia minor. Today it is technically possible to manufacture magnets with a very high strength level, such as the enclosed small perma-magnets with which the compass needle is rubbed.

Magnetic compasses align themselves according to the magnetic field of the earth and indicate all the directions. More details are given at the end of these assembly instructions.

At present, modern gyrocompasses and the satellite locating system GPS which function according to completely different principles are being increasingly used in ships worldwide. Nevertheless, the magnet compass continues to be part of the basic equipment of every ship and is undoubtedly the classical symbol for all seafaring vessels in general.

With your AstroMedia magnetic compass you have acquired a nice and, in particular, a fully functioning piece of equipment of educational value. Have fun with the assembly work!



## Contents of this assembly kit

4 printed and punched cardboard sheets, 1 perma-magnet, 2 nails, 1 pin, 1 needle bearing.

## Assembly instructions for the Magnetic Compass

**Please read each section thoroughly to the end before starting assembly work.**

The assembly itself is not difficult because all parts are pre-punched and fit together exactly. Each part is provided with an assembly part number ([A1], [A2], [B1], [B2] etc) and is marked with its name. The letter of the assembly part number is the same within an assembly group.

For assembly purposes you will require a sharp knife to accurately detach the punched parts from the cardboard sheet, a piece of black thread for the sighting attachments and a good all-purpose glue. An all-purpose solvent-containing glue is more suitable than the so-called solvent-free glues on a water basis because the cardboard does not get wavy in the process. Nails, magnet, pin and needle bearing for the compass needle are included in the kit.

Getting the glued spots to dry quicker: put a suitably thick layer of glue onto the sides to be glued, and then press the parts together so that the glue spreads out on both sides, and then take the parts off each other again. Then blow 2 or 3 times over the surfaces and press the parts together again, making sure of a good fit – the glue holds immediately.

## The compass base

**Step 1:** Detach the compass base [A1] from the cardboard sheet and remove the rotation axis of the compass rose [C3] from the middle of the base and put it in a safe place for later use. Remove also the cardboard from the two narrow slots for the insert pockets of the sighting attachments. Then fold the 8 sides of the base to the rear, also the 8 gluing tongues seated at their sides. Place the base with the printed side onto your working surface and glue each gluing tongue behind the neighbouring side part. Make sure that the side parts are standing vertically so that the base plate does not buckle. You then have an octagonal open box.

## The sighting attachments

**Step 2:** Detach the sighting attachments [B1] and [B2] from the cardboard sheet and remove the longitudinal cardboard parts in the sighting windows. Glue an approx. 10 cm long piece of black thread, over the length, onto the rear side of one part so that it runs from tip to tip in the middle over the sighting window. Glue the other part onto it, and check again to see if the visible thread really ends in the tips of the sighting window. If necessary, tighten it slightly a long as the glue has not yet dried.

**Step 3:** Proceed with the sighting attachment parts [B3] and [B4] in the same way.

**Step 4:** Fold the insert pocket [B5] in such a way that the two narrow strips are folded behind at the ends and the whole object is folded together along the groove in the middle. Insert the whole object into one of the two slots on the upper side of the compass base and glue solidly the narrow strips

next to the slot on the base. The black arrow must point towards the compass center. The ends of the strips now join each other and together they form a semicircle. Insert one sighting attachment into it and make sure that it has a good seating and that it is in a vertical position.

**Step 5:** Proceed with the other insert pocket [B6] in the same way.

## The compass rose

**Step 6:** Glue the rosette of the compass rose [C1] onto the rotary disk of the compass rose [C2]. Ensure that the north tip points exactly to the north marking, the 360° marking, respectively.

**Step 7:** Glue the axis disk of the compass rose [C3] onto the non-printed rear side of the rotary disk. In order to get the center point exactly, take out the pin from the bag with accessories and stick it through the center point of both disks and glue them solidly together in this way. Allow to dry well.

**Step 8:** Place the compass rose onto the compass base in such a way that the axis disk engages in the recess. Make sure that it has turning movement. Then place the whole object onto your working surface in such a way that the compass rose is lying below and the open side of the compass base is facing upwards. Glue the axis covering onto the axis of the compass rose. You can use the pin again to ensure exact center seating on the axis. **IMPORTANT:** the glue shall only be applied between the axis disk and the cover disk, but definitely not in the axis bearing or between the cover disk and the compass base.

**Step 9:** After drying, make sure that the compass rose can turn as required. The sluggish movement at the beginning will soon go away.

## The compass needle

**Step 10:** Detach the small square from the middle of the compass needle [D1].

**Step 11:** Take the small metal disk with the round tip in the middle (it looks like half a press button) from the bag with accessories. Detach the needle bearing [D2] from the cardboard and, with a needle, drill carefully the hole in the middle of the square to such an extent that the tip of the metal disk can be stuck through from the non-printed side. Glue solidly the metal disk in this position.

**Step 12:** With the needle bearing [D2], fold the four side parts adjoining the square downwards and fold the gluing tongues at their ends to the front. Then, stick the needle bearing from underneath through the hole in the compass needle [D1]. A square elevation closed off at the sides is formed where, in the middle, the tip of the metal disk is visible, the actual needle bearing. Glue the four gluing tongues from underneath at the compass needle.

**Step 13:** Remove the needle support for the compass needle [D3] from the cardboard and fold and glue the four triangles to a four-sided pyramid. Fold the four gluing tongues at the pyramid-triangles to the outside.

**Step 14:** Now stick the pin from underneath through the hole in the middle of the cover disk and compass rose and glue the pyramid of the needle support onto the cover disk. Before the glue dries, touch the pin at its tip and push it back to such an extent until you can feel that its head is lying in the interior of the pyramid tip. Check to make sure that the needle rises exactly vertical out of the compass rose. If this is not the case, you can easily correct it by moving the needle support a little.

Now you can try it out and place the compass needle onto the pin.

**Step 15:** Glue the two nails, from the bag of accessories, in such a way under the compass needle that their heads are lying on the inner perimeter of the square free zone and their tips are pointing outwards. Important: the nails must have the same and exact symmetrical distance to each other from the middle point of the compass needle, otherwise it has a slanted position. After the glue has dried, check to see if the compass needle suspends horizontally after it has been placed down on the pin and, if necessary, correct the seating of the nails. Allow to dry well.

If you discover that the compass needle is in a slanted position, it can be made horizontal even after drying by gluing unnoticeable small cardboard pieces underneath the lighter side.

## Magnetising the compass needle

In order to magnetise the compass needle, the nails must be magnetised. For checking purposes, you should be at a location where you know approximately where the sun is positioned in the midday hours.

**Step 16:** Mark one side of the perma-magnet with a small glued-on piece of paper. Take the compass needle into your hand and turn it around so that the nails are lying above. Now wipe the non-glued side of the magnet about 15 to 20 times over the length of the two nails, from the south tip of the compass needle to its north tip. Following this, the nails are sufficiently magnetised in order to react to the earth's magnetic field.

**Step 17:** Place the compass needle onto the pin tip. It will start a circulating pendulous movement and will come to rest after some time. Check to see if the "S" on the compass needle points in the direction where the sun is standing at midday. If this is the case, the compass needle is correctly

magnetised. However, if the "N" points in the midday direction, then the magnetising of the compass needle must be reversed, meaning, from the north to the south tip.

## The box bottom

**Step 18:** Fold the sides and the gluing tongues at the sides of the box bottom [E1] to the rear and glue it together in the same way as the compass base.

**Step 19:** With the opening facing downwards, place the box bottom onto your working surface. Detach the eight edge protectors of the box bottom [E2] to [E9] from the cardboard and fold the parts, over the length, on the non-printed side together and then the triangular ends to the rear. Then glue onto each edge of the box bottom one edge protector where the round ends are led around the corner of the box bottom to form a full-through circle segment.

**Step 20:** Place the compass needle in the box bottom. You do not have to glue it into position. The advantage here is that you can always get to its underneath side when required.

### The box cover

**Step 21:** Fold the sides of the box cover [F1] and the gluing tongues at the sides at the sides to the rear and glue them together in the same way as the box bottom. Also in the same manner, apply the eight edge protectors of the box cover [F2] to [F9] to the edges and corners.

**Step 22:** Detach the holder for the sighting windows [F10] from the cardboard and place them with the printed side downwards. Fold and glue the two narrow, mirror-imaged arranged parts on

each other and position them in a right-angled manner. With their rectangular cut-out, they form a type of buckle.

**Step 23:** For trial purposes, place the two sighting attachments onto the non-printed side of the holder and insert the lateral supports of the sighting attachments into the rectangular hole of the buckle as well as into the opposite-located rectangular hole below the tongue. Fold the long tongue at the two grooves in a right-angled manner in each case and insert the tip of the tongue into the buckle. The sighting attachments can now no longer fall out of the holder.

**Step 24:** Proceed in the same way with the holder for the compass needle [F11]. If you do a trial and place in the compass needle and insert the tongue into the buckle, the large hole in the buckle lies over the needle bearing protruding from the compass needle.

**Step 25:** Detach the needle protection [F12] and [F13] from the cardboard. Glue the two parts onto each other and exactly in the middle inside in the box cover.

**Step 26:** Now glue the two holders, symmetrically arranged, into the inside of the box cover. Before this, check to see if the buckles have adequate clearance from the cover perimeter and that they can be closed and opened well, as required.

**Step 27:** Put the box cover onto the compass base. If everything has gone according to plan, the edges of bottom and cover are exactly positioned over each other.

**Now your Magnetic Compass is completed. Congratulations !**

## How to use your Magnetic Compass

1. Wait for the compass needle to swing into its full resting position. A slight up-and-down-swing brings faster results than the horizontal circular swing. After the needle has come to rest, it has aligned itself in the field lines of the earth's magnetic field and indicates the north and south directions of the earth.

2. Turn the whole compass or also only the compass rose until the 0° mark (or the 360° mark which is the same) is located under the N-tip of the compass needle. The compass indication is now arranged and shows all directions.

3. **Attention:** magnets, electrical equipment, iron parts and even steel concrete walls in the vicinity can disturb the magnet needle, either because they bend the magnetic field of the earth at this location or they exert a direct magnetic influence on the compass needle.

4. If the needle no longer points clearly in any one direction, the magnetising requires refreshing as described in Steps 16 and 17. Keep the perma-magnet separately and away from the compass at all times.

5. Near the earth's north pole, there is the magnetic south pole to which the north tip of the compass needle is attracted. The reason is that unlike poles attract and like poles repel each other. The same applies for the earth's south pole and the magnetic north pole. The fact that geographic and magnetic poles are not at the same location and that the magnet field lines at various points around the globe deviate at different levels from the north-south-direction, leads to a difference between the indication of the compass needle and the true north-south direction. That is the so-called angle error or declination. The magnetic pole changes its location slowly (at present, about 3 km per annum). For this reason, the angle error at various locations

of the earth must be examined again and again, and the compass must be corrected by this amount. In 1992 the angle error in Germany was 1° west, meaning, the north tip of the needle had to stand at 359° so that the compass rose gives a correct indication. At present, the angle error in central Europe declines by about 1° in 10 years. In the year 2002, therefore, the compass needle was practically free of angle error at that location. By comparison: in west Iceland, it is 25° west, in eastern Australia 10° east. In extreme cases it can be even 180°.

6. How to take bearings of a target point and to determine its direction: Place the compass on a horizontal plane and insert the two sighting attachments into their pockets. Now look through the two windows and turn the compass until the target point lies in one line with the two vertical direction-finding threads of the sighting windows. Wait for the compass needle to come to rest and then turn the compass rose until the N-marking lies below the N-tip of the compass needle. After an error angle correction if necessary, the compass rose now indicates the direction of the target point and its azimuth, that is the angle counted clockwise between the north line and the target point.

7. How to determine the momentary celestial direction of the sun: Place the compass onto a horizontal surface and insert one sighting attachment in one of the insert pockets. Now turn the compass until the shadow of the sighting thread and the tip of the sighting attachment point exactly to the middle point of the compass rose. Wait for the compass needle to come to rest and turn the compass rose until the N-marking lies under the N-tip of the compass needle. You then have a reading of the celestial direction and azimuth of the sun.