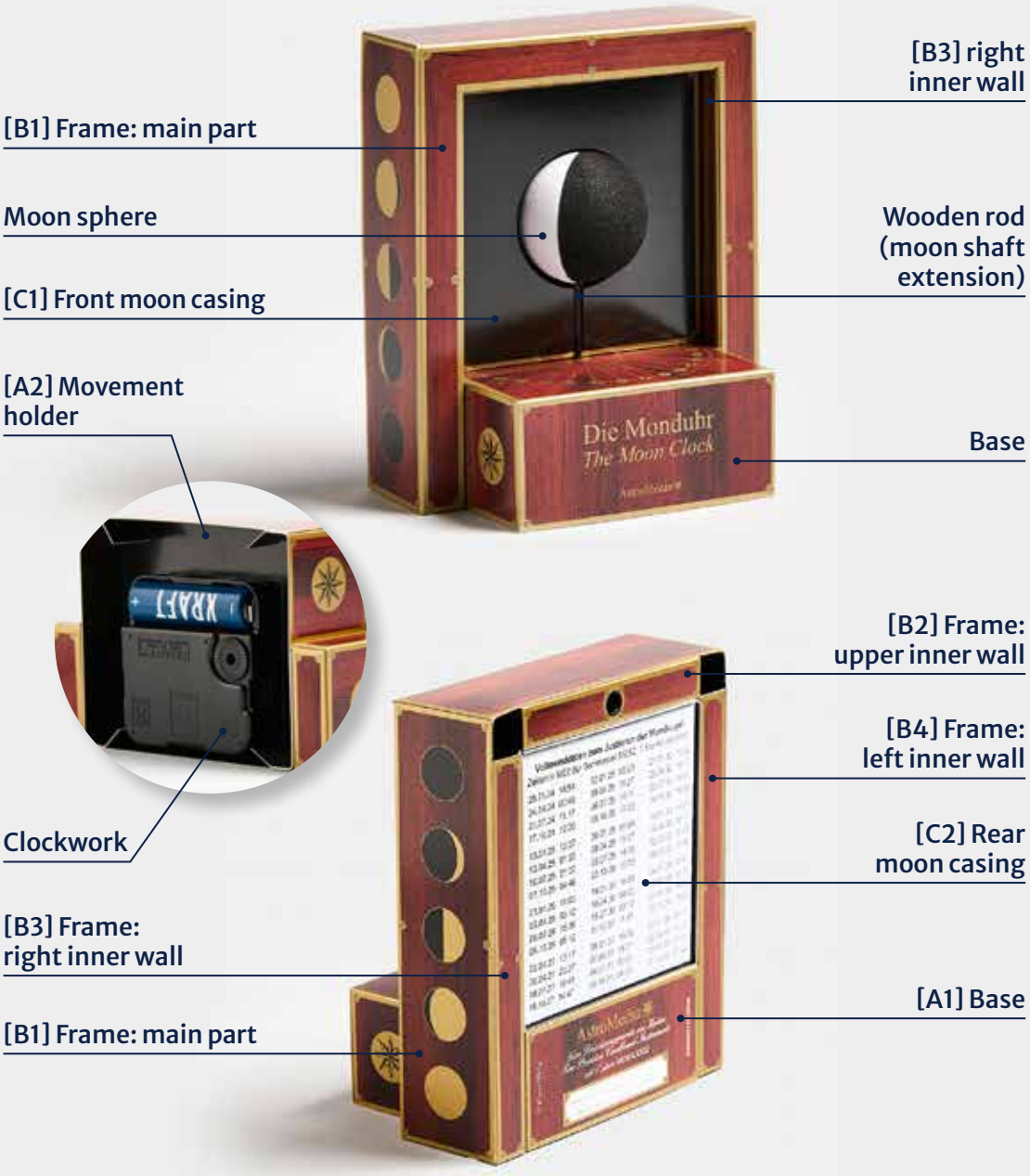
Instructions

The Moon Clock



AstroMedia

Hands-on Science Series

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The Moon Clock

Cardboard kit for a moon phase clock based on old astronomical clocks.
Shows the moon phase for each day with a rotating black and white sphere.

Astronomical clocks

The mother of all astronomical clocks was the "Astrarium", set up 1364 in Padua by Giovanni de Dondi. It was a clock with six dials showing the positions of the planets, the Sun and the Moon.

It was followed in the late Middle Ages by many highly complex clocks throughout Europe. These were installed inside large churches and on the outside of town halls. In addition to the time, they also showed the course of the Sun and the planets through the zodiac, the Easter calendar, and much more on numerous scales, often also the Moon and its phases.

These astronomical clocks are rightly regarded as technical marvels that still inspire awe and respect for their creators today.

Famous astronomical clocks can be found in *Strasbourg* and *Ulm Minsters*, the *Hofburg Palace* in Vienna and the *Old Town Hall* in Prague, but more can also be found and admired in many smaller towns and cities.

Astronomical Clock
Old Town Hall, Prague

Astronomical Clock
Cathedral Notre-Dame de Strasbourg, France

How the phases of the Moon can be represented

With a disc:

A disc rotates behind a cover with two bulging edges. A full moon is painted on the disc, which is gradually covered and revealed through the aperture in the cover. This mechanism can also be found in wristwatches. The illustration is very schematic and, except for the full moon, does not show the correct shape of the bright side of the Moon.

Image source: Wikimedia Commons, Richard Mayer, Astronomical Clock

With a sphere:

A sphere is painted half dark and half light, half of which protrudes from a flat surface. The sphere rotates once every 29½ days and thus shows the proportion of the light and dark part of the Moon at the time, as on the clock on the Old Clock Tower of Amalienburg Palace in Vienna. This is the most vivid and also the most beautiful way of displaying the Moon. This AstroMedia Moon Clock also uses this method.

Image source: Wikimedia Commons, Politikaner, Hofburg, Amalienburg, Vienna

With a hand and dial:

In the centre of a circular display of moon phase images is a pointer whose tip slowly moves from one phase to the next. The phase of the Moon is shown correctly, but divided into many individual images.

Image source: Wikimedia Commons, Görlitz, Old Town Hall, Untermarkt, moon phase clock

Image source: AstroMedia – Dorpskerk Arnemuiden, Middelburg, Zeeland

How does the AstroMedia Moon Clock work?

The central element of the Moon Clock is a battery-operated **moon phase movement.** It has three short, concentric tubes on its front, which in normal movements are the drive shafts for the second, minute and hour hands (from the inside out). In this moon phase movement however, the mechanics and electronics are modified so that the hour tube does not rotate once every 12 hours, but every 29 days 12 hours and 44 minutes. This is the average duration of a lunar orbit from new moon to the next new moon, a so-called **lunation.** The movement therefore has a **lunar arbour** instead of an hour arbour. It is extended by a thin wooden rod, which then carries the black and white moon sphere.

The movement is mounted horizontally in the clock **base** (section A). It has a small wheel underneath with which the current moon phase can be set.

A frame (section B) surrounds everything, and the optional **moon casing** (section C) ensures that only the front half of the sphere is visible.

Good to know: More information about the Moon can be found at the end of the instructions in the *Questions and Answers* section.

This kit contains:

- **3 pre-punched sheets made from 0.4 mm thick construction cardboard**
- **1 special clock movement 56 x 56 x 16 mm (1 rotation in 29.53 days), incl. washer, rubber washer and nut. (A standard AA battery is required to operate the movement.)**
- **3 toothpicks 2 x 80 mm for the wooden rod to extend the lunar arbour, 2 of which are spare**
- **1 cardboard drinking straw for the sleeve, needed to attach the wooden rod to the lunar arbour**
- **1 white and 1 black hemisphere 40 x 20 mm made of elastic hard foam for the two halves of the moon sphere**
- **1 cardboard sheet with cut-out pieces (rear moon casing and bottom cover)**

What you will need for assembly:

- A firm, flat **work surface** with a **cutting mat,** ideally a self-healing cutting mat which automatically closes cuts again
- A sharp **knife** (craft knife, e.g. the AstroMedia craft knife) or a scalpel for cutting through the retaining bars in the cardboard sheets and for cutting through some very narrow slits that can only be punched partly for technical reasons
- A bone **folder** or a small spoon for flattening sharp fold lines
- A good **all-purpose glue** – Solvent-based all-purpose glue is better than water-based solvent-free glue: it dries faster and does not warp the cardboard
- Some **adhesive tape**
- A black and optionally a golden **felt-tip pen** for colouring cardboard edges
- A sharp **pencil**
- A **ruler** or a **set square**
- **Pliers** or an 11mm **spanner** to tighten the nut on the movement

Tips for successful assembly

Please read before commencing:

The assembly instructions are divided into 22 (optionally 23) small steps with precise descriptions. At first glance, this looks like a lot of text, but it simplifies assembly because it makes each step very clear. At the end of the process, you will have built a precision clock that you can be proud of.

1 Each part is labelled with its name and a part number consisting of a letter and a number, e.g. A2 . The letter designates the assembly section, the number the sequence within the section.

2 It is best to only remove the parts from the cardboard sheets as they are needed. Don‘t tear the pieces out of the cardboard, but cut through the small retaining bars with a craft knife. This will keep the edges completely smooth.

3 Surfaces to be glued are printed in light grey. There are symbols on the glue surfaces: A2 . They indicate which other part is to be glued in this place. The symbol indicates that the part is being glued to itself. Sometimes there are also numbers in a circle in front of the glueing symbols, e.g. ③, to indicate the order in which the tabs must be glued. The glue surfaces are usually slightly smaller than the part that is glued to them so that there are no unwanted protruding grey edges.

4 All fold lines are prepared by grooves. They are folded either „forwards“, i.e. towards you when you look at the printed front of the part, or „backwards“, i.e. away from you. You can push down the folds with a folding bone or a small spoon to turn them into sharp edges.

5 ***Tip for using solvent-based all-purpose glue on small surfaces:*** Apply a not too thin layer of all-purpose glue to one side and press the parts together so that the glue is spread over both sides. Pull the parts apart again, remove any threads of glue and then blow over them two or three times. Then press the parts together firmly and accurately – the bond will hold immediately.

6 Larger glued areas should be pressed while drying so that they do not warp, e.g. with a few books on a flat surface.

7 ***“Option:”*** indicates instructions that you can carry out if you want to give your Moon Clock a particularly perfect appearance.

Assembly instructions

Please read each step carefully before commencing

Section A1: The Base

The base is a cuboid, open at the bottom, with a small hole in the top. From this protrudes the wooden rod that extends the lunar arbour of the movement and on which the moon sphere sits. The movement itself is mounted inside the base, screwed onto the movement holder, which can be easily removed if necessary. In the first three steps, the moon sphere is glued together, even though it won‘t be needed until much later. This gives the glue between the two foam halves more time to dry.

Step 1 Hold the white and black halves of the moon sphere with their surfaces facing each other and check that they are exactly the same size. Due to the production process, the diameters may differ slightly. If both hemispheres are the same size, or if the black hemisphere is slightly larger, you don‘t need to do anything and can move on to the next step. If the white hemisphere is slightly larger than the black one, the excess of the white hemisphere would look like a narrow white ring around the black moon sphere when the moon is in the new moon position (looking at the black half of the sphere). To prevent this from happening, this excess must be blackened. To do this, paint the edge of the flat side with the black felt-tip pen. Make sure that the black only goes up to the edge and does not spread over onto the curved side.

Step 2

To ensure the wooden rod sits exactly in the centre when inserted into the moon sphere, a guide cut must be made through the centre of the flat side of both hemispheres before glueing. To do this, determine the centre of the flat side of both hemispheres as precisely as possible using a ruler or set square. It is best to take several measurements at different angles. Then, using a ruler and a knife, make a cut approximately 2 mm deep right through the centre. The cut should be the same depth on both halves and be visible at the ends on the rounded side, so that the hemispheres can be glued together precisely groove on groove later on. ***Tip:*** *If a cut accidentally doesn't go exactly through the centre, simply make a new one at a different angle.*

Step 3

Place the hemispheres on top of each other, making sure the ends of the cuts line up exactly. Then glue the two hemispheres together in this position. The glue will not penetrate the cuts in the foam because they are too narrow. Then set the moon sphere aside to dry.

Step 4

Remove the base [A1, Sheet 1] from the cardboard sheet and open the small hole in the base surface. Fold all grooved lines backwards and smooth out the folds so that the edges of the base are nice and square. If you want to write your name and the year of construction in the white spaces, now is the perfect time to do so. ***Option:*** *Colour the cardboard edges gold or black, depending on the border colour, so that the white edges disappear.*

Step 5

Glue the four tabs to the marked locations to create a cuboid with an open bottom. The small black wings on both sides are the catches for the movement holder. They must remain movable, therefore they are not glued.

Step 6

Glue the movement holder reinforcement [A3, Sheet 2] to the movement holder [A2, Sheet 2]. ***Tip:*** *Cutting off a 2 mm piece diagonally off all four corners of the reinforcement beforehand to adjust it to the rounded corners of the movement, will simplify mounting the movement later in Step 13.* The holes for the screw neck of the movement must line up exactly. Now fold the four sides backwards along the groove lines. ***Option:*** *Colour all cardboard edges beforehand.* ***Note:*** *On a part of the print run the glueing instructions on the back of the reinforcement state* B2. *Please correct this to* A2.

Section A2: Assembly of the Movement and the Moon

The clockwork has a brass screw stud with a nut and washer. This is used to fit the movement to the movement holder. The small black rubber washer sits directly on the movement and stops it from turning when the nut is tightened. The movement requires one AA battery, which usually lasts more than a year. It is best to insert the battery before assembling the movement. Three white concentric shafts protrude from the screw stud. In a normal movement the hour, minute, and second hands (from outside to inside) would be attached to these shafts. In this moon clockwork, only the outer shaft is used. It has a diameter of 5.03 mm.

Step 7

Once the glue between the halves of the moon sphere has set, you can prepare the hole for the wooden rod. Take a toothpick and carefully insert its tip into the moon sphere where the ends of the two guide cuts are visible along the border between black and white. Push and turn it in small increments to about 3 cm deep into the sphere, checking from different angles to make sure the toothpick goes exactly through the centre of the sphere and that the sphere doesn't wobble when you turn it. Leave it in place and set the moon sphere aside for the moment.

Step 8

Remove the nut and washer from the movement and place the rubber washer over the brass screw stud, with the notch facing down and the grooved side facing up. Insert the battery (type AA) and place the movement on your work surface with the screw stud facing up. Place the movement holder [A2+3] on top, with the reinforcement facing down and the folded sides facing up. Slide the washer onto the stud and screw the nut onto the thread. Turn the movement so that the battery is in the centre of the movement holder, not at the edge, and tighten the nut.

The wooden rod that extends the moon shaft and supports the moon sphere is made from one of the toothpicks. It has a diameter of only 2 mm, while the moon shaft is approximately 5 mm. To connect the two, a reduction sleeve is needed. This is made in the following steps from a piece of the cardboard drinking straw and a strip of paper.

Step 9

Take one of the toothpicks. This will be the wooden rod that will extend the moon shaft and support the moon sphere. Cut off 10 mm from one end so that it now has a pointed end and a blunt end. Then cut out the 13 cm long and 8 mm wide paper strip (on the right of this page) and pull it over an edge of a table several times so that it begins to curl. Glue one end of the paper strip to the blunt end of the wooden rod so that it is flush with it. After the glue has set, roll the strip tightly around the wooden rod without any additional glue to turn it into an 8 mm high barrel. Check that the barrel fits into the cardboard straw without too much of a gap.

If it is too thick, shorten the strip slightly. Unroll the strip and then glue it along its entire length. Before the glue sets, check again that the barrel still fits into the straw. If the glue has made it too thick for the opening in the straw, you'll need to remove some more of the strip before the glue sets. Let it dry thoroughly.

Step 10

Glue the barrel with the wooden rod into the end of the straw so that it is flush with the edge of the straw. Make sure the wooden rod isn't stuck at an angle inside the straw, but rather protrudes as straight as possible. You can easily check this by eye by twisting the straw in your hand or rolling it back and forth on your work surface. Let it dry thoroughly and then paint the wooden rod black.

Spare paper strip

Paper strip to be wrapped around the wooden rod

Step 11

Measure 16 mm from the end of the straw where the wooden rod is inserted and cut through the straw as straight as possible with a sharp knife. This works best if you move the knife back and forth with only a small amount of pressure. This prevents the cardboard tube from kinking and allows the knife to slowly cut deeper and deeper through the straw. *The reduction sleeve is now complete.*

Step 12

Slide the reduction sleeve onto the moon shaft of the movement. It is important that it fits firmly and is not loose. Make sure it sits at right angles to the movement from all sides. ***Tip:*** *To ensure the sleeve sits particularly well, you can apply a thin even layer of glue to the inside and let it dry thoroughly. Then attach it again – it will now hold even more firmly on the shaft without sticking to it.*

Disposal instructions for the movement:

Disposal: By law, this product must be handed over to a collection point for electrical and electronic waste to ensure an environmentally friendly disposal. Electrical and electronic waste must not be disposed of with unsorted municipal waste. It may contain hazardous and environmentally damaging substances. Disposal with household waste is prohibited. If the device contains batteries or rechargeable batteries that are not permanently installed, they must be removed before disposal and disposed of separately in accordance with legal regulations. The easiest way to dispose of used batteries is to do so where new ones are sold. This helps to save resources and protect the environment. More information is available from local city and municipal authorities.

Battery: Requires one 1.5V AA battery. Not included. Always insert the battery according to the specified polarity. Remove the battery if the device is not used for an extended period of time.

Step 13

Insert the movement holder into the base from below. First, insert the wooden rod through the hole, then the four folded-up side pieces. The four small black tabs inside the base that were not glued must be pushed against the base wall, otherwise the holder will not fit.

When the four side pieces of the movement holder touch the inside of the base, the movement is in the correct position. Now turn the four small black tabs inwards so that they hold the movement holder in place. To make this possible we cut off the 4 corners in Step 6.

Place the base in front of you and rotate it slowly. Make sure that the wooden rod is at right angles to the base by checking from all sides.

Step 14

Remove the toothpick from the moon sphere that was holding the hole open. Before the hole closes completely, insert the wooden rod so far, that the distance between the surface of the base and the moon sphere is 25 mm.

Tip 1: *Hold the movement firmly with one hand and do not bend the wooden rod. If you need to pull the sphere out a little, you must hold the wooden rod at the same time; otherwise you will accidentally pull it off the movement along with the reducing sleeve.*

Tip 2: *To adjust the height of the moon sphere precisely at this stage, you can remove the front of the moon casing [C1, Sheet 2] from the cardboard, fold the four side pieces backwards, and use the piece as a template. The moon should be exactly in the centre of the circular cutout. Then set the moon casing aside; you will only need it at the very end.*

Tip 3: *To set the correct moon phase, you need to turn the small adjustment wheel located on the underside of the movement. It is best not to turn the moon sphere itself to avoid putting too much strain on the reduction sleeve.*

Section B: The Frame

The frame is attached to the side of the base, forming a 9 x 9 cm square opening above it, with the moon in the centre. It is assembled from the main part and the three inner wall sections. The three inner walls are glued to the main part of the frame and to each other in a specific order. For this purpose, the tabs and glue surfaces are numbered ① to ⑩ in addition to the glue markings.

There is a hole at the top of the back of the frame so that the moon clock can be hung on a wall if desired.

Step 15

Remove the main part of the frame [B1, Sheet 3] from the cardboard and firmly fold all groove lines backwards. ***Option****: Colour the cardboard edges.*

Step 16

Fold all tabs on the upper inner wall [B2, Sheet 3] backwards. ***Option:*** *Colour the cardboard edges.* Open the hanger hole and glue the hanger reinforcement 1 [B5, Sheet 3] onto the marked area on the back, followed by hanger reinforcement 2 [B6, Sheet 3]. ***Option:*** *Colour the cardboard edges.* Now glue tab ① centrally onto glue surface ① of the main part. Make sure that the folded edge of the upper inner wall lies exactly on the cut edge of the main part.

Step 17

On the right inner wall [B3, Sheet 3], fold all tabs backwards, except for tab ③, which is folded forwards. ***Option:*** *Colour the cardboard edges.* Then glue tab ② onto glue surface ② of the main part, with the folded edge exactly on the cut edge. After the glue has set, glue tab ③ onto glue surface ③ on the back of the upper inner wall. This creates a corner of the inner wall with a stable right angle. After the glue has set, glue tab ④ onto glue surface ④, again with the folded edge exactly on the cut edge of the main part. Then glue the three small tabs marked ⑤ into place.

The right wall of the frame is now complete. The left wall is assembled in the same way, only mirror-inverted:

Step 18

On the left inner wall [B4, Sheet 1], fold all tabs backwards, except for tab ⑦, which is folded forwards. ***Option:*** *Colour the cardboard edges.* Then, glue tab ⑥ onto glue surface ⑥ of the main part. After the glue has set, glue tab ⑦ onto glue surface ⑦ on the back of the upper inner wall. This creates the second right-angled corner of the inner wall. After the glue has set, glue tab ⑧ onto glue surface ⑧. Finally glue the three small tabs marked ⑨ into place.

Now the left wall of the frame is also finished.

Step 19

Glue tab ⑩ of the upper inner wall flush to the edge onto glue surface ⑩.

The frame is now finished and only needs to be glued to the base.

Step 20

First, check the fit of the frame on the base without using any glue. The two small square openings at the top of the frame should face the back of the base, where the name of the builder and the year are located. The edges of the base and frame should be flush at the back and bottom, so that they are at right angles to each other. If all fits, glue the parts together in this position.

Section C: The Moon Casing

The moon clock is now essentially finished and ready to use. In this section we will add the moon casing, which covers the back half of the moon sphere with its round cutout. It is simply inserted and not glued in place, so you can remove it later if you prefer to show the moon in the centre of the empty frame.

Step 21

Remove the cutouts for the moon sphere and the wooden rod from the front moon casing [C1, sheet 2] and fold all four side pieces backwards (if this hasn‘t already been done in Step 14). Then push the moon casing from the back into the frame so far that the ends of its side pieces are flush with the frame at the back. It will then cover the back half of the sphere and the wooden rod. If the moon is too high or too low in the frame, you can adjust its position as described in Tip 1 of Step 14. If the side pieces protrude slightly at the back, even though the moon casing is exactly centred to the moon sphere, you can trim off the excess.

Step 22

Cut out the rear moon casing [C2] from the enclosed cardboard sheet, groove all dotted lines, and fold all four side pieces backwards. Insert the casing, side pieces first, into the front moon casing from behind and push it in until it is flush with the frame. The rear half of the moon sphere is now in a dark chamber, preventing any light from shining through from behind the sphere. The list of four full moon dates for the coming years will help you readjust the moon clock if necessary, for example if the battery ran out.

Step 23 (optional)

The base of the moon clock is open at the bottom, which is not a problem when placed on a shelf or table. However, when the clock is hung on the wall, you can see the open base from below. In this case, you can cut out the base cover [A4] and insert it into the base from below. It isn't glued and can therefore be easily removed to adjust the moon phase or change the battery.

Now your moon clock is finished, and you can be proud of a home-made precision device for displaying the phases of the Moon.

Questions and Answers:

? How do I set the current phase of the moon clock?

! On the website *https://moonphases.co.uk/* you will find, amongst other valuable information about the Moon, a picture of the current moon phase, which is continually updated.

? The moon sphere sometimes rubs against one side of the of the round cut-out in the moon mount. What can I do?

! This is probably because the wooden rod isn't inserted totally straight in the reducing sleeve. Perhaps the moon sphere isn't centred on the wooden rod, or both. In this case, you'll need to repeat the corresponding steps in the assembly instructions. Spare parts for a new wooden rod and a new reducing sleeve are included in the kit or can be easily obtained. If not, simply send an email to *astromediashop@gmail.com.*

? How accurately does the moon clock display the phases of the Moon?

! As described above, the movement is very accurate, with an error of only about 10 minutes per year. However, due to the influence of the Sun and the position of its elliptical orbit, the Moon itself can complete its orbit from new moon to new moon **(Lunation)** up to 6 hours faster or 7 hours slower than average. However, because this corresponds to less than one percent of a lunar orbit, it is not noticeable to the eye. Over a longer period of time, these deviations balance out.

? Why are there no craters etc depicted on the lunar surface?

! The black and white sphere only shows the changing of the **Sun's light reflected** by the Moon and does not depict the lunar surface itself.

The Moon always presents the same side to us and never shows us its far side (astronomers refer to this as locked rotation). This, of course, cannot be depicted with a rotating sphere. Therefore, it is not possible to show lunar craters or similar objects, only light and dark.

? Can the moon clock be used anywhere on Earth?

! No, it only shows the phases of the Moon in the northern hemisphere as it appears in the sky. For locations in the southern hemisphere, the moon clock would have to be turned upside down (or the clock mechanism would need to run in reverse). To an observer coming from the north, the phases of the Moon appear reversed in the southern hemisphere. Although the Sun and Moon also rise in the east and set in the west in the southern hemisphere, they do not move from left to right across the southern horizon as they do in the north, but from right to left across the northern horizon, the sequence of the phases of the Moon therefore appears reversed.

? How does the Moon move around the Earth?

! The Moon orbits the Earth against the backdrop of the fixed stars in approximately four weeks, returning to the same fixed star after approximately 27.32 days (± 6 to 7 hours). This period is called a **sidereal month**. However, because the Earth also moves around the Sun during this time, it takes longer for the Moon to return to the same position relative to the Sun (e.g. from new moon to new moon), namely an average of 29 days, 12 hours, and 44 minutes (± 6 to 7 hours). This lunar month is also called a **synodic month** or lunation.

? Wie entstehen die Mondphasen?

! The Moon, like the Earth, has a roughly spherical shape. It is continuously illuminated by the Sun (except during a lunar eclipse, of course), which is why one half of the Moon is always bright and the other remains dark. When the Moon is in the same direction as the Sun as seen from us, it is a new moon. The Sun shines on it from behind and it cannot be seen by us because it only shows us its black, unlit side. In the days after new moon, the Moon moves further and further to the left away from the Sun. We see more and more of its illuminated side and less and less of its dark side: first as a waxing crescent, after a week as a waxing half moon, and after about 11 days as a gibbous (three-quarter) moon. Finally, after just under 15 days, as a full moon, it is directly opposite the Sun, which is the halfway point of the Lunation. After that, the Moon wanes in reverse order: it becomes a gibbous moon, a half moon, and shortly before the new moon, a waning crescent. The period from the new moon is counted in days and is called the age of the Moon.

? How can I read the age of the Moon?

! Look from above at the dividing line between the bright and dark halves of the moon, the so-called **terminator**, so that it looks like a straight line. Extend it downwards to the base onto the moon age scale. Since the lunar age begins with the new moon, it is read on the front half of the scale when the Moon is waxing, and on the back half when the Moon is waning (unless this is obscured by the moon‘s casing).

? Do high and low tides have anything to do with the phases of the Moon?

! Yes, definitely. A simplified explanation is this: The Moon exerts a gravitational pull on the Earth and thus also on the water in the oceans. This creates a slight bulge of water in the oceans on the side of the Earth facing the Moon, and the centrifugal force of the rotating Earth-Moon system also creates a bulge on the opposite side of the globe. That is where **high tide** is. Perpendicular to this, between the two high tide zones, two slight troughs of water form: that is where **low tide** is.

If the Moon were always in the same position in the sky, the two bulges of water (high tide) and the two troughs of water (low tide) would move around the

globe once every 24 hours due to the Earth's rotation; thus, there would be a high tide every 12 hours and a low tide every 12 hours, offset by 6 hours. But the Moon circles around the Earth (see above), which causes it to rise about 50 minutes later each day. As a result, each high tide and low tide are about 25 minutes later compared to the previous one.

In reality, however, the matter is more complicated, and calculating the **tides** is a demanding science in itself. This is because the influence of the Moon is superimposed by that of the Sun, and added to this are the influence of coastal features, major ocean currents, and wind. Just one more thing: When the Sun and Moon are in a line as seen from Earth, as during a **full moon** and a **new moon**, their gravitational forces are intensified, resulting in a **spring tide**: a particularly high tide followed by a particularly low ebb. When they are perpendicular to each other, as during a waxing or waning **crescent Moon**, their combined gravitational force is lower, and the high and low tides are significantly weaker. This is called a **neap tide**.

? Does the phase of the Moon play a role in solar and lunar eclipses?

! Yes, a very important one. A solar eclipse can only occur at a **new moon**, when the **Moon is in front of the Sun** and casts its shadow towards the Earth. About twice a year, the tip of the shadow hits the Earth's surface and crosses it as a large dark spot. Only those in the shadow see the Sun darkened for a short time. At all other new moon positions, the Moon's shadow misses the Earth. A solar eclipse can only be seen during the **day**, understandably.

A **lunar eclipse** can only occur at a **full moon**, when the **Sun and Moon are opposite to each other**. About twice a year, the Moon passes through the shadow cast by the Earth. It then darkens, but not completely, appearing in a reddish or brownish light. At all other full moon positions, the Moon passes above or below the Earth's shadow. Incidentally, everyone on Earth can see a lunar eclipse, but only when it is **nighttime** where they are, because only then is the full Moon above the horizon.

We wish you many interesting hours with your home-made moon clock!

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