Sky-in-a-Box Instructions

Large or Small?

The *Sky-in-a-Box* designs are provided ready to print on A4 or US Letter size paper. Used at this size they will require a base measuring 360mm x 280mm (14 x 11 inches) and the celestial sphere will have a diameter of 200mm (8 inches). The designs will scale up to any size. If you wish to construct a lager *Sky-in-a-Box,* you can enlarge them using a photocopier or print them on larger paper such as A3 or tabloid size.

What you will need:

Materials

1. Print-outs of the downloadable Sky-in-a-Box instructions and designs.
2. Two cardboard boxes, or more (You will need the walls of one or two boxes, and one complete box for the base)
3. Barbecue skewers (between 6 and 8 of them, to make the equator and ecliptic)
4. A piece of 8mm or 5/16 inch diameter dowel 270mm or 10½ inches long (to make the axle) – NOTE: If you enlarge the designs you will need a longer piece of dowel; take the length from the template. If you use a cardboard thicker than 4mm (1/8 inch) then the diameter of the dowel should be twice the thickness of the cardboard.
5. A plastic bead or marble roughly 10mm or ½ inch diameter (to be the Sun)
6. Two clothes pegs
7. Several hours of time and a reasonable measure of patience

Tools and fasteners

1. Hot melt glue gun with sticks of hot melt glue (for construction)

2. Bowl of cold water or nearby tap (to avoid burns)
3. Glue stick (for sticking paper to cardboard)

4. Blu-tack (for sticking Sun bead or marble to the ecliptic)
5. Packing tape (for taping the base box closed)
6. Scissors (for cutting paper)
7. Saw (for cutting dowel)
8. Large craft knife (for cutting cardboard)

9. Replacement blades for the craft knife
10. Cutting board or pile of newspapers
11. Side cutters (for cutting barbecue skewers)
13. Dressmakers pin or push-pin (for marking points through the cardboard)

Selection of materials, tools and glues

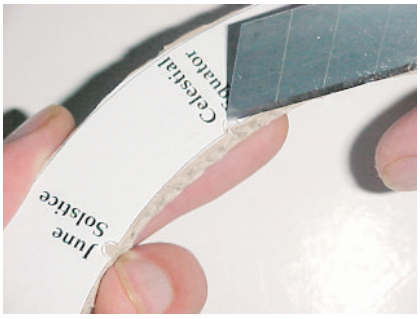
- This design is for corrugated cardboard that is 3 to 4 mm thick or about 1/8 inch. Some boxes are made from lighter board, some from heavier. Choose boxes of the correct weight using a ruler. (If you are enlarging the designs you might prefer to use a heavier cardboard.)
- Select boxes with smooth, undamaged sides. Take care not to bend them. If you want to flatten boxes when transporting them, slit the packing tape that holds them together using a sharp knife so that you can fold them without damaging the walls.
- Barbecue skewers come in different thicknesses and lengths. Any thickness and any length will do for this project.
- Hot melt glue is repositionable for a few seconds, sets in about 1 minute, and has good gap-filling abilities making it ideal for construction of this type. If you are looking for an alternative then a tube of rubber adhesive or contact cement is probably the next best choice.
- Hot melt glue is capable of giving quite nasty burns if you touch the glue while it is still hot or touch the glue gun nozzle itself. However, provided you put your finger (or whatever part of your body touched it) straight into cold water you will not get a burn at all. To completely avoid burns, just have a bowl of cold water beside the glue gun.
- Glue sticks are fast-setting and allow paper to be glued to cardboard without much wrinkling. They are also repositionable for about 1 minute. The best alternative is a spray-on rubber adhesive which will usually have very similar properties, combined with better adhesion, but is more difficult to work with. Both wallpaper paste and PVA are effective, but are slower drying and tend to give a wrinkled appearance.
- Cutting cardboard with a large craft knife gives the neatest results. You need a truly sharp blade for a good result and it is essential to start a project like this with an entirely new blade. Obtain new blades before beginning this project. You can cut cardboard with scissors, but this tends to collapse the corrugations along the edges giving a rough, dented finish. If you choose scissors for safety reasons, remember to check that the scissors you are using will, in fact, cut the cardboard you are using.

- When using a craft knife, you do not need a cutting board; a large pile of newspaper will suffice. Throw the top paper away as it becomes shredded.
- Side cutters make cutting bamboo skewers easy, but scissors work perfectly well for this job if you do not have side cutters.

Construction of the celestial sphere

1. Stick sheets 1 to 4 of the designs onto cardboard using a glue stick. Spread the glue thinly and evenly without leaving any gaps. If the cardboard has printing on one side, stick the sheets to the printed side. Line the arrows up with the grain of the cardboard. If you prefer, you can cut the paper designs out before gluing them to the cardboard.

2. When the glue is dry, cut out each of the 8 arms and the two spacers using a large craft knife with a sharp blade. Accurate cutting is essential. Follow the line and keep the cut vertical. (It is quite difficult to cut the spacers neatly, but neatness is not so important for these two components.)
3. Using a craft knife cut the U-shaped ecliptic/equator indentations out of the paper, but not out of the cardboard. This enables the barbecue skewers to be glued directly to the cardboard at those points. (Gluing things to the paper is not as strong as gluing things to the cardboard.)



4. Cut a length of 8mm dowel to the length shown on the template on sheet 10. (Use thicker dowel if you are using thicker cardboard. The diameter of the dowel should be twice the thickness of the cardbaord.) With a pencil, mark the dowel all the way around at the places shown on the template.
5. Run a bead of hot glue along both ends of the 0 hours arm, like this:

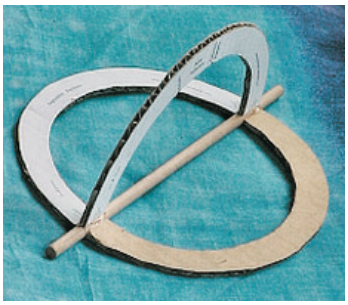
By making a bead, and avoiding spreading the glue out at this stage, you will slow down the cooling of the glue. This means you do not need to hurry as the glue remains workable for quite a few seconds.

6. Press the glued ends against the dowel so that the arm's ends both touch the pencil marks, and the arm sits square and straight against the dowel. Hold it in place for one minute until the

glue has set. Now that the glue has been spread out it will set a lot faster.

7. Next glue the 12 hours arm. Glue it with the North Celestial Pole at the same end as the North Celestial Pole of the 0 hours arm. Glue it directly opposite the 0 hours arm, with its ends both touching the pencil marks. Make sure it lies in the same plane as the 0 hours arm. It will look like this:

8. It is absolutely critical that you glue the next arm on the correct side. Holding the 0 hours arm towards you, with the North Celestial Pole up, the 6 hours arm will go on the right. If you lay the printed side of the 0 hours arm face down on the table you will be ready to glue the 6 hours arm on straight up, like this:



Make sure the North Celestial Pole is at the same end as the North Celestial Poles that you have already glued. Glue it at right angles to the ones already glued.

9. Next glue the 18 hours arm directly opposite the 6 hours arm, making sure that the 6 and 18 hours arms are in the same plane. Keep the North Celestial Pole at the same end as the ones already glued.

10. Now you are ready to glue the remaining arms between the ones you have already glued. Glue them in order so that it goes 0, 3, 6, 9, 12, 15, 18, 21 hours as you go around. Glue each of the remaining arms exactly half way between the ones already glued. The photo shows the first one glued:

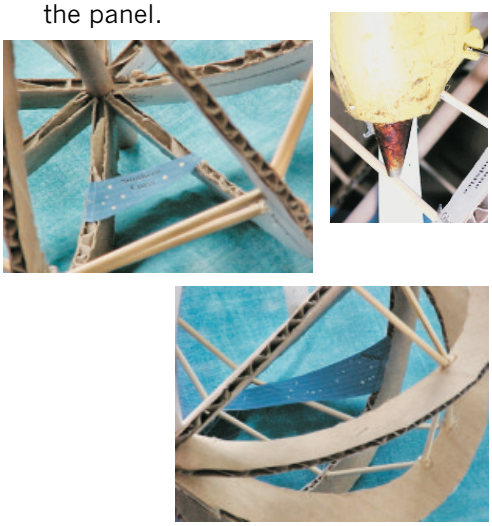
11. Cut the bamboo skewers to the lengths shown on the template (sheet 10).

12. The U-shaped ecliptic/equator marks show where to attach one end of each skewer. Poke a pin through the cardboard in the centre of the U-shaped marks, so that you have a pin-prick on the other side as a guide for gluing the other ends.

13. Glue the equator first. Start at one point and work around the equator. Glue each skewer at one end to a pin-prick and at the other end to the centre of a U-shaped mark. Check each piece before you glue it making sure that you keep every two arms sitting at right angles to each other, and opposite arms sitting in the same plane. You will need to trim the skewers a little to achieve this. Trim them as you go. Once trimmed and checked, a blob of hot glue at both ends is sufficient to hold each skewer in place.

14. Glue the ecliptic next. The long pieces go from the equinox arms, and the short pieces from the solstice arms. Trim them to fit as you go.

15. Cut the star panels (sheet 5) out with scissors. Each star panel has a letter at each end. These match the letters printed on the arms. Glue them in place inside the globe with the letters matching. They will not fit perfectly due to the natural variability of a hand-made object. Position them so that they fit as best as possible. Glue them temporarily with a glue stick, and then finalise their position with a blob of hot melt glue added from the back of the panel.



16. Slide the spacers over the ends of the dowel. Do not use glue for the spacers. (The first photo on page 7 shows the spacers in place.) Your celestial sphere is now complete.

Construction of the meridian ring

1. Stick sheet 6 onto cardboard using a glue stick. Spread the glue thinly and evenly without leaving any gaps. If the cardboard has printing on one side, stick sheet 6 to the plain side. Line the arrows up with the grain of the cardboard. If you prefer, you can cut the paper design out before gluing it to the cardboard. If you do this, make sure you leave the alignment marks attached until after gluing.
2. Cut the grey area off sheet 7 with scissors.
3. Stick sheet 7 onto sheet 6 matching the alignment marks up. This will create a complete ring on the cardboard.
4. When the glue is dry, cut out the meridian ring using a large craft knife with a sharp blade. Accurate cutting is essential. Follow the line and keep the cut vertical.
5. Using the ring as a template, trace around it onto another piece of cardboard.
6. Use the traced line to cut a second, identical, ring.
7. Place the two rings together without gluing them yet.
8. Turn the rings so that the grains of the two rings run at right angles to one another. (It is not critical that you get the grains at right angles, but it does strengthen the ring if you do.)
9. Using a pen or pencil, squash the corrugations along the lines labelled "North Celestial Pole" and "South Celestial Pole." This creates an indentation into which the axle of the celestial sphere will fit. Do this to both of the rings that you have cut.

10. Glue the two rings together half way. Run a wavy bead of hot melt glue half way around one of the rings, from "North Celestial Pole" to "South Celestial Pole." Do not put any glue closer then 1 cm from the indentations. Press the two rings together, and slide them until they line up with each other. Accurate alignment is essential. Hold them for a minute until the glue sets.
11. Insert the celestial sphere. Check that you have remembered the spacers. Be extra careful that the "North Celestial Pole" of the sphere goes with the "North Celestial Pole" of the meridian ring. The axle should fit neatly into the indentations.
12. Glue the remaining half of the two rings together using hot melt glue, again making sure that you do not put glue closer then 1 cm from the indentations.

As you press the rings together adjust the axle so that it sits naturally aligned with the lines that mark the celestial poles on the ring. Hold for a minute until the glue sets.

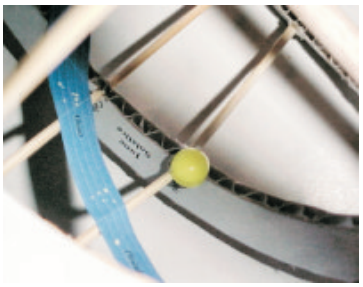
13. Your celestial sphere should now turn freely within the ring. Try it now, and see if it catches at any points. Using a sharp craft knife (this could be time for a new blade) trim any parts that catch.
14. Your *Sky-in-a-Box* is now ready to be mounted in its base.

Construction of the base

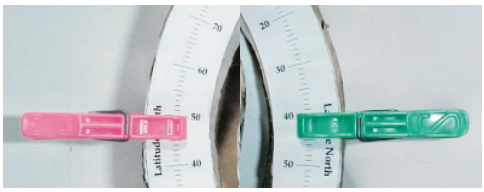
1. You need a complete supermarket carton for this. Tape the carton closed, top and bottom, using packing tape.
2. Stick sheet 8 onto one side of the cardboard box using a glue stick. Spread the glue thinly and evenly without leaving any gaps. If you prefer, you can cut out the paper design before gluing it to the cardboard. If you do this, make sure you leave the alignment marks attached until after gluing.
3. Cut the grey area off sheet 9 with scissors.
4. Stick sheet 9 onto sheet 8 matching the alignment marks up.
5. When the glue is dry, cut out the horizon opening using a sharp craft knife. Because you are cutting into a box, you cannot use a cutting board. Push the knife in through the wall of the box, and then use it like a saw. (If you cannot succeed with the "knife as a saw" technique, you will need to do the cutting on a flattened box, then assemble the box and tape it closed.)
6. Your base is now ready for use.

Assembly and Setting

1. Select a small yellow bead or marble to be the sun.
2. Stick the sun to the ecliptic at the correct place with a small piece of blu-tack. Four of the arms are labelled with months: March, June, September and December. For the months in between, just estimate the location of the sun. Any intermediate location will do, so long as it is on the ecliptic.

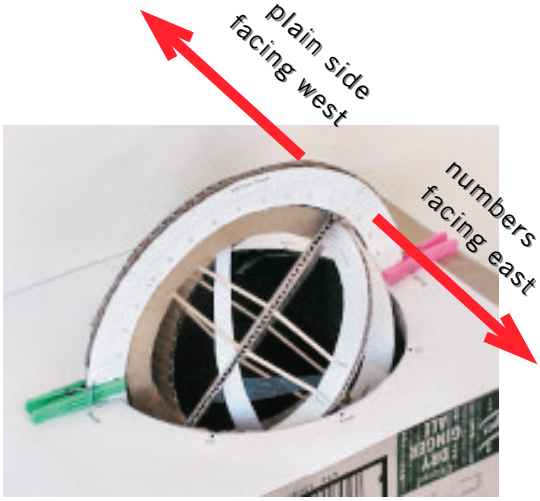


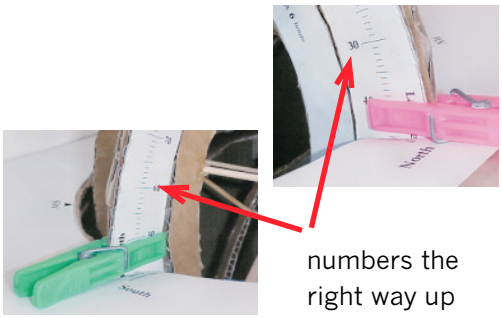
3. To set your Sky-in-a-Box for a particular latitude you need two spring-type clothes pegs. Put both pegs on the meridian ring at the correct latitude position. Here are two pegs set for 45° N latitude. The two pegs should be directly opposite one another.



4. If you do not know your latitude, look in an atlas, or use the Star Wheel download page at Astronomy In Your Hands.
5. The meridian ring sits half way into the base supported by the two pegs. The base represents the horizon. The half of the celestial sphere that sticks out of the box forms the dome of the sky above the horizon. The half of the celestial sphere inside the box is below the horizon.

   It is vital that you mount the meridian ring the right way around. Mount it so that the latitude numbers are the right way up. Slide it through the slots in the base with the latitude numbers facing east.The plain side of the meridian ring will face west.





numbers the
right way up

6. To help you understand which way everything goes, turn the base so that north on the base points roughly towards true north. Now your model of the sky will match the way things really are outside. (This doesn't apply if you have set the Sky-in-a-Box for a different latitude from your own.)

The above photograph shows the sun setting due west, at the March equinox.

The final touch

When you want to put your Sky-in-a-Box away, or carry it around, just take the clothes pegs off and let the celestial sphere drop through the slots and into the base box. You now have the sky in a box. You could even make a lid that closes over the opening in the box.