Make your own Quadrant

Activities

The Quadrant

The first quadrant was probably made by *Ptolemy* in the C2nd.CE. it was rather cumbersome and may have been awkward to use The first true quadrant, was conceived by *Muhammad ibn Musa al-Khwarizmi* in the C9th.CE.

At the *House of Wisdom in Baghdad*. Essentially a device for measuring the angle of elevation; when applied to the pole star, this angle of elevation equals the latitude of the observer.

Many versions of the quadrant were developed and adapted for surveying, direction finding, time of day calculations and astronomical problem solving.

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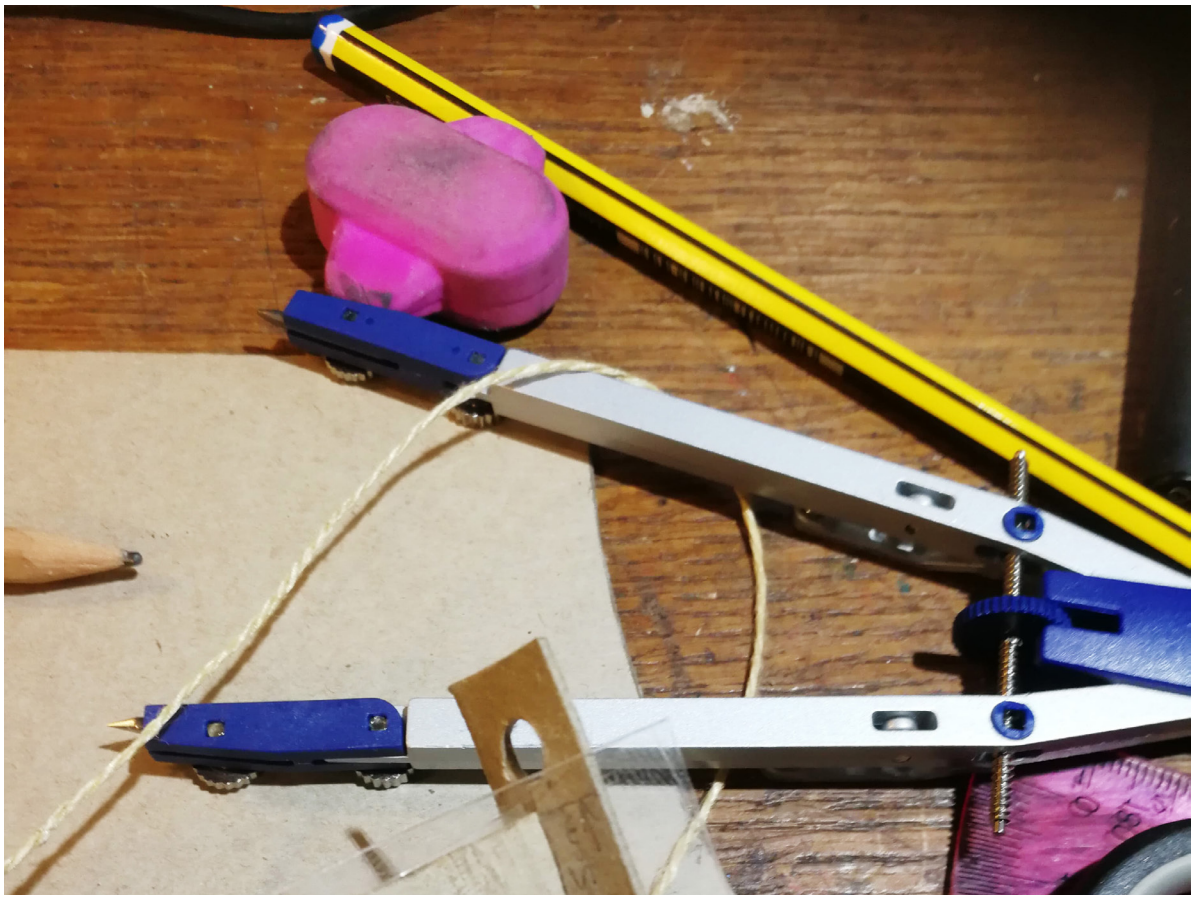
Activities

You will need:

1 Piece of thick cardboard
1 Protractor
1 Pencil
1 Rubber
2 Sellotape
1 pair scissors
1 Paper punch
1 Button
Some thread



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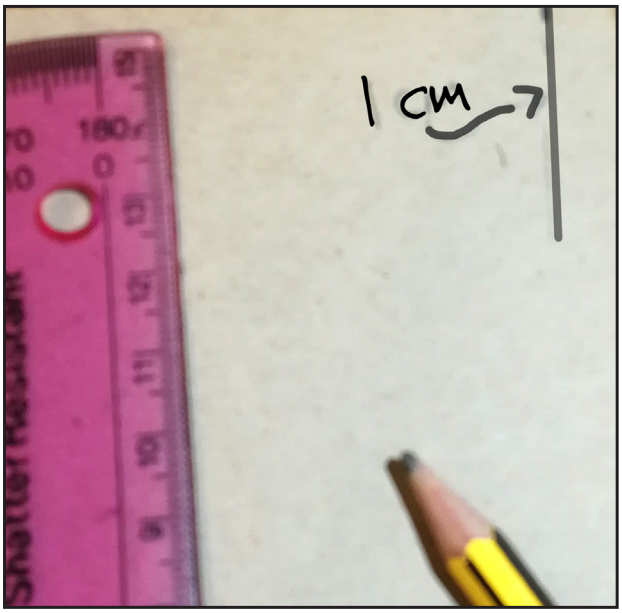
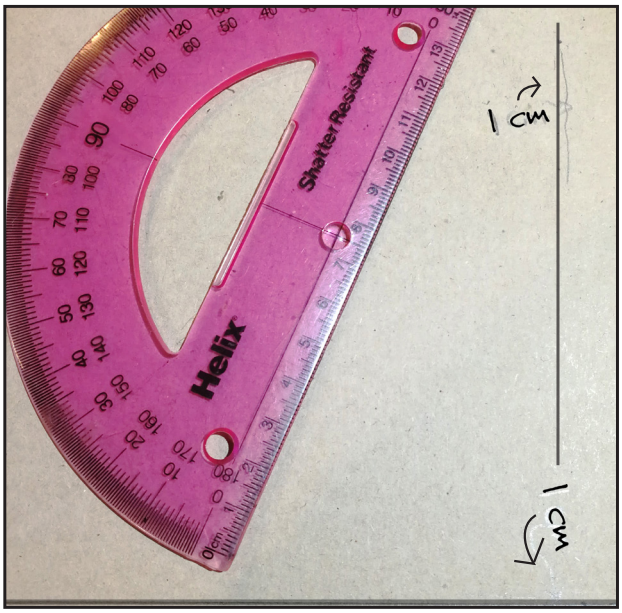
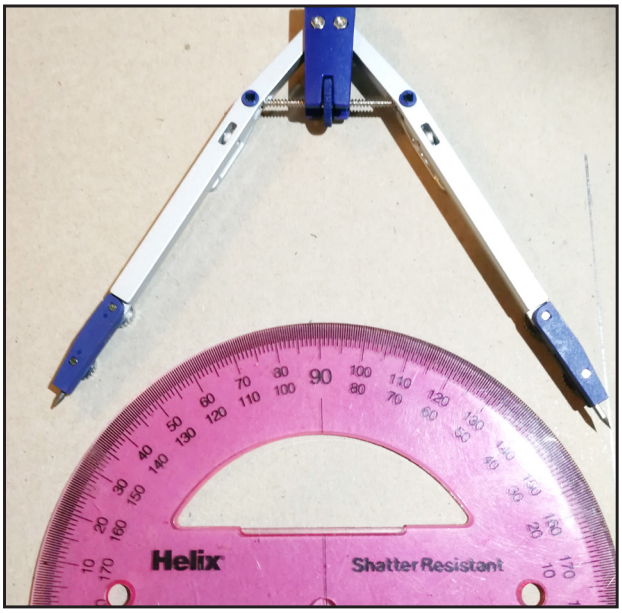
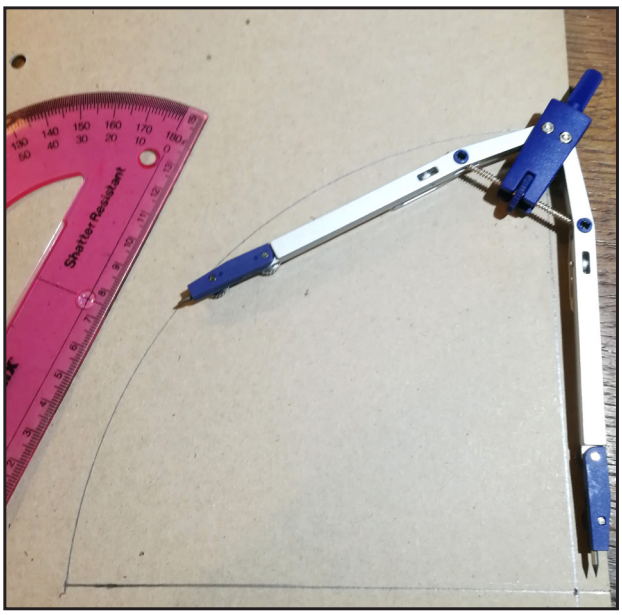
1. On the top edge and down one side of the card board mark out a 10mm border.





2. Then set a pair of compasses, to the size you want your quadrant.150mm is a useful, working size.





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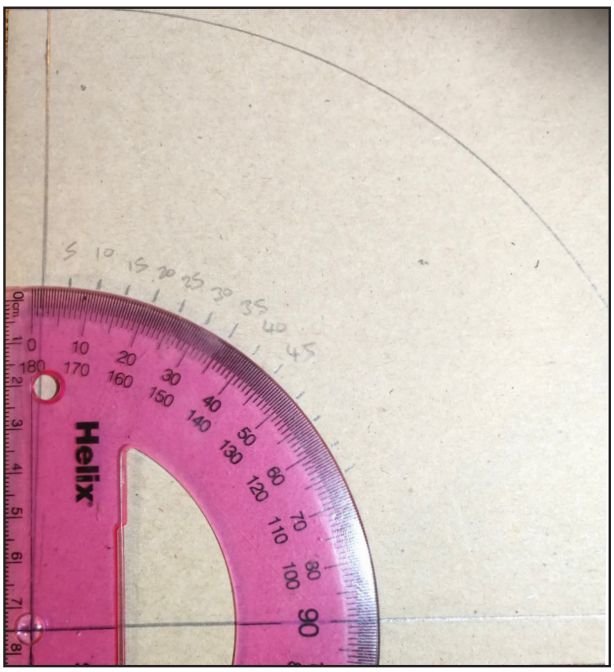
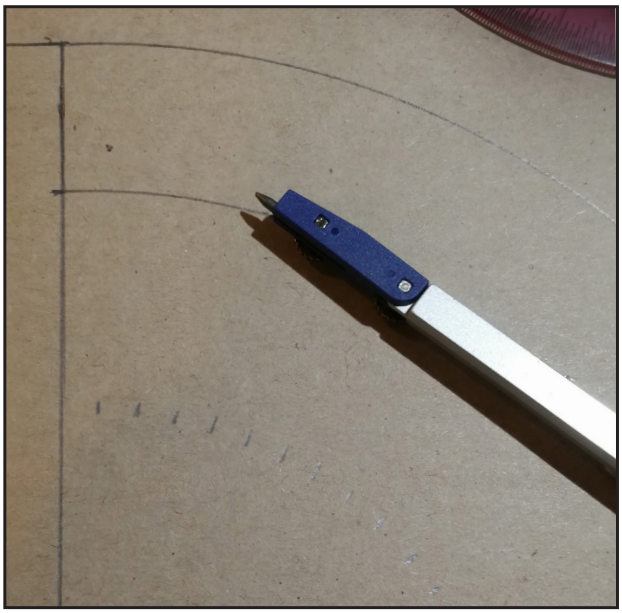
3. Next you can start to mark out your quadrant in degrees. First every 10 degrees, then every 5 degrees. If you feel confident, you could do every degree. But its better to start off with something simple.



4. Before drawing the radial lines in, its probably better to draw a second arc. Measure 30mm from the existing arc.and draw a second one.



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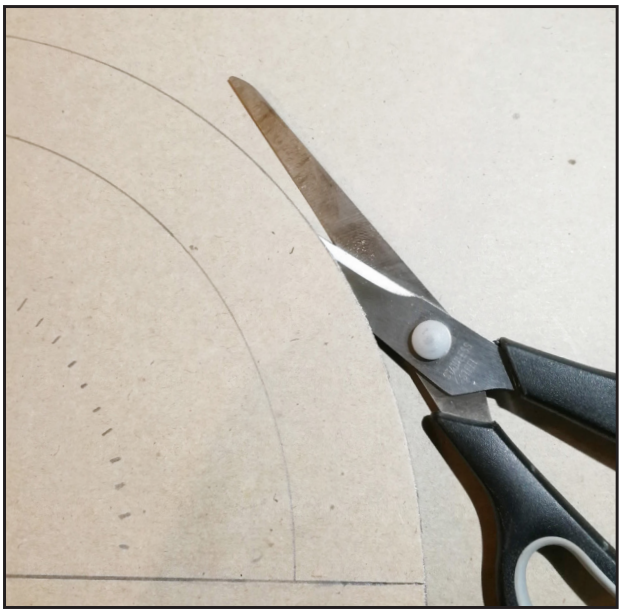
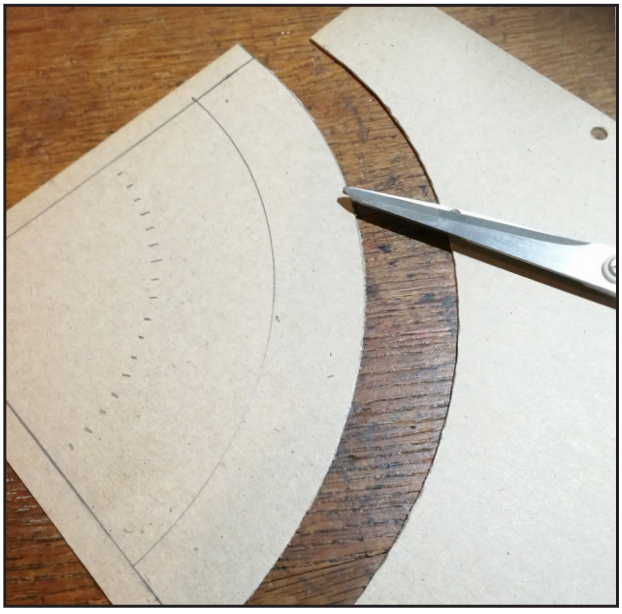
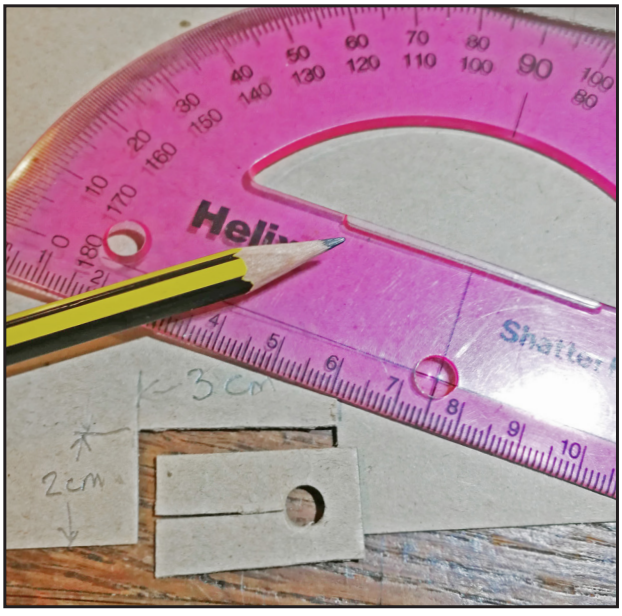
5. Next its probably easier if you cut the cardboard quadrant out using a sharp pair of scissors. Be careful they are sharp!
It may be safer to get an adult to do this for you.





6. At the same time you can cut out a ‘foresight’ and a ‘backsight’.
These are what you use to align the device when taking a reading.
The foresight is a rectangle of cardboard 10mm. by 20mm.
The backsight is similar, 20mm by 30mm. with a hole punched through.
Sometimes, cardboard dividers come pre punched, so you don’t need a hole punch with them.



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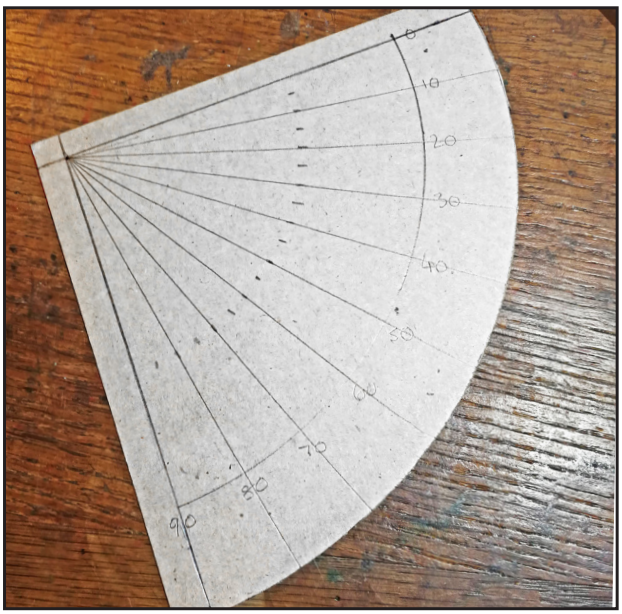
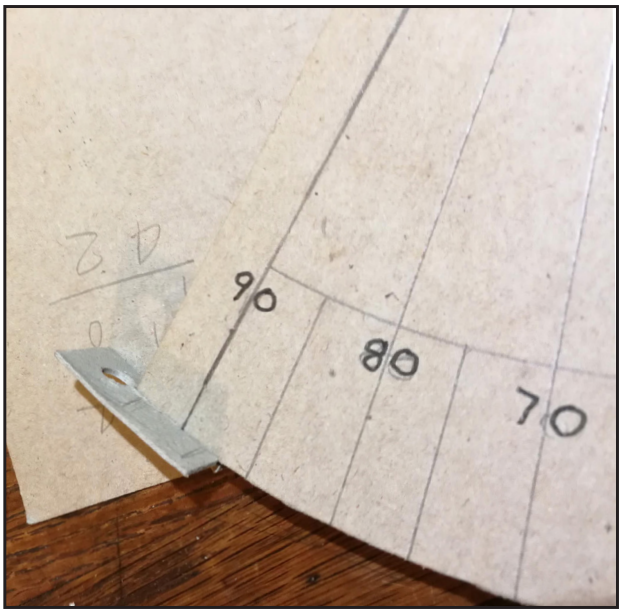
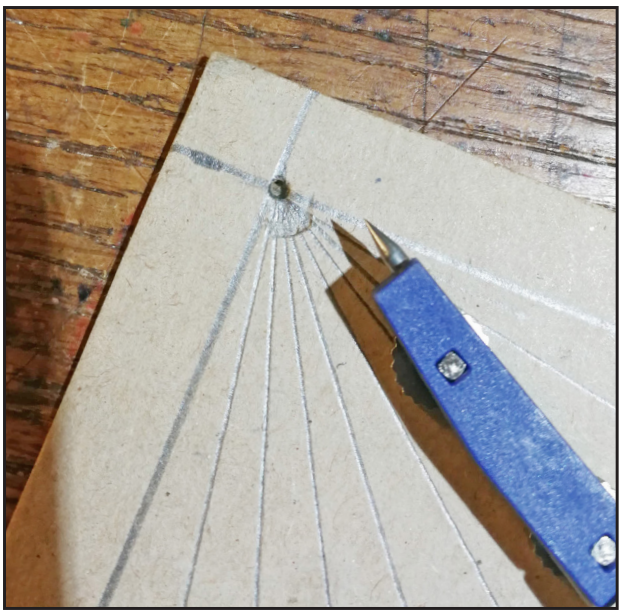
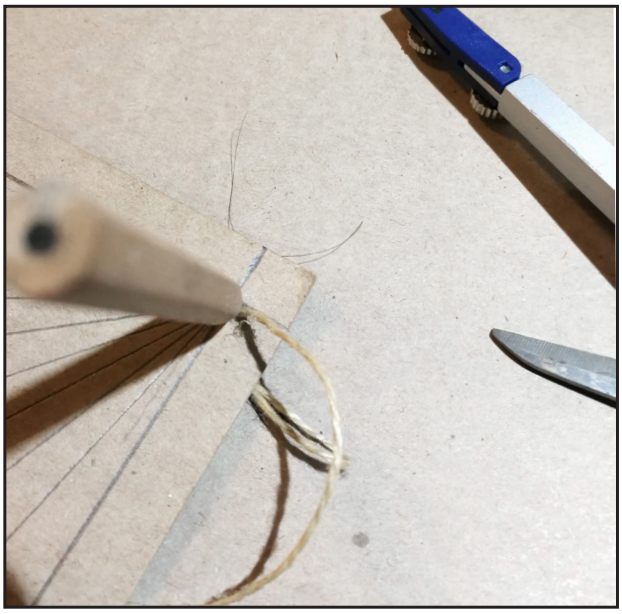
7. Now draw in your radial lines. Draw the multiple of 10 degrees lines, i.e.10, 20, 30 etc. from the top corner (called the 'origin') to the outer edge arc. Now draw the intermediate 5 degree lines, i.e. 5, 15, 25 etc between the inner arc and the outer edge arc.





8. Now make a hole at the origin, this can be done with the compass point. It is very sharp, so let an adult do this for you. Then pass one end of your thread through the hole, this can be done with a blunt pencil, but again be careful!





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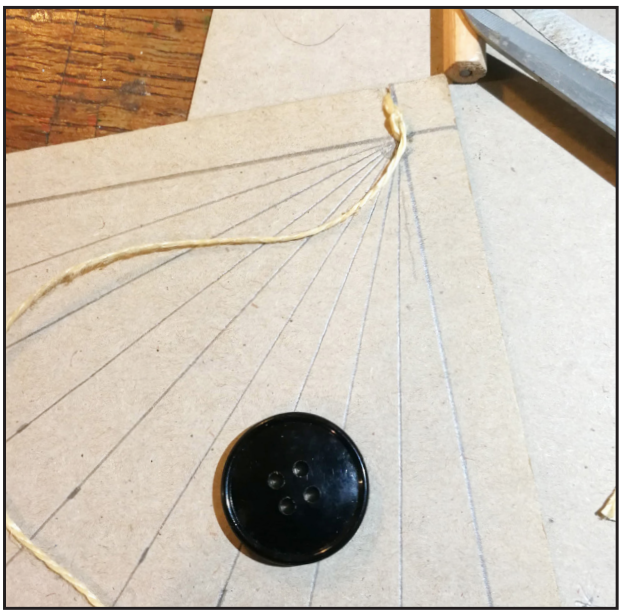
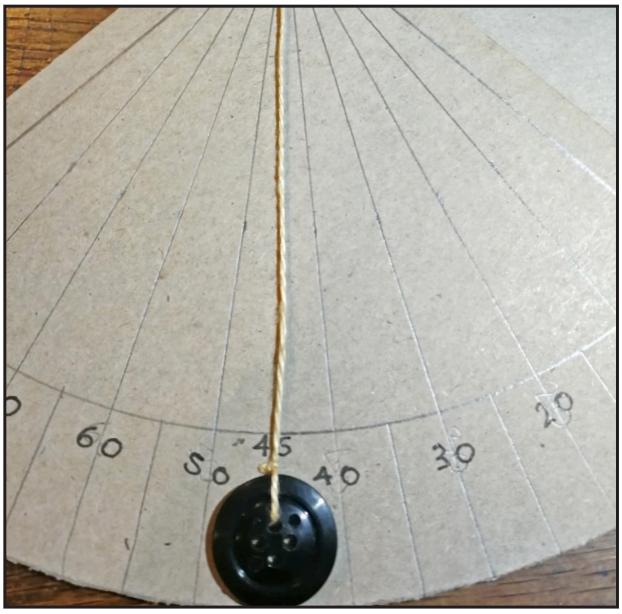
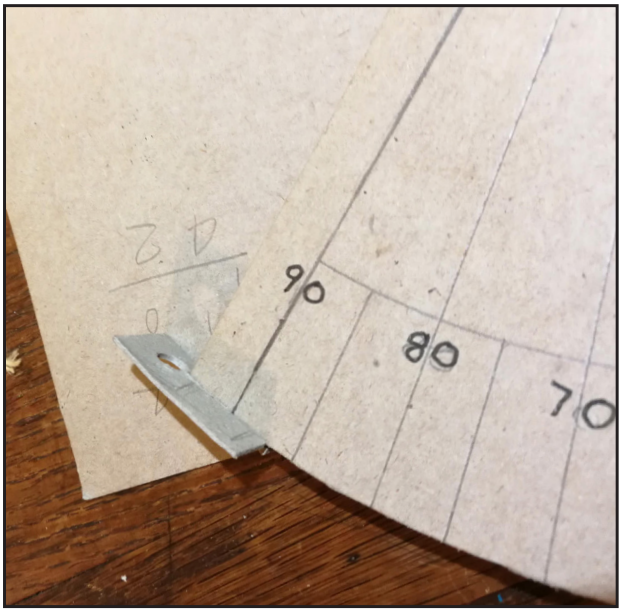
9. Tie a knot your thread, then on the other end tie your button.





10. Next, carefully tape your backsight on, by the 90 degree line on the edge of the device. Next tape your foresight on the same edge as the back-sight, by the origin, but on the back.



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11. Your device is now ready to use. Put the backsight close to your eye, align the hole with the foresight with the object you want to measure the angle to.

Tilt the device slightly to the right, so that the button weight or pendulum is free from the quadrant, otherwise it may drag across it and stick at the wrong place! Allow any movement in the pendulum to cease, then gently tilt the device to the left. The pendulum will come to rest and you can get an accurate reading off your device.

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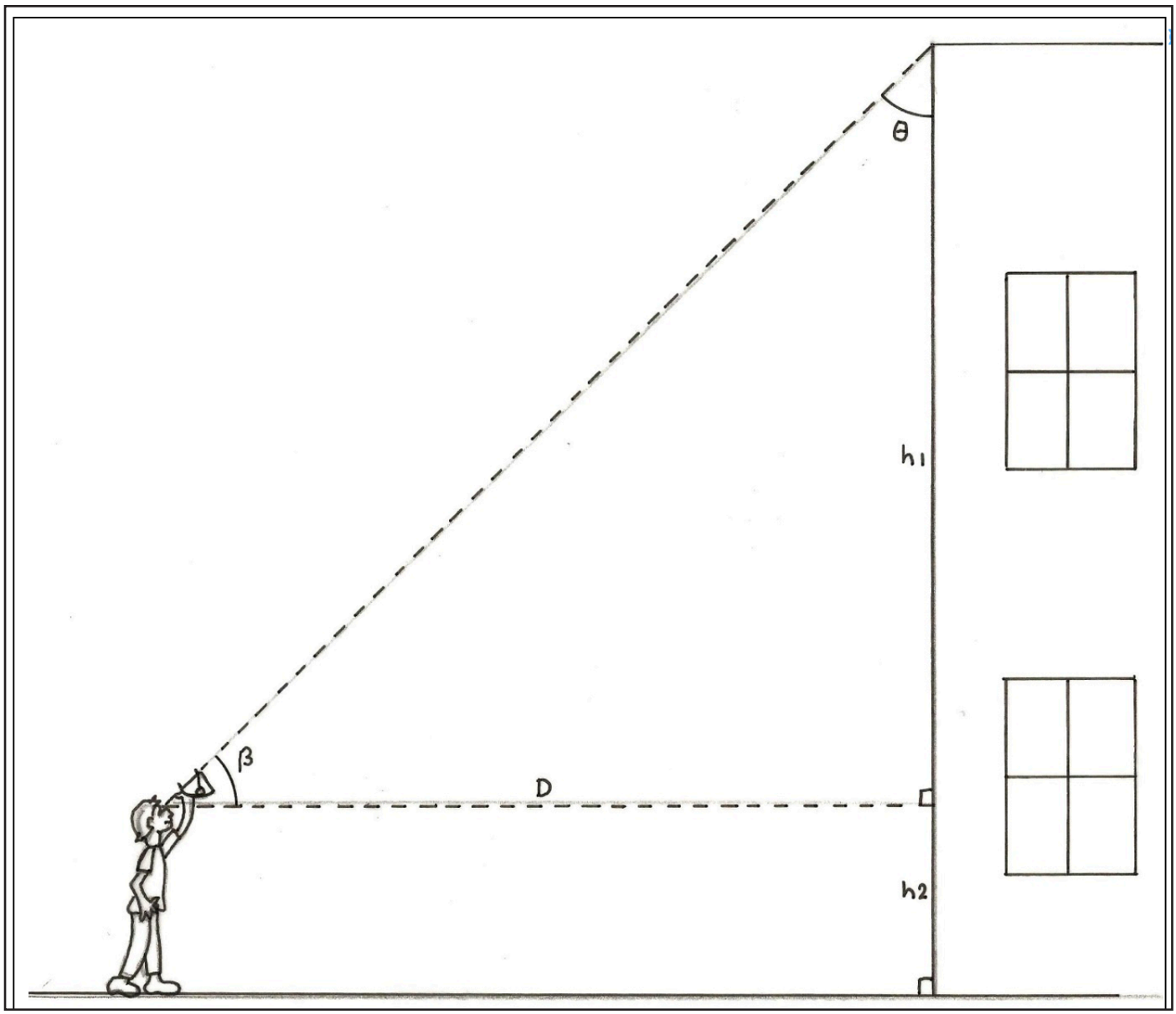
12. Using your device to measure the height of a building. Align your quadrant on the top edge of a building. Find the angle on your quadrant and record it.
Then measure the distance (in meters) between yourself and the front edge of the building. Using trigonometry, you can work out the height of the building.
You can make this easier for yourself, by moving closer or further away from the building, till the angle on the quadrant is 45 degrees. Then measure the distance to the edge of the building. This will be about the same as the height of the building, so no maths required. However, work this out on paper to see why this is so.



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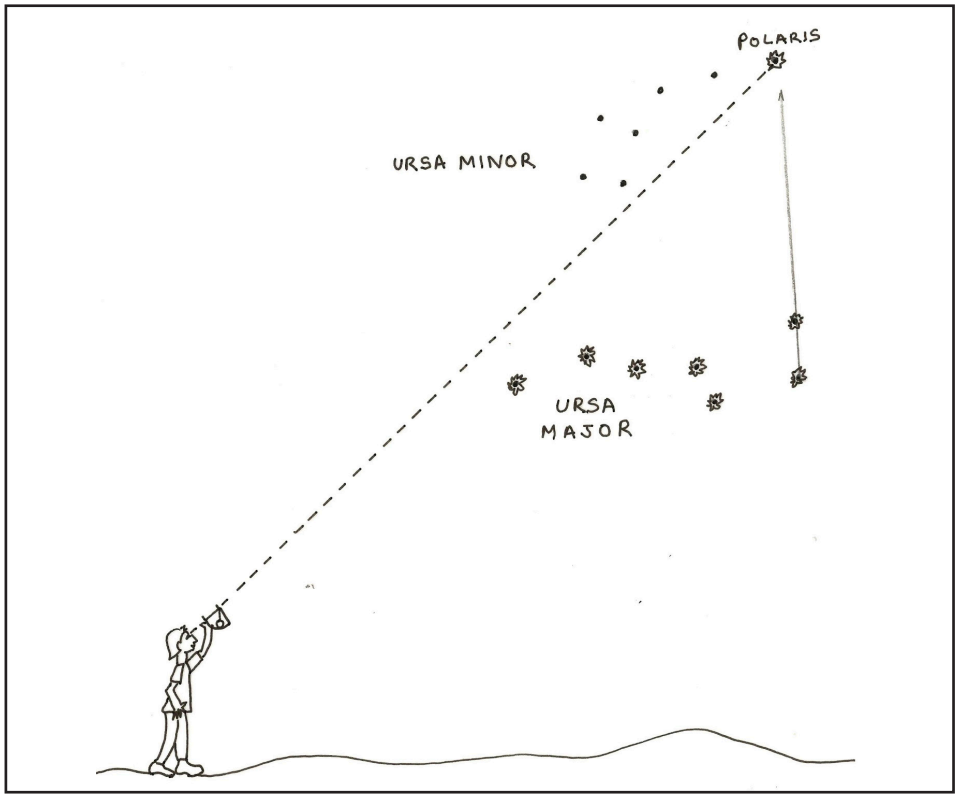
13.The height of the building, 'H' is expressed as 'h1 +h2'. The height, h1 can be found by measuring the distance to the building 'D' and the angle 'ß ' measured with the quadrant, and using trigonometry to calculate the answer. However, when angle 'ß ' is 45°, then angle 'θ ' must be 45°, as well.
This can be calculated by knowing that all the angles in a triangle add up to 180° The right angle, is 90°and so if we add, '45°+ 45°+ 90°' we get 180°.
So if the angles are the same, the distances must also be the same. Distance D must equal h1. H can be found by adding h1 to h2 where h2 is the height (to the eye) of the observer. So when ß is 45° , H equals (D plus the observers height h2).

14. Using your device to find your latitude. This has many useful applications in Navigation and time keeping. On a clear night, go out and measure the angle with your quadrant to the Pole star. This can be found using the constellation Ursa Major as pointers, it can be found in the constellation, Ursa minor.



15. Measure the angle, it should be about 53°. That is the same as the latitude you are on! One very useful application for this information is to help you make or aligning a sundial. The pointer or Gnomon is most accurate when it is inclined at an angle equivalent to your latitude!
See if you can find out why?

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16. When making a sundial, the sun is in the south at midday. This can be verified by measuring the suns shadow from a gnomon (perhaps just a stick, stuck in the ground) when it is at its shortest length it is midday. The direction south can be verified by finding the pole star at night.

When making sundials in the House of Wisdom in Baghdad they found that the sundials were more accurate when the gnomon was tilted towards the south.

And the most efficient angle of tilt was achieved when the angle equalled the angle of latitude as measured above!