Unit Cell Nets

Introduction

Much like a patterned fabric or wallpaper, crystals contain repeating units. The name for the smallest repeating unit inside a crystal is a unit cell. Unit cells come in a variety of shapes and each of these pack together in three dimensions. This activity demonstrates the nature of each of these shapes and how they pack together tightly to form a larger lattice – the crystal.

Set up

- Print a one of each net. This can be done on coloured card or the nets can be coloured in prior to cutting and sticking.
- This activity is focussed on making the unit cell nets, however much of the discussion is centred around stacking and tessellation. Multiple nets can be made to aid this, but it can be quite time consuming. If you don't have the time, it is recommended to try and imagine how they would stack multiple unit cells to produce some of these images.

Equipment and consumables:

- Safety Scissors
- Glue Stick
- A number of each of the provided unit cell templates printed onto card – we recommend printing each unit cell onto a different colour card
- Colouring pencils / crayons if you want to colour them in

Activity instructions

1. Select a unit cell type and cut around the outline
2. Fold on all the internal black lines so that the lines are showing on the outside
3. Assemble and stick together using tabs on the nets and allow to dry
4. Stack the finished unit cells on top of each other

Discussion Points

- Can the participants work out how to stack the unit cells together?
- What happens if you try and stack different shapes together?
- Compare these cells to a patterned wallpaper, or similar, how are these different? (Extending in three dimensions)

Contact us

We would love to see how you got on with the activity! Please share any feedback or pictures with us at info@ncs.ac.uk with "SOTSEF 2020" in the subject line or tweet us @UK_NCS using #SOTSEF.

Unit Cell Nets - Explanation

Each of these further discussions points is to help teach a little more around the topic that the activity is based on. To help select appropriate discussion points these have been colour coded:

Beginner | Intermediate | Advanced

Symmetry

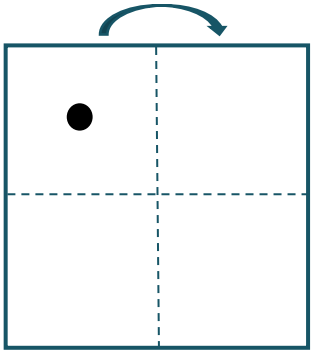
Crystals are made up of regularly repeating units. The smallest unit that can be used to build the crystal structure with only translation is called a unit cell. These unit cells can be copied and moved by 'reflection', 'rotation' or 'gliding' to expand infinitely within a crystal. A reflection is what you would see in a mirror, if you placed it on the edge of an object. A rotation is turning the object around the middle point whilst a translation or glide is to move an object without changing anything else about it. We see these kinds of repeating units everywhere, a great example is in tiled floors or wallpaper.

Smallest repeating unit

Unit Cell

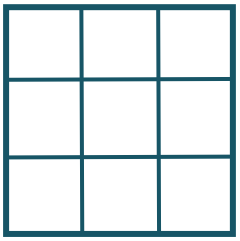
Above you can see the smallest repeating unit. This is different from the unit cell, as to form the unit cell we need to use either rotation or reflection. The unit cell can then generate the larger structure by translations. Try to imagine how you would generate the large structure on the right using the smallest repeating unit. What operations would you use and where?

One way of doing this is to get a square piece of paper and fold it in half twice. Put a dot in the top left quadrant and think about what you would have to do to move that dot to a different square. If you put a pencil in the middle of the square and rotate the paper where does it move? What if you were to put a mirror down the middle of the paper?

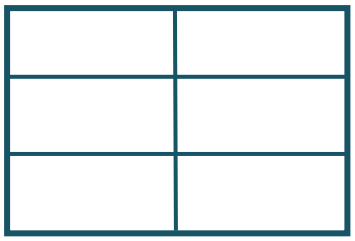


Unit Cells

The unit cells you have built can also be laid out to produce repeating patterns. The cubic unit cell can produce a grid of squares (when viewed from above), a tetragonal unit cell can produce both a grid of squares and of rectangles depending on how they are placed. Think about how you could lay some of your unit cells out to make some of the shapes below. What other patterns can you come up with?



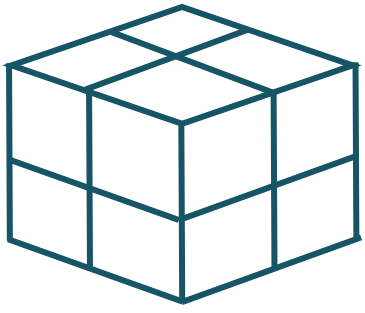
Cubic / Tetragonal / Monoclinic

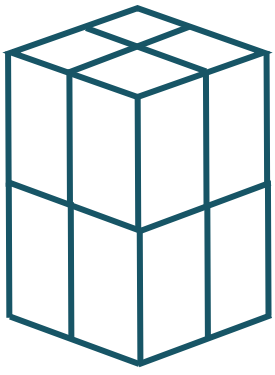


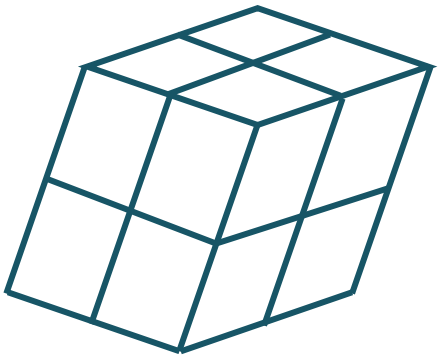
Tetragonal

Hexagonal

When we think of crystal systems, we don't just think of symmetry in two dimensions. These symmetries can extend in all three dimensions. What kind of repeating patterns can you get by stacking your lattices as well as placing them side to side? Think about how you would make some of the shapes below if you had a number of lattices to work with. What happens if you try to stack different lattices together?







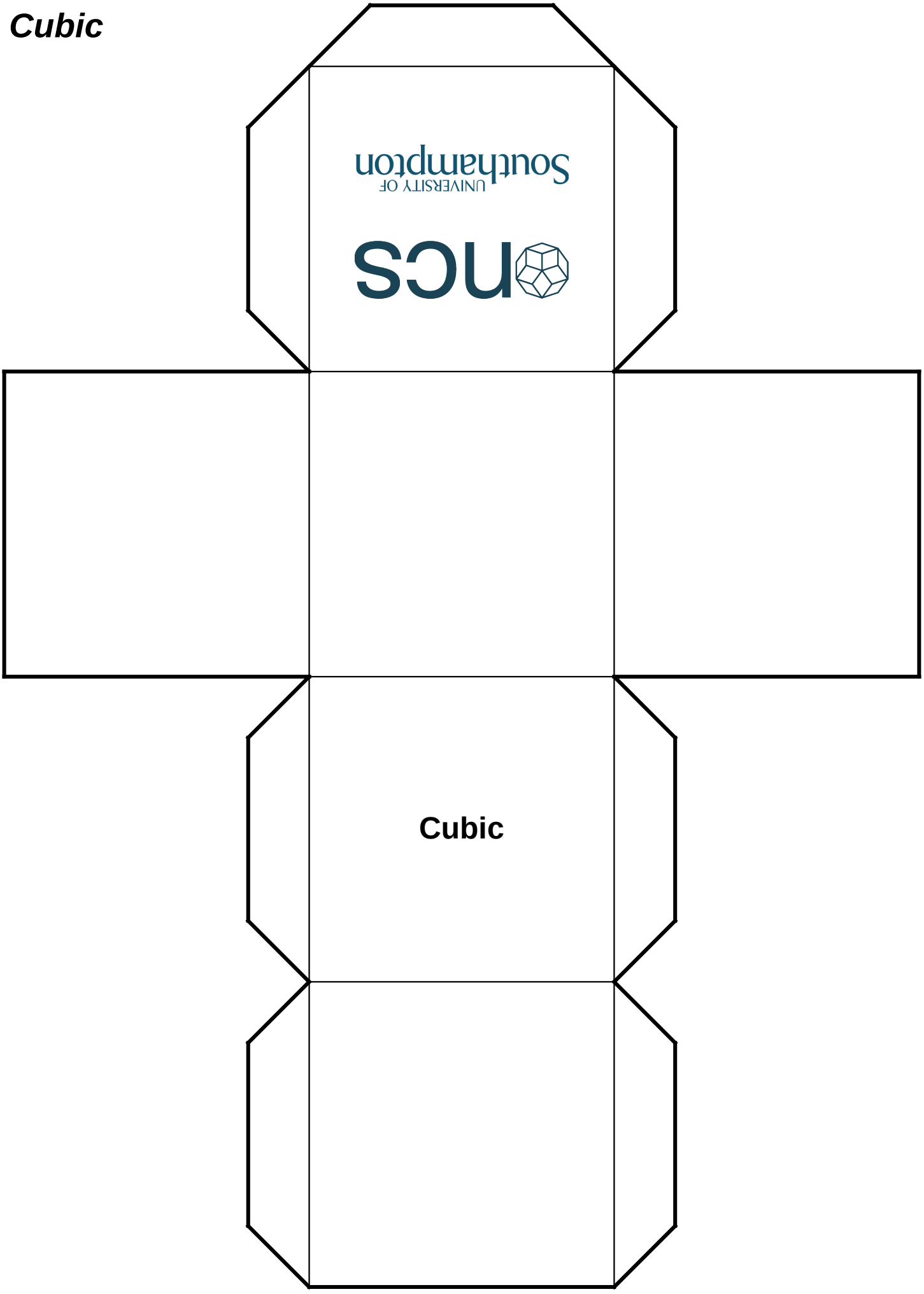
Risk Assessment –

The risks for this activity are listed below and are taken at your own risk. Ensure the activity is undertaken under the supervision of a responsible adult. If you are running this activity as part of an organised group a full risk assessment can be found at – http://learn.crystallography.org.uk/downloads/

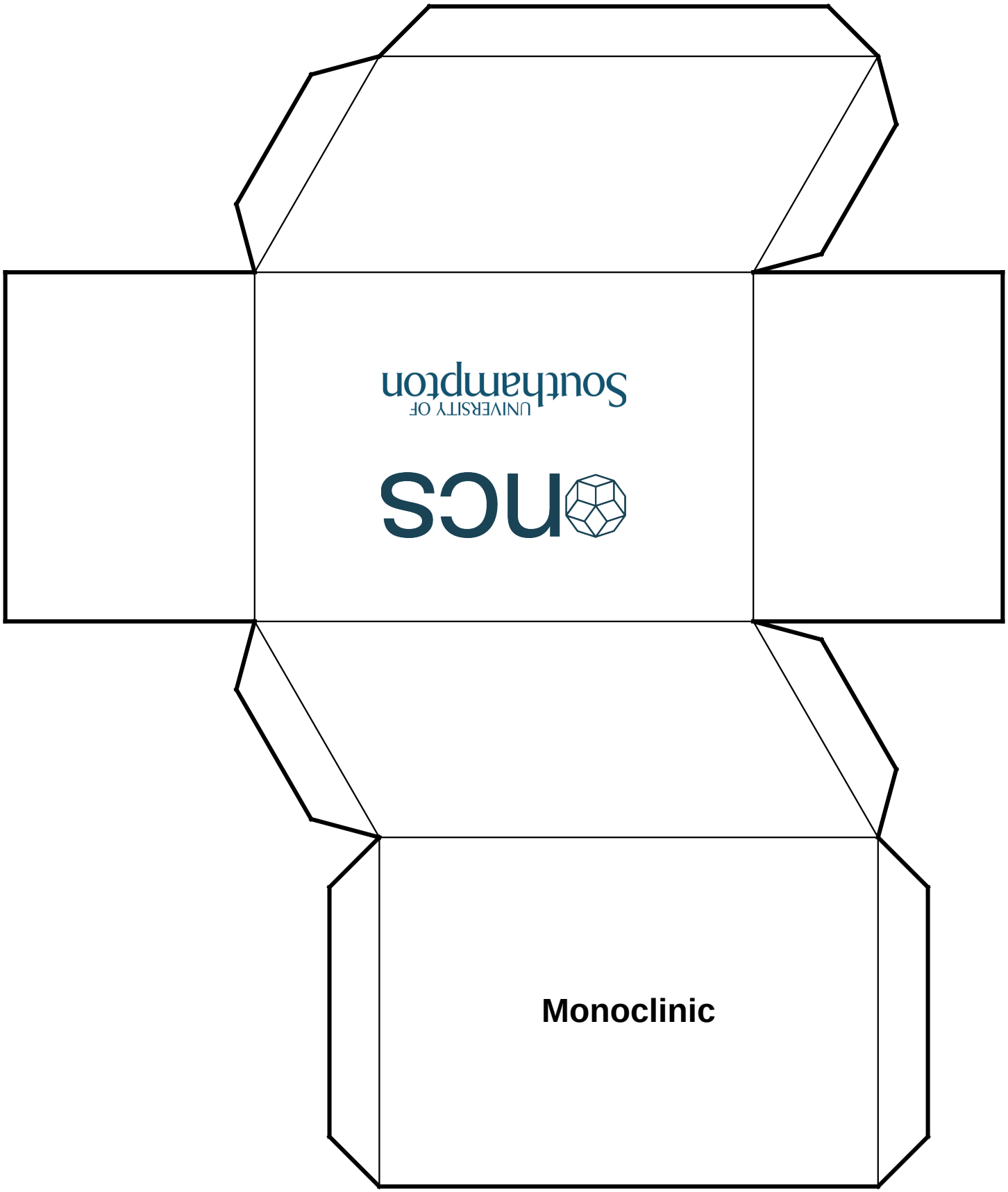
Scissors / paper – Serious cuts

Glue – Contact with skin, hair or eyes could cause irritation

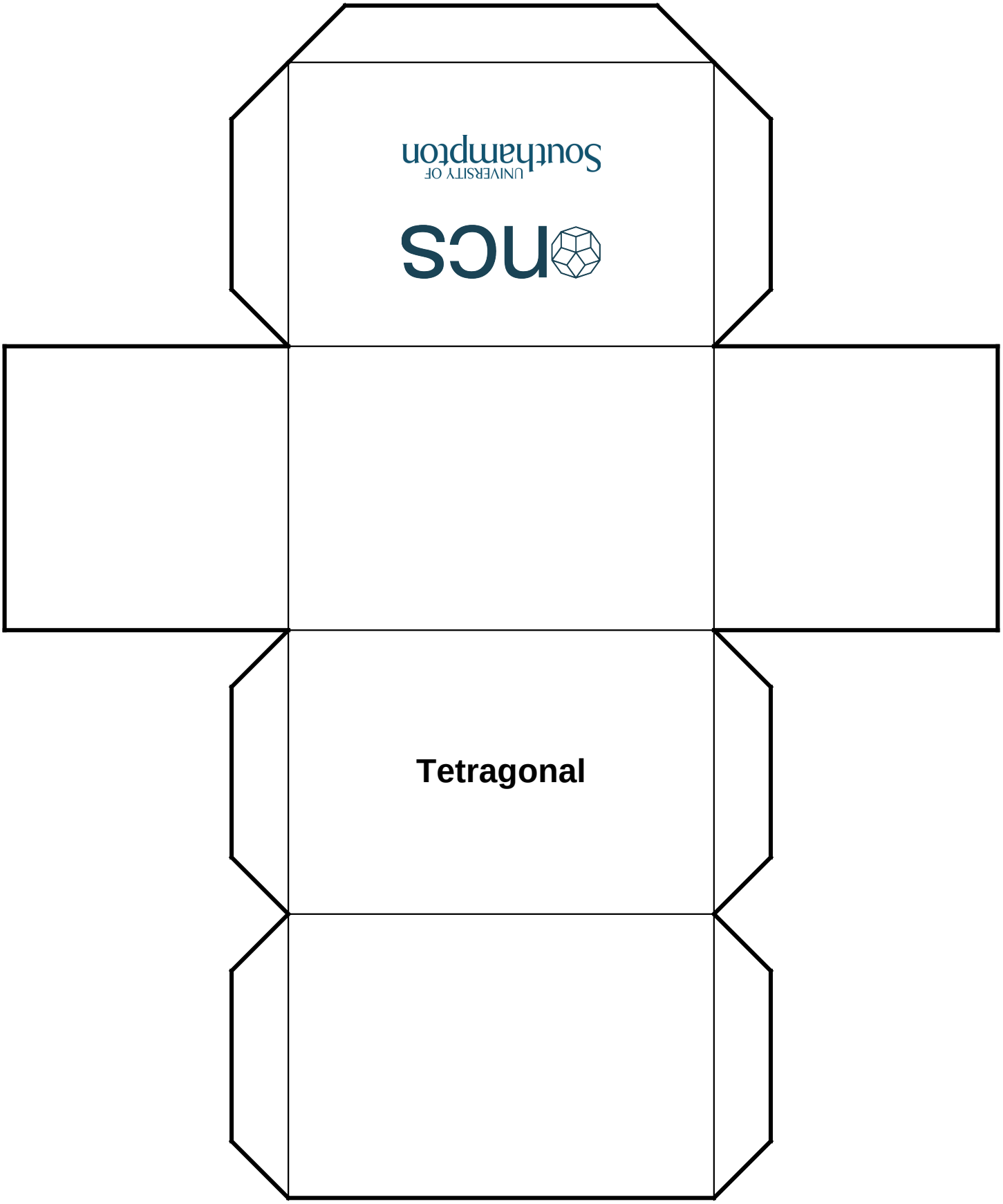
Cubic



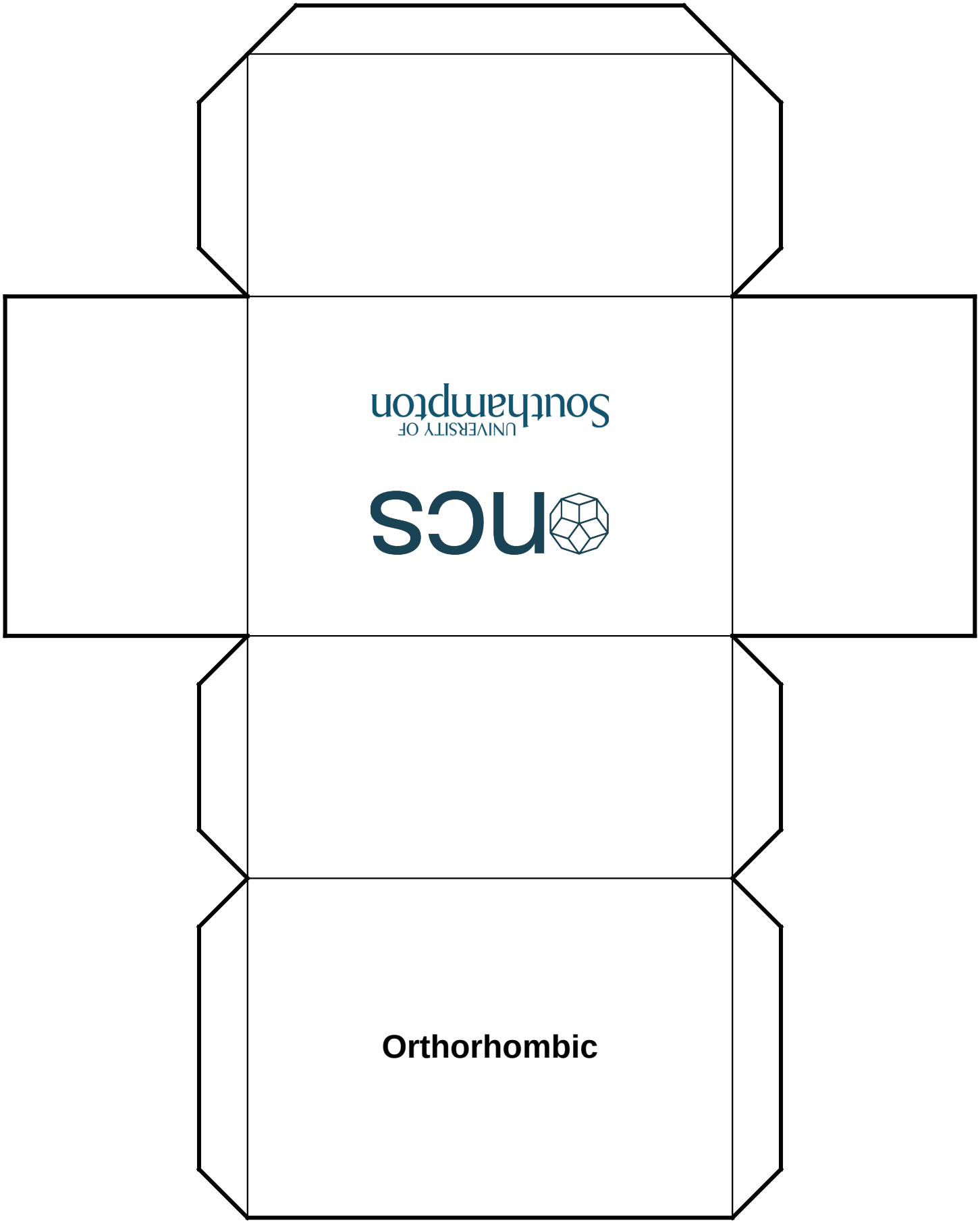
Monoclinic



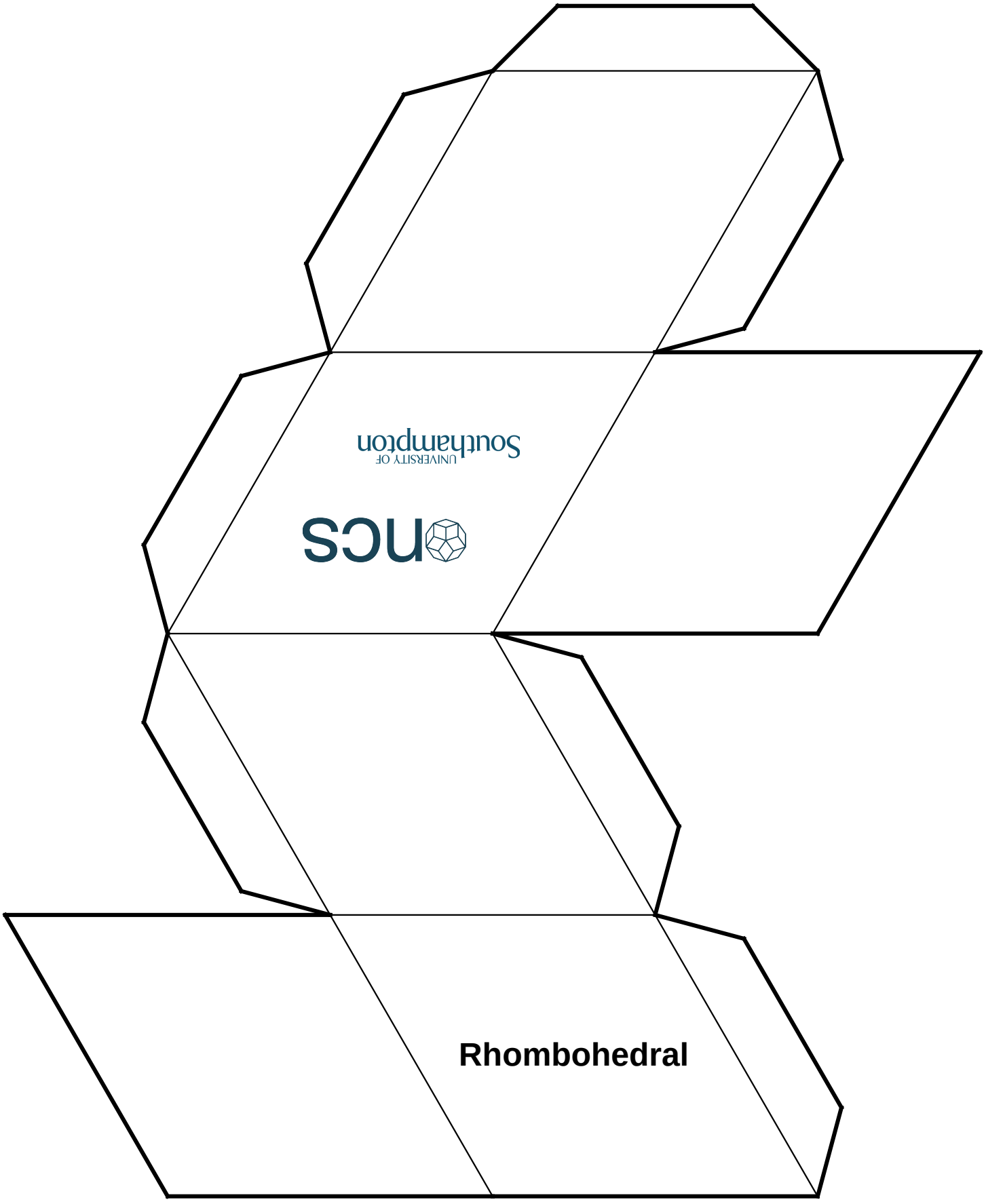
Tetragonal



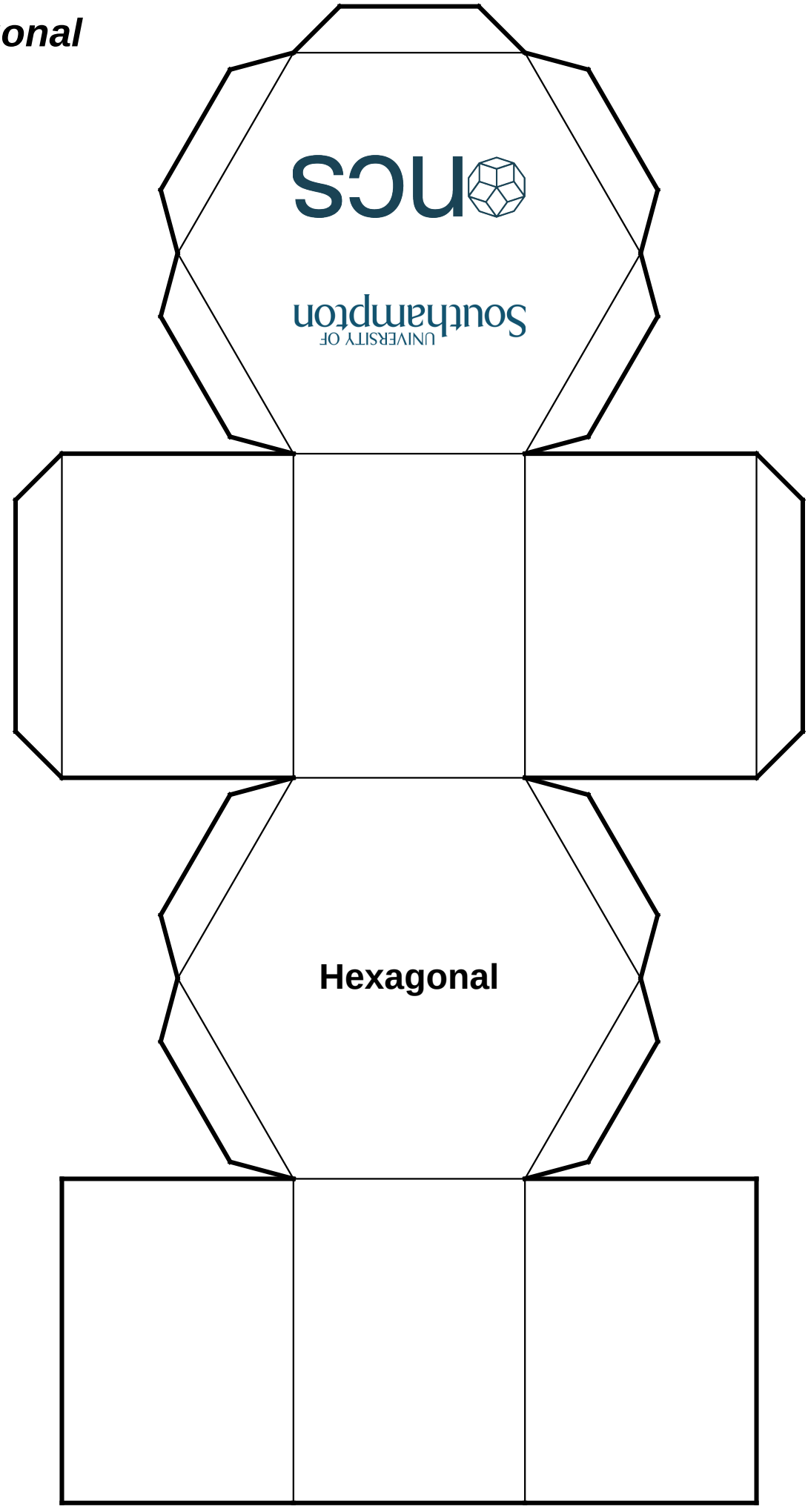
Orthorhombic



Rhombohedral



Hexagonal



Triclinic