Botanical Gardens

_TEACHERS NOTES
RIBA KS3 | **Mathematics Activity**

INTRODUCTION /

The session is introduced with the power point presentation featuring Towncaster Architects Sophie and Tomas and the Mayor of Greater Towncaster.

The Mayor sets the scene and what she thinks the city needs. Sophie and Tomas narrate their approach to these needs and make a design solution for which they enlist the help of your pupils and their mathematical skills. In this activity students work in groups of 4 or 5. Each group is provided with an activity sheet and materials to build an experimental model of a Botanical Garden.

ACTIVITY /

A Botanical Garden is often an educational type of building and its design an environmental exemplar. In this activity, pupils can experiment with recycled materials to create a form. Using mathematics to analyse the results, students can begin to understand how form is important in the energy performance of a building.

AIM /

"By creating a form and using mathematics to analyse it, pupils can begin to understand how form is an important part of the energy performance of a building as well as its appearance. **They will see the real-world value of mathematics, in particular volume and surface area.**"

_Curriculum Links

KS3 Maths:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/239058/SECONDARY_national_curriculum_-_Mathematics.pdf

‘LET’S DO SOME MATHS!’

ALGEBRA /

_**substitute numerical values** into formulae and expressions, including scientific formulae

_**model situations or procedures** by translating them into algebraic expressions or formulae and by using graphs

_**recognise, sketch and produce graphs** of linear and quadratic functions of one variable with appropriate scaling, using equations in x and y and the Cartesian plane

_**interpret mathematical relationships** both algebraically and graphically

RATIO, PROPORTION + RATES OF CHANGE /

_ **change freely between related standard units** [for example time, length, area, volume/capacity, mass]

GEOMETRY + MEASURES /

_**derive and apply formulae** to calculate and solve problems involving: perimeter and area of triangles, parallelograms, trapezia, volume of cuboids (including cubes) and other prisms (including cylinders)

_**describe, sketch and draw using conventional terms and notations:** points, lines, parallel lines, perpendicular lines, right angles, regular polygons, and other polygons that are reflectively and rotationally symmetric

_**use the properties** of faces, surfaces, edges and vertices of cubes, cuboids, prisms, cylinders, pyramids, cones and spheres to solve problems in 3-D

_**interpret mathematical relationships** both algebraically and geometrically

SUBJECT CONTENT /

Maths: Algebra; Ratio, proportion and rates of change; Geometry and measures

Architecture & Design: Shape-making possibilities of materials; Energy performance; Pollution & recycling; Model making; Structure; Sustainability

MATERIALS /

MATERIAL	SIZE	QUANTITY
Recycled Drinking Cups	78mm x78mm or similar	60
Paper Clips	Large	100
Clear Sticky Tape	Roll on Dispenser	2
Green Card (various shades)	A4	3
Ruler	30cm	1
Sheet Corrugated Cardboard, 6mm thick	A2	50

RECYCLED CUPS /

Disposable, single-use plastic cups are a potential source of pollution so it important that you do not use new cups for this activity. Think creatively about how you can obtain the cups you need for the activity. Collecting the cups from a nearby office could form part of the project. **Please make sure that recycled cups are washed** prior to issuing to the pupils and that cups are disposed of in the correct recycling bin after the activity.

OUTPUTS + OUTCOMES /

Outputs:

Models of arches and domes, with calculated surface areas and volumes

Outcomes:

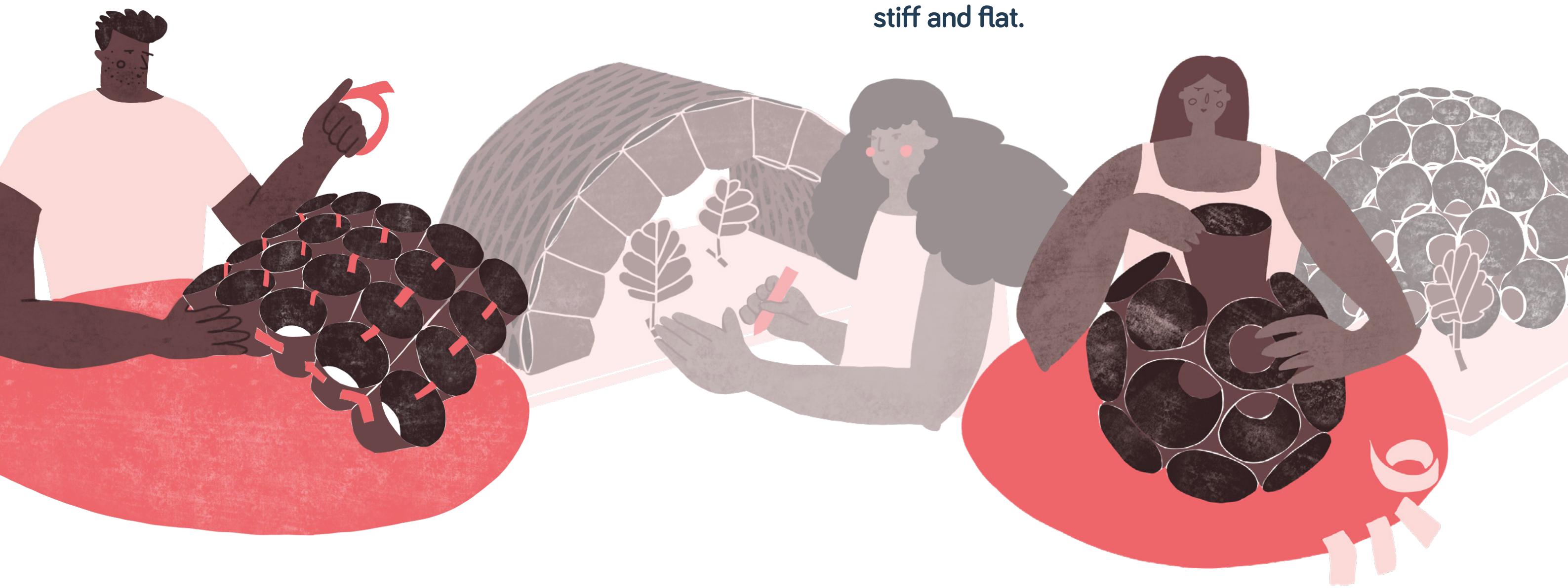
Understanding the relationship between shape, form and geometry.

CONNECTING CUPS /

Cups can be connected using sticky tape and/or large paper clips. Because the cups have a tapered shape they will naturally start to form a **curved shape** when connected together. To make the **arch** and **dome forms** and hence conduct the calculations as set out, the cups will need to connected together in the manner suggested. Other forms can be made by creatively exploring different patterns of connecting the cups e.g. try turning some of the cups the other way round.

BASEBOARD /

The corrugated cardboard **should be as thick as possible** e.g. 6mm. Depending on the skills of your students, you can decide how they can cut the corrugated cardboard such as with scissors or a craft knife (with a metal straight edge on a cutting mat with supervision) if deemed appropriate. Alternatively, you can provide the cardboard baseboard ready cut or use a different material such as foamboard which is available from craft shops **The important thing is that it is stiff and flat.**



ACTIVITY /

Working in groups of 4 and 5, students will make an experimental model.

The materials for one group are listed on the activity sheet and are sufficient to make one model. It is recommended that you **encourage some groups to make the arch form** and **some groups to make the dome form.** If there is time, a group completing one of the forms and its associated calculations could then dismantle the model, recycle the materials and make the other form. Alternatively, the group could dismantle the model and use the recycled materials to experiment with their own ideas.

CALCULATIONS /

The formulae will calculate the volumes and surface areas of a hemisphere and a half cylinder.

The accuracy of the results will depend on how well the model fits the actual form. If the model is distorted then the result will be less accurate – **this is a good topic to discuss with students** when they are doing their measurements. Another source of error is the thickness of the model surface which is due to the depth of the cups themselves. **For simplicity measure the radius to the outside surface of the cups.** This will mean the calculated volume will be bigger than the internal volume of the models but the comparisons will still be valid.

Some of your more advanced students may be able to discuss the implication of the surface thickness.

Perhaps the thickness of the surface could represent a layer of insulation on a real building?