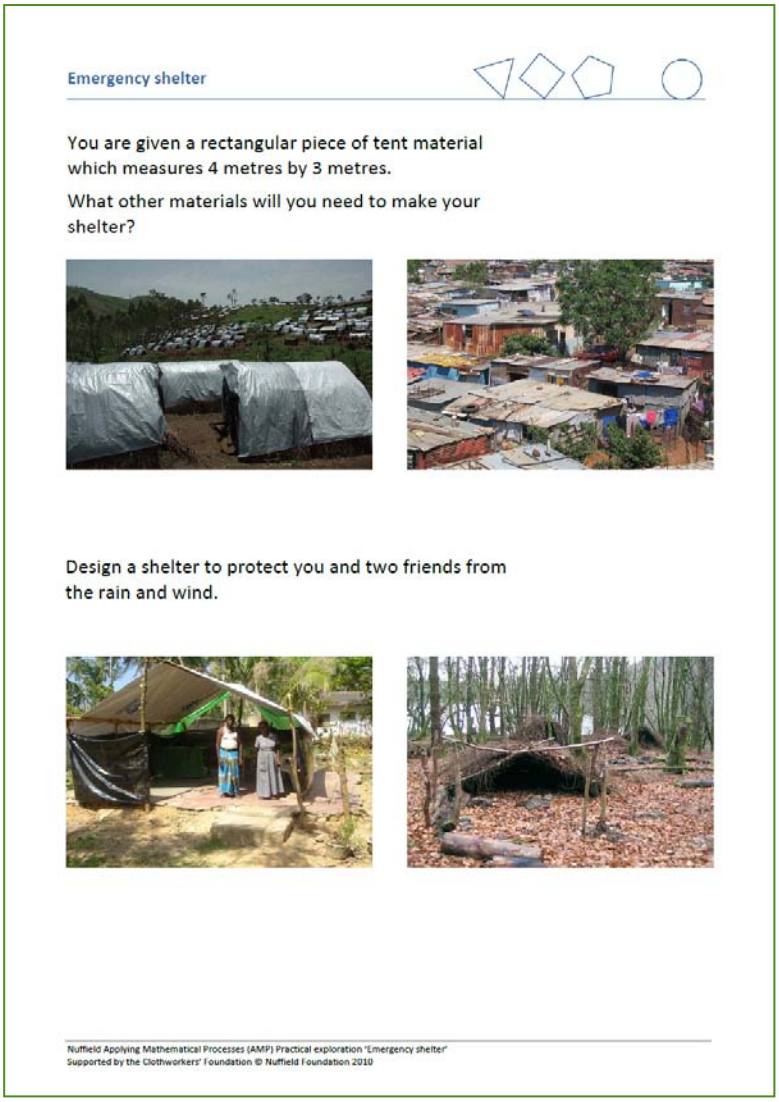
Activity description

Pupils design an emergency shelter to protect three people from the wind and rain. The shelter will be made from a rectangular piece of tent material measuring 4 metres by 3 metres, and they will need to identify any other materials required.


Emergency shelter

You are given a rectangular piece of tent material which measures 4 metres by 3 metres.

What other materials will you need to make your shelter?

Design a shelter to protect you and two friends from the rain and wind.

Nuffield Applying Mathematical Processes (AMP) Practical exploration 'Emergency shelter'
Supported by the Clothworkers' Foundation © Nuffield Foundation 2010

Suitability

Pupils working at all levels in small groups

Time

Minimum of 1 hour

AMP resources

Pupil stimulus

Equipment

Tape measure or metre rule
Squared paper
Calculator
Straws, wire, or pipe cleaners
Scissors, sticky tape, glue
Cloth (material), needles and thread

Key mathematical language

3D, area, cross-section, height, length, net, polyhedra, prism, scale drawing, shape, space, surface, volume

Key processes

Representing Recognising where mathematics can help with the design of the shelter, for example choosing and interpreting data, measuring, using scale drawing.

Analysing Finding reliable measurements to create an appropriate product; considering different possible arrangements; working accurately.

Interpreting and evaluating Considering the data and selecting appropriate data to help develop a design to meet criteria; justifying chosen design.

Communicating and reflecting Producing a clear design with appropriate measurements and explanatory commentary; consideration is given to rejected designs.

Teacher guidance

Present the task using images illustrating different approaches to shelter design. Discuss issues affecting good design, such as space per person, ability to sit and sleep, and best protection from the weather.

Organise pupils into groups, and ask them to begin to think about an effective design. Through discussion, generate statements/questions pupils see as important for their design, such as 'Does my shelter need a base?' and 'How much room do we need?' Pupils can then estimate or research measurements for their design.

Discuss and arrive at a consensus on assessment criteria for the designs, emphasising that designs must be justified mathematically.

You may like to suggest that pupils construct paper models of their designs before choosing their final design.

Consider setting a context for the activity: shelter needed for a family following a disaster, for example an earthquake, giving pupils additional information regarding terrain and other available materials.

During the activity

Remind pupils that they will have to justify their designs. They need to record their decisions, along with their reasoning, as they go.

Encourage pupils to use personal experiences and research, including looking at shelters for different situations. This can continue outside the classroom.

Set a deadline by which pupils must be ready to present and justify their work.

As a conclusion, organise group presentations. Presentations might be given to external 'experts' or the whole class. Any criteria agreed at the beginning should feature in how pupils judge one another's designs.

You may want to introduce a competitive element by saying that there will be a winning group at the end. If there is a competition, pupils should determine which design wins.

Probing questions and feedback

AMP activities are well suited to formative assessment, enabling pupils to discuss their understanding and decide how to move forward. See www.nuffieldfoundation.org/whyAMP for related reading.

- What measurements did you make/consider to inform your design?
- Discuss reasons for choice of or rejection of designs.
- How stable is your design? How will it handle emergencies?
- How can you probe disadvantages in your chosen design?

Extensions

- Given a smaller amount of cloth (material), what features would be sacrificed, and why?
- Consider the relationship between number of people and size of cloth.
- Adapt chosen design for different terrains to take advantage of 'natural' shelter or support, such as tree trunks.

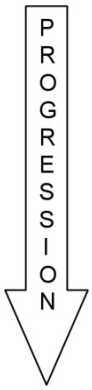
Progression table

The table below can be used for:

- sharing with pupils the aims of their work
- self- and peer-assessment
- helping pupils review their work and improve on it.

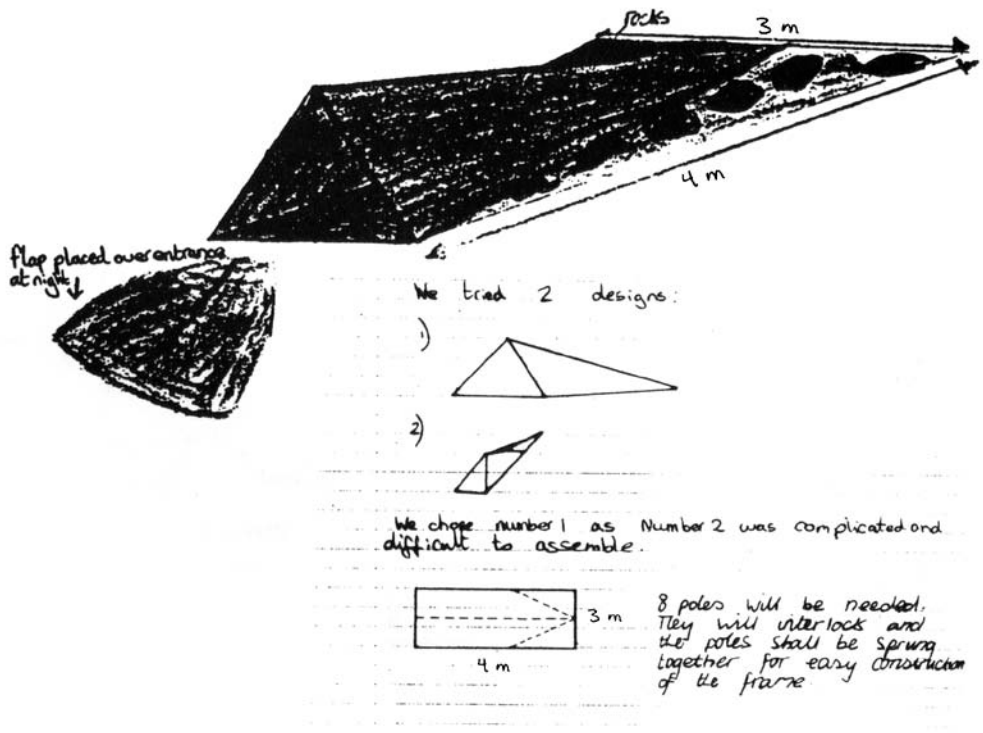
The table supports formative assessment but does not provide a procedure for summative assessment. It also does not address the rich overlap between the processes, nor the interplay of processes and activity-specific content. Please edit the table as necessary.

Representing *Selecting a mathematical approach and identifying what mathematical knowledge to use*	**Analysing** *Calculating accurately using effective strategies, and working logically towards a solution*	**Interpreting and evaluating** *Interpreting the results of calculations and justifying decisions in developing the final design*	**Communicating and reflecting** *Throughout the task, communicating reasoning and decisions clearly; presenting final design*
Generates basic measurements/designs to explore the situation Pupils A,B	Has computations for a basic design	Shows minimal evidence of comparing or interpreting results Pupil A	Produces a simple sketch of the shelter Pupil A
Considers one or more designs with minimal mathematical modelling	Attempts to identify how designs work, with simple use of dimensions shown Pupil B	Meaningfully relates designs to at least one aspect of the original problem Pupil B	Presents a simple design, with dimensions that meet the basic principles of the activity Pupil B
Considers more than one design with some appropriate mathematical aspects, such as dimensions Pupil C	Meaningful calculations for dimensions of the shelter Pupil C	Explains how designs meet some of the criteria or how different considerations are being balanced	Presents an appropriate design that meets the activity criteria, giving simple reasons for some choices Pupil C
Identifies mathematical aspects and uses mathematical information, methods and tools to help create a solution Pupil D	Uses appropriate and accurate mathematics with evidence of sensible data being used to calculate design dimensions Pupil D	Creates a design that has taken account of some desirable features; the dimensions of the final product are shown to be appropriate Pupil D	Presents an appropriate design that meets the activity criteria, with some explanation for assumptions made, the choice of features and / or dimensions Pupil D
Carefully considers the data required to create a sophisticated design, and uses a selection of mathematical information, methods and tools	Develops clear, detailed and accurate designs; shows how the cloth can be used; checks the appropriateness of solutions and conclusions	Justifies the selection of dimensions and other features of the final design	Fully describes how the design is fit for purpose, giving full account of all relevant considerations



Sample responses

Pupil A



Pupil A has produced a sketch with some relevant dimensions. The design uses the rectangular material as provided; no heed is given to selecting data, calculating dimensions, or to explaining choices made.

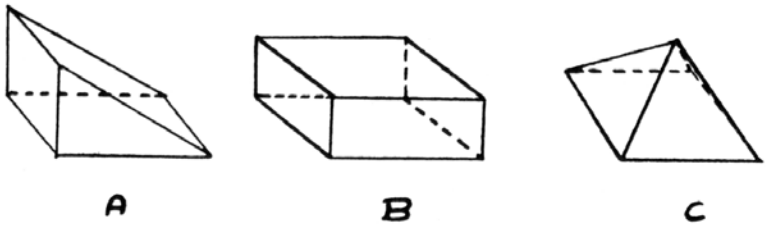
Probing questions

- How did you decide on this design?
- What shape is your design? How will it be used to keep people warm and dry?
- How big is the inside of your tent? How many people can use it at one time?
- How can you find the height of the entrance to your tent?
- Please describe your second design further and explain its drawbacks.

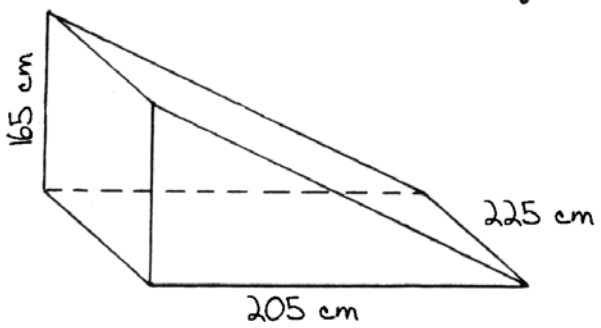
Pupil B

I picked several likely looking shapes and chose the one that :-

had the most ecomical use of material,
had a large base area big enough for three people to sleep in,
was high enough for someone to stand up in, in at least one place.



I picked 'A' as it enabled people to walk alone its length at ease.

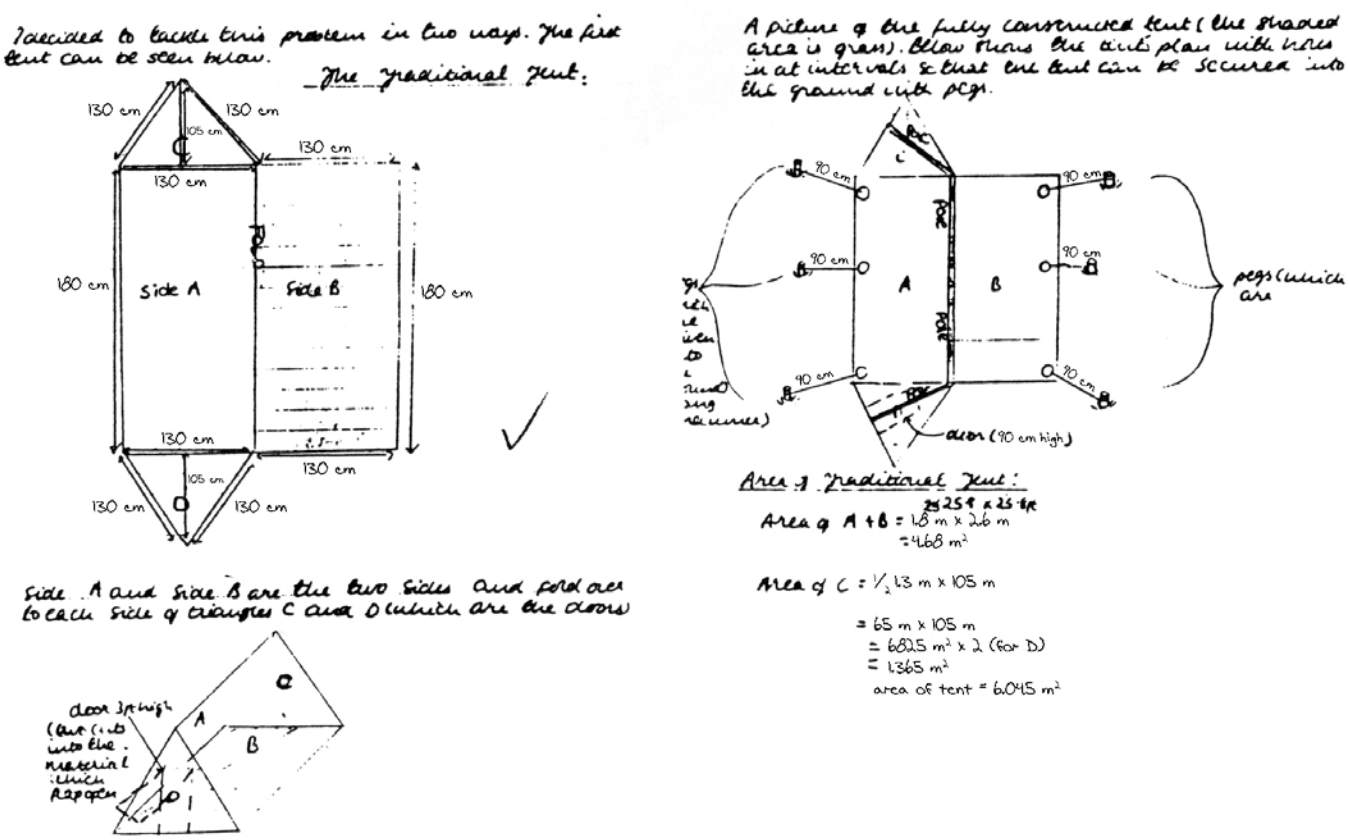


Pupil B considered and sketched several possible designs, providing simple justification for the chosen design. The chosen design has some relevant dimensions.

Probing questions

- How did you decide what shapes to choose from?
- You chose your design because it enables people to walk along its length at ease. Can you explain how you know this is possible?
- You say that your chosen design is the most economical. Explain why this is the case.
- You say that the base area is big enough for three people to sleep in. How do you know?

Pupil C

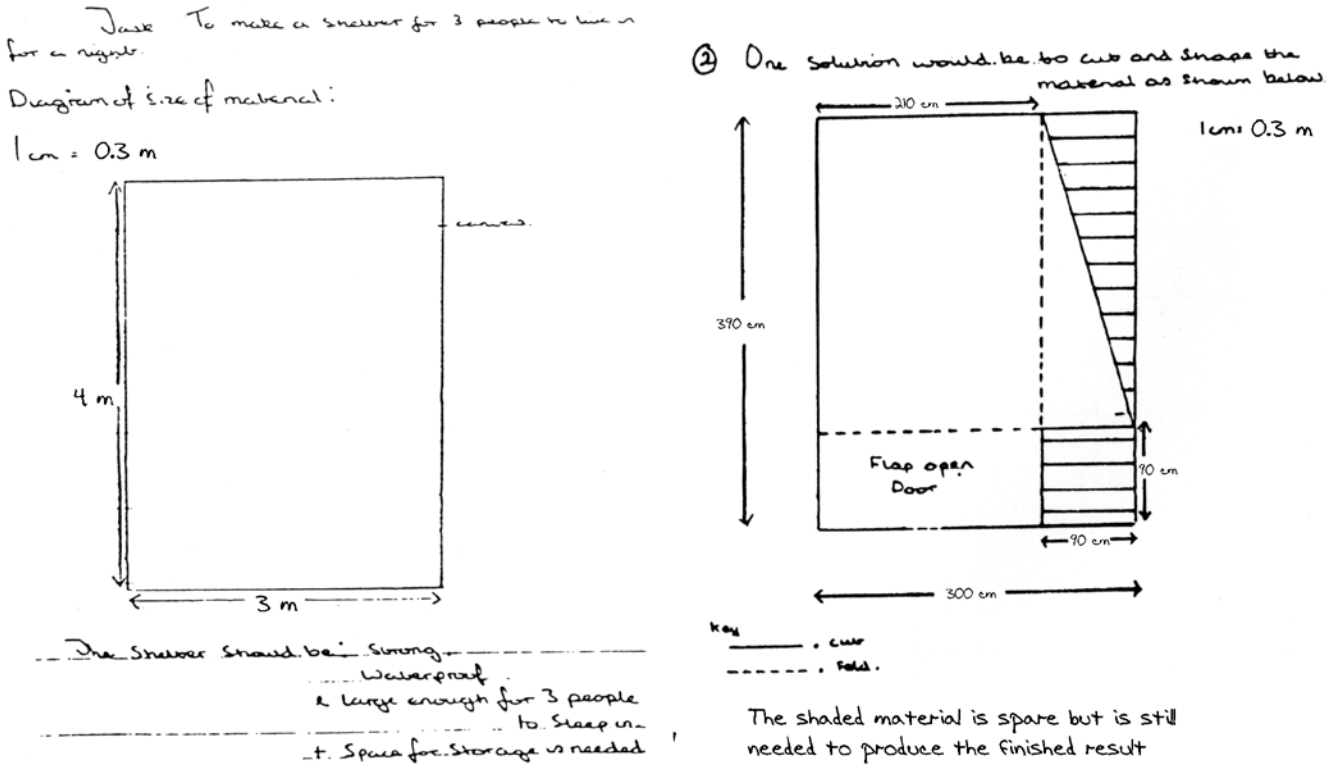


Pupil C has produced a scale drawing, including relevant dimensions, explaining how the design meets the requirements. Some relevant calculations are included.

Probing questions

- How did you find the height of your tent? Is it high enough for people to stand in?
- You have found the area of the material used. How can you be sure that this is the most economical use of the material?
- How many people can fit inside your chosen design? How do you know?

Pupil D



See more of Pupil D's work on the next page

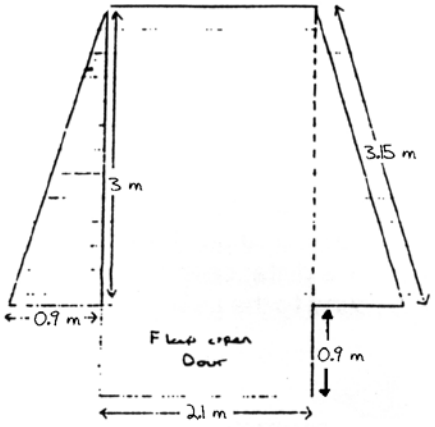
Pupil D has created a solution to the activity with explanations for each stage of the design. The scale drawing is accurate with dimensions stated. There is evidence of some data being used to determine the dimensions for the tent, showing how three people can sleep inside.

Probing questions

- Did you consider other designs? Why did you reject them? Why did you choose this one?
- How would you adapt your design for two people? What effect would this have on the space inside the tent?
- How would you cut the material for a one-person tent or for a two-person tent?
- Is it possible to create a four-person tent to sleep in with this size of material (cloth)?
- Suppose you were asked to incorporate a ground sheet in your design. How would you do this?

Pupil D *continued*

③ You should now have an end and sleeve like the one below:



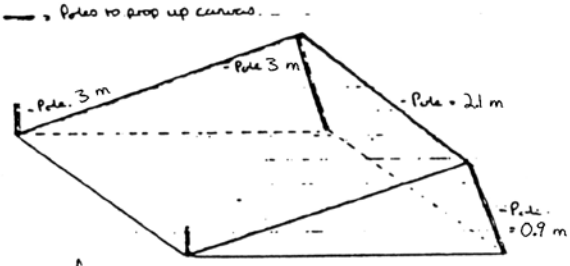
The spare canvas is placed on the opposite side to give the tent more width. It would be sewn on.

Poles would be used to prop up the tent and the positioning of these poles is shown later.

You now have an extra spare piece of canvas left measuring 3F by 3F... ⑤

This piece of material could be kept to patch up any small rips or holes that may occur.

The poles must be placed as shown below:



Features of tent.

Rain does not stay on canvas. It rolls off when the sun

The tent has a strong and steady structure.

The least amount of sewing is needed to get the required shape

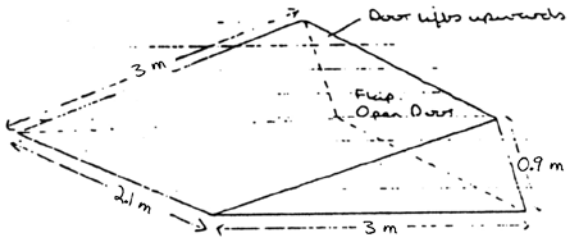
After all this is done you have a sturdy water-proof shelter for the night.

④ The diagram below shows the tent when it is propped up

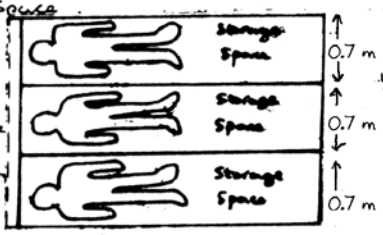
The maximum height of the tent is 0.9 m

The length = 3.15 m

The width = 2.1 m



Top view: This diagram (below) shows the sleeping space



As you can see a 6 foot person has plenty of room to sleep and store his things