

Design a table

Applying Mathematical Processes

This **practical exploration** asks pupils to design a table for a group of 5 people for daily use. The table must be extendable to accommodate 8 to 10 people for some occasions.

Suitability Pupils working in groups or pairs

Time 2–4 hours

Equipment

Tape measure

Squared paper, isometric paper

Table(s), tableware (plates, etc)

Internet access

Resources

PUPIL STIMULUS

TEACHER SUMMARY

TEACHER GUIDANCE

PROGRESSION TABLE

SAMPLE RESPONSES

Design a table

TableCraft Inc.



Industrial Rd
London SW24 8DU
UK

Dear Sir/Madam,

At Table Craft Inc. we construct tables of the highest quality. After recent market research we have decided to add a new table to our range. We have recently been informed that your group has great ability in mathematics and would therefore be ideal for the task of producing a design for this project.

The Project:

- We need designs for a cost effective family table
- It must normally be able to seat 5 people eating a family meal
- It must extend so that 8 or 10 people can eat around it on special occasions
- We must have drawings for the plan and elevation of the table including all measurements necessary for us to make the table in our factory
- You must prepare a short report showing the details of your design and explaining its main features. Parts of this will be used in our promotional materials.

We are currently in contact with several other groups to complete this project. Your report and design will be considered against those from other groups in the competition for this contract.

We look forward to seeing your design soon.

Yours sincerely,

Adam Sheraton

Mr. Adam Sheraton
Managing Director
Table Craft Incorporated

The
Clothworkers'
Foundation



 Nuffield
Foundation



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Design a table: Information sheet A

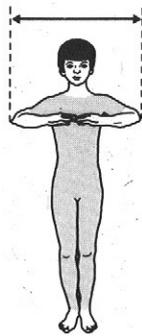
1 Shoulder breadth



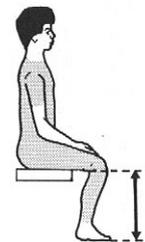
5 Thigh clearance



2 Elbow span



6 Kneeback height



3 Horizontal forward reach



7 Buttock–knee length



4 Elbow–fingertip length



8 Hip breadth





Design a table: Information sheet B

Table 1 Body measurements for adult women

Body dimension	Size in millimetres		
	5th percentile	50th percentile (median)	95th percentile
1 Shoulder breadth	370	415	460
2 Elbow span	815	890	960
3 Horizontal forward reach	665	725	785
4 elbow fingertip length	405	440	475
5 Thigh clearance	105	140	170
6 Kneeback height	380	415	450
7 Buttock knee length	520	570	620
8 Hip breadth	320	375	430

Table 2 Body measurements for adult men

Body dimension	Size in millimetres		
	5th percentile	50th percentile (median)	95th percentile
1 shoulder breadth	415	460	500
2 Elbow span	880	960	1040
3 Horizontal forward reach	715	780	850
4 Elbow fingertip length	430	470	510
5 Thigh clearance	125	150	175
6 Kneeback height	400	440	480
7 Buttock knee length	540	595	645
8 Hip breadth	315	360	400



NUFFIELD APPLYING MATHEMATICAL PROCESSES

TEACHER NOTES Design a table

Activity description

Pupils design a table for a group of 5 people for daily use. The table must be extendable to accommodate 8 to 10 people for some occasions.

Suitability Pupils working in groups or pairs

Time 2–4 hours

AMP resources Pupil stimulus, two information sheets, and slideshow

Equipment

Tape measure

Squared paper, isometric paper

Table(s), tableware (plates etc)

Internet access

Key mathematical language

length, width, area, perimeter, maximum, minimum, percentile, median, average, scale drawing, plan, elevation, isometric drawing

Key processes

Representing Recognising where mathematics can help with the table design, for example, interpreting data, measuring, using scale drawing.

Analysing Looking at the data already available, and using it in combination with their own measurements and calculations to create an appropriate product.

Interpreting and evaluating Considering how the design meets the given criteria and whether any modifications are needed.

Communicating Producing a clear design and explanatory commentary.

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Nuffield AMP Pupil stimulus 'Design a table'
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Teacher guidance

The activity can be presented using the slideshow and pupil stimulus. You may choose to use images (video/photographs/magazine articles/posters) which illustrate different approaches and issues affecting good design (such as space per person, height from the ground) though there is the chance that the images may pre-dispose pupils to certain types of design. The activity is well-suited for cross-curricular collaboration with Design & Technology.

Through discussion, pupils can generate statements and questions they see as important for designing a table, such as 'what works well for adults may not be ideal for children' or 'how much room do you need to get your legs under the table?'

Some tables of body measurement data are given on the Information sheets. These are provided as a guideline. Alternatively, you may have pupils collect body measurements for the whole class and use them and/or compare them with the information sheets.

The activity provides an opportunity to introduce or consider the meaning of median and percentiles. Consider exploring the significance of these for the activity; for example, should the table be designed for an 'average' person? For a range of persons? And if so, how wide should the range be?

If running the activity as a design competition, agree a set of criteria by which designs will be judged.

During the activity

Remind pupils that they will have to justify their design choices.

Encourage pupils to use their own personal experiences and further research. This can continue outside the classroom.

Give pupils a deadline by which they must be ready to present and justify their solutions. You may choose to organise group presentations. These might be to external 'experts', the whole class, or to a subset of the class, leading to a final. The design criteria agreed at the beginning should feature in decisions about which design wins the contract.

If feasible/appropriate, consider providing access to 3-D design software to enable pupils to develop and present their designs.

Google *Sketch Up* <http://sketchup.google.com/> is freely downloadable software that has functionality to develop and display detailed 3-D designs. There is also a virtual warehouse <http://sketchup.google.com/3dwarehouse/> with a search facility ('extendable table' brings up some relevant designs).

Education software such as *Yenka* www.yenka.com/en/Yenka_3D_Shapes/ provide more basic yet helpful interfaces. For experimenting with isometric drawing, the US National Council of Teachers of Mathematics has an



interactive isometric drawing tool as part of its free *Illuminations* resource
<http://illuminations.nctm.org/ActivityDetail.aspx?ID=125>

Probing questions and feedback

- How have you decided what data you need to help with the design?
- What are the important features of your table? Why have you designed them? Have you rejected some design ideas? Why?

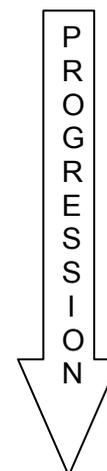
Possible extensions

- Take into account the cost of making and marketing the design, with consideration of waste wood, packing/delivery, profit margins, and so on.
- Produce an advertisement for your table.
- Write a critique for the table design of a peer.
- Design a chair to go with the table.
- Build a scale model/ working model of your design.



Progression table

Representing	Analysing	Interpreting and evaluating	Communicating and reflecting
<i>Identifying relevant mathematical aspects and knowledge that might be needed, and formulating suitable approach</i>	<i>Analysing available data, working logically, and calculating accurately to produce a solution</i>	<i>Interpreting the results of calculations and design decisions in developing the final design</i>	<i>Communicating and justifying decisions and designs clearly</i>
Simple images are used to explore the situation	Makes some attempt to identify seating positions or dimensions Pupils A, B	Presents a simple design that satisfies some of the basic criteria Pupils A, B	Produces a simple sketch of the table with some indication of seating positions or dimensions Pupil A
Uses simple forms of representation with some appropriate mathematical aspects, such as dimensions, identified Pupils A, B	Uses images with some relevant dimensions indicated Uses basic body measurement data	Uses some of the data to design a table with appropriate dimensions Relates design to the original problem, e.g. by showing how the table can accommodate different numbers of people Pupil C	Presents a simple design that meets the basic principles of the task Includes plan, elevation and dimensions Pupil B
Identifies the mathematical aspects of the task and connects them to their mathematical knowledge to design a table	Evidence of choosing relevant data to calculate dimensions Uses appropriate and accurate mathematical diagrams, e.g. plans and elevations Pupil C	Justifies choice of relevant data Considers how choice of data/dimensions affects design of table Pupil D	Presents an appropriate design that meets the task criteria with some explanation for the choice of features and dimensions Shows a clear method of table extension Pupils C, D
Carefully considers the data required to create a sophisticated design, and uses a selection of mathematical information, methods and tools Pupil D	Uses clear, detailed and accurate plans and elevations Uses accurate calculations based upon the analysis of data Pupil D	Takes full account of the relevant data Checks the appropriateness of solutions and conclusions Justifies how these led to design of table	Fully explains choice of design and the selection of all dimensions Describes issues to be considered when the table is in use



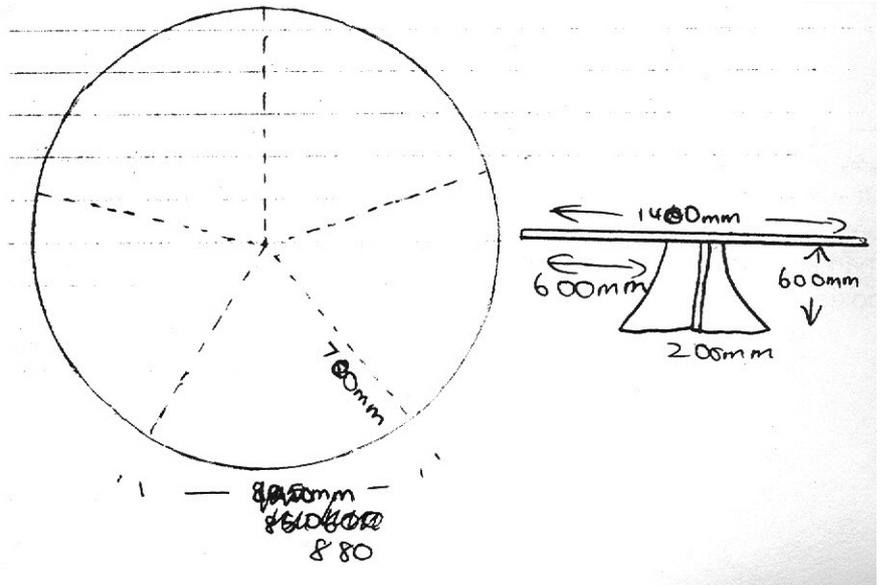
Download a Word version of this Progression Table from www.nuffieldfoundation.org/AMP



Sample responses

Pupil A

Pupil A has created a table that can easily seat 5 people, and shows main dimensions on plan and elevation views. There is no explanation for the choice of dimensions, and it is not clear how the table could accommodate 8/10 people.

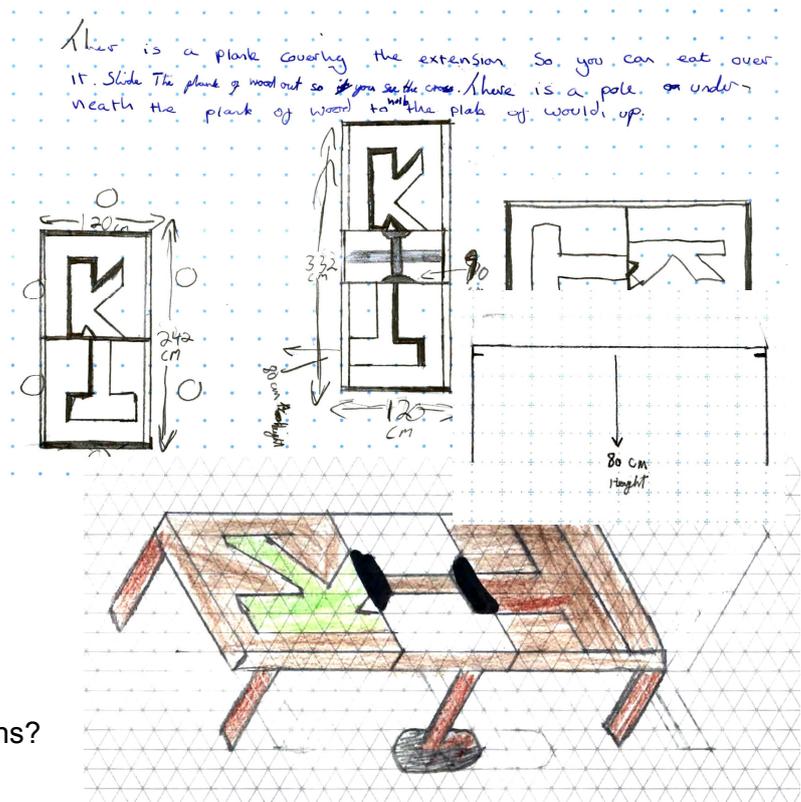


Probing questions

- How did you choose these dimensions?
- How would your table be extended to meet the requirements of the task?

Pupil B

This pupil has used plans and elevations to illustrate a solution, and has attempted an isometric drawing. There is an attempt to describe the mechanism for extending the table and the dimensions are given, although it is not clear that these have been based on the data given.

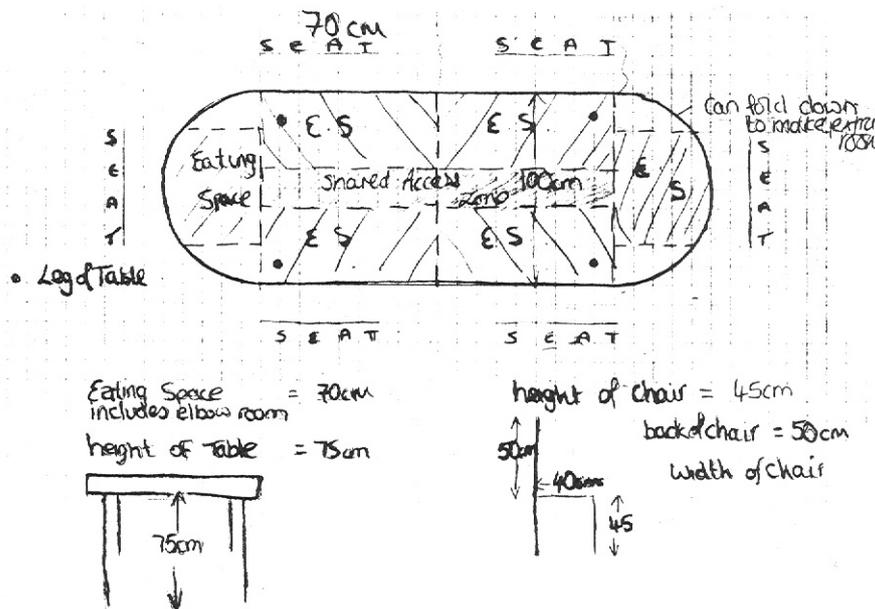


Probing questions

- Why did you select this design?
- How did you choose the dimensions?



Pupil C



When the table is pulled from both ends, it opens out. Extension can be pulled out, seats & extra people.

The semi-circles can be up or down depending on the amount of people or space you want. When they are down, the table can seat four people. When up, it will seat six. The extension is in the middle of the table and there are clasps under the table which hold it in position when it is up, with that it will seat 8 people.

This pupil has created a solution to the task, with a clear explanation as to how the table can sit the minimum and extended numbers (8). The accurate scale drawing gives the dimensions of the table top and a side elevation gives the height. There is documented evidence of some data being used to determine the dimensions for the table, which are appropriate.

Probing questions

- How did you decide on the 70cm eating space?
- How did you choose the total length of your table?
- How will you convince the manufacturer that your shape and size are the best?



Pupil D

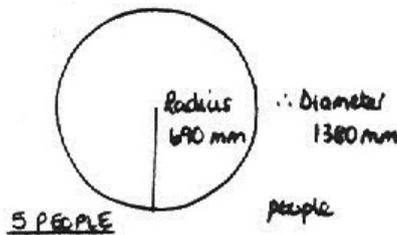
DESIGN A TABLE

	AV.M. 19-65	AV.M. 8-11	AV.M. 15-18	MEAN
Thigh clearance	150	115	150	138.33
Knee height	540	430	546	505.00
Popliteal height	440	350	440	410.00
Buttock knee length	595	450	580	541.66
Buttock popliteal height	495	370	490	481.66
Shoulder breadth	460	330	435	408.33
Hip breadth	360	250	330	313.33
Elbow span	960	720	940	873.33
Forward reach	780	565	725	690.00 *
Elbow, fingertip length	470	365	470	435.00

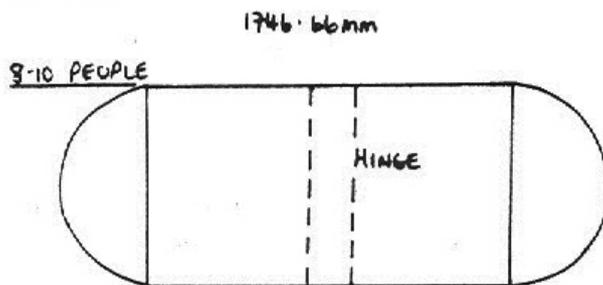
AV.M. = AVERAGE MALE, FOLLOWED BY YEAR GROUP

* Forward reach: The mean for forward reach (690 mm) seemed to be too long. I had decided to design the table for children over 8 years old because I felt that children younger than this should be eating at a different time. A forward reach of 690 mm was too far for a child, however a f. reach of 565 mm was too short, therefore an average of 600 mm was calculated approximately.

Average elbow span is 873.33 mm, \therefore this must be the very minimum span for comfort at the table. Total circumference of a table for 5 must be at least (873.33×5) 4366.65 mm for comfort.

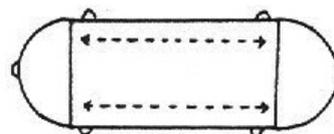
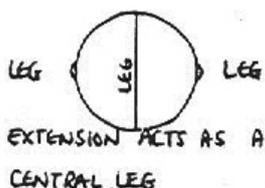


$$\begin{aligned} \text{Circumference} &= 2\pi r \\ &= 2 \times 3.14 \times 690 \text{ mm} \\ &= 4335.398 \text{ mm} \end{aligned}$$



TOTAL LENGTH WHEN EXT'D
3126.66 mm

(\therefore more comfortable when not extended)



EXTRA LEGS TO BE
CLIPPED ONTO A ROLLER
WHEN TABLE IS EXTENDED
 \therefore SUITING ANY POSITION
(COMFORT WITH CHAIRS)

See notes on pupil D's work on the next page



Pupil D (see previous page for this pupil's work)

This pupil has designed and drawn an appropriate table based upon the data given, explaining the way it extends. The dimensions and features of the table have been carefully thought about, although the pupil does not communicate how the tension between elbow span and forward reach has been resolved. The pupil's design allows for the legs to be placed in a range of positions, but it is not clear how more than 8 people can be seated around the extended table.

Probing questions

- What are the risks in using average elbow span for minimum spacing around a circular table?
- How did you decide on the figure of 1746.66mm?
- How will the people be seated around the extended table?