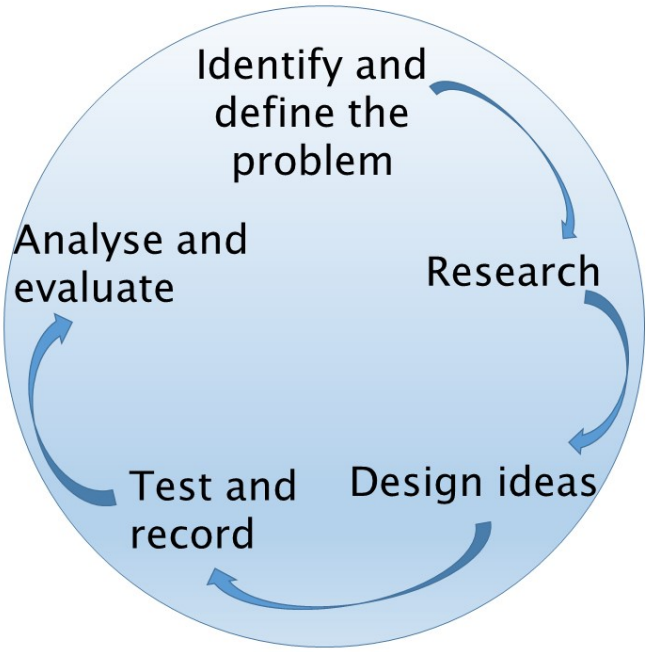
Chopping on Rock – Student Booklet

The Challenge

You are moving house and your parents have decided that they would like some new equipment for the kitchen. They would like to keep it modern and stylish, but also practical. In particular they would like a new chopping board, as they are sick of the flimsy plastic one they have been using. You have decided for their anniversary you would like to have one made for them, and have taken on the challenge of designing it yourself.



Background Information

Some of the earliest tools ever used by humans were those intended for food preparation; chopping, grinding and tenderising have always been important techniques in the kitchen. The simple chopping board, is actually anything but – and can be designed for multi-purpose use, for example a heat mat and chopping board combined. New designs are still entering the market, with developments to make them more user friendly, or convenient for storage and cleaning.

One of the most important aspects of a chopping board is that it is food safe. Chopping boards need to be able to be cleaned easily and effectively, so that they do not harbour any bacteria. It is vital that their surface is not too absorbent. This will also prevent bad smells as well as staining.

Personalised chopping boards have become very popular in the past few years, especially as house warming, wedding and anniversary gifts. Often they are made with engravings including names or dates. For "foodies" they might include words suggesting what to place where on them, such as cheese names.

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There is a wide array of materials that are used for chopping boards, and it is important that they have been tested properly to ensure that they can withstand everyday use, as well as any accidental knocks or bumps that might occur. Chopping boards need to be durable, reliable, cost effective and convenient.

Figure 1. Slate cheese platter. (Acabashi, 2017)

Background Research

1. What are possible materials for a chopping board?

_____

_____

2. What dimensions would be practical for a chopping board?

_____

3. Which materials are most sustainable?

_____

_____

4. What are the most important features and functions of a chopping board?

_____

_____

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Investigation: Density of Different Materials

Figure 2. Archimedes reportedly cried "Eureka! Eureka!" after he stepped into a bath and noticed the water level rising. He realised that the volume of water displaced must be equal to his volume. (Arlindi, 1999)

Objective

To determine the density of different materials and consider which materials are most suitable for their intended use.

Useful links: video on how to measure the volume of an irregular shape:
https://www.youtube.com/watch?v=e0geXKxeTn4

Equipment

- Range of samples – different types of wood, rock etc.
- Weighing scales
- 2 x ice cream tubs
- Tray
- Sand
- Measuring Beaker (size will depend on the size of the samples)

Method

1. Use the scales to find the mass of each sample and record it in the table provided.
2. Fill the ice cream container full of water and place it in the tray.
3. Put a sample into the ice-cream container, so that the water overflows into the tray.
4. Pour the water in the tray into the measuring beaker to determine the volume of water displaced, this is equal to the volume of the rock (1 ml = 1 cm^3) and record in the table.

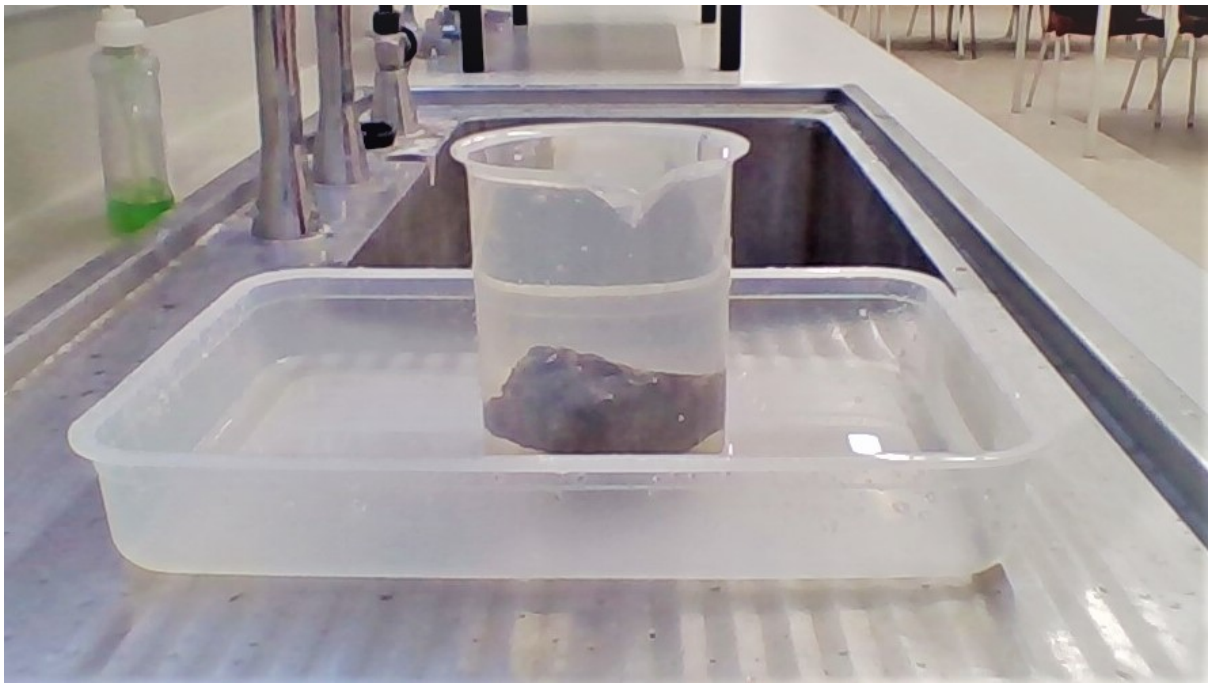

Figure 3. Determining the volume of an irregular shape by placing it in a beaker full of water and then measuring the volume of water with has been displaced into the tray below it.

Also note that if you are using small samples, you could just put them in a beaker half filled with water and measure how much the water rises when the sample is placed inside, subtracting the difference. Or if you have regular shaped samples you could find the volume mathematically.

Figure 4. If you have a smaller sample you can measure the difference in the level of water before and after a rock is placed into the beaker.

5. *If you have pumice or a sample that will float and hence not displace water:*
    - Fill an ice cream tub to the very top with sand.
    - Put the sample in another identical ice cream tub.
    - Pour the sand over the sample, shaking it gently so the sand works its way into as many interconnected pore spaces as possible, until the container is full and the rock is completely buried.
    - Measure the volume of sand that is left in the first ice-cream container by pouring it into the beaker. The volume of sand in the beaker is equal to the volume of the rock. NB – make sure that everything is kept very dry for this stage otherwise the sand will get stuck to the container and sample.

Results and Analysis

1. Create a table for your results, ensure you include units of measurement.

2. Calculate the density of the samples by dividing the mass by its volume, and add this as a new column to the table.
3. List the samples in order from lowest density to highest density.

Lowest Density						Highest density

4. Considering usual dimensions for a stone chopping board are around 40 x 22 x 1 cm calculate what the mass of a board that size would be for each sample material. Remember: **Density x Volume = mass**

Sample	Density (g/cm^3)	Volume (cm^3)	Mass (g)	Mass (kg)

5. Will any of the boards be too heavy they become impractical, if so which ones?

_____

_____

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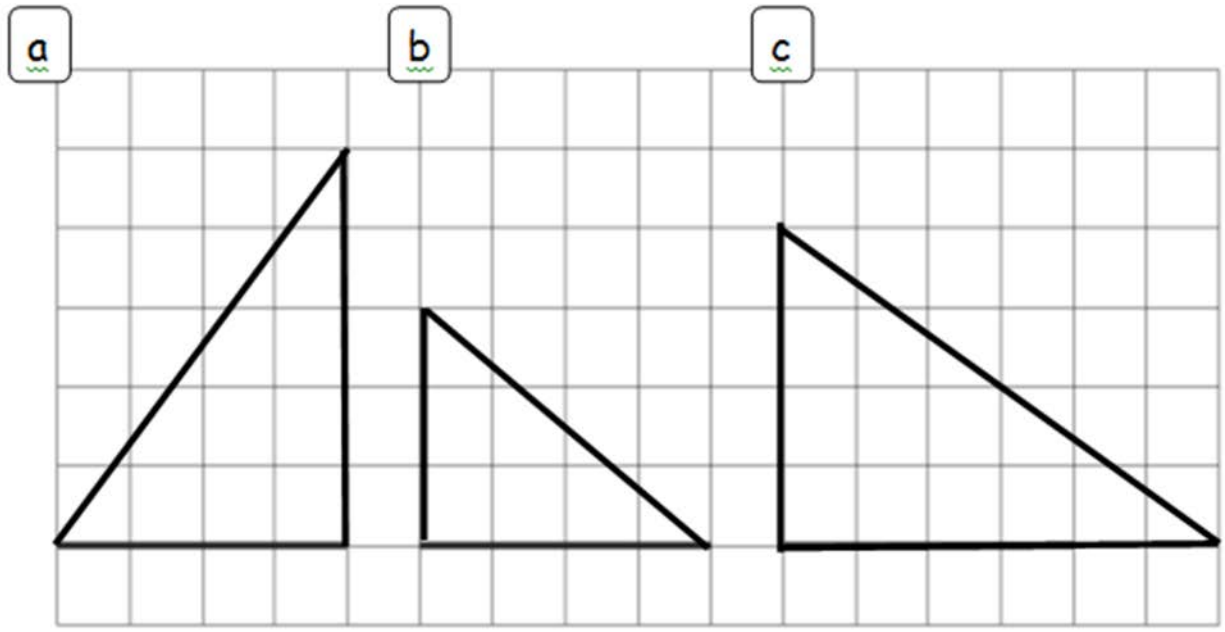
Investigation: Shaking Up the Style

A rectangular chopping board might be a bit boring, how about making your chopping board a different shape?

1. A triangular chopping board could look good, especially if used for cheese. What is the formula for the volume of a triangular prism?'

_____

2. Calculate the volume of the following chopping boards, if each square represents 10 cm and they are 3 cm deep? (show working)



A	
B	
C	

3. Calculate the mass of each chopping board, using different rock types :

	Slate (2.8 g/cm^3)	Granite (2.7 g/cm^3)	Marble (2.5 g/cm^3)
A			
B			
C			

Work out the area of the following shapes: Area □= L x W Area △ = ½ B x H

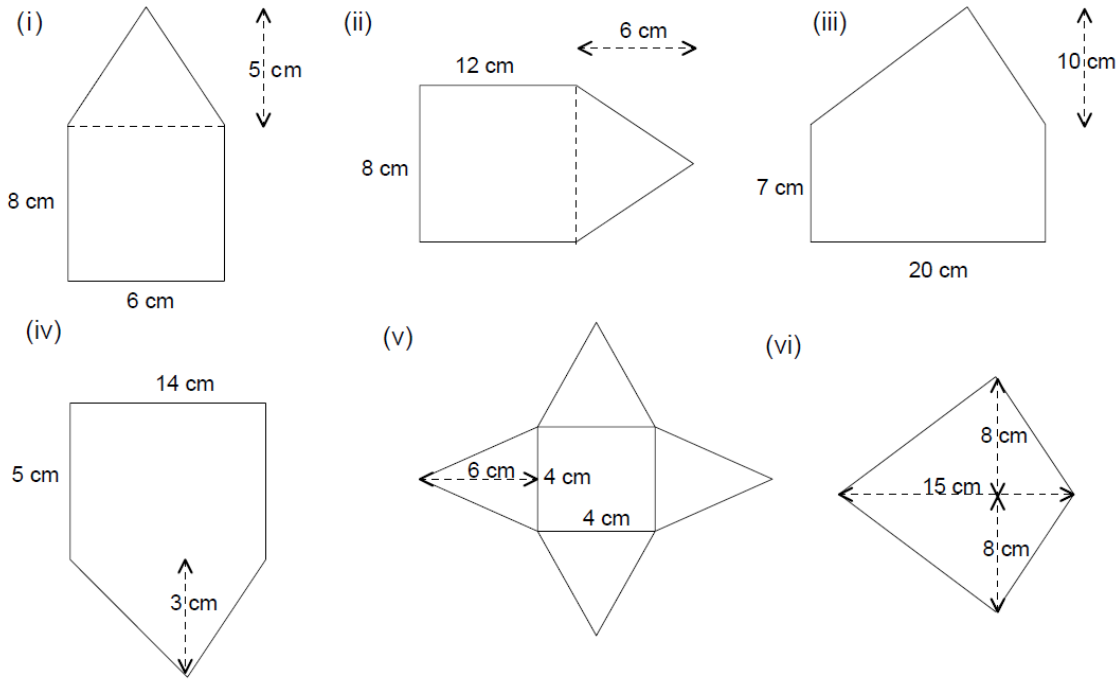


Figure 5. Compound shapes (Nuoba, 2018)

I	
II	
III	
IV	
V	
vi	

4. Are any of the shapes too large/ small to be practical?

_____

5. It has become very fashionable to have round chopping boards, as they look stylish in the center of a table.

   a. What is the formula for the area of a circle?

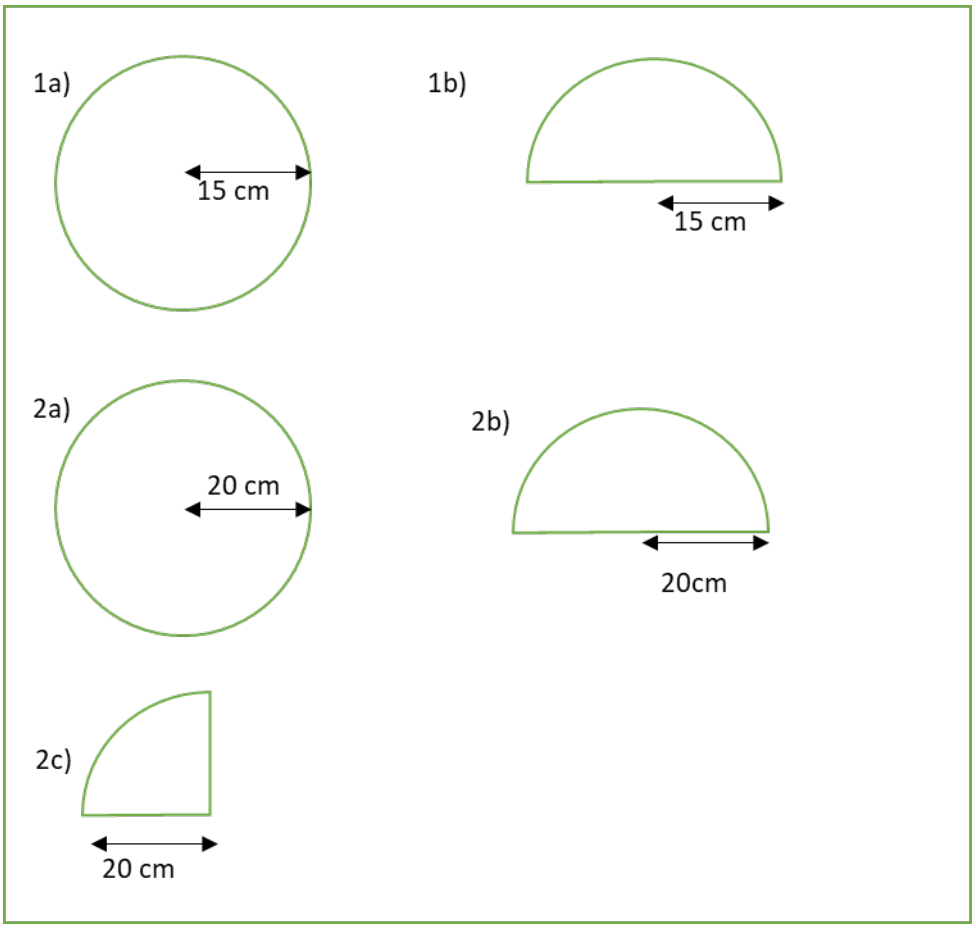
_____

   b. What is the formula for the circumference of a circle?

_____

6. Calculate the circumference and area for the shapes on the next page (show working):

Shape	Circumference (cm)	Area (cm^2)
1a		
1b		
2a		
2b		
2c		



7. Find the volume and mass of each shape from question 6 if they are 2 cm thick and made of marble – using the density of marble given in question 3. (Show working).

Shape	Volume (cm^3)	Mass (g/cm^3)
1a		
1b		

2a		
2b		
2c		

8. Which shape and material do you think would be best for your chopping board design? Explain why and give suggested dimensions.

_____

_____

_____

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Investigation: Durability of Materials

Figure 6. Testing the durability of materials for knocks and blows needn't be this hard! (Wikipedia, 2016)

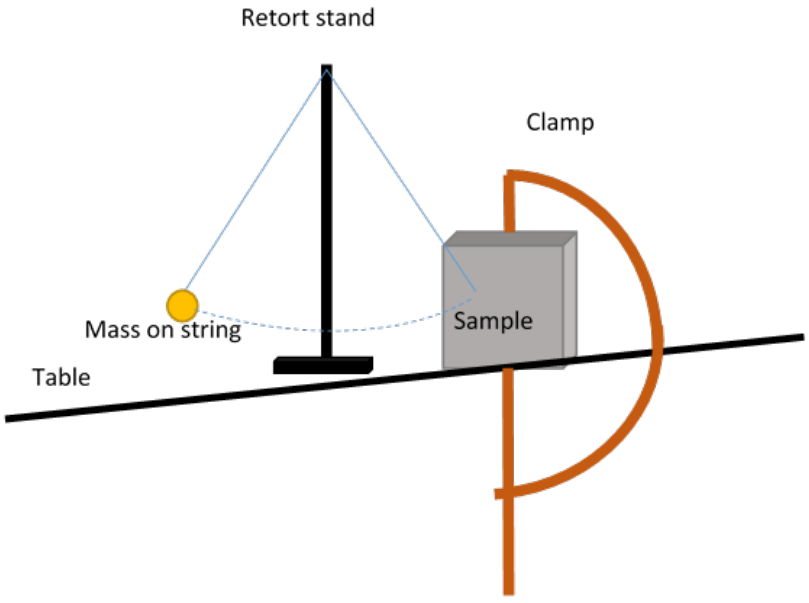
Objective

Investigate the durability of different materials, and determine which materials will be most suitable for use as a chopping board.

Equipment

- Samples of possible materials to make a chopping board from (around 5 x 5 x 2 cm)
- A clamp
- A retort stand and books
- Mass on a string
- Meter rule
- Safety glasses
- Camera

Method



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1. Take a photo of your samples.
2. Clamp a sample to the table so that it is upright on the narrow edge.
3. Connect the mass on a string to the retort stand, and secure the retort stand with books (or even a second clamp) so that it will not topple over.
4. Adjust the height and location of the retort stand so that when the mass on a string is brought back and released it will hit the sample.
5. Put on your safety glasses
6. Pull the mass back so that it is a set height off the table, record this height, and ensure you always pull it back to the same height each time.
7. Release the mass, allowing it to hit the sample.
8. Repeat steps 5 and 6 a set number of times.
9. Repeat the experiment for all the samples, ensuring you keep the height of the mass on the string the same and the number of times you hit the sample the same.

Results and Analysis

1. Were there any materials which did not stand up to the test?

_____

2. Did any materials complete the test unaltered?

_____

3. Which materials will be most suitable for the intended design in relation to durability?

_____

4. Add photos below to show the samples before and after the test.

5. Do you have any suggestions for improvement, or could you do a similar test a different way?

_____

_____

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Investigation: Reactivity of Materials

Objective

To test the reactivity of different materials with everyday household cleaning products which it may be subjected to when used as a chopping board.

Equipment

- Multiple small samples of each material (number will depend on how many solutions you wish to test)
- 200 ml beakers for each sample.
- Dilute acid and alkali solutions, with similar strength to everyday household liquids such as water, lemon juice, vinegar and cleaning product.
- Camera (optional)

Method

1. Take photos of the samples (optional).
2. Measure 100 ml of each solution for each sample in the beakers and label the beakers.
3. Place a sample into each of the different solutions and record any observations.
4. Leave overnight and make observations again.
5. Take photos of the samples (optional).

Results and Analysis

1. Create a table to present results/ observations, if you have taken photos to show changes add these.

2. Which samples changed/ reacted and what did they react to?

_____

_____

_____

_____

3. Can you think of any means of stopping the reaction, for example coatings?

_____

_____

_____

_____

You may wish to redo this experiment with varnish/ coatings applied to the surfaces – remember the intended purpose and that all varnishes used must be safe for that purpose.

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Porosity and Permeability

Objective

To determine which materials are permeable to assess their suitability for chopping boards.

Equipment

- Selection of different samples with similar dimensions
- Tray
- Pipette
- Cup of water

Method

1. Place a sample in the tray
2. Suck up water into the pipette from the cup
3. Add 5 drops of water onto the surface of the sample and note if the water runs off or "dissolves" into the sample.
4. If the water has entered the sample, touch the bottom of the sample and feel if it is damp. If not continue adding drops of water and count how many drops it takes before the water passes through. NB: if the water has just run off the sample, it may get wet underneath from the water pooling under it, therefore this does not mean it has allowed the water to pass through. *If you find that the material allows some water to enter, but then after a few more drops it starts to run off this means the rock is porous but not very permeable*.

Results and Analysis

1. Present your results in a table – adding photos if possible.

2. Which material was the most permeable?

_____

3. Which material was the least permeable?

_____

4. Were any of the samples porous (had holes in them) but not permeable?

_____

5. Which materials would not be suitable for the required purpose? Explain your answer using your results to justify your decision.

_____

_____

_____

6. How could you improve this experiment?

_____

_____

_____

_____

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_____

You may wish to redo this experiment with varnish/ coatings applied to the surfaces – remember the intended purpose and that all varnishes used must be food safe.

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Testing for Bacteria

Objective

To test a range of materials to see which ones host bacteria, even after they have been cleaned, to determine which might be best to use for a chopping board.

Equipment

- Range of samples of chopping board materials, e.g. granite, marble, slate etc.
- Cleaning product
- Agar plate for each sample with lid
- Cotton bud/ swab
- Sticky tape
- Marker pen
- Microscope (optional)

Method

1. Wash all the samples the same way, using the same cleaning product and rinse well.
2. Leave overnight to dry, and longer if possible in a warm area (a windowsill will be ideal).
3. Use a fresh cotton bud to swab a sample and gently brush the bud on the agar plate.
4. Close the lid of the plate and stick down tight with tape. **These should not be re-opened**
5. Label the agar plate with the sample type and your group name.
6. Repeat steps 3 – 5 for each sample.
7. Leave for a few days, in a warm place or incubator, and then make observations (under the microscope if possible).

Results and Analysis

1. Did any bacteria grow on the agar plates? If so which samples did it grow from?

_____

_____

2. Which sample had the largest colonies of bacteria?

_____

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3. Which sample had the largest variety of bacteria?

_____

4. Are any of the samples unsafe for using for a chopping board, why?

_____

_____

5. Was your test fair? Explain your answer.

_____

_____

6. Using your knowledge of bacteria growth explain why it was suggested that the samples were put in a warm area before you swabbed them?

_____

_____

_____

_____

7. Explain any suggestions for improvement to the test.

_____

_____

_____

_____

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Cost Analysis

Objective

The price of materials will always affect a designer's decision on what material to use for a design. Your job is to investigate the price of different materials to determine how much it will cost to make your chopping board – you may find that it is best value to buy a large volume and make a few boards with the aim of selling the extras.

Method

1. Create a table which will allow you to input calculations and data (Excel will do calculations for you).
2. Decide on the ideal dimensions you will use for your product.
3. Research different merchants to find at least 3 quotes for the price of the materials, ensure you note where you got each quote from.
4. Consider the size that you can buy the material in – will it need to be cut down? If so will there be lots of waste, or would it even be possible to make a few?
5. Will you have to varnish the product, if so how many times? How much varnish will you use, and how much will that cost?
6. How much time will it take to make the product roughly? Consider that a tougher material may take more time to cut. Adding layers of varnish will also add time. How much is your time worth?
7. Will you have to buy new tools to make the product? If so what is the cost of the tools?
8. If you are intending to make a few you should research how much you can sell them for and determine if you will make any profit, taking into account the extra time required.

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Designing and Planning the Product

Objective

To create different design ideas to decide on the most suitable design for the intention. To make a clear and safe plan of how the product will be made.

Method

1. Carry out some background research into products that have already been made, creating a document with images of those which fit into the design brief and highlight the features which make them appropriate.
2. Create 3D scale drawings of different design ideas, highlighting the features which make them appropriate for the design brief, use SketchUp or CAD for this, if possible.
3. Write a plan of how you could make your chosen design, ensuring you have completed a risk assessment.

Equipment and tools needed:

Method/ Steps:

Risk assessment

Hazard	**Risk**	**Prevention**
Spilling varnish	Could damage clothing, and surfaces, may stain skin	Use care, and cover surfaces. Wear an apron and roll up sleeves. Ensure lid is put straight back onto bottle after use

		Clean spillages straight away and dispose of tissues safely.