

# Wardrobe

## Teaching Notes

This task focuses on the mathematics of assembling a piece of flatpack furniture.

### Task A: Diagonals

#### Outline

Students consider the thinking and planning that needs to be made before assembling a wardrobe. They are presented with facts about a wardrobe and a room and, by calculating, work out how best to start the assembly.

You will need:

- Teachers' script
- PowerPoint
- Question sheet
- The room
- A useful diagram (optional)
- Task A Markscheme

### Task B: Nails

#### Outline

Students are faced with a seemingly straightforward problem that is not as obvious as it first appears.

You will need:

- Question sheet
- Task B Markscheme

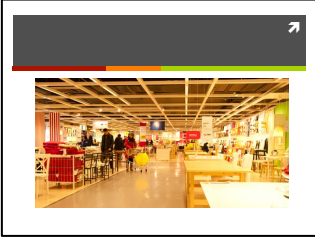
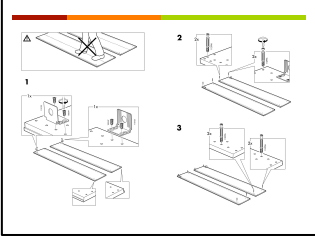
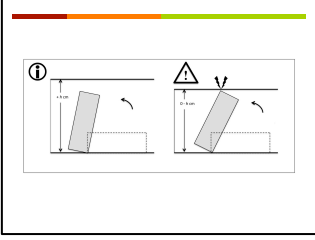
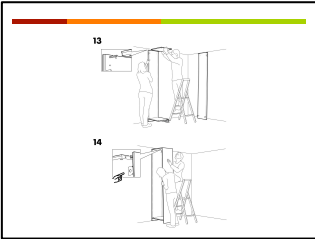
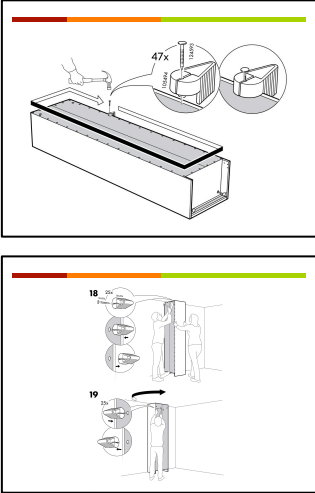
### Task A: Teachers' script for PowerPoint presentation

The text in the right-hand boxes provides a possible script to be read to students. However, it is probably preferable to use your own words and elaboration. When questions are asked, time for discussion in pairs/groups should be provided. Ensure that students are given opportunity to explain their reasoning in response to these questions. All students need to understand the concepts in order to make progress with the task.

Slide 1



*Keep this slide on the screen until you are ready to start the presentation.*

Slide 2		<p>Many of you will have flatpack furniture in your home. What does 'flatpack furniture' actually mean?</p> <p>What items of flatpack furniture do you have in your home?</p> <p>Has anyone helped build flatpack furniture? What did you build?</p>
Slide 3		<p>The instructions for flatpack furniture often look like the picture here. There are very few words, and many diagrams to interpret.</p>
Slide 4		<p>This diagram is from the instructions for constructing a wardrobe.</p> <p>It is easiest to build the wardrobe on the floor and then tilt it into position. However, the maximum height of the wardrobe during the tilt is greater than the actual height of the wardrobe. Can you see why?</p> <p><i>(The relevant diagonal is the hypotenuse of a right angled triangle)</i></p> <p>The wardrobe is 205 centimetres high and 36 centimetres deep. What number should replace the 'h'?</p> <p><i>(The length of the hypotenuse of the relevant triangle is 208.1... cm. It is necessary to round up in this context, so <math>h = 209</math>)</i></p>
Slide 5		<p>If there is not space to tilt the wardrobe then it has to be built in position, as shown here.</p>
Slides 6 & 7		<p>The final step in building this wardrobe is to nail a board to the back. This is much easier if the wardrobe is assembled on the floor first.</p> <p><i>Advance to slide 7 to compare</i></p>

## Task A: Diagonals

Lisa has bought a wardrobe for a bedroom.

The wardrobe measures 206 cm tall, 100 cm wide and 36 cm deep.

The wardrobe will be placed in an attic room with an unusual shape. A diagram of the bedroom is shown on the next page. There is an exposed wooden beam on the sloping ceiling.

The wardrobe will be positioned on the rectangular wall that measures 230 cm by 245 cm.

The second diagram on the next page shows the cross-section of the bedroom with the wardrobe in its final position.

Your task is to work out if Lisa can build the wardrobe on the floor and tilt it into position.

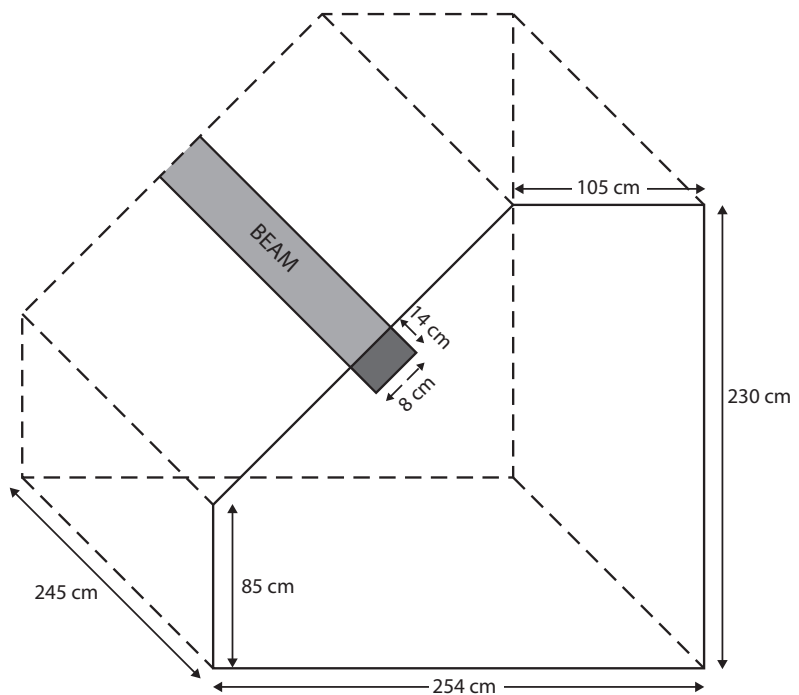
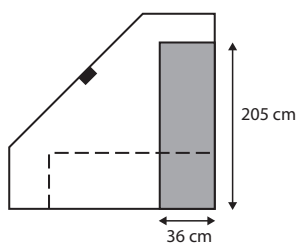
You should use diagrams and calculations to justify your decision.

*HINT: Create a diagram of the cross-section of the room.*

### Remember

The diagonal of the 36 cm by 205 cm rectangle is 209 cm when rounded up to the next whole number.

### The Room

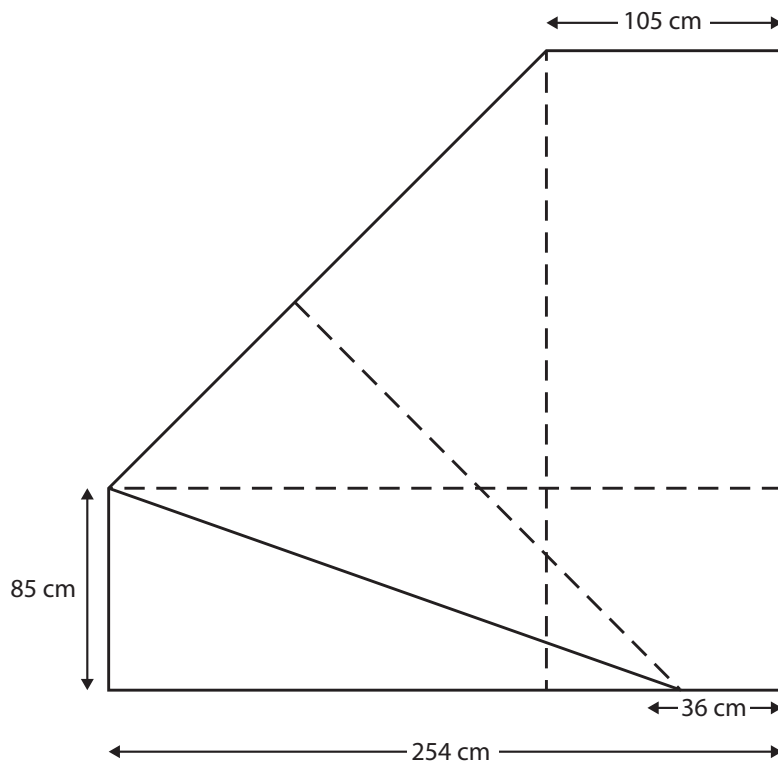


The beam is 102 cm from the lower edge of the sloping ceiling.

### A useful diagram

Some students may find this diagram useful.

Diagram not to scale.



### Task A: Markscheme

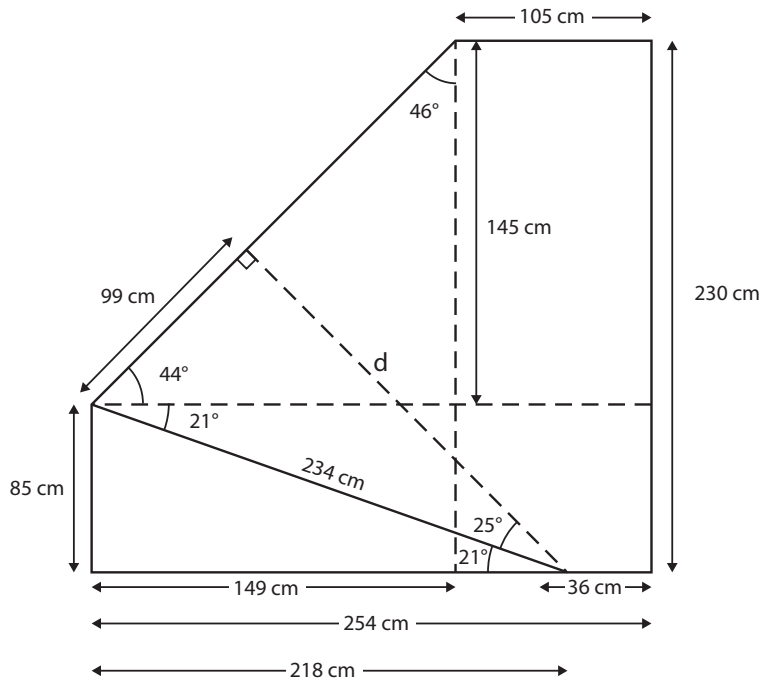
The information below is intended as a guide only

#### Full credit

Justifies a decision that the wardrobe cannot be tilted into position directly on the 100 cm edge because the beam is in the way.

For example, the diagram below can be built by:

- Finding the lengths 145 cm and 149 cm
- Using trigonometry to find the  $44^\circ$  and  $46^\circ$  angles
- Finding the 218 cm length
- Using trigonometry to find the  $21^\circ$  angle
- Using observation of alternate angles to find another  $21^\circ$  angle
- Using the angle sum of a triangle to find the  $25^\circ$  angle
- Using Pythagoras' theorem to find the 234 cm length
- Using trigonometry to find the 99 cm length
- Using Pythagoras' theorem to establish that  $d = 212$  cm
- Realising that there would be 3 cm to spare if the beam were not there, but the beam prevents the tilt being possible.



Note that it is not possible to tilt on the 36 cm edge either.

OR

Creates a scale diagram and solves the problem by constructing the locus of all points 209 cm from the centre of rotation on the diagram above.

Note that the tolerances are small in this situation and a scale diagram would have to be very accurate.

### Partial credit

Uses **A useful diagram** to get started on the problem and establishes a solution as outlined above.

OR

Forgets that the beam is present and concludes that it is possible using an approach as outlined above.

OR

Uses an approach such as the one above with no more than two errors in logic or calculation.

### Limited credit

Shows at least four of the following:

- A diagram of the cross-section of the room with additional relevant lengths and angles

Using the diagram in **full credit**

- Finding the lengths 145 cm and 149 cm
- Using trigonometry to find the  $44^\circ$  and  $46^\circ$  angles
- Finding the 218 cm length
- Using trigonometry to find the  $21^\circ$  angle
- Using observation of alternate angles to find another  $21^\circ$  angle
- Using the angle sum of a triangle to find the  $25^\circ$  angle

- Using Pythagoras' theorem to find the 234 cm length
- Using trigonometry to find the 99 cm length
- Using Pythagoras' theorem to establish that  $d = 212$  cm
- Realising that there would be 3 cm to spare if the beam were not there, but the beam prevents the tilt being possible
- Finds the length of a relevant diagonal of the wardrobe as 228 cm
- Attempts to create a scale diagram and sketch the locus of points traced by the corner of the wardrobe.

**No credit**

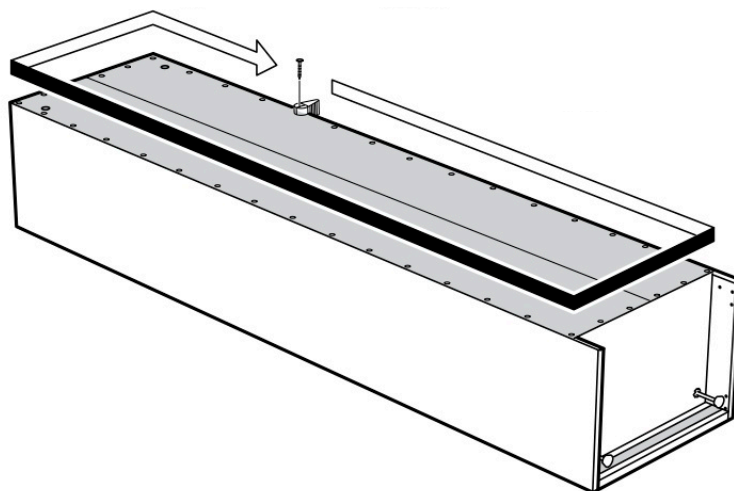
Any other response

**Task B: Question**

The back-board of the wardrobe measures 100 cm by 200 cm.

It is to be fitted to the frame with 48 evenly spaced nails.

How many nails should be fixed along the longest side? What size of gap should be left between them?



**Task B: Markscheme**

The information below is intended as a guide only.

**Full credit**

Fully justifies a solution of 17 nails along the long side (and 9 nails along the short side), leaving a gap of 12.5 cm between nails

**Partial credit**

States a solution of 17 nails with some justification

**Limited credit**

Provides a solution of 17 with no justification

OR

States a gap of 12.5 cm

**No credit**

Any other response

GCSE Content	
GCSE Mathematics – Numeracy and GCSE Mathematics	GCSE Mathematics only
<p><b>Understanding number relationships and methods of calculation</b></p> <ul style="list-style-type: none"> <li>Using the facilities of a calculator, including the <u>constant function, memory and brackets</u>, to plan a calculation and evaluate expressions;</li> <li>Knowing how a calculator orders its operations;</li> <li><u>Using appropriate trigonometric functions on a calculator.</u></li> </ul>	
<p><b>Solving numerical problems</b></p> <ul style="list-style-type: none"> <li>Giving solutions in the context of a problem, <u>selecting an appropriate degree of accuracy</u>, interpreting the display on a calculator, and <u>recognising limitations on the accuracy of data and measurements</u>;</li> <li><u>Rounding an answer to a reasonable degree of accuracy in the light of the context</u>;</li> <li>Interpreting the display on a calculator;</li> <li>Knowing whether to round up or down as appropriate.</li> </ul>	
<p><b>Understanding and using properties of shape</b></p> <ul style="list-style-type: none"> <li>Using and drawing 2-D representations of 3-D shapes, including the use of isometric paper;</li> <li>Accurate use of ruler, pair of compasses and protractor (Lengths accurate to 2mm and angles accurate to 2°);</li> <li>Constructing 2-D shapes from given information and <u>drawing plans and elevations of any 3-D solid</u>;</li> <li><u>Using Pythagoras’ theorem in 2-D and 3-D, including reverse problems</u>;</li> <li><u>Using trigonometric relationships in right-angled triangles to solve problems, including those involving bearings and angles of elevation and depression. Calculating a side or an angle of a right-angled triangle in 2-D and 3-D.</u></li> </ul>	<ul style="list-style-type: none"> <li>Use of ruler and pair of compasses to do constructions.</li> </ul>
<p><b>Understanding and using properties of position, movement and transformation</b></p> <ul style="list-style-type: none"> <li>Interpretation and construction of scale drawings;</li> <li><u>Constructing the locus of a point which moves such that it satisfies certain conditions, for example,</u> (i) <u>a given distance from a fixed point or line,</u> (ii) <u>equidistant from two fixed points or lines,</u></li> <li><u>Solving problems involving intersecting loci in two dimensions.</u></li> </ul>	

**Key**

Foundation tier content is in standard text.

Intermediate tier content that is in addition to foundation tier content is in underlined text.

Higher tier content that is in addition to intermediate tier content is in **bold text**.

**Progression in reasoning**

<p><b>Identify processes and connections</b></p> <ul style="list-style-type: none"> <li>Select, trial and evaluate a variety of possible approaches and break complex problems into a series of tasks</li> </ul>	<p>Start with an approach; e.g. creates a scale diagram</p>	<p>Identify some steps towards achieving a solution; e.g. recognises the need to identify right-angled triangles within the diagram of the cross-section of the room</p>	<p>Identify a sequence of steps towards achieving a solution; e.g. repeatedly applies trigonometry and Pythagoras' theorem to identified right-angled triangles</p>
<p><b>Represent and communicate</b></p> <ul style="list-style-type: none"> <li>Explain results and procedures precisely using appropriate mathematical language</li> </ul>	<p>Explanations are clear – both orally and in writing, using some mathematical vocabulary; scale diagram is labeled clearly</p>	<p>A wider range of appropriate mathematical vocabulary is used in explanations. Arguments are supported with evidence; e.g. trigonometric equations are set up and solved logically</p>	<p>Orally and in writing: use mathematical vocabulary precisely; e.g. completes a correct chain of logical reasoning using correct vocabulary and geometric notation</p>
<p><b>Review</b></p> <ul style="list-style-type: none"> <li><b>Explain and justify strategies, methods, reasoning and conclusions in a variety of different ways</b></li> </ul>	<p>Explains which line in the diagram represents the diagonal of the side of the wardrobe</p>	<p>Justifies the position of the line in the diagram representing the diagonal of the side of the wardrobe</p>	<p>e.g. justifies a correct chain of logical reasoning based on angle facts, trigonometry and Pythagoras' theorem</p>