

SS6 • Representing 3D shapes

Mathematical goals

To enable learners to:

- interpret 2D representations of 3D shapes;
- analyse 3D shapes using plans, elevations, and isometric drawings;
- develop their reasoning ability in spatial contexts.

Starting points

Many learners may have met these ideas before, but they may still experience difficulties in this area. In this session, learners match cards showing 3D drawings of 'cube houses' with plans and elevations. They are then provided with an opportunity to create their own cube houses and draw their plans, elevations and isometric representations.

This session is much enhanced if the accompanying software *Building houses* is used. This is a computer program produced by the Freudenthal Institute for secondary education in Holland. It is available on the DVD-ROM and, along with many other useful programs, is on the website www.fi.uu.nl/

Materials required

- OHT 1 – *Plans and elevations*;
- OHT 2 – *Isometric drawing*.

For each small group of learners you will need:

- Card set A – *Perspectives*;
- Card set B – *Plans and elevations*;
- Card set C – *Isometric drawings*;
- squared and triangular grid and isometric graph paper;
- a supply of interlocking cubes (optional, but very helpful).

During discussions with learners, it is helpful if you have overhead projector transparencies of the cards as well as OHTs 1 and 2.

Time needed

Learners usually need between 1 and 2 hours but this depends on how many of the problems in the software are used.

For learners aiming at lower level qualifications, a supply of interlocking cubes is particularly helpful.

Suggested approach **Beginning the session**

Provide each learner with a sheet of squared grid paper. Place OHT 1 – *Plans and elevations* on the projector, hiding the plans and elevations. Explain that what learners can see is a perspective drawing of a model of a 'cube house'. Ask learners to draw, on squared grid paper, what they think the house looks like from above (its plan), from the front looking in the direction of the arrow (its front elevation), and from the right hand side (its right side elevation). Collect and discuss their suggestions before revealing the plans and elevations on the OHT. There may be more than one correct answer.

Alternatively, use a data projector and the computer program *Building Houses 1* to do this (see page SS6-4 – *Using the computer software (1)*). This has the advantage that the building can be turned round gradually so that learners can see all sides.

Working in groups

Ask learners to sit in pairs (or threes) and give each group Card set A – *Perspectives* and Card set B – *Plans and elevations*.

Ask learners to take it in turns to match each *Perspective* card with the correct *Plan and elevation* card. As they do this, they should explain to their partner(s) why they have matched the cards in that way. When they have given their explanation, their partner(s) should either challenge what they have said or say why they agree.

When learners have done this, ask them to sketch, on *Perspective* card F, a cube house that matches the remaining three *Plan and elevation* cards. Alternatively, they might make a model of the missing cube house using interlocking cubes. Learners who find this easy may be challenged to try to find more than one solution.

When learners are comfortable with their final results, ask them to compare the positions of their cards with those of another group. Ask learners to reconcile any differences that emerge.

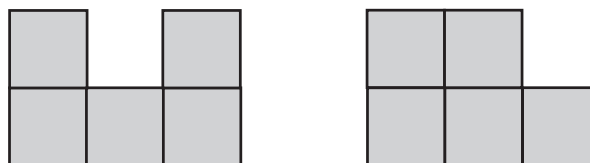
When a group has finished these activities, ask them to make their own cube house, using up to twenty interlocking cubes. They should then draw its plan and elevations on squared paper. These drawings should then be given to another group who should try to draw the 3D cube house.

You may also wish to introduce the convention of isometric drawings of 3D shapes by showing OHT 2 – *Isometric drawings*. This shows *Perspective* card F together with *Isometric* card L. Explain how this shows how cubes can be hidden in the isometric view.

Give out Card set C – *Isometric drawings*. Learners can try to match *Isometric* cards G–L with *Perspective* cards A–F.

Reviewing and extending learning

Follow up the learning by posing some open problems, using plans and elevations, e.g.



Here is a front and side elevation.

- Draw me a possible plan view.
- Draw me an impossible plan view.
- What is the greatest possible number of cubes that can be in the house?
- What is the least possible number?

Further ideas

This activity uses multiple representations to deepen learners' spatial sense. This type of activity may be used in any topic where a range of representations is used. Examples in this pack include:

A1 Interpreting algebraic expressions;

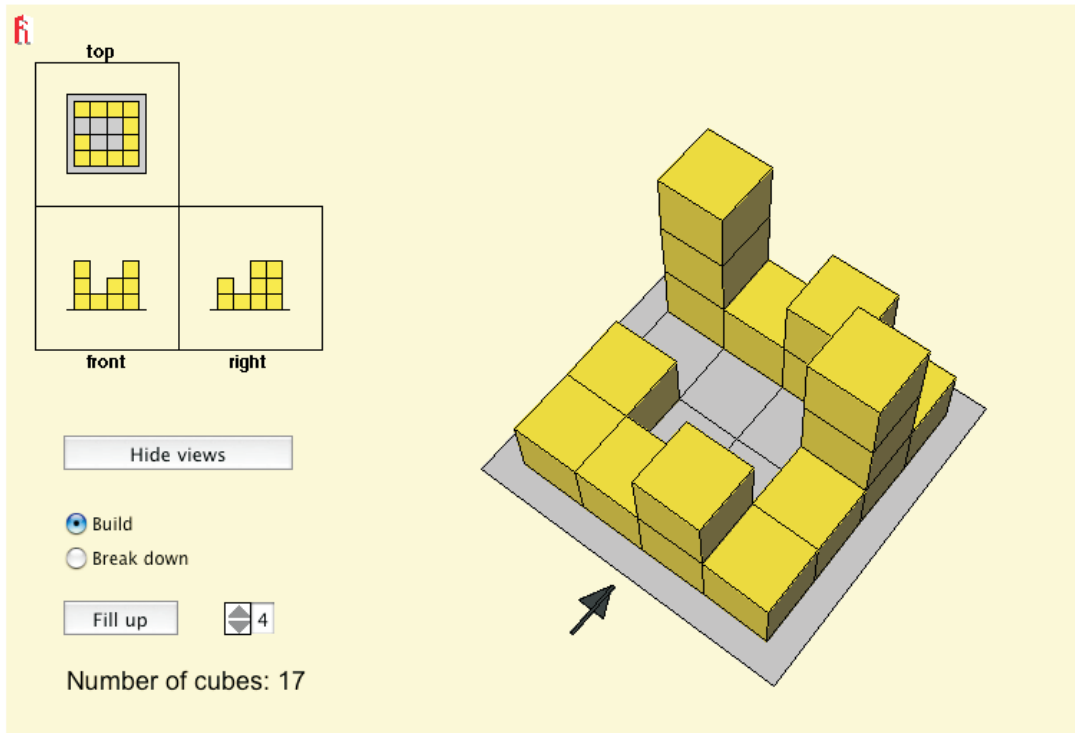
SS7 Transforming shapes;

S5 Interpreting bar charts, pie charts, box and whisker plots;

S6 Interpreting frequency graphs, cumulative frequency graphs, box and whisker plots.

Using the computer software (1)

Building houses 1



This piece of software, particularly if used with an interactive whiteboard, considerably enhances the introduction to this session. It also allows learners to check their card matching and provides a medium in which learners can construct their own examples.

The opening screen is set to build a 'house' on a square base of size 4. The size of the square base can be changed using the 'Up' and 'Down' buttons. The black arrow always shows the direction of the front of the house. You can click and drag the house around to obtain different views.

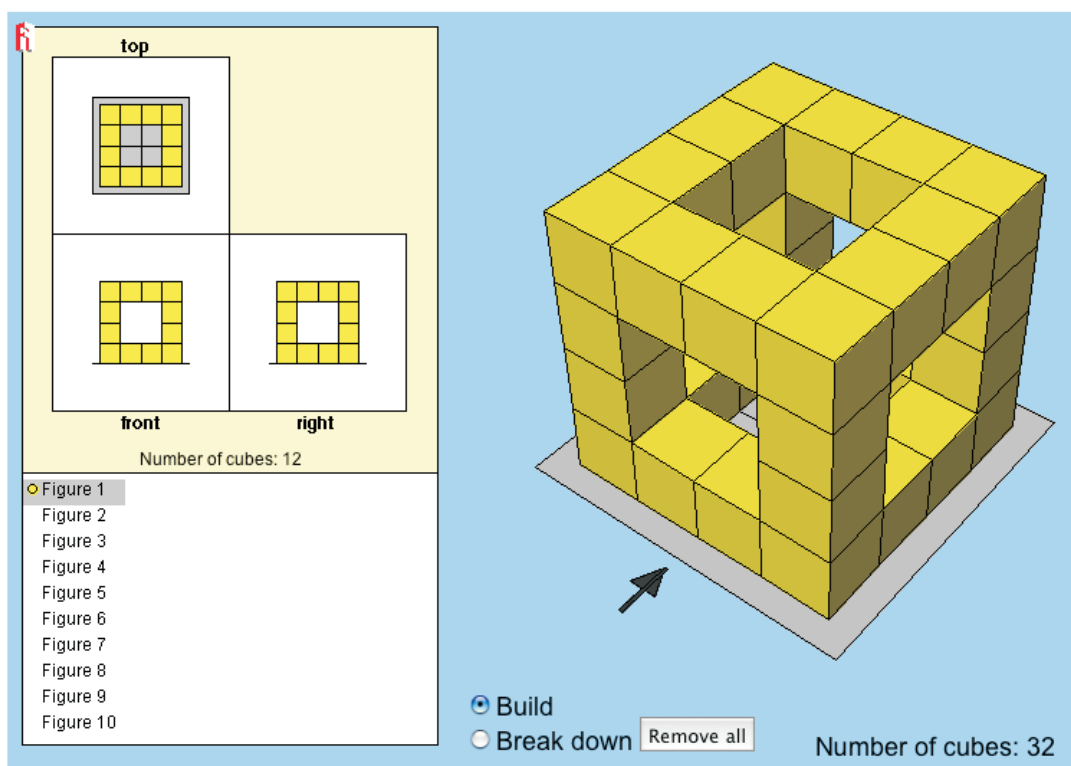
Clicking on the 'Fill up' button builds a cubical house 4 by 4 by 4: the number of cubes is 64. The plan, front and side elevations of the cube are shown in the top left of the screen. Clicking on the 'Remove all' button breaks down the house.

To build a more interesting house, click on any square on the base; a cube appears on the 3D representation, and on the plan and elevations. Click on the top (or side) of any cube to place another cube on top (or to the side) of the first cube. Clicking on the 'Break down' button, then clicking on a cube, deletes that cube.

Problems can be posed by hiding the plan and elevations using the 'Hide views' button, creating a house, then asking learners to predict what the plan and elevations will look like when they are revealed.

Using the computer software (2)

Building houses 2

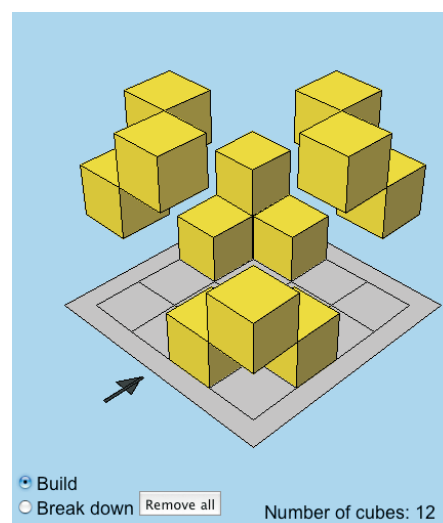


In this program, learners are challenged to construct 3D models from given plans and elevations.

The program provides the plans and elevations (see top left in the screen shown above) and learners have to build appropriate houses. For example, figure 1 has been successfully created in the screen shown above. When this happens, a green blob appears next to the figure number.

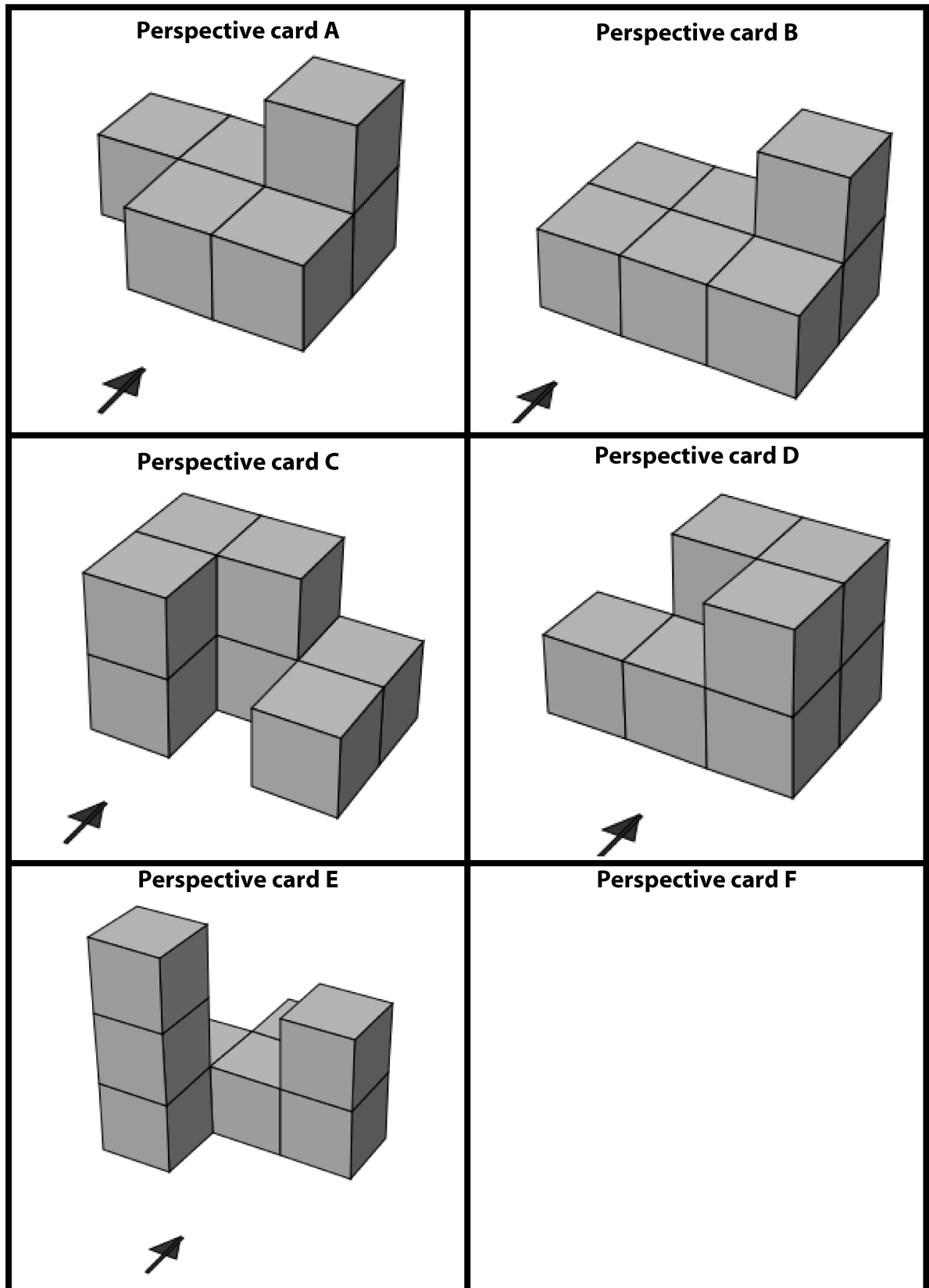
The program, however, presents a further challenge. In the above example, it suggests that only twelve cubes are needed to build the model.

This is possible using the software, though it involves floating cubes, as shown in the screen on the right. When learners succeed at this, a yellow blob appears next to the figure number.

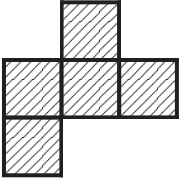
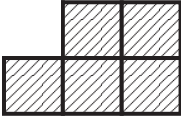
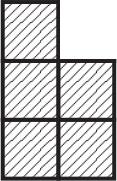
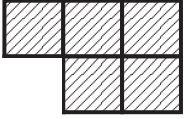
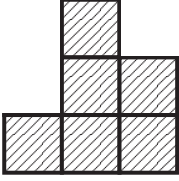
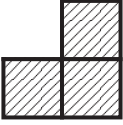
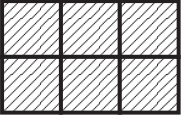
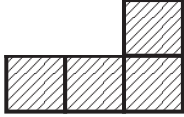
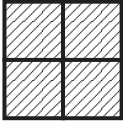
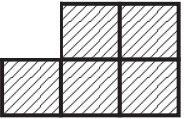
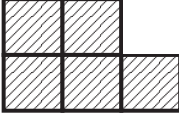
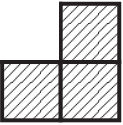
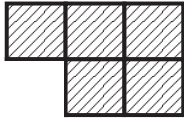
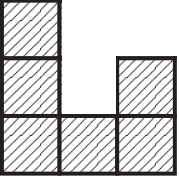
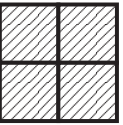
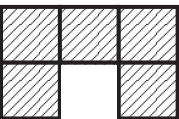
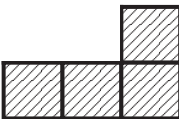
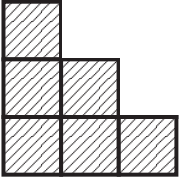


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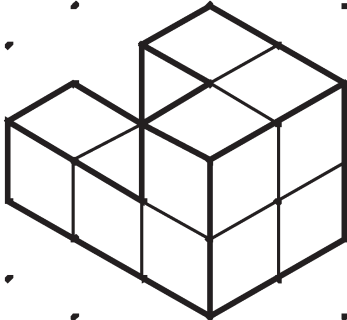
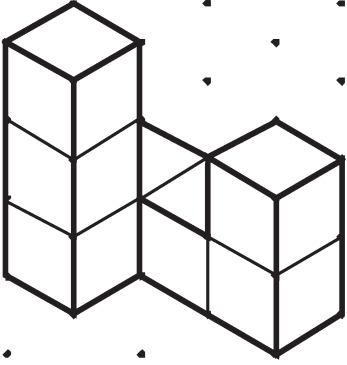
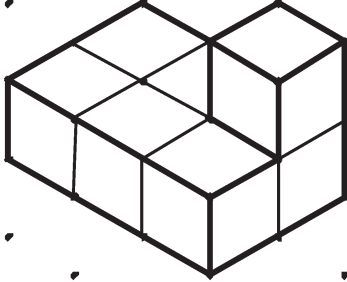
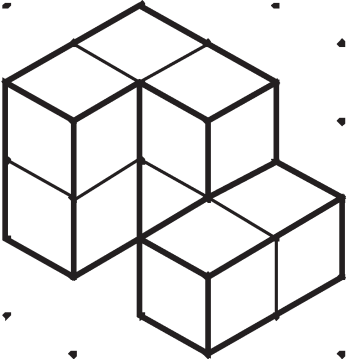
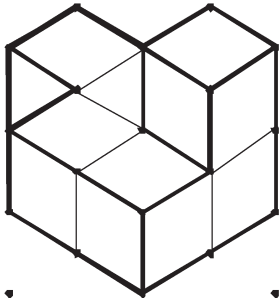
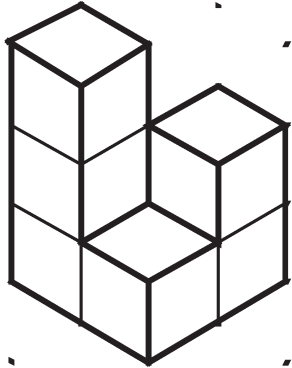
SS6 Card set A – Perspectives



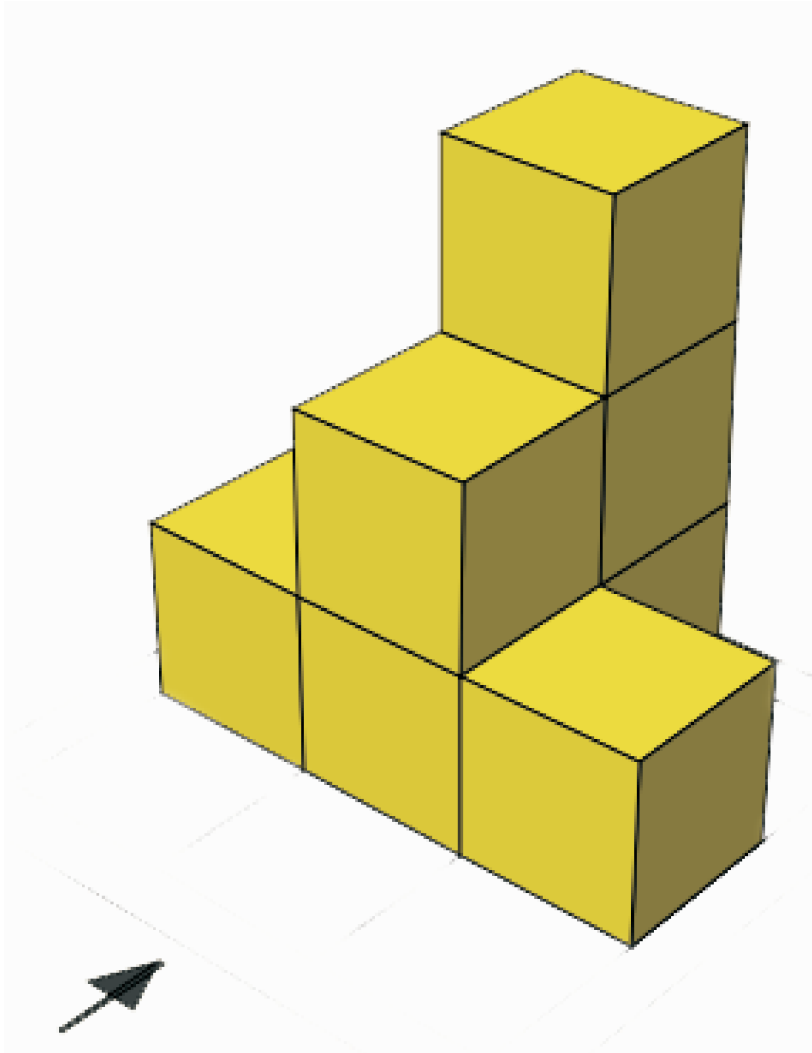
SS6 Card set B – Plans and elevations

<p>1 Plan card</p> 	<p>2 Front card</p> 	<p>3 Right side card</p> 
<p>4 Plan card</p> 	<p>5 Front card</p> 	<p>6 Right side card</p> 
<p>7 Plan card</p> 	<p>8 Front card</p> 	<p>9 Right side card</p> 
<p>10 Plan card</p> 	<p>11 Front card</p> 	<p>12 Right side card</p> 
<p>13 Plan card</p> 	<p>14 Front card</p> 	<p>15 Right side card</p> 
<p>16 Plan card</p> 	<p>17 Front card</p> 	<p>18 Right side card</p> 

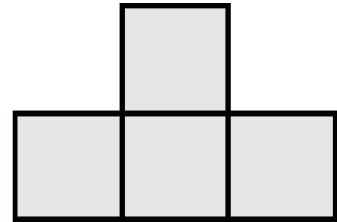
SS6 Card set C – Isometric drawings

<p style="text-align: center;">Isometric card G</p> 	<p style="text-align: center;">Isometric card H</p> 
<p style="text-align: center;">Isometric card I</p> 	<p style="text-align: center;">Isometric card J</p> 
<p style="text-align: center;">Isometric card K</p> 	<p style="text-align: center;">Isometric card L</p> 

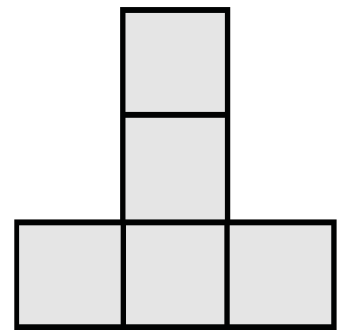
SS6 OHT 1 – Plans and elevations



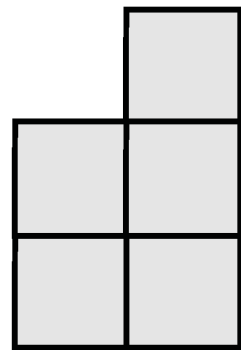
Plan



Front elevation



Side elevation



SS6 OHT 2 – Isometric drawing

