

CHAPTER 7

Plans and Elevations



What will you learn?

7.1

Orthogonal Projections

7.2

Plans and Elevations

Why do you learn this chapter?

- The drawing of a plan and the elevations of an object allows the actual shape of the object to be seen in a two-dimensional form from various viewing directions.
- Plans and elevations are used in engineering, industrial construction, graphic design, architecture, computations and so on.

Each building in Putrajaya has its own uniqueness. The Malaysia Energy Commission Headquarters in Putrajaya which is known as the Diamond Building is a very beautiful building with a unique design. The Diamond Building has received the ASEAN Energy Award for its structure and design that maximises the use of sunlight. The Malaysia Green Building Index and Singapore Green Mark Scheme also awarded platinum ratings to recognise the building's design that enable sustainable recycling of rainwater. The uniqueness and creativity of the Diamond Building architecture is distinctive when viewed from various directions. Have you ever visited the Diamond Building?





Exploring Era

Mimar Sinan is one of the greatest and most influential architects. His real name is Sinar bin Abdulmennan bin Dogan Yusuf (1498-1588). He was born into a Christian Turkish family, from the Anatolian region of Agirnas in Kayseri. In 1539, Sinan was awarded the rank of Chief Architects of the Ottoman. Since then, he has been called Mimar Sinan, meaning Sinan the Architect. After Hagia Sophia (Ayasofya in Turkish) was converted into a mosque, Ottoman architects often used the mosque as a benchmark when designing other mosques. This is why most mosques in Turkey are similar in design.



<http://bukutekskssm.my/Mathematics/F3/ExploringEraChapter7.pdf>

WORD BANK

- origin
- geometrical shape
- elevation
- solid line
- dashed line
- orthogon
- plan
- scale
- quadrant
- projection
- *asalan*
- *bentuk geometri*
- *dongakan*
- *garis padu*
- *garis sempang*
- *ortogon*
- *pelan*
- *skala*
- *sukuan*
- *unjuran*

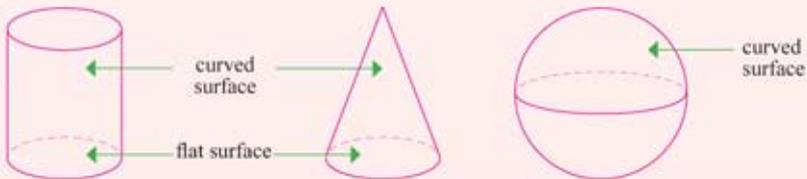
7.1 Orthogonal Projections

What is a plane and a normal to a plane?

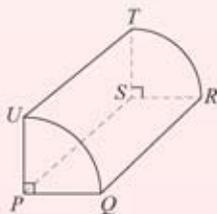
You have studied objects in two and three dimensions. Each of these objects consists of flat surfaces or curved surfaces or both.

LEARNING STANDARD

Draw orthogonal projections.

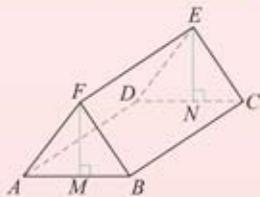


The diagram on the right shows a quarter of a right cylinder with a horizontal base $PQRS$. Both $PSTU$ and $PQRS$ are planes and $QRTU$ is a curved surface.



A **plane** is the **flat surface** of an object. There are three types of planes, namely **horizontal plane**, **vertical plane** and **inclined plane**.

The diagram on the right shows a right prism with a horizontal plane $ABCD$. ABF and CDE are vertical planes. $BCEF$ and $ADEF$ are inclined planes. The lines FM and EN are perpendicular to the lines AB and CD respectively. The lines FM and EN are also known as the normal to the plane $ABCD$.



A **normal to a plane** is a straight line that is **perpendicular** or that forms a right angle to any **line on the plane**.

Example 1

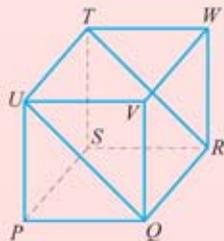
The diagram on the right shows a cube. State the normal to the following planes.

- (a) $PQRS$ (b) $PSTU$ (c) $RSTW$ (d) $QRTU$

Solution:

- (a) UP, VQ, WR, TS
 (b) QP, RS, WT, VU
 (c) QR, PS, UT, VW
 (d) PV, SW

The order of letters to specify a normal is important. TS means the line TS is perpendicular to the plane $PQRS$ at point S .



In Diagram 3, $PQRS$ is projected on a vertical plane and in Diagram 4 $EFGH$ is projected on a horizontal plane.

Diagram	Object	Normal to the plane	Orthogonal projection on the plane
Diagram 3	$PQRS$	PA, QB, RC, SD	$ABCD$
Diagram 4	$EFGH$	ER, FS, GT, HU	$RSTU$

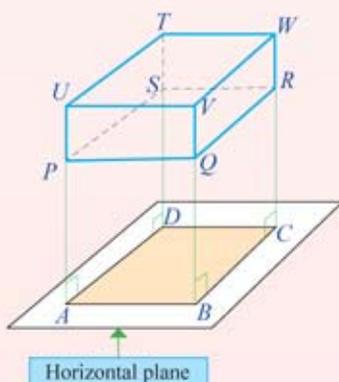


Diagram 5

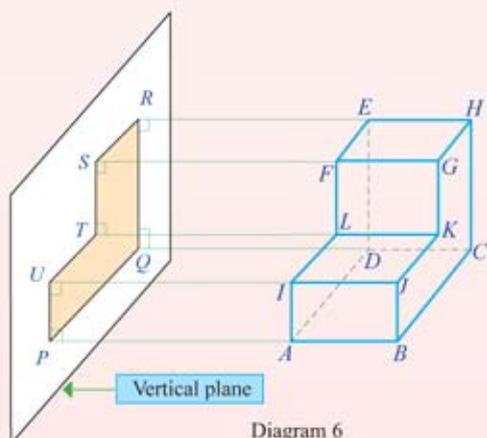


Diagram 6

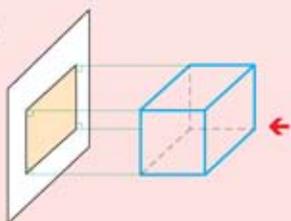
In Diagram 5, a cuboid is projected on a horizontal plane and in Diagram 6 a right prism with the surface $BCHGKJ$ as a uniform cross section is projected on a vertical plane.

Diagram	Object	Normal to the plane	Orthogonal projection on the plane
Diagram 5	Cuboid	PA, QB, RC, SD	$ABCD$
Diagram 6	Right prism	AP, IU, LT, DQ, FS, ER	$PQRSTU$

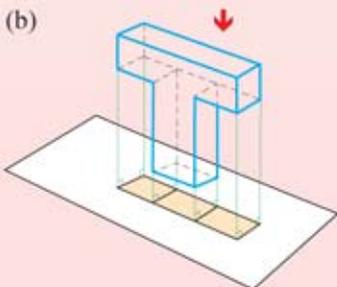
Example 3

Each of the following diagrams shows the projection of an object on a vertical plane or a horizontal plane. Determine whether the resulting projection is an orthogonal projection.

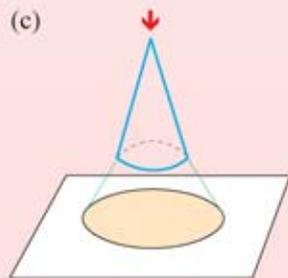
(a)



(b)



(c)



Solution:

(a) Yes

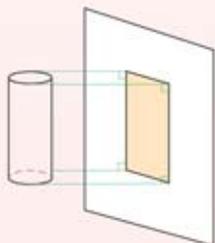
(b) Yes

(c) No, because the lines projected from the object to the plane is not a normal.

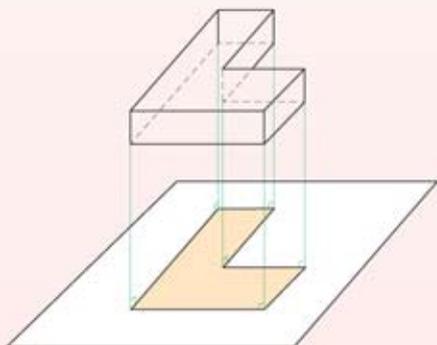
MIND TEST 7.1a

1. Each diagram below shows the object and its projection on a plane. Determine whether the projection is an orthogonal projection.

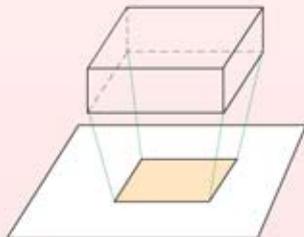
(a)



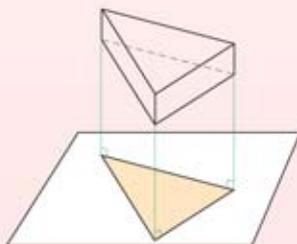
(b)



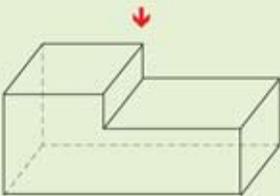
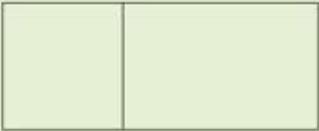
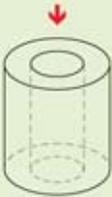
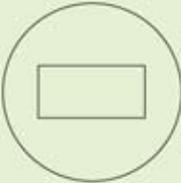
(c)



(d)



2. A student looks at the following object from a given viewing direction. Which of the following combinations shows the correct orthogonal projection?

Object	Orthogonal projection
(a) 	
(b) 	

How do you draw an orthogonal projection?

You can draw an orthogonal projection of an object on a horizontal plane or a vertical plane using the following steps.

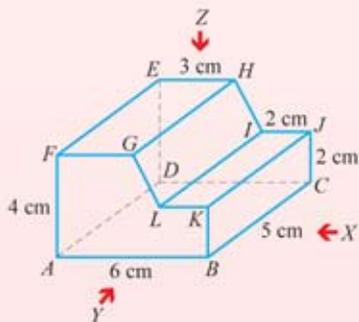
1. Identify the type of plane and the direction in which the object that should be projected.
2. Draw normal lines from all vertices of the object to the plane. Make sure all the normal lines are straight and upright so that the length of projected sides and the length of sides of object are the same.
3. Connect the points of intersection of the normal to the plane to draw the shape of the orthogonal projection.
4. Redraw the orthogonal projection with actual measurements. Label all vertices and side lengths.

Example 4

The diagram on the right shows a right prism with rectangular base $ABCD$ on a horizontal plane. $ABKLGJ$ is a uniform cross section of the prism. The sides AF and BK are vertical.

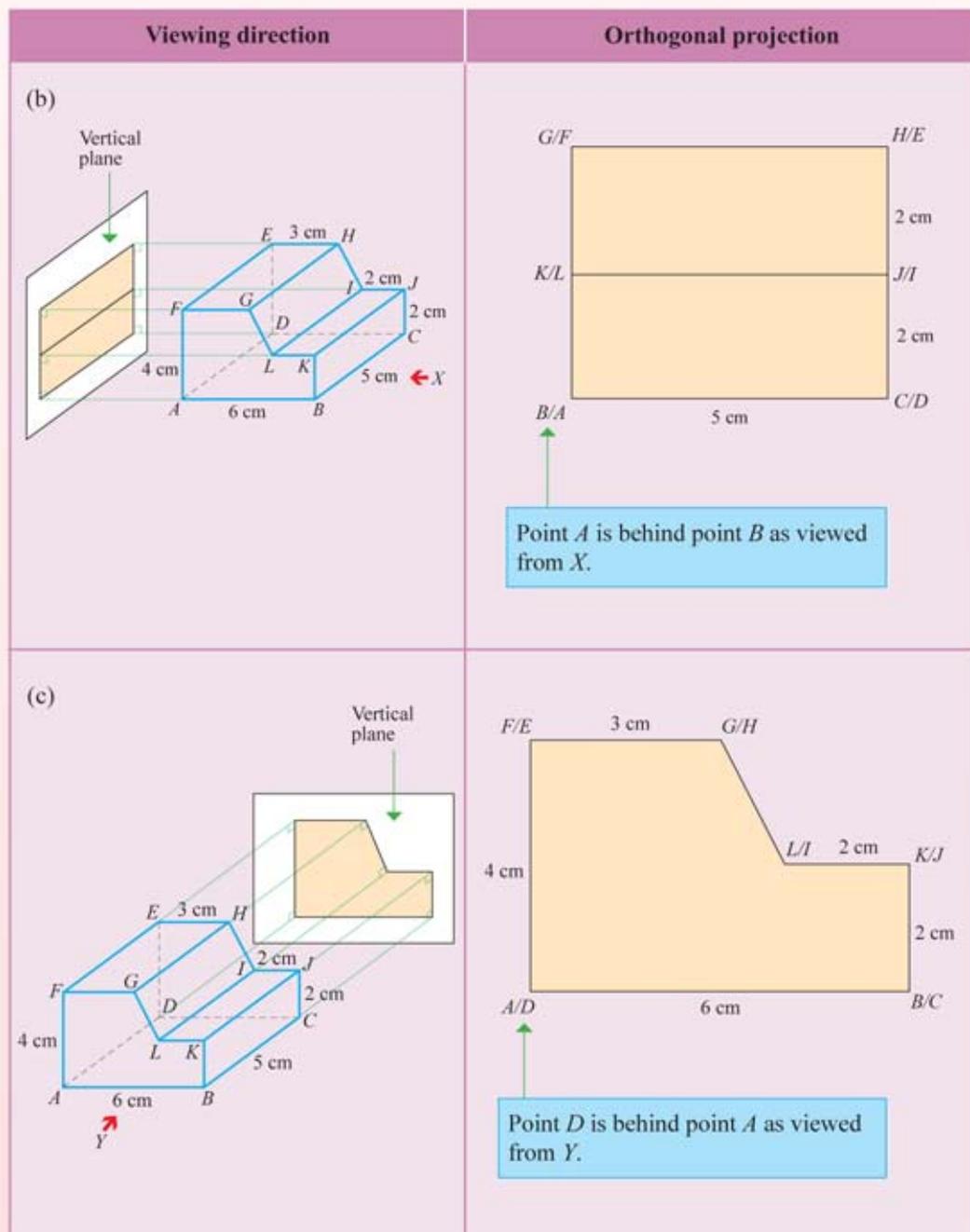
Draw the orthogonal projection of the object on a

- (a) horizontal plane as viewed from Z
- (b) vertical plane as viewed from X
- (c) vertical plane as viewed from Y



Solution:

Viewing direction	Orthogonal projection
<p>(a)</p>	<p>The order of letters is following the viewing direction. Point D is below point E as viewed from Z.</p>



Example 5

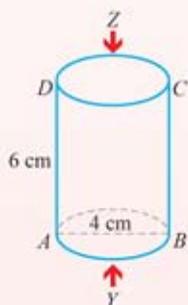
The diagram on the right shows a cylindrical object on a horizontal plane. It is given that the diameter of the cylinder is 4 cm and its height is 6 cm.

Draw the orthogonal projection of the cylindrical object on a

(a) horizontal plane as viewed from Z

(b) vertical plane as viewed from Y

Solution:



Viewing direction	Orthogonal projection
(a) 	
(b) 	

Brainstorming 1



In groups

Aim: To determine the orthogonal projections of an object.

Materials: Dynamic software, drawing paper.

Steps:

1. Open *View*  and select *3D graphics*.
2. Select the shape of pyramid .
3. Basic display is formed (Diagram 1).
4. Drag the cursor to display and select the four points:
 - (a) Point $(-2, 0)$ on the red line.
 - (b) Point $(-2, 0)$ on the green line.
 - (c) Point $(2, 0)$ on the red line.
 - (d) Point $(2, 0)$ on the green line and connect it to the starting point $(-2, 0)$ at the red line (Diagram 2).
5. The display will show a brownish shape (Diagram 3).
6. Drag the cursor up to the blue line $(0, 4)$ (Diagram 4).
7. Select the *3D rotate icon*,  select *view in front of* .
8. Place the arrow at the top end of the blue line to see the orthogonal projection on the horizontal plane (Diagram 5).



Diagram 1

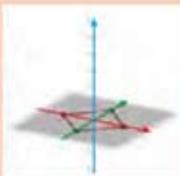


Diagram 2

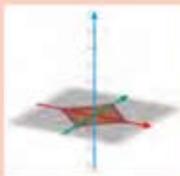


Diagram 3

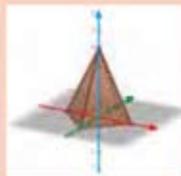


Diagram 4

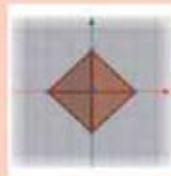


Diagram 5

9. Repeat step 8 on the red line and the green line to see various orthogonal projections on vertical planes.
10. Draw the resulting orthogonal projections as in steps 8 and 9 in the given table.
11. Select a new file. Build other 3D shapes and draw orthogonal projections from different perspectives.



Results of findings:

Pyramid 	Orthogonal projection
The view on the horizontal plane as seen from the blue line	
The view on the vertical plane as seen from the red line	
The view on the vertical plane as seen from the green line	

Discussion:

Discuss the resulting shape of the orthogonal projection as compared to the actual shape of the object.

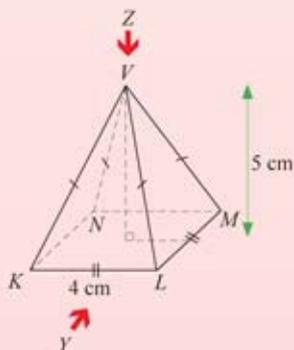
From Brainstorming 1, it is found that:

Pyramid 	Orthogonal projection
The view on the horizontal plane as seen from the blue line	
The view on the vertical plane as seen from the red line	
The view on the vertical plane as seen from the green line	

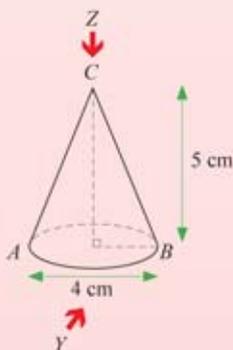
MIND TEST 7.1b

1. Each object below lies on a horizontal plane. Draw orthogonal projections of each object on a
- horizontal plane as viewed from Z
 - vertical plane as viewed from Y

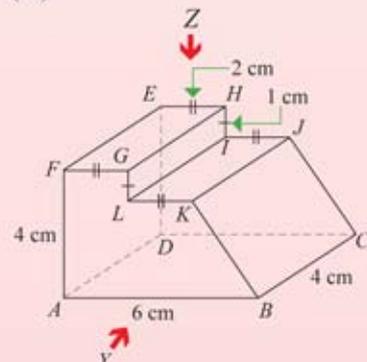
(i)



(ii)



(iii)



How do you compare and contrast objects with their projections?

LEARNING STANDARD

Compare and contrast between objects and the corresponding orthogonal projections.

Brainstorming 2



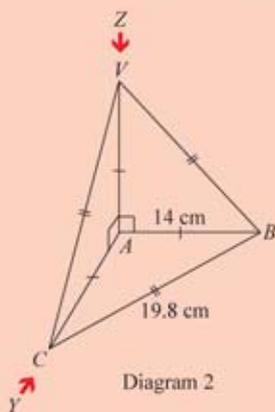
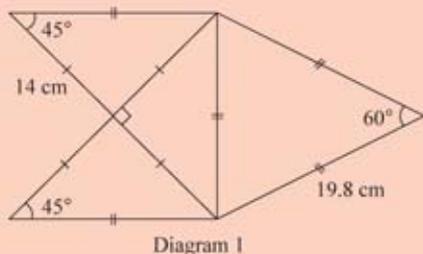
In groups

Aim: Compare and contrast an object with an orthogonal projection in terms of length of side and size of angle.

Materials: Cardboard, a pencil, a pair of scissors, adhesive tape and drawing paper.

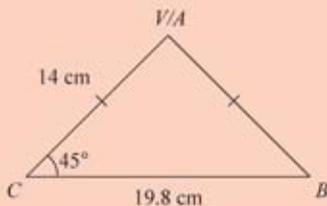
Steps:

1. Draw the following shape according to the size given on a cardboard (Diagram 1).
2. Cut out the shape in Diagram 1 and use adhesive tape to build the shape in Diagram 2.

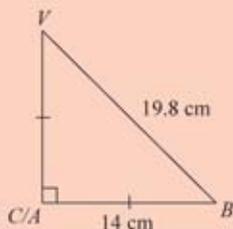


3. Draw an orthogonal projection for the shape that you built on a horizontal plane as viewed from Z and on a vertical plane as viewed from Y .
4. Produce the orthogonal projections on the horizontal plane and the vertical plane as follows:

Projection from direction Z
(horizontal plane)



Projection from direction Y
(vertical plane)



5. Measure each of the length of sides and angles of the two orthogonal projections you drawn. Complete the table below.

Side	Object	Projection from direction Z	Angle	Object	Projection from direction Z
<i>AC</i>	14 cm	14 cm	$\angle VCB$	60°	45°
<i>AB</i>			$\angle VBC$		
<i>BC</i>	19.8 cm	19.8 cm	$\angle BAC$	90°	90°
<i>VC</i>	19.8 cm	14 cm	$\angle CAB$		
<i>VB</i>					

Side	Object	Projection from direction Y	Angle	Object	Projection from direction Y
<i>AV</i>	14 cm	14 cm	$\angle VCB$	60°	90°
<i>AB</i>			$\angle VBC$	60°	45°
<i>BC</i>	19.8 cm	14 cm	$\angle CVB$		
<i>VC</i>			$\angle AVB$	45°	45°
<i>VB</i>	19.8 cm	19.8 cm			

Discussion:

Are all sides and angles of the orthogonal projection of the same size as those of the object? Discuss.

From Brainstorming 2, it is found that:

- For orthogonal projections on a horizontal plane from direction Z, the lengths of *AC*, *AB* and *BC*, and the size of $\angle BAC$, $\angle ACB$ and $\angle ABC$ remain unchanged.
- For orthogonal projections on a vertical plane from direction Y, the lengths of *AV*, *AB* and *VB*, and the size of $\angle AVB$ and $\angle ABV$ remain unchanged.

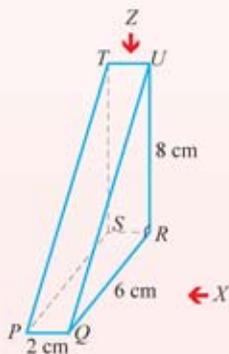
In general,

The **length of sides** and **size of angles** of the **orthogonal projections** of an object can remain unchanged or vary according to the **viewing direction**.

Example 6

The diagram on the right shows a right prism with a rectangular base $PQRS$ which lies on a horizontal plane. The plane URQ is a uniform cross section of the object.

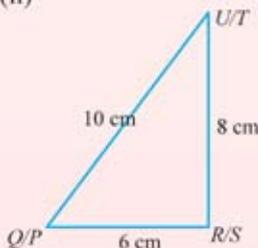
- (a) Draw to full scale the orthogonal projection of the prism on
- a horizontal plane as viewed from Z
 - a vertical plane as viewed from X
- (b) State your conclusion about the length of sides and the size of angles of the object and its orthogonal projections. Explain your conclusions.

**Solution:**

- (a) (i)



- (ii)



- (b) (i) The length of sides of TU , SR , PQ , PS and QR and the right angle remain unchanged on orthogonal projections as viewed from Z . The length of sides TP and UQ are changed.
- (ii) The length of sides of TP , UQ , PS , QR , TS and UR as well as the size of all angles remain unchanged on the orthogonal projection as viewed from X .

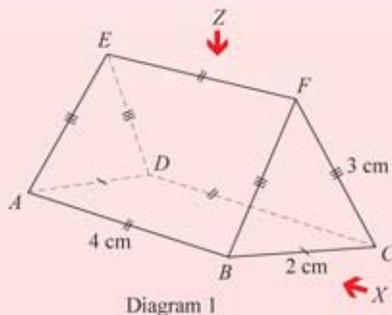
MIND TEST 7.1c

Diagram 1

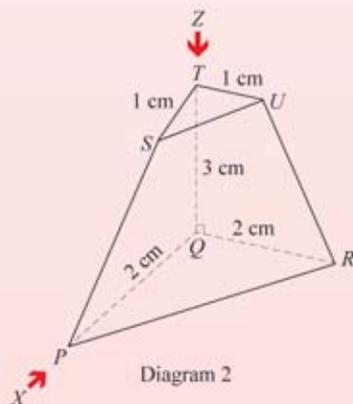


Diagram 2

1. (a) Diagram 1 and Diagram 2 above show two objects placed on a horizontal plane. Draw a full scale orthogonal projection of both objects on a
- horizontal plane as viewed from Z
 - vertical plane as viewed from X
- (b) State your conclusion about the length of sides and the size of angles of the objects and their orthogonal projections for Diagram 1 and Diagram 2. Explain your conclusion.

What are plans and elevations?

You have learnt that the orthogonal projection of an object or a solid can be drawn on a horizontal plane and a vertical plane.

The **orthogonal projection** on a **horizontal plane**, which is seen from the top view, is known as a **plan**. The **orthogonal projection** on a **vertical plane**, which is seen from either the side view or the front view, is known as **elevations**. Orthogonal projection drawings give accurate information on the design as well as the size of an object.

LEARNING STANDARD

Draw the plan and elevations of an object to scale.

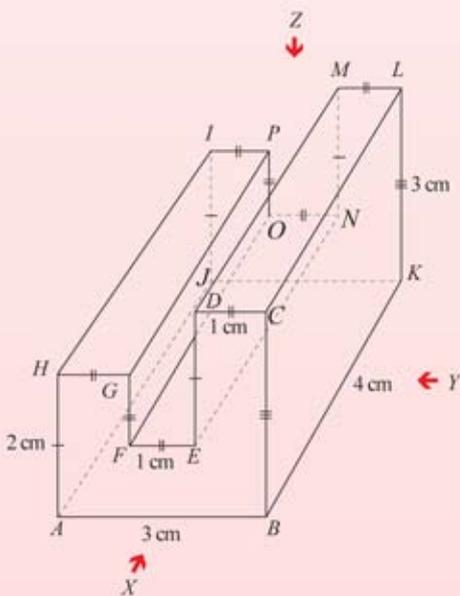
TIPS

Full scale means the actual size.

How do you draw a plan and elevations of an object to scale?

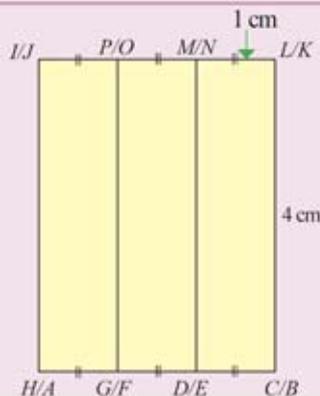
The diagram below shows a right prism with a rectangular base $ABKJ$ which lies on a horizontal plane. $ABCDEFGH$ is a uniform cross section of the prism. The sides AH , FG , ED and BC are vertical. The plan of the right prism can be drawn as viewed from Z and the elevations of the object can be drawn as viewed from X and Y . Plan and elevations should be drawn to full scale.

Right prism (object)



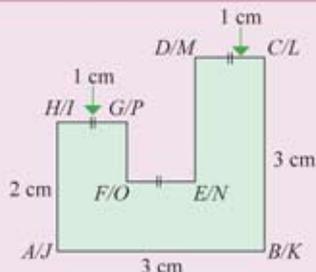
Plan

As viewed from Z , which is the view from the top.

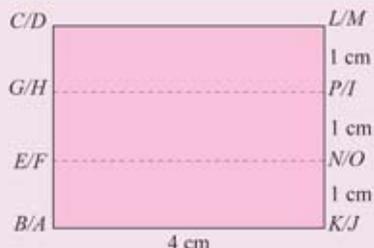


Note:

All sides are drawn with **solid lines** because they are visible from the top.

Front elevationAs viewed from X .

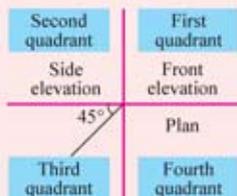
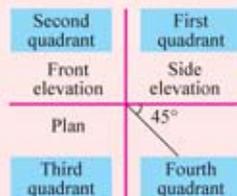
Note:

All sides are drawn with **solid lines** because they can be seen when viewed from X .**Side elevation**As viewed from Y .

Note:

Lines GP , HI , EN and FO are drawn with **dashed lines** because the sides are hidden when viewed from Y .

The drawings of a plan, a front elevation and a side elevation of an object can also be combined on a piece of paper which is divided into four quadrants. Here are two commonly used methods.

Method 1**Method 2**

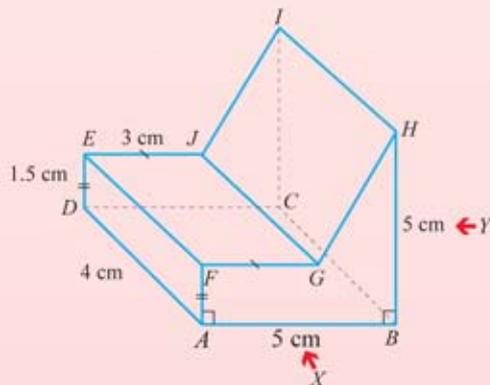
The position of the front elevation is at the top of the plan. The side elevation is drawn on the left side or the right side of the front elevation, depending on the viewing direction.

In method 1, the side view is from right to left as in Example 7. Thus, the position of this elevation is on the left side of the front elevation as method 1. In method 2, a side view is from left to right as in example 8. Thus, the position of this elevation is on the right side of the front elevation as method 2.

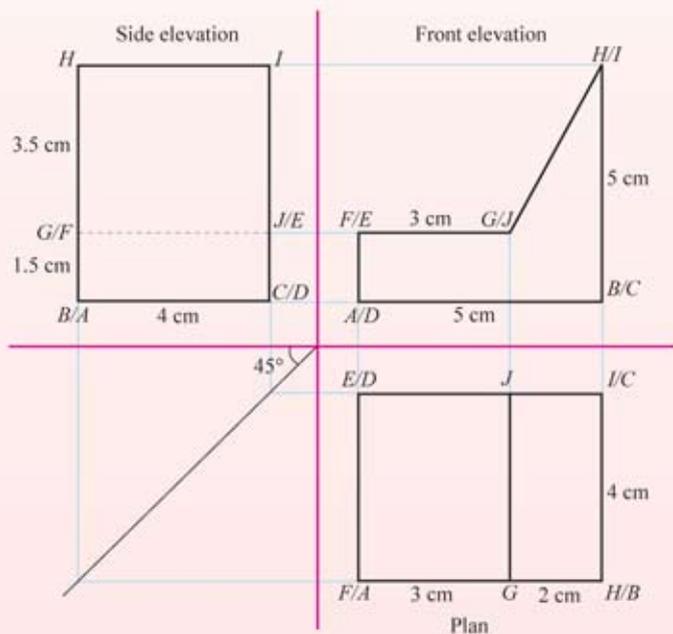
Example 7

The diagram on the right shows a right prism with rectangle $ABCD$ that lies on a horizontal plane. $ABHG$ is a uniform cross section of the prism. The sides of AF and BH are vertical. Draw to full scale,

- the plan of the prism
- the elevation of the prism as viewed from X
- the elevation of the prism as viewed from Y



Solution:



Steps:

- 1 The direction of the side elevation (direction Y) is from right to left, thus the position of the side elevation is in the second quadrant.
- 2 Draw the plan to full scale in the fourth quadrant.
- 3 Project sides of the plan with thin solid lines to the first quadrant as a guide to draw the front elevation (direction X).
- 4 Project the sides of the plan and the front elevation to the second quadrant to draw the side elevation.

TIPS

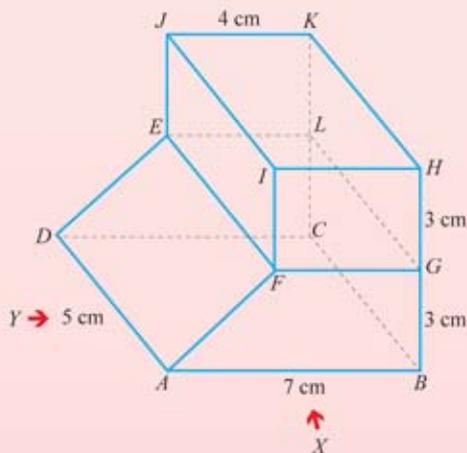
Guide for drawing plan and elevation.

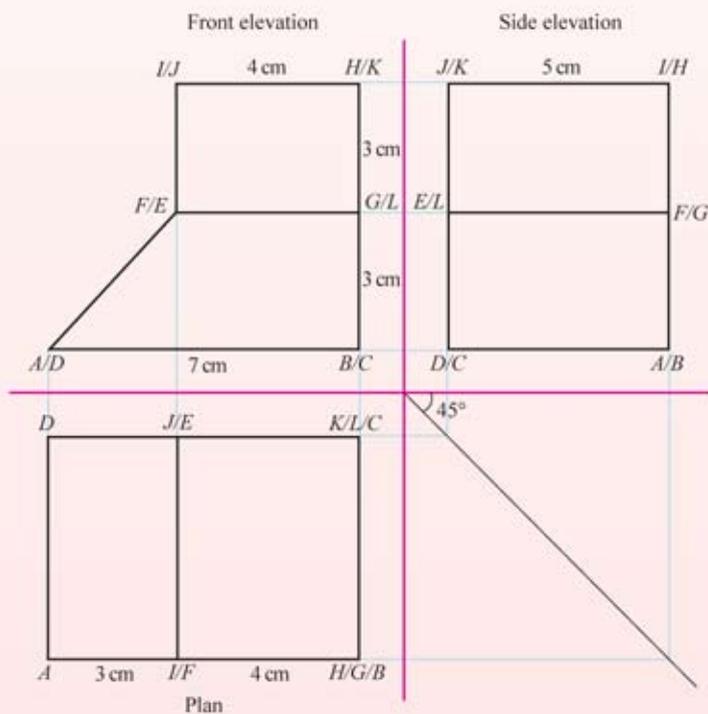
- ◆ Thick solid lines for visible sides.
- ◆ Dashed lines for hidden sides.
- ◆ Thin solid lines for construction lines.

Example 8

The diagram on the right shows a combination of a cuboid and a right prism with rectangle $ABCD$ on a horizontal plane. $ABGHIF$ is a uniform cross section of the object. BH and FI are vertical. Draw to full scale,

- (a) the plan of the object
- (b) the elevation of the object as viewed from X
- (c) the elevation of the object as viewed from Y



Solution:**TIPS**

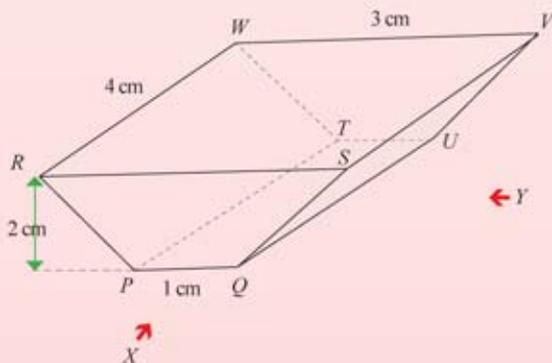
The direction of the side elevation (direction Y) is from left to right, thus the position of the side elevation is on the first quadrant.

DISCUSSION CORNER

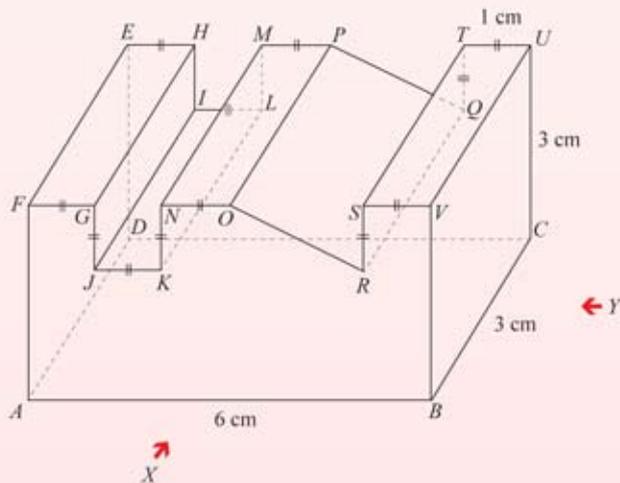
In the subject *Reka Bentuk dan Teknologi (RBT)*, the plan and elevations of an object are drawn with orthographic projection method. Is this method the same as the method you use in this chapter? Discuss.

MIND TEST 7.2a

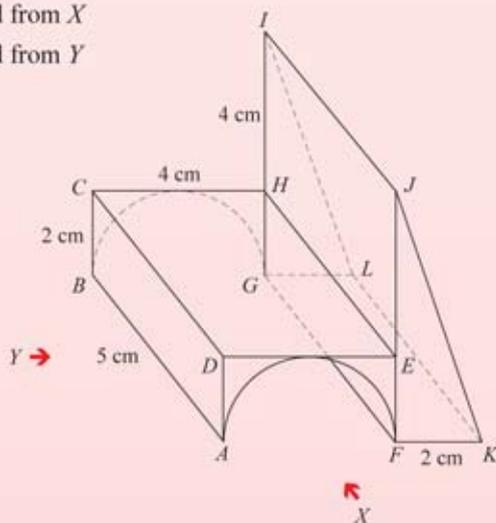
- The diagram below shows a prism with rectangle $PQUT$ on a horizontal plane. $PQSR$ is a uniform cross section of the prism. Draw to full scale,
 - the plan of the prism
 - the elevation of the prism as viewed from X
 - the elevation of the prism as viewed from Y



2. The diagram below shows a block where rectangle $ABCD$ lies on a horizontal plane. $ABVSRONKJGF$ is a uniform cross section of the block. AF, JG, KN, RS and BV are vertical. Draw to full scale,
- the plan of the object
 - the elevation of the object as viewed from X
 - the elevation of the object as viewed from Y



3. The diagram below shows a combination of a cuboid and a right prism placed on a horizontal plane. A semi-cylinder is removed from the cuboid. $ADEJKF$ is a uniform cross section of the object. AD and FEJ are vertical. Draw to full scale,
- the plan of the object
 - the elevation of the object as viewed from X
 - the elevation of the object as viewed from Y



How do you synthesise plan and elevations of an object and sketch the object?

LEARNING STANDARD

Synthesise plan and elevations of an object and sketch the object.

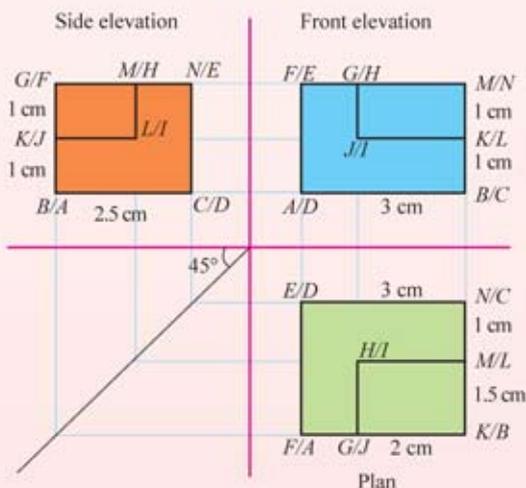
The drawings of plan and elevations on four quadrants are connected to each other and can be used to sketch the three-dimensional shape of an object with ease.

Example 9

The diagram on the right shows the plan, front elevation and side elevation of a right prism with a rectangular base. A cuboid-shaped block has been removed from the prism. Sketch the three-dimensional shape of the prism.

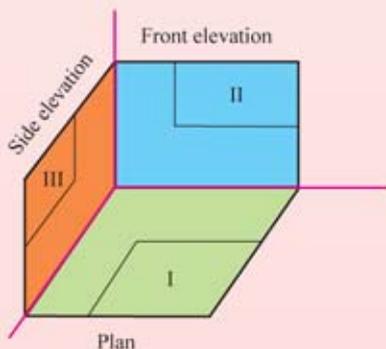
Solution:

The position of the side elevation is on the second quadrant. Thus, the view of the side elevation is from the right.



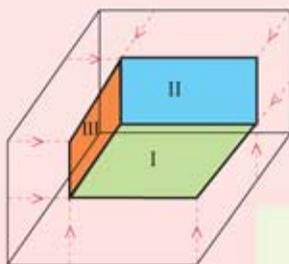
Step 1

Sketch the three orthogonal projections given on the planes using the measurements given. Surfaces marked I, II and III are surfaces of the cuboid block.



Step 2

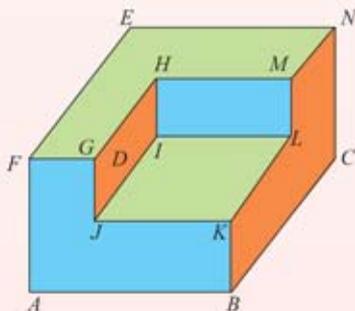
Project the surfaces I, II and III so that they meet as shown in the diagram below.



Scan QR Code or browse <http://yakin-pelajar.com/Bab%207%video/> to watch a video about orthographic projection drawings using dynamic software.

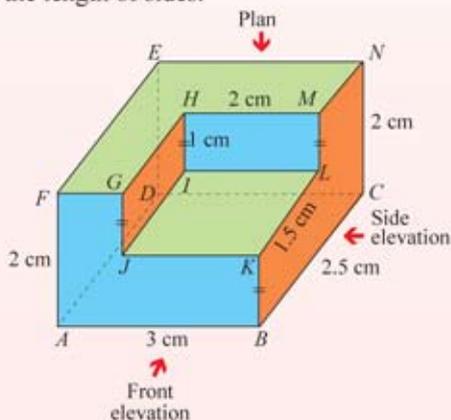
Step 3

Sketch the object and label the vertices with the letters in the orthogonal projections using the colours as the guide.



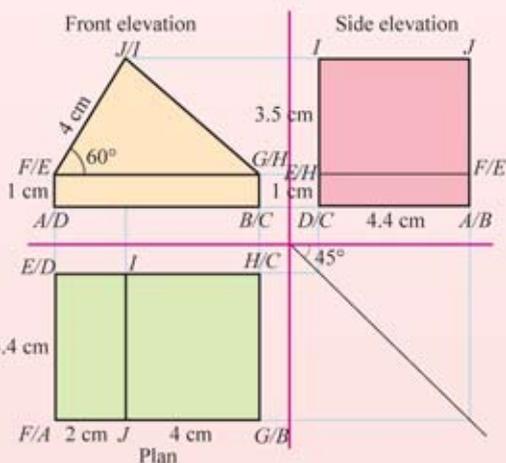
Step 4

Complete the sketched object by labelling the length of sides.



Example 10

The diagram on the right shows the plan, front elevation and side elevation of a combination of a cuboid and a right prism. Sketch the three-dimensional shape of the object.



Solution:

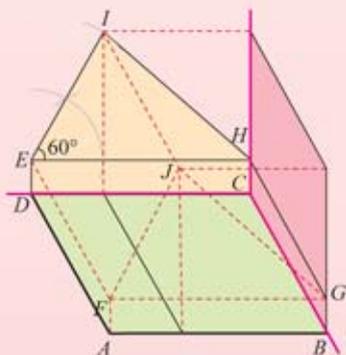
The position of side elevation is in the first quadrant. Thus, the view of side elevation is from left to right.

Step 1

Sketch the three orthogonal projections given on the planes using the measurements given. This object contains an angle of 60° on a triangular surface. Thus, the angle of 60° must be built with the correct method.

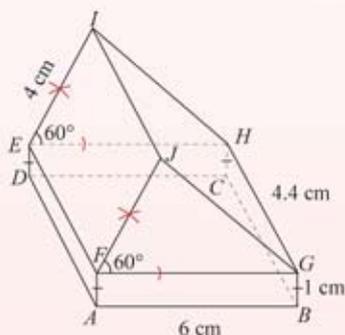
Step 2

Connect the vertices to create a combined object. Label the vertices according to the projections.



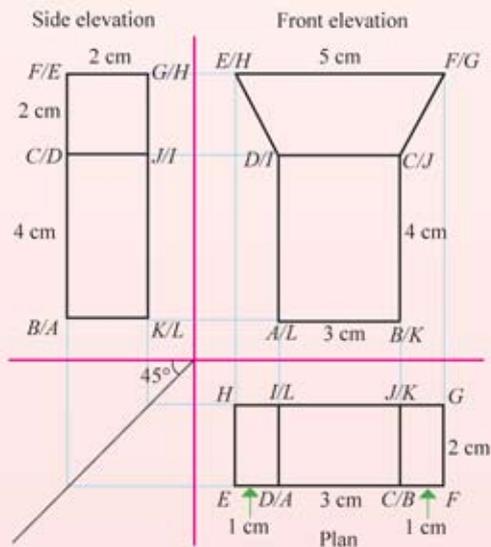
Step 3

Draw the combined object and label the vertices and the length of the sides.

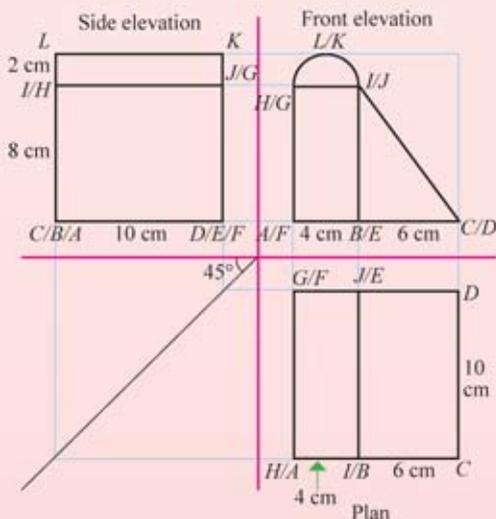


MIND TEST 7.2b

- The diagram on the right shows the plan, front elevation and side elevation of a combination of a cuboid and a right prism. Sketch the three-dimensional shape of the combined object.



- The diagram on the right shows the plan, front elevation and side elevation of a combination of a cuboid, a right prism and a semi-cylinder. Sketch the three-dimensional shape of the combined object.

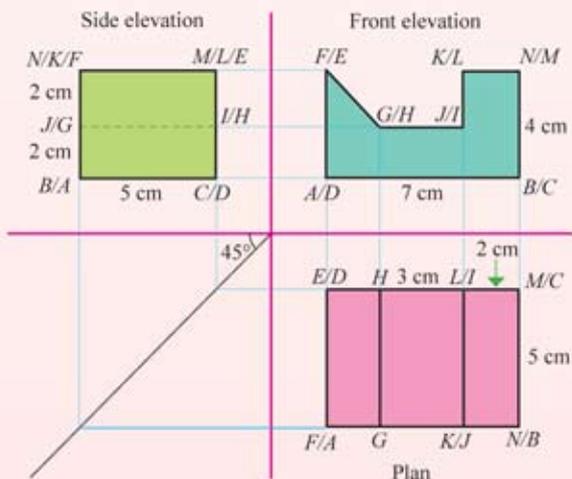


How do you solve problems involving plans and elevations?

LEARNING STANDARD
Solve problems involving plans and elevations.

Example 11

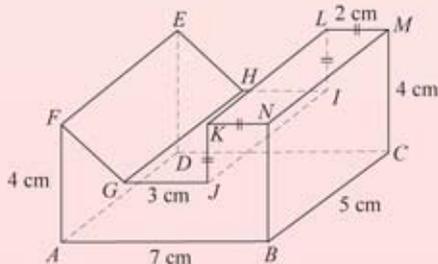
The diagram below shows the plan, front elevation and side elevation of a right prism.



- Draw the right prism to full scale.
- State the length of FG , in cm, correct to one decimal place.
- Originally the prism was a cuboid of size $7 \text{ cm} \times 5 \text{ cm} \times 4 \text{ cm}$. Calculate the volume of the right prism $EFGJKLIH$, in cm^3 , which was removed from the cuboid.
- State the ratio of the volume of the right prism that was removed to the volume of the right prism you drew in question (a).

Solution:

(a)



(b) $FG = 2.8 \text{ cm}$

(c) The volume of the removed prism
 $= \frac{1}{2}(2 \text{ cm})(3 + 5) \text{ cm} \times 5 \text{ cm}$
 $= 40 \text{ cm}^3$

(d) The volume of the projected right prism
 $= \text{the volume of the cuboid} - \text{the volume of the prism } EFGJKLIH$
 $= (7 \text{ cm} \times 5 \text{ cm} \times 4 \text{ cm}) - 40 \text{ cm}^3$
 $= 140 \text{ cm}^3 - 40 \text{ cm}^3$
 $= 100 \text{ cm}^3$

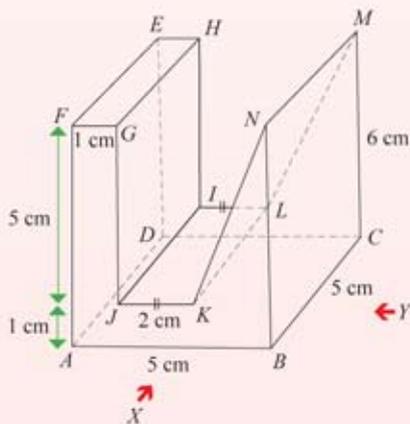
Thus, the ratio is
 $40 : 100$
 $2 : 5$

MIND TEST 7.2c

1. The diagram below shows a right prism with square $ABCD$ on a horizontal plane. $ABNKJGF$ is a uniform cross section of the prism.



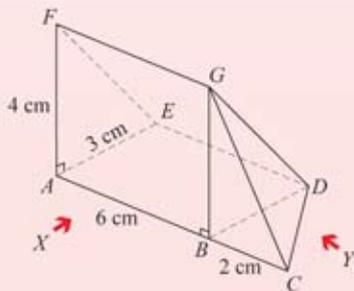
- (a) Draw to full scale,
- the plan of the prism.
 - the elevation on a vertical plane parallel to AB as viewed from X .
 - the elevation on a vertical plane parallel to BC as viewed from Y .
- (b) This right prism was originally a cuboid with a dimension of $5\text{ cm} \times 5\text{ cm} \times 6\text{ cm}$. A right prism $GJKNMLIH$ has been removed from the cuboid. Calculate
- the volume of the removed prism
 - the ratio of the volume of the right prism $GJKNMLIH$ to the volume of the remaining right prism



2. The diagram below shows a combination of a right prism and a triangular pyramid on a horizontal plane. AF and BG are vertical.



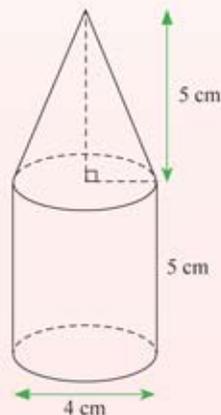
- (a) Draw to full scale,
- the plan of the combined prism
 - the elevation on a vertical plane parallel to AC as viewed from X
 - the elevation on a vertical plane parallel to BD as viewed from Y
- (b) Measure the lengths of CD , CG and DG on the plan, elevation as viewed from X and elevation as viewed from Y .
- (c) Use another way to calculate the lengths CD , CG and DG of the original object. Is your answer the same as the answer in question (b)? Explain.
- (d) Which orthogonal projections show the actual values of $\angle AEF$, $\angle AFE$, $\angle BCG$, $\angle BGC$, $\angle BCD$ and $\angle BDC$?



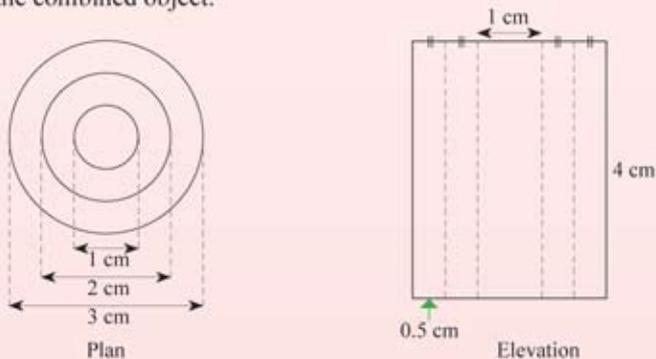


Test Yourself

- The diagram on the right shows a combination of a cylinder and a cone placed on a horizontal table. State whether the following statements are true or false regarding the orthogonal projections of the combined object.
 - The plan is a circle of diameter 4 cm with a dot in the centre of the circle.
 - The elevations of the orthogonal projections from all directions are congruent.
 - The length of the hypotenuse of the cone on the side elevation is less than 5 cm.
 - There is no curved surface on the front elevation.

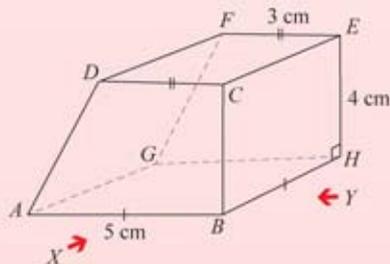


- The diagram below shows the plan and the elevation of a combined object. Describe the original design of the combined object.



Skills Enhancement

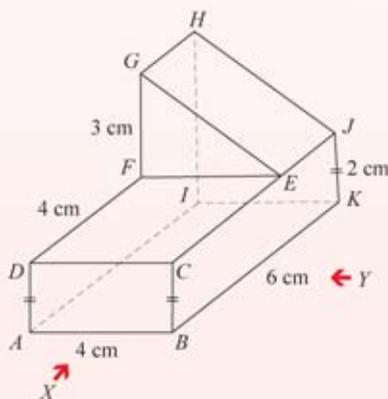
- The diagram on the right shows a right prism with square $ABHG$ placed on a horizontal plane. $ABCD$ is a uniform cross section of the prism.
 - Draw to full scale,
 - the plan of the prism
 - the elevation as viewed from X
 - the elevation as viewed from Y
 - Measure the length of AD and size of $\angle ADC$ on the projection plane which is the uniform cross section of the prism.



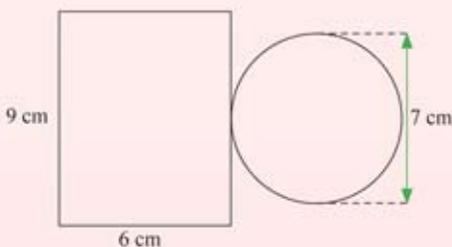
2. The diagram on the right shows a combination of a right prism and a cuboid placed on a horizontal plane. AD, FG, BC and KJ are vertical.

- (a) Draw to full scale,
 (i) the plan of the object
 (ii) the elevation as viewed from X
 (iii) the elevation as viewed from Y

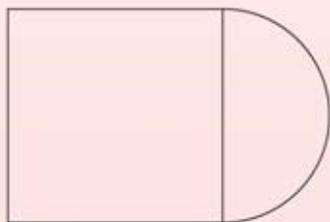
- (b) Calculate the volume, in cm^3 , of the combined solid.



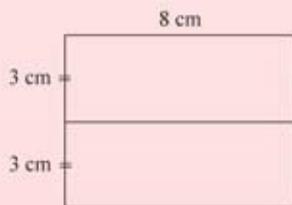
3. The diagram on the right shows the plan of a combination of a cuboid and a right cylinder. If the heights of the cuboid and the cylinder are 5 cm, calculate the volume of the combined solid in cm^3 .



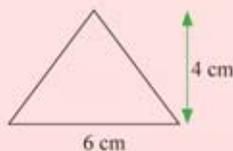
4. The diagram on the right shows the plan of a combination of a cube and a semi-cylinder. Given that the circumference of the plan of the semi-cylinder is 11 cm and the height of the semi-cylinder is equal to the length of the side of the cube, calculate the volume of the combined solid, in cm^3 .



5. The diagram below shows the plan and the front elevation of a prism. Calculate the volume of the prism in cm^3 .



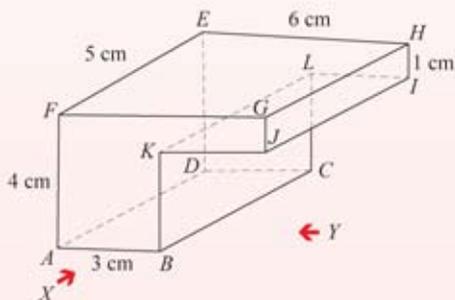
Plan



Front elevation

Self Mastery

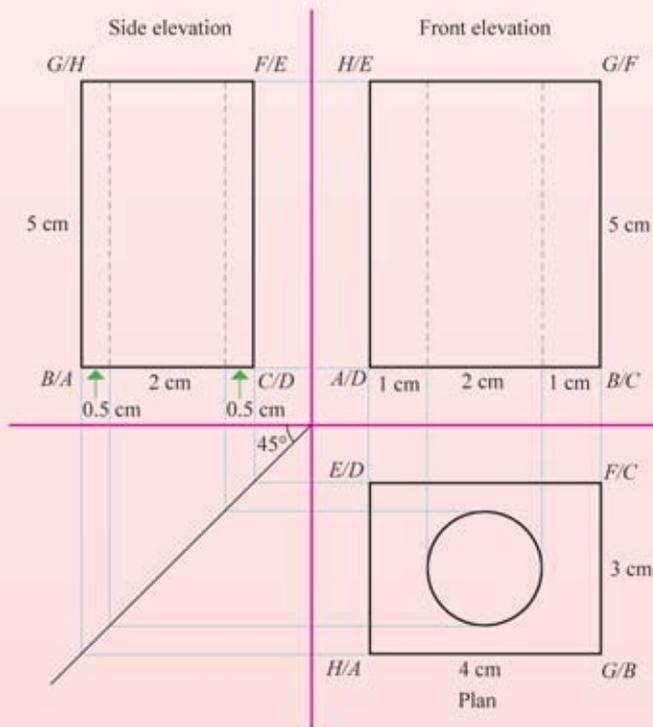
1. The diagram on the right shows a right prism with rectangle $ABCD$ placed on a horizontal plane. AF , BK and JG are vertical.



- (a) Draw to full scale,
- the plan of the prism
 - the elevation on a vertical plane parallel to AB as viewed from X
 - the elevation on a vertical plane parallel to BC as viewed from Y
- (b) The object should be reinforced so that the base of the object is equal to the shape of the plan. What is the volume of the new object to be added?
- (c) If the cost of 1 cm^3 of the new object is RM2.20, calculate the total cost to build the entire combined object.

2. The diagram below shows the plan, front elevation and side elevation of a hollow cuboid. The hollowed section is a right cylinder.

- (a) Sketch the three-dimensional shape of the object.
- (b) Calculate the volume of the object.



STEM

Aim: To build a study hut.

Instructions:

1. Carry out this activity in groups.
2. Propose the construction of a covered study hut in an area of $5\text{ m} \times 5\text{ m}$.
3. Your proposal should consider the following criteria:
 - (a) Maximum use of sunlight during the day.
 - (b) Good air circulation.
 - (c) Eco-friendly and conducive.
 - (d) Minimum construction cost.
4. Prepare a report using multimedia applications.



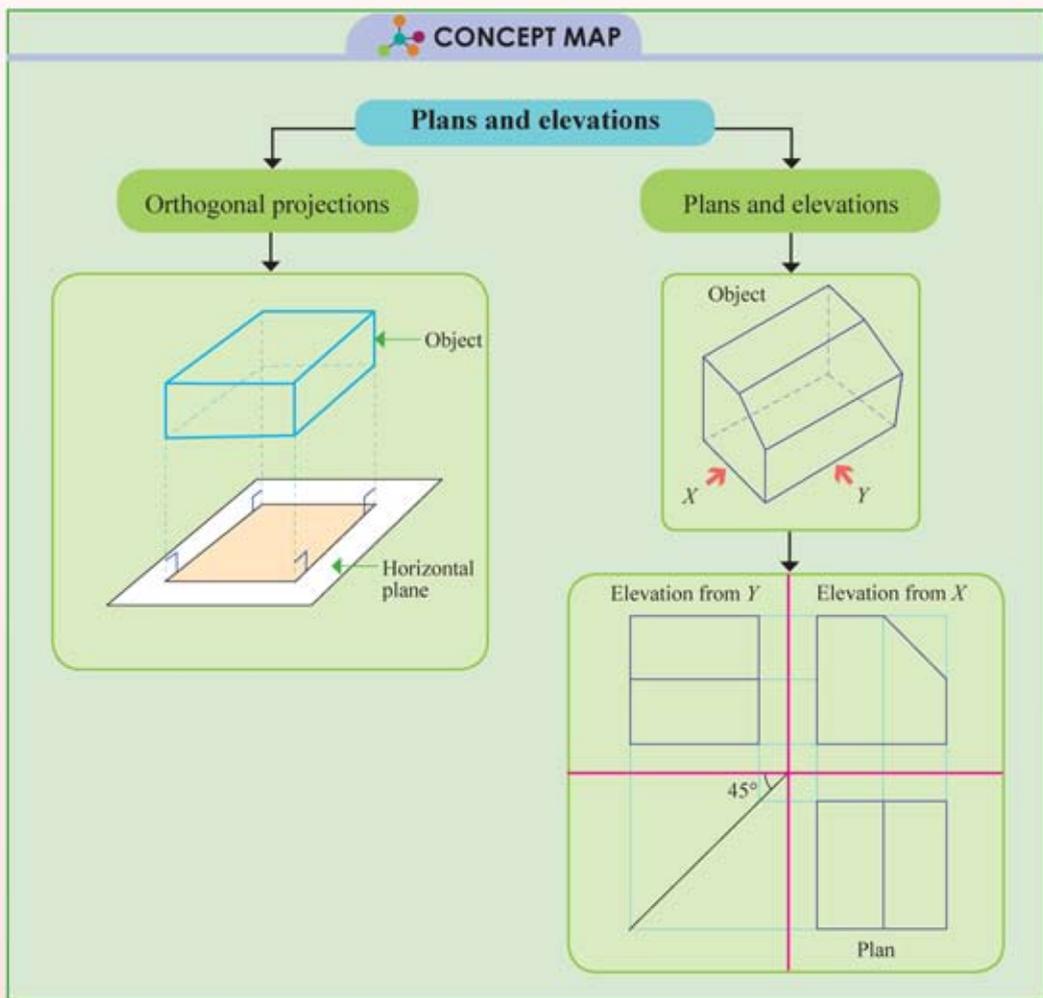
PROJECT

My dream house

1. Draw your dream house with an appropriate scale using scale drawing.
2. Draw the plan, front elevation and side elevation of the house.
3. Build a model of your dream house based on the scale drawing, the plan and the elevations drawn.
4. Decide the building materials required from various sources based on the size of the house that you want to build.
5. Calculate the estimated cost to build your dream house.
6. Show your model house and present your project.



CONCEPT MAP



SELF-REFLECT

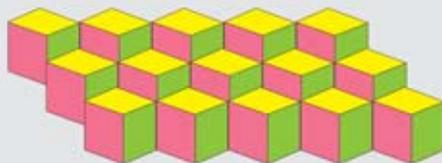
At the end of this chapter, I can:



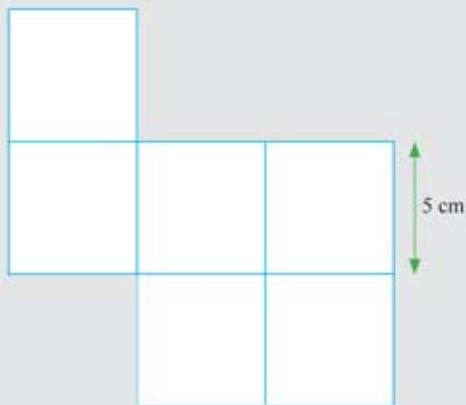
- | | | |
|---|--|--|
| 1. Draw orthogonal projections. | | |
| 2. Compare and contrast between objects and the corresponding orthogonal projections. | | |
| 3. Draw the plan and elevations of an object to scale. | | |
| 4. Synthesise the plan and elevations of an object and sketch the object. | | |
| 5. Solve problems involving plans and elevations. | | |

 EXPLORING MATHEMATICS

1. Prepare 15 pieces of cubes with the side of 5 cm as shown in the diagram. You can also use the Rubik's cube.



2. Use the cubes to form a combined object according to your creativity.
3. Draw the plan and elevations of the combined object that you have created.



4. The group that builds the most creative combined object is the winner.