7 Graphic expression and communication

In this unit you will learn the answers to these questions:

- What is the difference between artistic drawing and technical drawing?
- What **drawing tools** do you know? What are they for?
- What are the differences between a **sketch**, a **diagram** and a **technical drawing**?
- What is **scale** used for in a drawing?
- Why do we have rules for technical drawing?
- How do we show **dimensions**?
- What are the main **views** of an object?

Before you start, check you understand the meaning of the words in blue.

KEY WORDS

drawing tools: instruments to help us draw precise lines

sketch: the first rough drawing of the object we want to create

diagram: a sketch with information about measurements, materials, ways of joining pieces, etc.

technical drawing: a very precise drawing of an object

scale: the proportion between the size of an object in a drawing and its real size

dimension: measurement

view (of an object): the perception of the shape of an object from a particular viewpoint

KEY WORDS

renaissance: renacentista

perspective: the art of making images look three-dimensional (3D)

abstract painting: painting which does not show specific objects or people. The emphasis is on shapes, colours, structures and proportions

digitally altered: changed using a computer

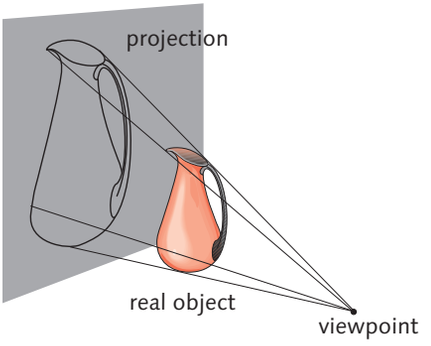
1 Graphic expression

Human beings have always expressed ideas through graphic representation, from cave paintings to computer-generated plans. Graphic expression is used in many different ways for many different purposes.

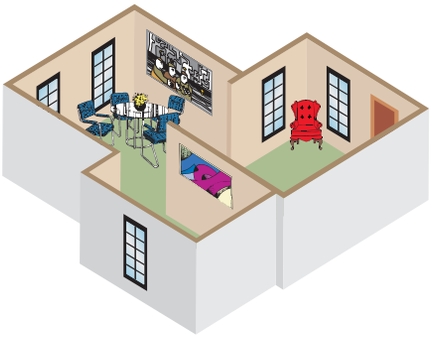
Prehistoric cave painting

Renaissance perspective

Abstract painting



Perspective drawing



Three-dimensional drawings

Digitally altered photograph

The aims of graphic expression in Technology are:

1. To design our own objects, organise our ideas, check how pieces fit together and choose measurements for them.
2. To show our ideas to other people, with sketches and plans that they can understand and reproduce.
3. To make our designs attractive for people who want to use them.

Activities

1 Look at the images above and answer the questions.

a) Which pictures can we create using a computer?

b) Which pictures use paint?

c) Which pictures can we draw with a pencil?

2 Graphic materials

We use different tools for drawing. The choice depends on the type of drawing we want to do.

KEY WORDS

lead: part of a pencil that makes a mark

graphite: a sticky black metallic-looking mineral made of crystallised carbon

clay: a type of fine earth

grade (of pencil / pencil lead): level of hardness

2.1. Pencils

Pencils have a wooden case with a **lead** inside made of **graphite** and **clay**. The lead is softer or harder depending on the amount of graphite it contains. The most common **grades** are:

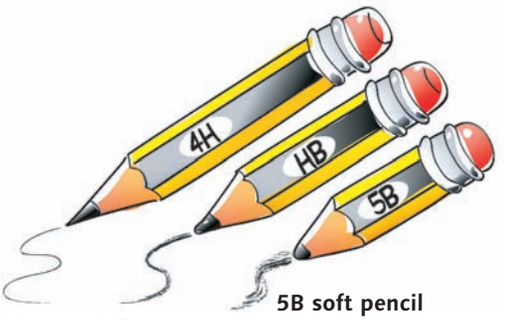
6H, 5H, 4H, 3H, 2H, H, HB, B, 2B, 3B, 4B, 5B, 6B

The hardest is 6H and the softest is 6B.

Types of pencil

There are two types of pencil: H and B. There is also a pencil called HB, which is medium hard.

- **Hard pencils:**
  - Identified by the letter H.
  - Hard and for drawing thin lines.
  - For technical drawing.
- **Soft pencils:**
  - Identified by the letter B.
  - Soft and for drawing thick lines.
  - For artistic drawing.
- **Medium pencils:**
  - Identified by the letters HB.
  - Medium hard and for drawing medium lines.
  - For technical or artistic drawing.



4H hard pencil **HB medium pencil** **5B soft pencil**

Activities

2 In your exercise book, write these grades of pencils in order from the softest to the hardest.

a) H
b) 3B
c) 5H
d) HB
e) 6B
f) 3H

3 Copy and complete the sentences in your exercise book.

a) Drawing pencils can be classified into two types: _____ and _____ according to how hard they are.

b) In technical drawing, we use pencils which are harder than _____ grade.

c) The hardest pencil is _____, and the softest is _____.

d) Hard pencils are identified by the letter _____. They enable you to draw _____ and are used for _____ _____.

e) Soft pencils are identified by the letter _____. The lines that they draw are _____ and they are used for _____ _____.

KEY WORDS

size: how big or small something is

weight (of paper): how thick or thin it is

finish: the appearance of the surface something, e.g. shiny

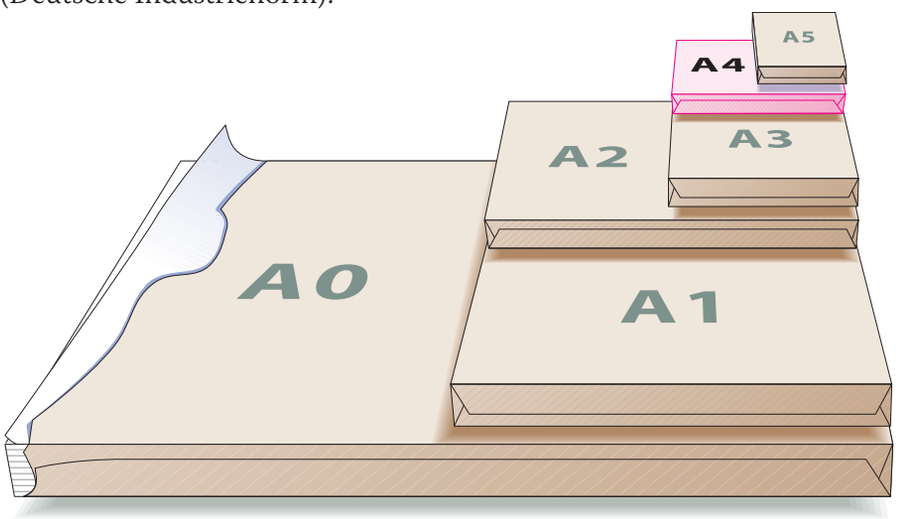
format: the way something is presented in terms of size, shape and appearance

2.2. Paper

The paper we use is also important. Paper can be classified by **size**, **weight** and **finish**.

Types of paper

There are different sizes of paper. These sizes can also be called **formats.** In technical drawing, the most common formats are from the international standard (ISO) 'A' series, which is based on the DIN (Deutsche Industrienorm).



'A' series paper sizes. A0 is a rectangle with an area of 1 m^2. Each format is calculated by dividing the previous format in half.

- A0 is the biggest format in the 'A' series (84.1 cm × 118.9 cm).
- A1 is half the size of A0 (59.4 cm × 84.1 cm).
- A2 is half the size of A1 (42.0 cm × 59.4 cm).
- A3 is half the size of A2 (29.7 cm × 42.0 cm).
- A4 is half the size of A3 (21.0 cm × 29.7 cm).
- A5 is half the size of A4 (14.8 cm × 21.0 cm).

Paper of different textures and colours

Activities

4 Copy the sentences in your exercise book and choose the correct option.

a) A3 format paper is *bigger / smaller* than A5.

b) The format number of the paper is *higher / lower,* if the paper is smaller.

c) The 'A' series paper formats are obtained by *dividing / multiplying* the length of the previous paper size in the series.

3 Drawing tools

The correct drawing tools help us draw precise lines.

KEY WORDS

segment: part of a straight line between two points

angle: the shape, measured in degrees, between two lines that start at the same point

vertex: the point where the two lines of an angle meet

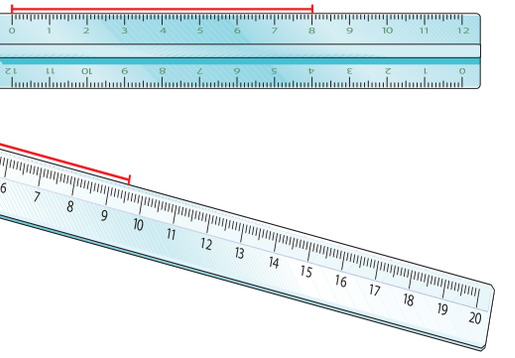
3.1. Measuring tools

Two of the most useful measuring tools are a ruler and a protractor.

Ruler

We use a ruler to measure the length of a **segment**.

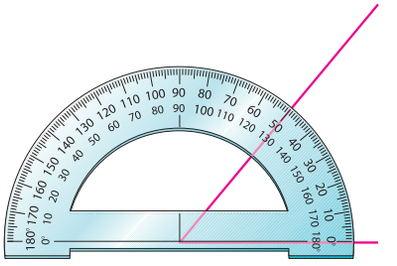
The markings on a ruler show centimetres (a long line) and millimetres (a short line).



1. Put the 0 line on the ruler at the beginning of the segment you want to measure.
2. The measurement is the point on the ruler that matches the end of the segment.
3. Write the measurement in centimetres with a decimal to express the millimetres.

Protractor

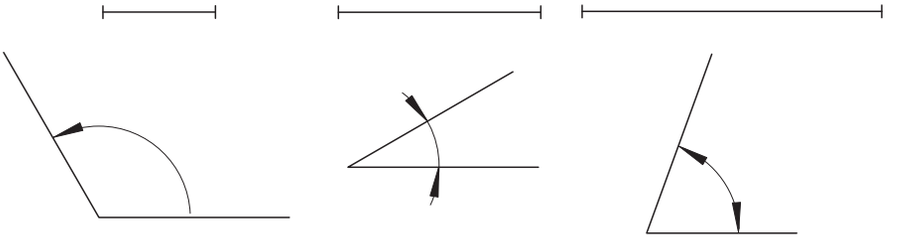
We use a protractor to measure and draw **angles**. A protractor is usually a semicircle with markings to show degrees from 0° to 180°. Sometimes it is a circle with markings up to 360°.



1. Put the centre of the protractor on the **vertex** of the angle you want to measure.
2. Cover one of the sides of the angle with the horizontal line on the protractor. The other line of the angle will correspond to a number on the semicircle of the protractor. This is the measurement of the angle.
3. The measurement is expressed in degrees, using the symbol °.

Activities

5 Measure these segments and angles. Write the measurements in your exercise book.



6 Copy and complete the sentences in your exercise book. Listen and check your answers.

a) 5.5 cm equal _____ mm.

b) 0.1 m equal _____ mm.

c) 10 m equal _____ cm.

d) _____ cm equal 125 mm.

KEY WORDS

set square: a flat piece of metal or plastic in the shape of a triangle with one angle of 90°

parallel: lines with the same distance continuously between them

perpendicular: a line at 90° to another

arc: part of a curve or circle

radius: the measurement from the centre of a circle to its circumference

stencil: a sheet of plastic or paper with shapes cut out so they can be reproduced on a surface

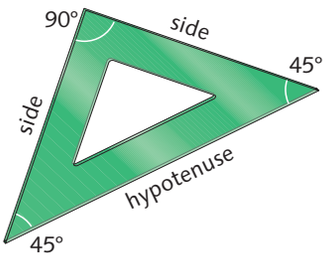
3.2. Tools for drawing lines

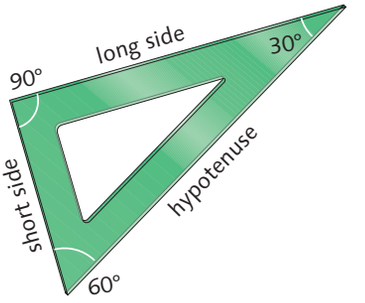
We can draw lines using a set square or a pair of compasses.

Set square

Set squares are triangular 'rulers' for drawing **parallel** and **perpendicular** lines. They come in two shapes:

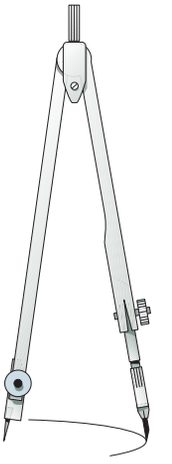
- A right-angled isosceles triangle (*escuadra*) with 45°, 45° and 90° angles.
- A right-angled scalene triangle (*cartabón*) with 90°, 60° and 30° angles.





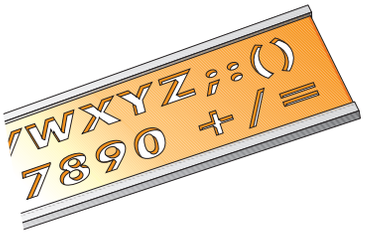
Compass

This instrument is used to draw circles and **arcs**, and to copy segments. It has two connected arms. One has a sharp metal point and the other a lead. Both arms must be the same length.



1. Open the compasses to the measurement you want. If you want to draw a circle, the measurement is the same as the **radius**.
2. Put the metal point in the centre of the arc or circle you want to draw.
3. Turn the compass to draw the arc or circle with the lead.

We can also use **stencils** to draw circles, squares, rectangles, numbers, letters, symbols, etc.



Activities

7 In your exercise book, draw a circle with a radius of 1.5 cm. Then draw a circle with a radius that's 1.5 cm bigger around the first circle.

8 Match the words and definitions. Write them in your notebook.

Set square	We use it to measure angles.
Ruler	We use it to draw parallel and perpendicular lines.
Compass	We use it to draw arcs and circumferences.
Protractor	We use it to measure lines.

3.3. How to draw straight lines

KEY WORDS

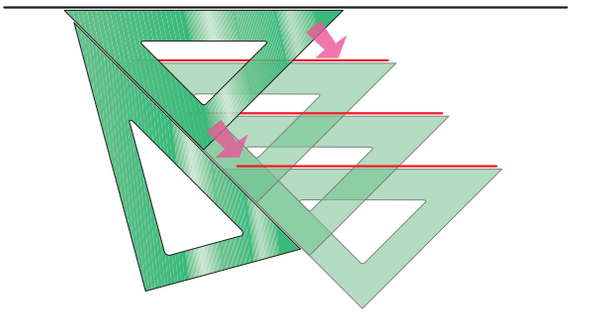
hypotenuse: the side of a triangle opposite the 90° angle

dot: a small mark made with the point of a pencil

Drawing parallel lines

These lines never cross.

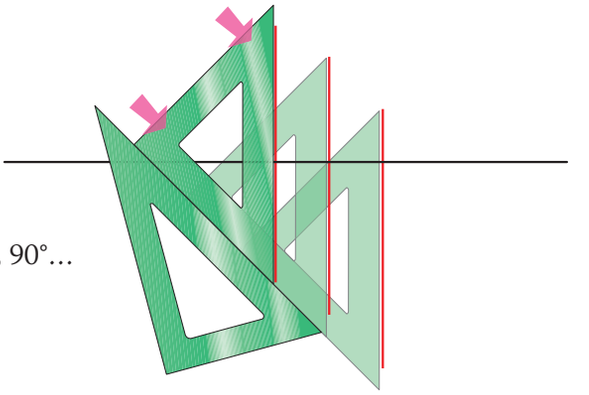
1. Draw a straight line.
2. Put the **hypotenuse** of the isosceles set square on the line.
3. Put the scalene set square on the other side.
4. Hold the scalene set square in place and move the isosceles set square up or down to draw a parallel line.



Drawing perpendicular lines

These lines touch and make an angle of 90°.

1. Draw a straight line.
2. Put the set squares in the same position as for parallel lines.
3. Turn the isosceles set square round and draw another line perpendicular to the first line.

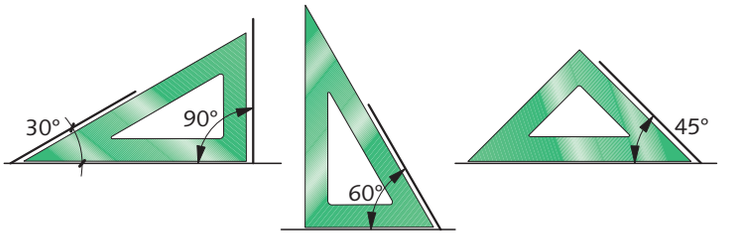


3.4. How to draw angles

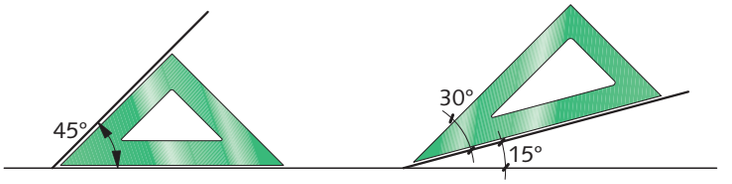
Using set squares

We can use set squares to make angles of 15°, 30°, 45°, 60°, 75°, 90°… in fact any multiples of 15.

1. We can draw 30°, 45°, 60° and 90° angles directly.

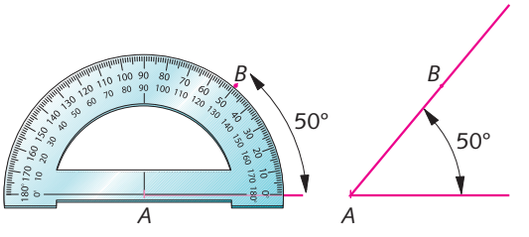


2. To draw a 15° angle, first draw a 45° angle with the isosceles set square. Then place the scalene set square on the new line and draw a 30° angle. The new angle will be 15° (45° – 30°).



Using a protractor

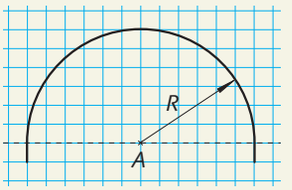
1. Draw a line.
2. Put the protractor on the line with the end of the line at the centre of the protractor (A).
3. Choose the angle you want and put a **dot** (B) next to the number.
4. With a ruler, draw a line connecting A to B.



3.5. How to draw arcs

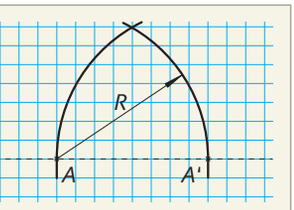
We can draw arcs and combinations of arcs with a pair of compass.

Drawing a semi-circular arc



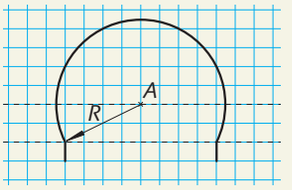
1. Choose two base points.
2. Measure to find the centre point between them.
3. Put the point of the compasses on the centre point and the lead on one of the end points. Rotate the arm with the lead around the centre point. The arc is half the circumference of a circle.

Drawing a pointed arch shape



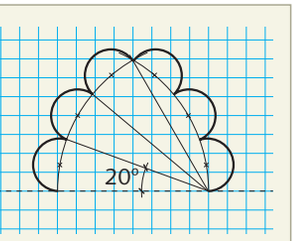
1. Choose two base points.
2. Put the point of the compass on one bass point and draw an arc.
3. Keeping the same radius, put the point of the compasses on the other bass point. Draw another arc crossing the first.

Drawing a horseshoe arc



1. Choose two base points.
2. Measure to find the centre point between them.
3. Divide this measurement by 4 and put the point of the compass that distance above the centre, at A.
4. Draw an arc to connect the two original points.

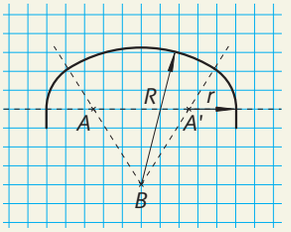
Drawing arcs around an arch shape



1. Draw a pointed arch shape.
2. Divide it into equal parts, using 10° and 20° angles.
3. Find the centre point of each part and draw a small semi-circle around each point.

Drawing a carpanel arch shape

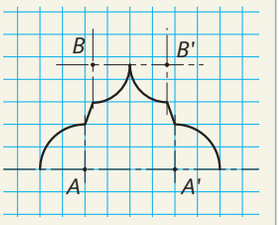
This has three centre points and two radii.



1. Choose two base points. Choose two other points between the base points and the same distance from them, at A and A'.
2. Draw a small arc from both A and A'.
3. Choose a point of equal distance between, but below, the base points (B).
4. With the point of the compasses at B, draw an arc to connect the two small arcs.

Drawing a multilinear arch shape

We can make a shape like this, using arcs and straight lines.



1. To make two arcs meet to make a point, put the point of the compasses on the same line for each arc (B and B'). Use the same radius.
2. To make an arc meet a straight line, find a point in a vertical line from the end of the straight line and put the compass point there to draw the arc.

Activities

9 Listen and write the words in your exercise book. Mark the stress on each word. Listen and repeat.

10 Use set squares to draw three parallel lines in your exercise book.

11 ***a)*** Use set squares to draw a square with 5 cm sides.

b) Draw two diagonal lines to join opposite corners. Put the point of the compasses where the lines meet and draw a circle that touches the sides of the square.

c) Draw another circle outside the square that touches each vertex.

12 In your exercise book, draw and label the different shapes you can make with arcs.

13 Listen and follow the instructions, writing in your exercise book.

14 Listen and repeat.

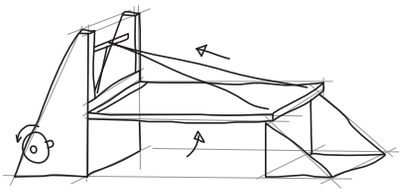
4 Sketches, diagrams and technical drawings

KEY WORDS

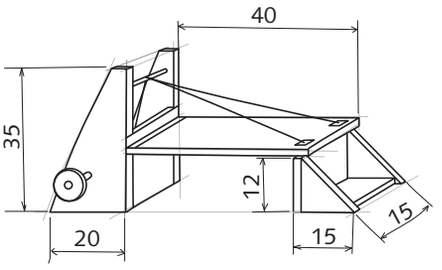
freehand: drawing without using rulers or other drawing tools

materials: e.g. wood, paper, card, paint

This is a **sketch.** It is an initial drawing which shows the fundamental elements of a design and reflects its main concept.

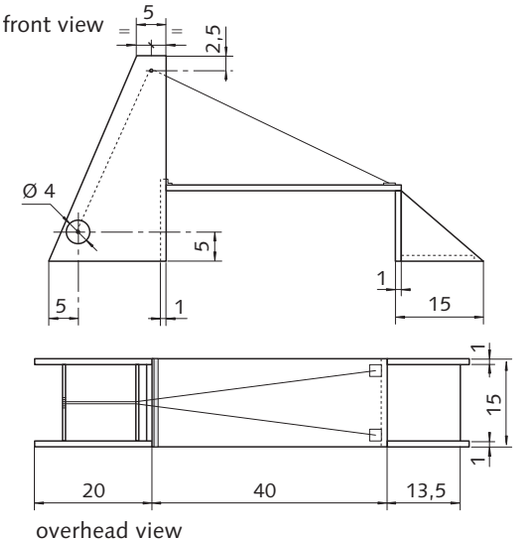


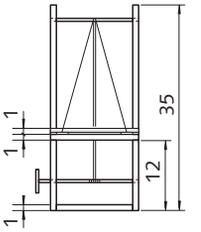
This is a **diagram.** It has more information than a sketch.



We draw sketches **freehand** with a pencil. We don't have to use rulers or other drawing tools. We can draw diagrams in the same way. To start a project, we usually draw various sketches, then a more specific diagram and finally an accurate technical drawing.

- A sketch shows our first idea of the object we want to make.
- A diagram gives more specific information, including measurements, **materials**, ways of connecting the pieces, etc.
- A technical drawing has the same information as a diagram but we must use a ruler, set squares, a pair of compasses or a computer to give an exact picture.





Activities

15 In your exercise book, draw a diagram of your pencil case.

16 In your exercise book, draw a sketch of a toy car made of wood.

17 In your exercise book, draw your ideal bedroom. Include details of measurements.

18 Copy and complete the sentences in your exercise book. Use these words: *measurements, freehand, exact.*

a) We draw a sketch _____, without a ruler.

b) We use diagrams to show the _____ of the object.

c) We make technical drawings to give an _____ picture.

19 Listen and decide if the person is describing a sketch, diagram or technical drawing.

KEY WORDS

reduce: make smaller

enlarge: make bigger

scale rule: ruler for measuring scale

5 Scale

We often design objects that are bigger or smaller than the paper we draw on. We need to choose a scale to fit on the paper and show the proportion between the life-size object and the technical drawing.

When the drawing is the same size as the real object, the scale is called full scale (*escala natural*). Full scale is expressed as a scale of 1:1.

However, we can choose a scale to **reduce** (*escala de reducción*) the size of the drawing to make it smaller than the object.

Examples:

Scale 1:2: The drawing is half the size of the real object.

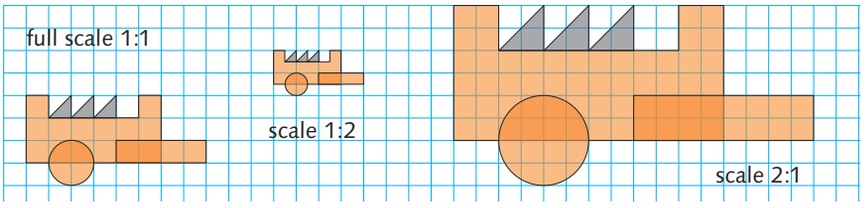
Scale 1:3: The drawing is a tenth of the size of the real object.

We can also choose to **enlarge** the drawing (*escala de ampliación*) to make it bigger than the object.

Examples:

Scale 2:1: The drawing is twice as big as the real object.

Scale 3:1: The drawing is three times as big as the real object.



Scale rule

We use a **scale rule** to read and write scale measurements. A scale rule is a measuring tool in the shape of a triangular prism that has 6 engraved measuring scales. If we know the scale of a drawing, we can use the appropriate measuring scale to interpret the measurements without having to make numerical calculations. For example, when you are interpreting a drawing with a scale of 1:100, you simply count each principal division on the scale rule as equivalent to 1 m in reality.

Activities

20 In your exercise book, draw your pencil sharpener to these scales.

a) 1:1 ***b)*** 1:2 ***c)*** 2:1

21 Describe these scales in your exercise book. Then listen and check.

Example: *Scale 1:2 means half as big.*

a) Scale 2:1 ***c)*** Scale 1:5

b) Scale 10:1 ***d)*** Scale 100:1

22 Copy and complete the sentences in your exercise book. Choose the correct words.

a) An object is *smaller / larger* than the drawing in an enlarged scale.

b) We use a *scale rule / ruler* to read the measurement of a scale.

c) The drawing is smaller than the object in *an enlarged / a reduced* scale.

6 Rules and dimensions

6.1. Rules

There are some general rules which apply to technical drawing. These rules are called *normalización técnica* in Spanish. They define: the types of lines and symbols used in technical drawings, the sizes of paper, the most common scales, the angles of perspectives, etc.

Types of lines

Different types of lines are used on a technical drawing to represent different things.

Name	Style	Purpose
Edge	———	Shows the edge of the object
Hidden edge	- - - - - -	Shows a hidden edge (not visible on the real object from a particular viewpoint)
Section	———	Shows a cut (usually imaginary) through the object
Axis	—·—·—	Shows the axis of an object
Sectioned plane	▨	Shows the plane of a sectioned object

KEY WORDS

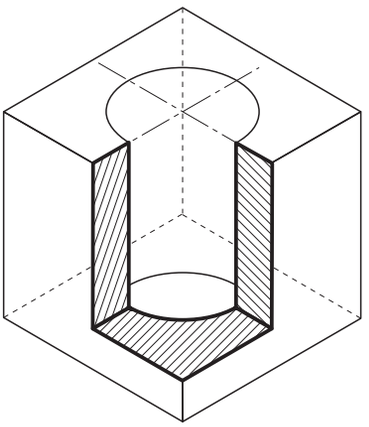
edge: the line that shows the limit of an object

axis: a line dividing a symmetrical shape or object

sectioned: cut

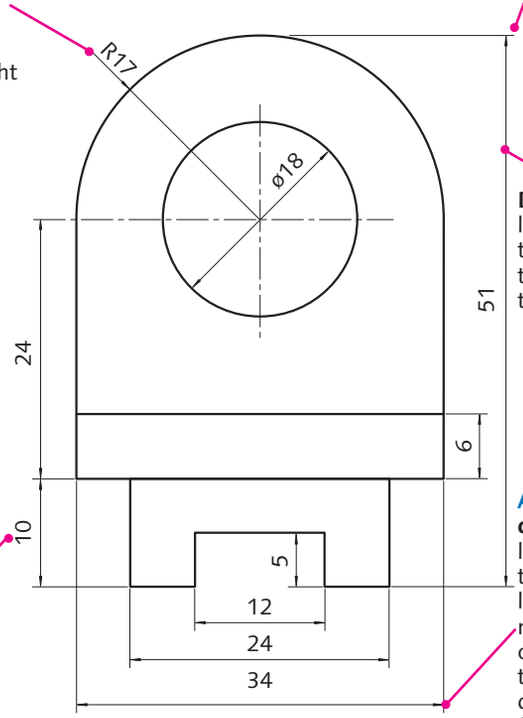
plane: a flat surface

auxiliary: additional / supporting



6.2. Dimensions

Dimensions show the real measurements of an object to help us understand the drawing. The following elements can be used in annotations.



Symbols: we write these before a number to show a special dimension that is not a straight edge, e.g. *R* for radius.

Symbols at the end of the dimension lines: these include arrows, sloping lines or dots.

Dimension line: a line parallel to and the same length as the edge we want to measure.

Dimension: this number shows the real measurement of the object. We normally write it in millimetres. You must write all measurements in the same unit.

Auxiliary dimension line: a line perpendicular to two dimension lines. It shows the measurement from one line, or edge, to the other. We draw it 2 mm in from the end of the dimension lines.

Activities

23 Copy these sentences in your exercise book and complete them with these words about dimensions: *dot, axis, dimension.*

a) We draw a _____ line parallel to the edge we want to measure.

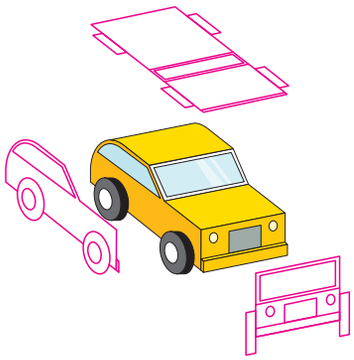
b) We use a line like this _____ to show the _____ of an object.

c) A _____ (•) is an example of symbol used in dimension drawing.

KEY WORDS

perception: the way we see something

elevation: a scale drawing showing one side of an object or building



Various lines show different parts of the object

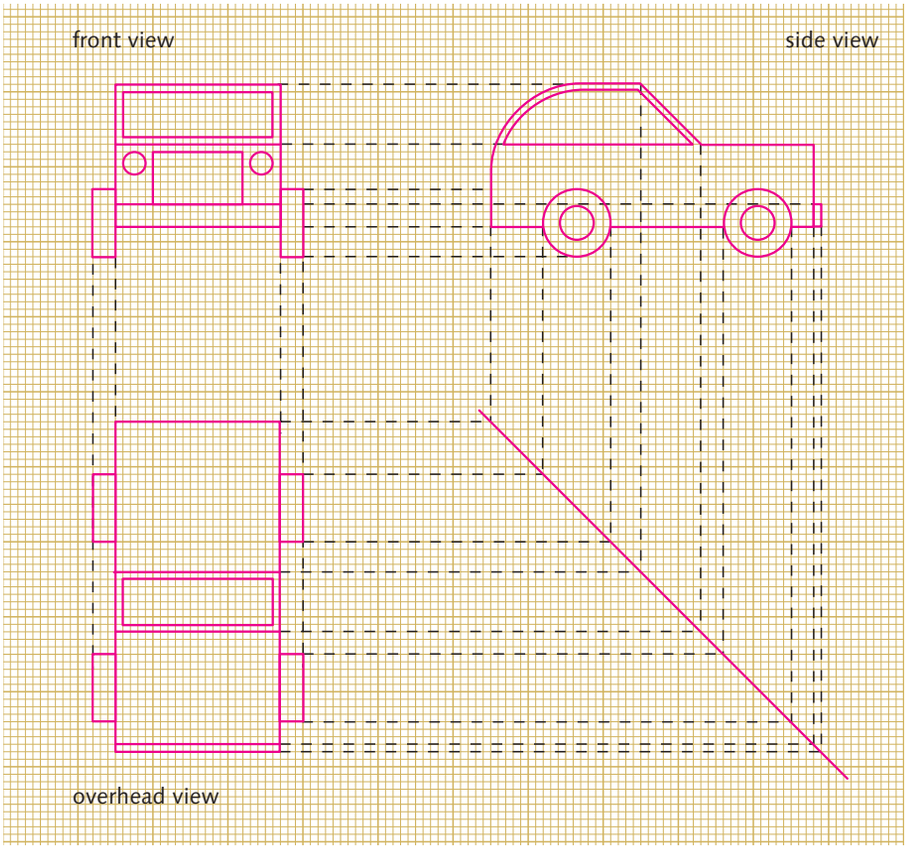
7 Views of an object

Our **perception** of an object depends on which viewpoint we look at it from. An infinite number of viewpoints are possible, but for technical drawing we use three principal views to give complete details of an object:

- **Front view** (***alzado***)**:** this is what we see when we are in front of the object. The drawing from this view is called a front **elevation**.
- **Side view:** this is what we see when we look at the profile from one side of the object. The view can be from the left (*perfil izquierdo*) or the right (*perfil derecho*). The drawing from this view is called a side elevation.
- **Overhead view** (***planta***): this is what we see when we look down from above the object. The drawing from this view is called a plan.

Before you make drawings of a small object, hold it up and close one eye so you can see the edges more clearly.

When you put the drawings together on a page, they have to be in specific positions in relations to each other so that we can interpret them. Look at the positions of the three views on the drawing below.

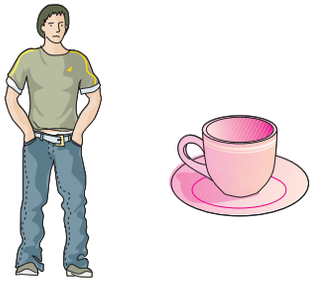


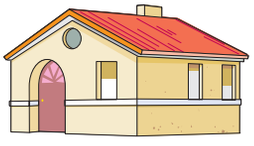
When you draw the front, side and overhead views of an object:

- Use the same scale for all the drawings.
- Make sure the outlines of the object match the same lines in all the drawings.
- Choose the best views to draw. This depends on the shape of the object.

Activities

24 In your exercise book, draw a side view and an overhead view of these objects.





7.1. How to draw plans and elevations

KEY WORDS

vertices: plural of vertex.

projected: show as an image.

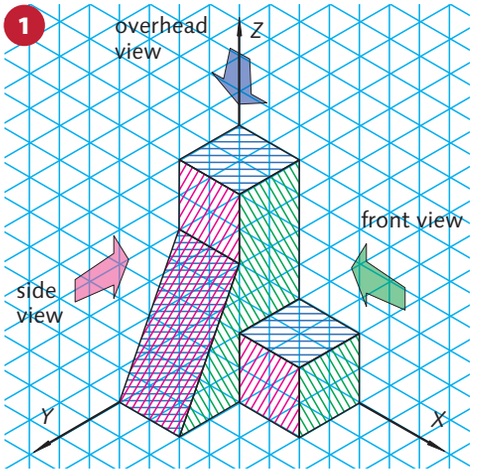
projection: presentation of a shape as a image on a flat surface.

height: a measurement from the top to the bottom of an object.

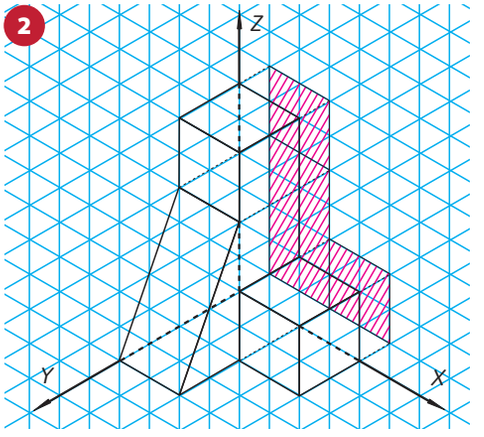
width: a horizontal measurement.

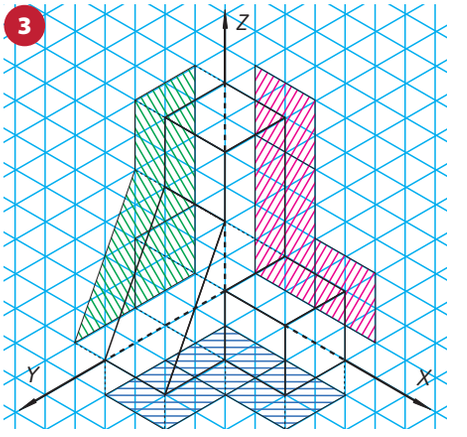
depth: a measurement from the front to the back of an object.

1. Mark the surfaces in each plane, using a different colour for what you can see from each viewpoint. When surfaces can be seen from two different viewpoints (this happens when surfaces slope or curve), use stripes of the relevant colours.



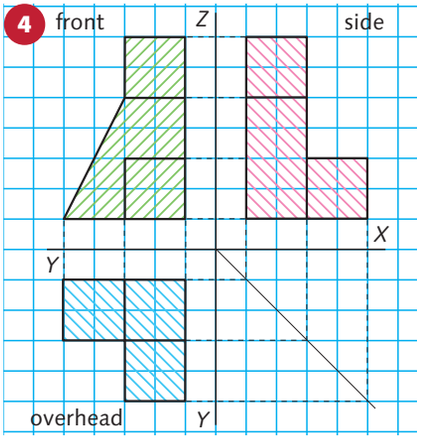
2. All the surfaces in each colour will be shown on separate drawings. Start with the simplest surface from one viewpoint. Think about the whole shape (rectangle, triangle, etc.) from that viewpoint, even if part is hidden behind another shape. Find its **vertices**, measure it and draw it as though it is projected onto the paper. Then draw the other surfaces seen from the same viewpoint, in relation to the first.





3. Imagine the **projection** of the surfaces in each plane. There are edges and vertices on different surfaces that have the same projection.

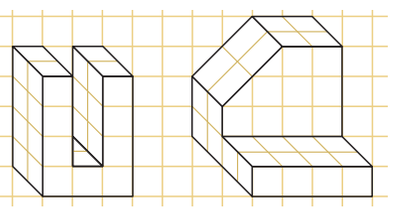
   These surfaces can be connected together. Draw them first. Finally, draw the surfaces that are not parallel to any others to show how they are projected onto the plane.



4. When you have made the two other drawings, consider how all three interrelate. The front and side elevations have the same **height**. The plan and front elevation have the same **width**. The plan and side elevation have the same **depth**. You now have three separate but related drawings on one sheet of paper.

Activities

25 Draw the plan, front elevation, and left and right elevations of the objects.



26 In your exercise book, draw the plan and front elevation of a pen with the lid on. Do you need to draw the side elevation? Why/Why not?

KEY WORDS

orthogonal projection: a system of drawing an object by projecting its outline onto various planes at right angles to each other

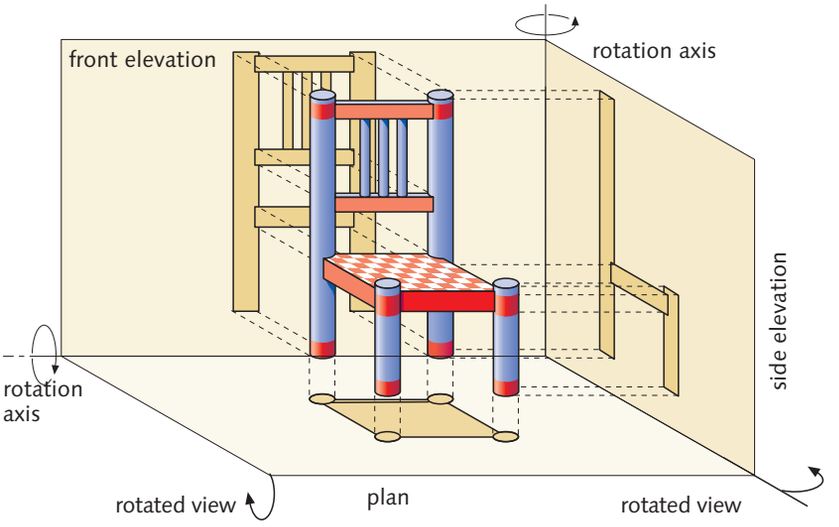
rotation axis: where two planes meet

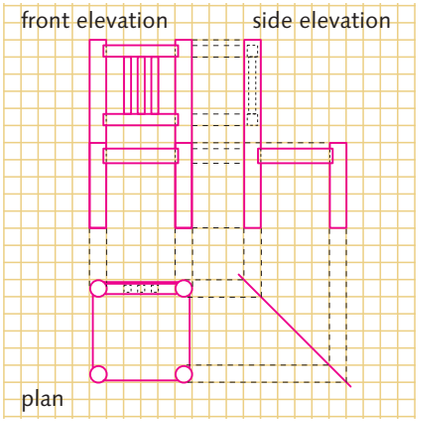
aligned: on the same level as something else

8 Dihedral system

When we represent the views of an object, we are in fact simplifying another system of representation: the dihedral system.

This system uses **orthogonal projection**. We project the edges of the object onto flat planes on the other side of the object, to help us draw the plan and elevations on one sheet of paper.





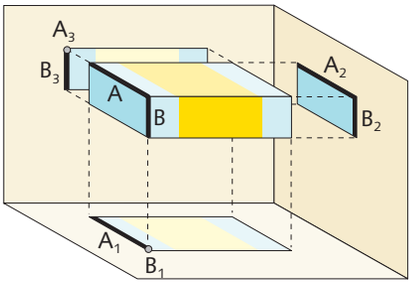
Orthogonal projections of a chair

Orthogonal views of an object, such as a chair, can be shown on a flat surface like a sheet of paper.

- The overhead view is projected onto the horizontal plane under the chair. If the plane is a sheet of paper, it can be folded along the **rotation axis** to make a vertical plan. The front view appears on the vertical plane at right angles to the plan, behind the chair.
- We now have two interrelated views: the plan and the front elevation. The edges that appear on both planes are **aligned**.
- The side view is created in a similar way to give the side elevation with more information about the object. Again, the relevant edges are aligned with the other drawings.

Activities

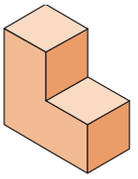
27 Look at the picture and answer the questions.



a) How many times does each edge of the object appear on the plan and elevations?

b) How does an edge that appears on an elevation appear on a plan?

28 In your exercise book draw freehand the plan and front and side elevation of this object.



9 Perspective

KEY WORDS

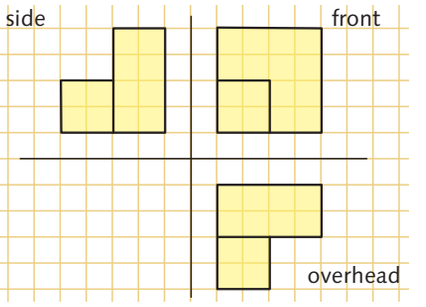
axes: plural of axis

isometric: a shape with equal dimensions

Perspective shows us the whole object instead of its separate views.

We use perspective:

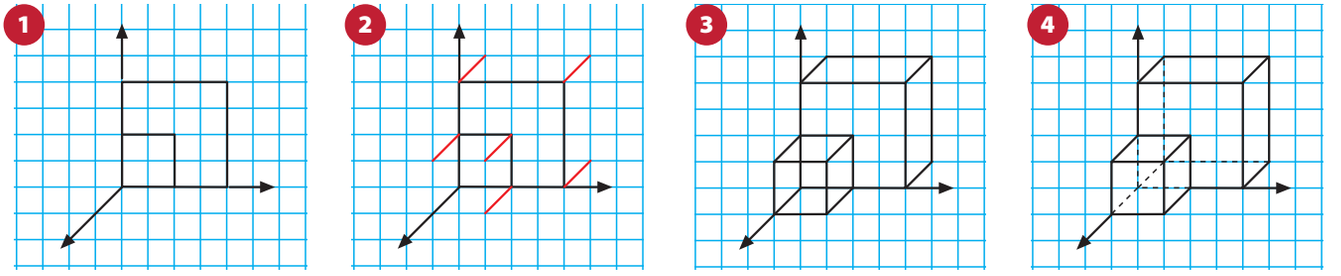
- To show a complete object in the way we really see it
- To draw several views of an object on the same sheet of paper.



9.1. Types of perspective

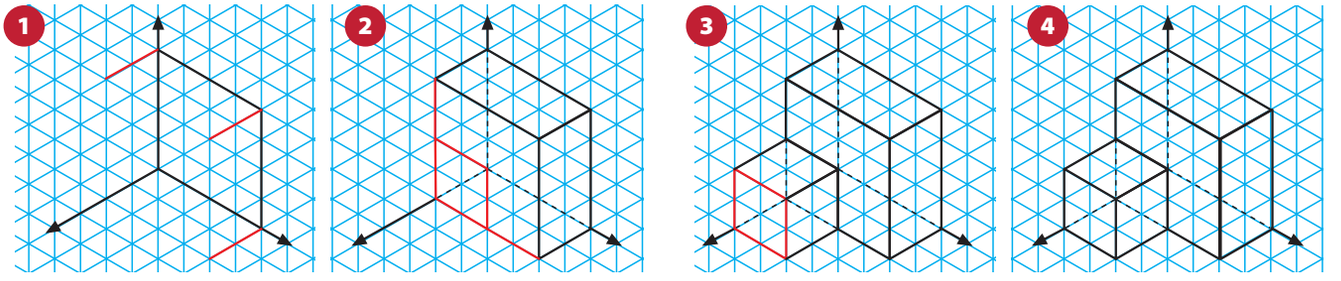
One-point perspective

On a two-dimensional surface like a sheet of paper, we show this perspective by using two **axes** at right angles to each other, with a third axis at 135° to the others. Drawing an object on squared paper is easy because any lines parallel to the main axes follow the squares or the diagonals.



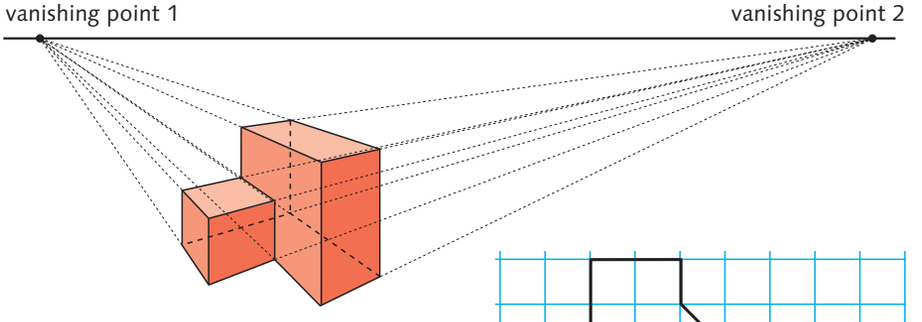
Isometric perspective

We draw the three main axes with a separation of 120° between them. We draw the edges of the object parallel to these axes.



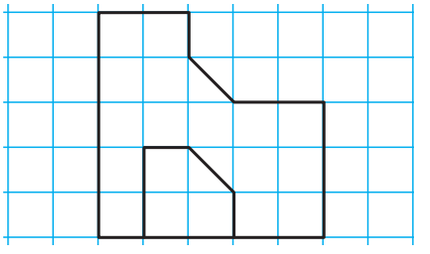
Conical perspective

The object looks the same as we really see it. The lines in the drawing come from one viewpoint (like the human eye).



Activities

29 Copy this shape in your exercise book. Draw the external face diagonally in one square. Draw the interior part in two squares. Draw the three views of the object.



Analysis of a water filter jug

KEY WORDS

pour: to pass liquid out of a bottle or jug

handle: the part of an object you use to hold it

spout: the part of a jug where the liquid comes out

A water filter jug has various different shaped parts, which help it to work effectively. In order to analyse the jug, we need drawings and descriptions:

- **Complete drawing** of the object (using perspective) and a description. We can use photographs to help examine the shape and parts.
- **Plan, side elevation and front elevation** describe the exact measurements of the jug and its parts.

Front view

Side view

Overhead view

- **Description of how it works:** We need to know how the jug works in order to understand why the parts are a particular shape. For example, *Lift the lid and **pour** water into the top part of the jug. The water goes through the filter into the bottom part. The filter collects the impurities and salts from the water.*
- **Parts of the object:** Draw each part of the object separately (using perspective or views). Describe the shape and location of each part and think about the relation between form and function.
  - The **main jug** is a rectangular prism with round corners. It has a **handle** on one side and a **spout** for pouring the water on the opposite side.
  - The **filter jug** is white. It is on top of the main jug and has the same basic shape.
  - The **lid** is curved. It covers the jug, the handle and the spout. It clips into place so that it stays on while pouring. The part covering the spout opens to pour the water.
  - The **filter** is tube-shaped. Inside it has material that collects the impurities from the water.

Activities

30 Draw the filter jug in perspective.

31 Draw a plan and two elevations of the jug.

32 Label the different parts of the jug.

Drawing tools

CAD (Computer-Assisted Design)

There are two main groups of computer programs:

Artistic drawing programs include Paint, OpenOffice Draw and Corel Draw. There are also programs to digitally enhance photographs.

We use these programs to change the colour of the **pixels** on the screen and create pictures.

Technical drawing programs include AutoCAD®, QCad, MicroStation, etc.

We use these to draw precise plans with geometrical forms.

There are also programs that combine both types of drawing.

This is an image made with the program **Paint**. This program has a toolbar that allows you to do the following operations:

PAINT DRAWING TOOLS		
Free-form select		Select (rectangular area)
Eraser (secondary colour)		Fill with colour (in a limited area)
Pick colour (choose colour on the drawing)		Magnifier
Pencil (free drawing)		Brush (draws thicker lines)
Airbrush (diffuse colour)		Text (to include text in a drawing)
Straight line (between two points)		Curved line
Rectangle		Irregular polygon
Ellipse (by axis; pressing Caps makes circles)		Rectangle with round corners

Other options in the main menu include:

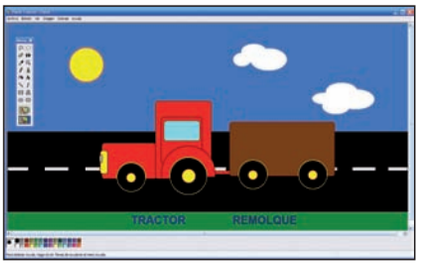
- File (*Archivo*)
- Edit (*Edición*)
- Help (*Ayuda*)
- View (*Ver*) (to magnify or reduce)
- Image (*Imagen*) (to change size or rotate)
- Colours (*Colores*) (to create different colours).

This program does not let you draw with precision. You draw freehand, so it is not very appropriate for technical drawing.

KEY WORDS

pixel: dots of colour on a computer screen

spectrum: a range



To use different colours, we can select from a spectrum of given colours or create colours using RGB, combining red, green and blue.

Activities

33 Which Paint tools were used to create the drawing of the tractor?

34 Use Paint to draw the picture of the tractor or create a new picture.

The magic egg

KEY WORDS

label: write information on the object

bisector: a line or plane that cuts or divides another line or angle into two parts

erase: delete or remove

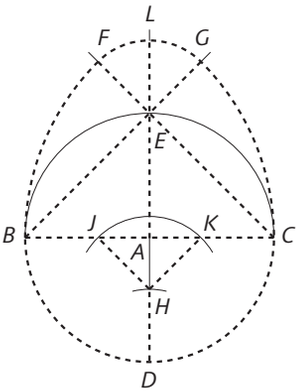
Do you know Chinese tangram puzzles? Each puzzle is a set of flat geometric shapes that make a three-dimensional shape.

We can use the same idea to create the shape of an egg, using technical drawing tools or a computer program.

Making a tangram with drawing tools

Follow the instructions to make the egg.

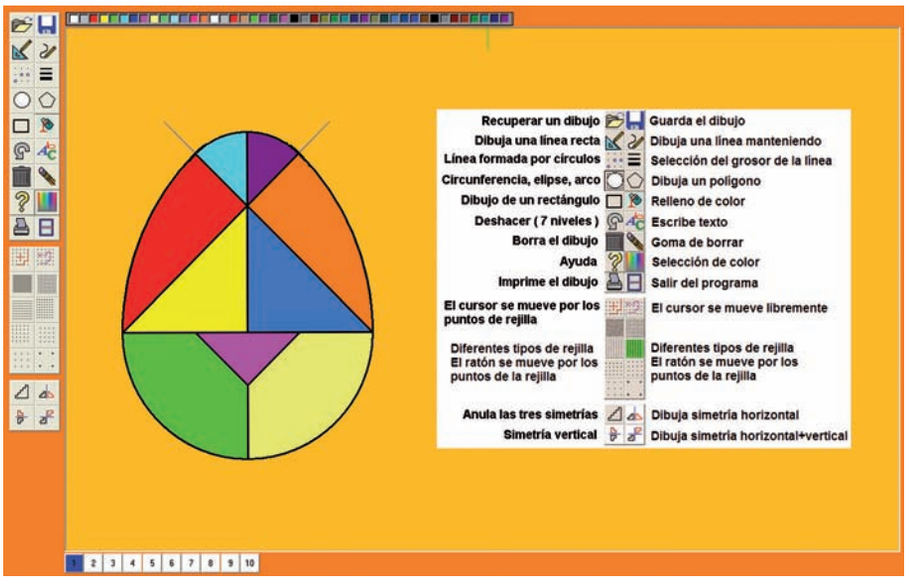
1. Draw a horizontal line 15 cm long. **Label** the ends B and C.
2. Draw the **bisector** with a compass and label it A.
3. Draw a circle (with centre A and radius AB). Label points D and E.
4. Join B with E and C with E. Continue the line DE for 5 cm above E. Label the end point L
5. Draw an arc (with centre B and radius BC). It cuts the line BE at point G.
6. Repeat step 5, with centre C. It cuts the line CE at point F.
7. Draw an arc (with centre E and radius EF) to join F and G through L.
8. Draw a line parallel to EF to label H on the line DA.
9. Use radius EF to draw an arc (with centre H) to cut the line BC at J and K.
10. Join H to J and H to K. **Erase** HA.



Making a tangram with a computer program

You can use DibuGeo. Download this program from: **http://www.soldetardor.com/jffa/portada.htm**.

Look at the tools in the program:



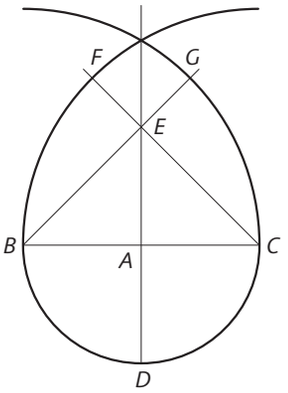
DibuGeo Tools: Click on a tool option. A submenu appears. To draw, click and drag the option you want. Try drawing lines, circles and arcs. Use different colours, thicknesses and sizes.

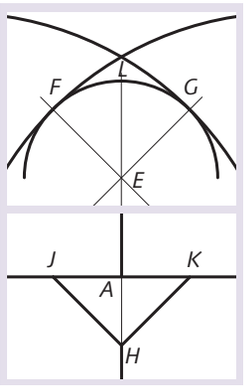
Drawing instructions

KEY WORDS

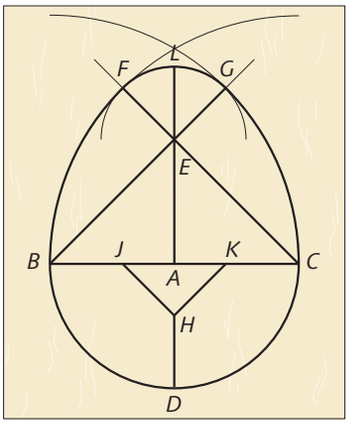
grid: network of squares

1. Select the biggest **grid**, the colour blue and the thinnest line.
2. Draw a vertical line DE over 12 squares on the grid.
3. Draw a horizontal line BC across the centre point of DE. The lines cross at A.
4. Draw the diagonal lines BG and CF through point E, extending the lines three squares beyond E.





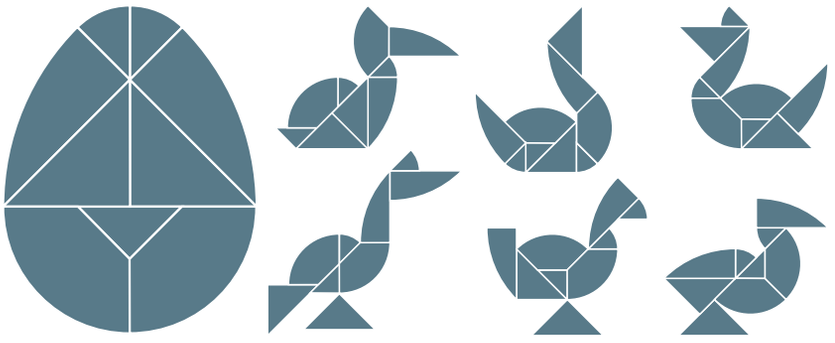
5. Select the colour black and the third line thickness. Draw a semi-circle at the bottom of the egg from point B to C. The radius is 6. Select the smallest grid and draw two quarter circles from points B and C. The radius is BC. They cross at L.
6. From point E, draw a semicircle through points F and G.
7. Select the grid in the fourth place (half the size of the biggest one). Draw two diagonal lines JH and KH. Each point is five spaces from A.
8. Erase the lines that are not needed for the tangram and colour the different areas.
9. Print the tangram onto card and cut out along the thick lines.

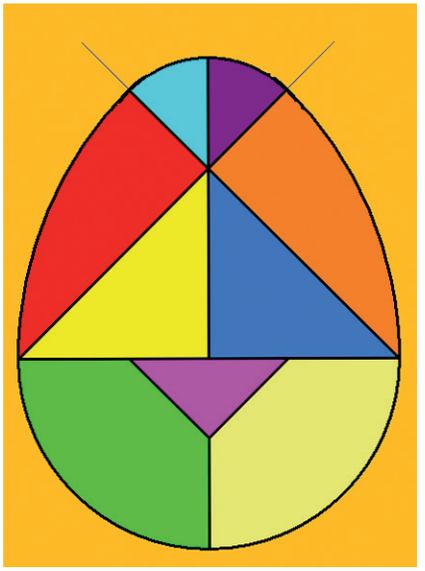


Activities

35 Copy the egg shape onto card or paper. Cut out the separate pieces and measure the straight sides. Which pieces have the same measurements?

36 Use the tangram pieces for the egg and make the birds shapes.





37 Draw the outline of the birds in your exercise book. Close this book and try to make the bird shapes again.

38 Invent another shape, using all the tangram pieces. Guess what your partner's shape is. **Example:** *Is it a… car?; It looks like a … train.*

Making your own three-dimensional model

KEY WORDS

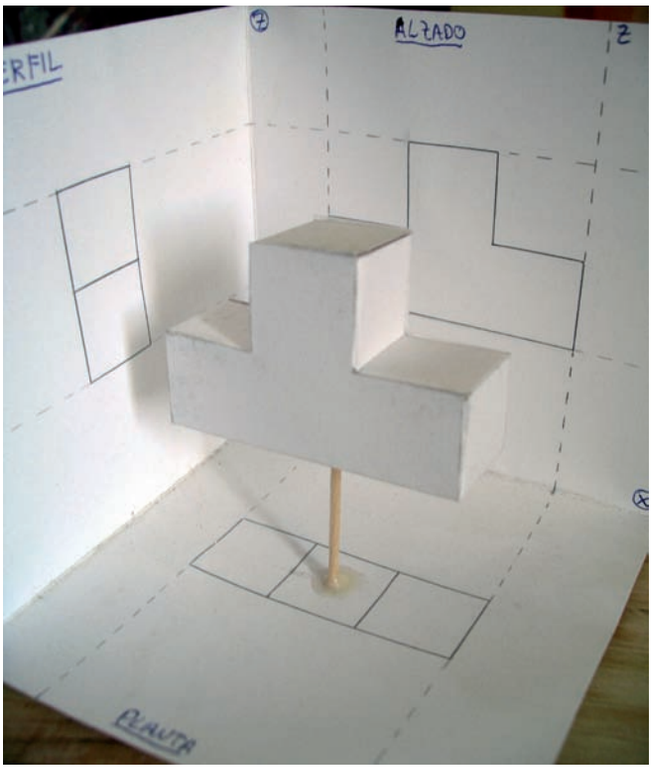
trihedral plane: a folded plane to make three views at right angles to each other

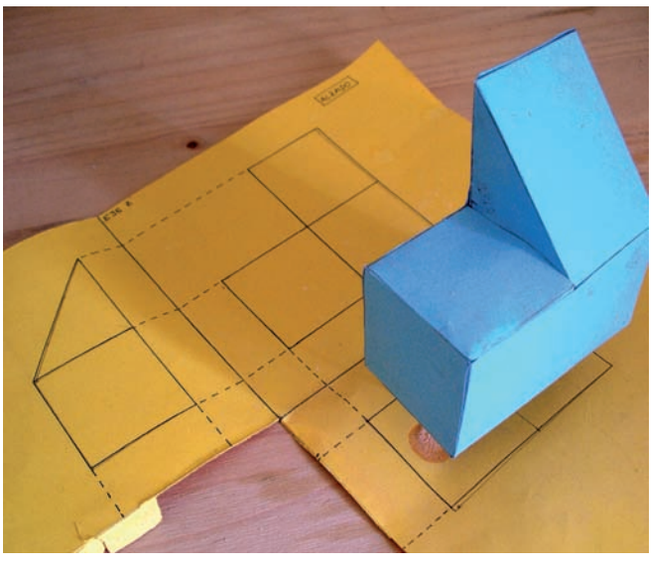
tab: a small flap or strip (of card) for connecting one piece to another

In this section you are going to build a three-dimensional model, using orthogonal projections. This will also help you to understand the different views.

To make the models, use thin card, a ruler, a pencil, thin card, scissors and glue or adhesive tape.

Making a simple model

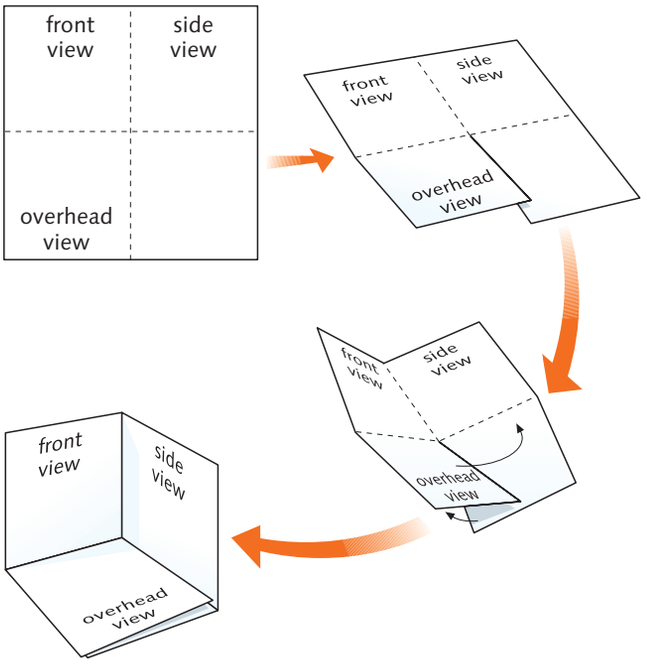




1. Draw the overhead, front and side views of the object on paper. Use an appropriate scale.
2. Copy the shapes onto card and cut around the outlines.
3. Join the pieces along the edges they have in common to make the original three-dimensional shape.
4. Fold your original drawings to make a **trihedral plane** as shown opposite. Compare your model to the trihedral plane.

Making a trihedral plane

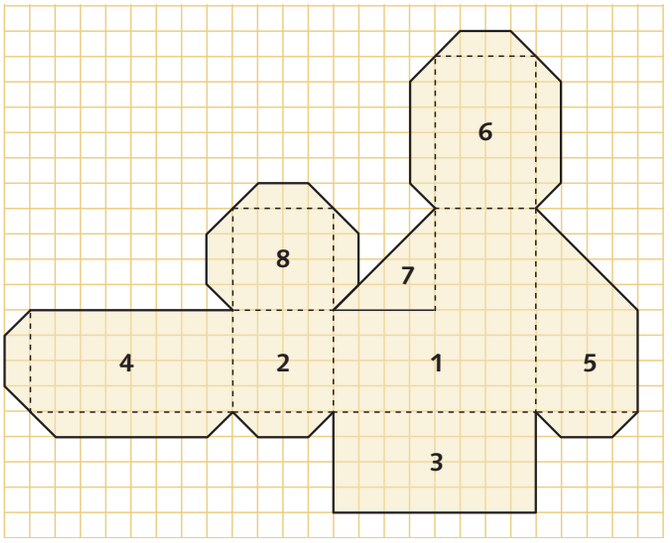
1. Look at the diagram and draw four squares (15 cm × 15 cm) on the paper.
2. Cut along the thick lines and fold along the dotted lines. Fold carefully and you will not need glue.
3. Label the views: front, side and overhead.

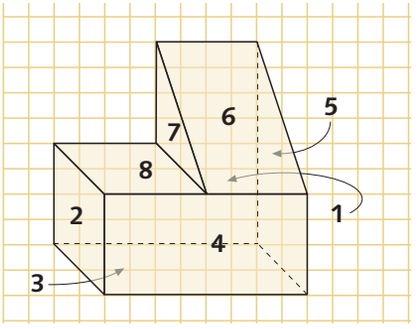


Construction of a trihedral plane

Making a more complex model

1. Draw the front, side and overhead views of a simple object. Use an appropriate scale and accurate measurements. Number each surface.
2. Choose one surface and copy it onto thin card.
3. Draw the other surfaces that share edges with the first surface.
4. Think about which other edges need to be stuck together and draw a connecting **tab** on each of them.
5. Draw the remaining surfaces in the same way. Be careful – don't forget or repeat any of them.
6. Cut out the whole flat plan along the outlines. Fold it to make a three-dimensional model of the object. Stick the surfaces together, using the tabs and glue.
7. Now put the model inside the trihedral plane and label the views.



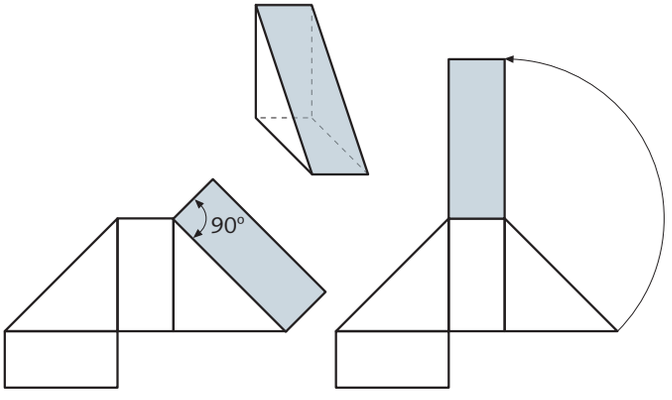


Measuring difficult surfaces and edges

It is more difficult to measure the lengths of sloping surfaces and curves.

Sloping surfaces: the length of the sloping surface is the same as the hypotenuse of the triangle shape that supports it. There are two ways to calculate this:

- Draw a vertical line from the top of the slope and a horizontal line from the base of the slope. Use the lengths of these to calculate the hypotenuse.
- Use a compass to find the length of the slope.



Two ways to calculate the length of a slope

Arcs: to calculate the length of an arc:

1. Find the circumference of the whole circle that the arc is a segment of by calculating $2\pi R$.
2. Divide the angle of the arc by 360 to give the proportion of the total circumference that needs measuring.
3. Divide the circumference of the whole circle by the proportion to give the length of the arc.

Activities

39 Make one of the models opposite or above. Make a simple and a complex model.

40 Compare the two methods:

a) How many cuts do you need in each?

b) How many edges do you need to stick together in each?

41 Which method is better? Why?

42 Is there a difference if you use wood instead of card?

Revision activities

1 Listen and repeat. Which word is the odd one out?

2 True or false? Write the answers in your exercise book.

a) We use a 2B pencil for technical drawing.

b) A0 paper is the smallest size.

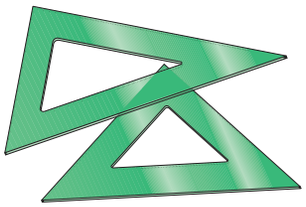
c) We use a ruler to measure lengths.

d) We can make angles with set squares.

e) We use a protractor to draw perpendicular lines.

f) We use a pair of compasses to copy measurements.

3 Name these drawing tools in your exercise book.



a) How are they different?

b) What lines can we draw with them?

c) In your exercise book, draw and name the angles we can measure with them.

4 In your exercise book, match and complete the sentences.

With a pair of compasses, we can …	… measure angles.
With a set square, we can …	… represent all the views of an object.
With a protractor, we can …	… draw arcs.
With an orthogonal projection, we can …	… create a 3D image.
With the dihedral system, we can …	… draw parallel lines.

5 Draw the angles from 15° to 180° in your exercise book, using set squares.

6 Draw two squares with 5 cm sides in your exercise book.

a) Fill one of the squares with parallel vertical lines 1 cm apart.

b) Fill the other with horizontal lines 1 cm apart.

7 Draw a square with 7 cm sides and fill it with parallel lines inclined at 30° and 1 cm apart.

8 Draw a square with 7 cm sides in your exercise book, and fill it with parallel lines inclined at 45° and 1 cm apart.

9 Make a pattern with circles in your exercise book, following these instructions:

a) Draw a straight line 15 cm long.

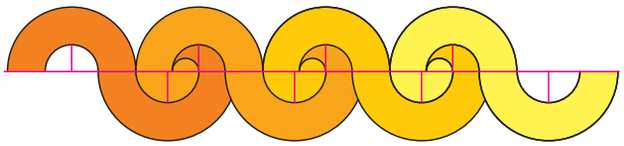
b) Divide it into 3 cm segments.

c) Use each mark as the centre of a circle with a 2 cm radius.

d) Draw other circles inside with a 1.5 cm radius.

e) Colour the pattern.

10 Copy this pattern using semicircles on a straight line in your exercise book.



Measure the distance between the centre of each circle and its radius to get the proportions.

11 Draw an equilateral triangle with 3 cm sides with a pair of compasses in your exercise book.

12 Draw a circle with a 5 cm radius in your exercise book. Make six equally spaced marks around the circumference to draw a regular hexagon.

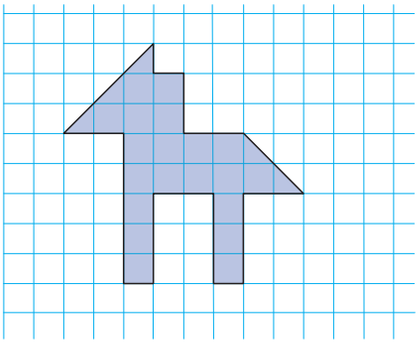
Draw a circle to fit inside the hexagon.

Repeat until you have three circles and three hexagons.

13 Draw a sketch and a diagram for a toaster in your exercise book.

14 What scale would you use to draw a spoon on A4 paper? What scale would you use for a bookshelf?

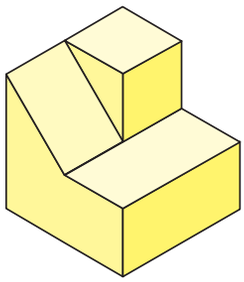
15 Draw this shape in your exercise book at scales of 2:1 and 1:2.



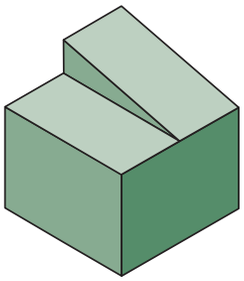
Revision activities

16 In your exercise book, draw freehand the plan and front, left and right elevations of these objects:

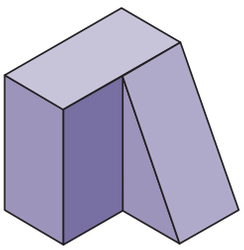
a)



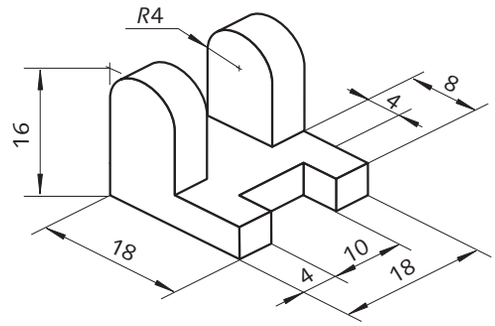
b)



c)



17 Choose one of the objects in Activity 16. Accurately, draw its dimensions in your exercise book. Look at the example to help you.

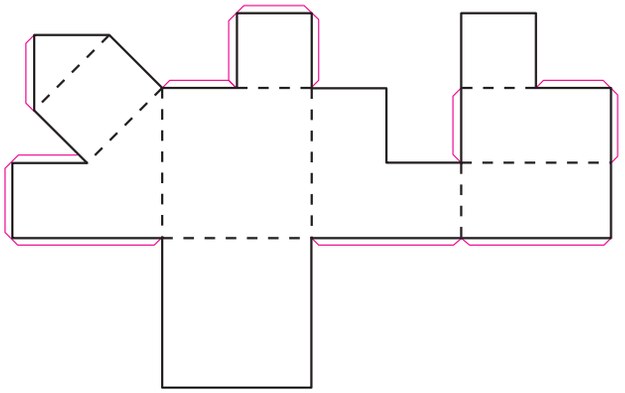


18 In your exercise book, draw the plan and front elevation of a craft knife.

19 In your exercise book, draw the flat plan of one of the objects in activity 16.

20 In your exercise book, draw the plan and front elevation of a glue stick. Do you need to draw the side elevation? Why/Why not?

21 Identify the object in activity 16 that corresponds to this flat plan.



22 Copy the flat plan above onto a piece of thin card, enlarging the scale by three. Make the object.

Talking points

23 What pencils, paper size and other materials would you use to make these things?

a) A poster for a school event

b) The first page of a Science project

c) A picture for a Christmas card competition

d) A birthday card

e) A party invitation

Example: *For a poster we use A3 paper, HB pencils for drawing and coloured pens.*

24 Work in pairs to ask the questions below. Then change roles and repeat the questions in a different order.

A: You have left your pencil case at home. Ask your friend for the different tools you need.

B: Say "Of course, here you are!" and give your friend the object.

a) I need to draw a circle. Can I borrow your _____?

b) I need to draw an angle. Can I borrow your _____?

c) I need to draw a straight line. Can I borrow your _____?

d) I need to draw parallel lines. Can I borrow your _____?

25 Can you remember the different arcs?

Ask each other to draw two different shapes with arcs without special tools.

Check your partner's drawing. You can say "Yes, this looks like a …"

Unit summary

Graphic expression and communication

In your exercise book, copy and complete the chart with the words shown below.

- **Drawing materials**
  - _____ — hard or soft
  - **Paper** — _____, A4
- **Drawing tools**
  - to help draw _____ lines
- **Measuring tools**
  - to measure segments: _____
  - to measure angles: protractor
  - to draw different lines: set squares and _____
- **Using drawing tools**
  - to draw parallel and _____ lines: set squares
  - to draw angles: multiples of 15° (set squares), any _____ (protractor)
  - to draw circles and _____: compasses
- **Types of drawing**
  - _____ — shows our first idea of the object we want to make
  - _____ — has more specific information (measurements, materials, ways of connecting pieces, etc.)
  - **Technical drawing** — has the same information as a diagram but we use a ruler, set squares, compasses or a computer to give an _____ picture
- **Scale**
  - shows the proportion between the _____ size of the object and the drawing
- **Dimensions**
  - shows the real _____ of an object to help us understand the drawing
  - ways of showing dimensions: _____, symbols at the end of dimension lines, dimension lines, auxiliary dimension lines, dimensions
- **Views of an object**
  - our perception of an object from different points of view
  - **Main views** — front, side, _____
  - **Drawings of** _____ — dihedral system, plan, front elevation, side elevation
- **Perspective**
  - how to represent a three-dimensional object on a two-dimensional surface
  - **Types of perspective** — one-point, _____, conical

A0, A1, A2, A3,	perpendicular	angles	arcs
precise	sketch	exact	real
diagram	overhead	views	isometric
symbols	compasses	pencil	measurements
ruler			