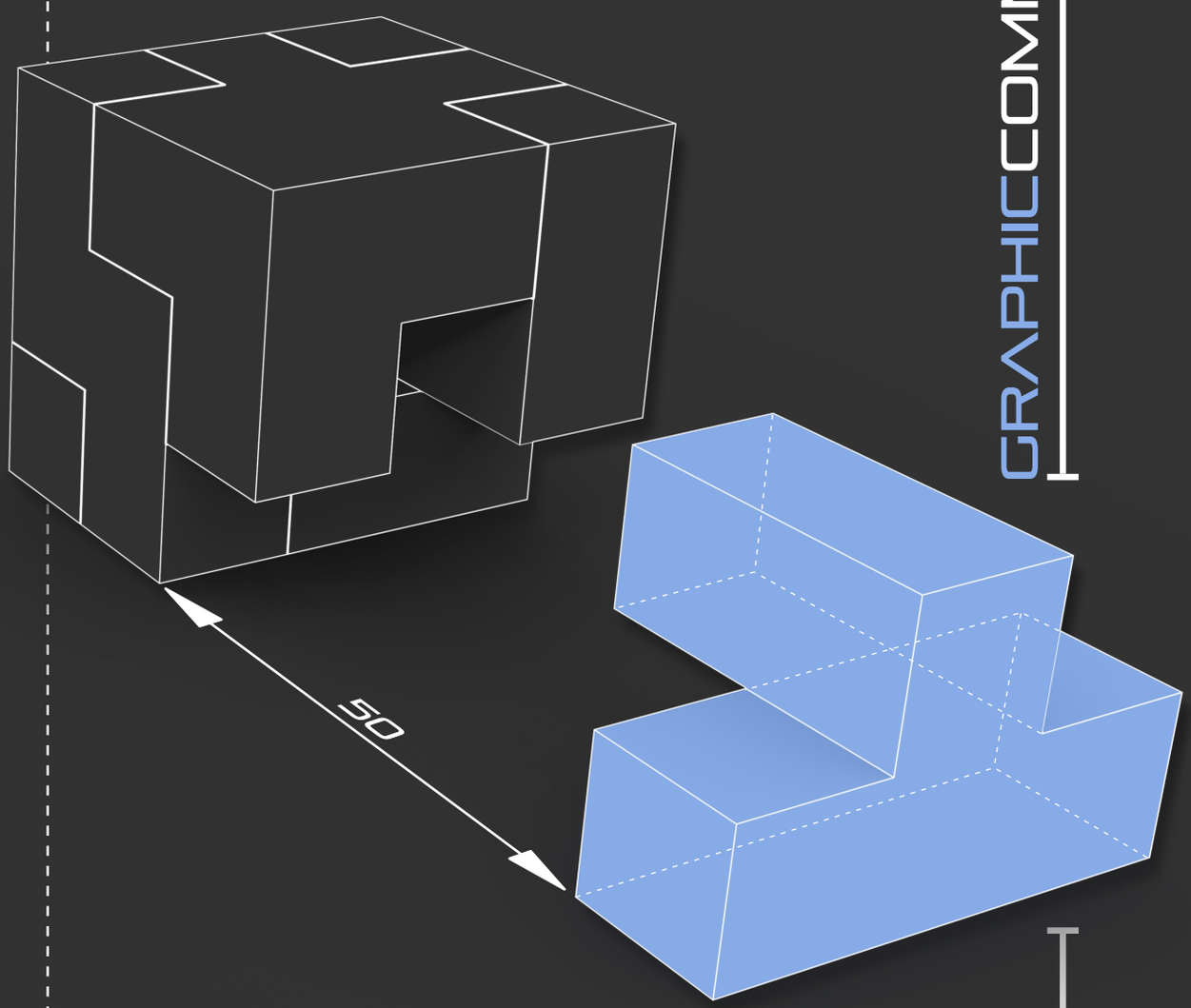
TECHNICAL GRAPHICS

GRAPHIC COMMUNICATION



INTRODUCTION

Technical graphics are the backbone of our modern world.. They are essential for any physical product that needs to be manufactured, any building constructed or any complex instructions given.

As part of your Graphic Communication course you are expected to be able to read, create and fix technical graphics of different types. These course notes, coupled with lessons, will help you with the basics.

WHAT WILL WE LEARN?

You will learn about:

- What technical graphics are and why they are used.
- Who uses technical graphics.
- Orthographic Projection.
- Pictorial formats - Isometric, Oblique and Planometric.
- 3rd Angle Projection.
- British Standards Institute and I.S.O.
- Line types.
- How to layout a technical graphic.
- How to dimension a technical graphic.
- How we create graphics in industry.
- How graphics are used to explain the assembly of products.
- How graphics are used to make items,
- Tolerances and how we can make sure items fit together.

WHAT WILL YOU BE ASSESSED?

Technical graphics are an essential part of this course. You will be assessed in a number of ways. Don't panic! If you learn the content of this book and follow the practice tasks you will be in a great position to do very well.

You will face the following assessments:

- Your folio of example work.
- The depth and quality of your research tasks.
- Your answers in this book

- A written exam, covering:
    1. Reading different views
    2. Symbols
    3. Line types
    4. Types of technical graphic
    5. Who uses technical graphics
    6. Tolerances
    7. Manufacturing

- A practical exam, covering
    1. Creating orthographic sketches
    2. Creating orthographic drawings
    3. Creating pictorial sketches
    4. Creating pictorial drawings
    5. Created exploded drawings
    6. Layout of drawings
    7. Applying dimensions and titles

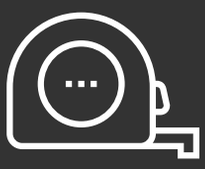
WHAT ARE TECHNICAL GRAPHICS?

Technical graphics are not just pretty pictures. They are forms of graphics used to explain complex information in as easy and clear a manner as possible.

Technical graphics can either be found as freehand sketches, printed pages or digitally via computers.

Technical graphics are created with a specific purpose in mind, such as explaining:

- how something is manufactured
- how something is assembled
- how something is packaged
- how something works.



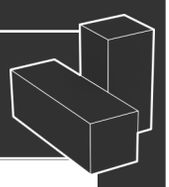
OBJECT SIZES

HOW TO MAKE THINGS

HOW TO FIX THINGS

TECHNICAL DETAILS

QUESTION



Lego is a popular toy with many children (and adults!).
Discuss whether 'Instruction Booklets' that come with Lego packs are 'technical graphics.'

_____
_____
_____
_____
_____
_____(2 MARKS)

WHO USES TECHNICAL GRAPHICS?

Technical graphics can be used by anyone, but there are several professions that make extensive use of them. Six examples are shown below.

Each user of technical graphics have their own specific needs and requirements.

Someone that creates technical graphics should understand what an end-user will need from those graphics.

RESEARCH

Each of the professions below use technical graphics.
Research one of the professions below and **present on one A3 page** how they use technical graphics.

ARCHITECT

CIVIL ENGINEER

FURNITURE DESIGNER

PACKAGING DESIGNER

PRODUCTION ENGINEER

AUTOMOTIVE ENGINEER

In this research task, you should describe:

- what your profession does..
- what qualifications they require
- major employers and average salary

Source examples of the graphics they may use.

In your research, you should consider what graphics your user needs to see:

- how things fit together?
- the size of objects assembled?
- the sizes of individual parts?
- how something is cut or made?
- materials to be used?
- large scales or small details?
- printed or shown on a screen?
- Should it show how something conforms with laws, regulations or technical standards?

QUESTION

Graphics can sometimes be used by 'non-technical audiences'.
Describe a scenario where a non-technical audience may use technical graphics.

_____
_____
_____
_____
_____
_____(2 MARKS)

WHO MAKES TECHNICAL GRAPHICS?

Any designer, scientist or engineer may make technical graphics. Technical graphics are often the best way of explaining complex information to different audiences. There are different types of technical graphics used for specific purposes. There are also several ways of creating technical graphics.

TOOLS OF THE TRADE

CAD WORKSTATION

Computer Aided Design (CAD) workstations are powerful PCs designed specifically for creating graphics.

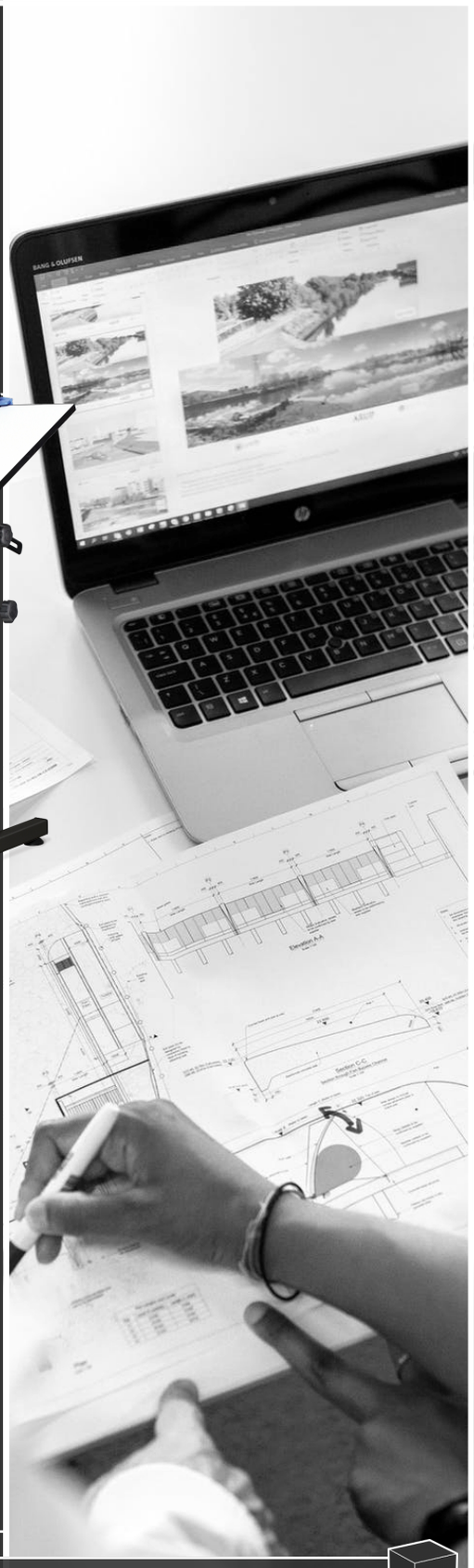
Graphics can be created as 2D drawings or as realistic 3D models. These graphics can also be used to simulate how something works, manufacture an item or make a photo-realistic render.

CAD is the industry standard for creating graphics

DRAWING BOARD

Drawing boards can be used to create drawings manually, using a range of tools such a 't-squares', 'set-squares' and compasses.

The skills and techniques for using drawing boards take time to practice and whilst the process can be satisfying, drawing boards are no longer used extensively in industry.



QUESTION

Computer Aided Design (CAD) workstations have replaced drawing boards in industry.
Describe three advantages CAD offers over drawing boards. ("Quicker" is not an answer...)

_____
_____
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_____(2 MARKS)

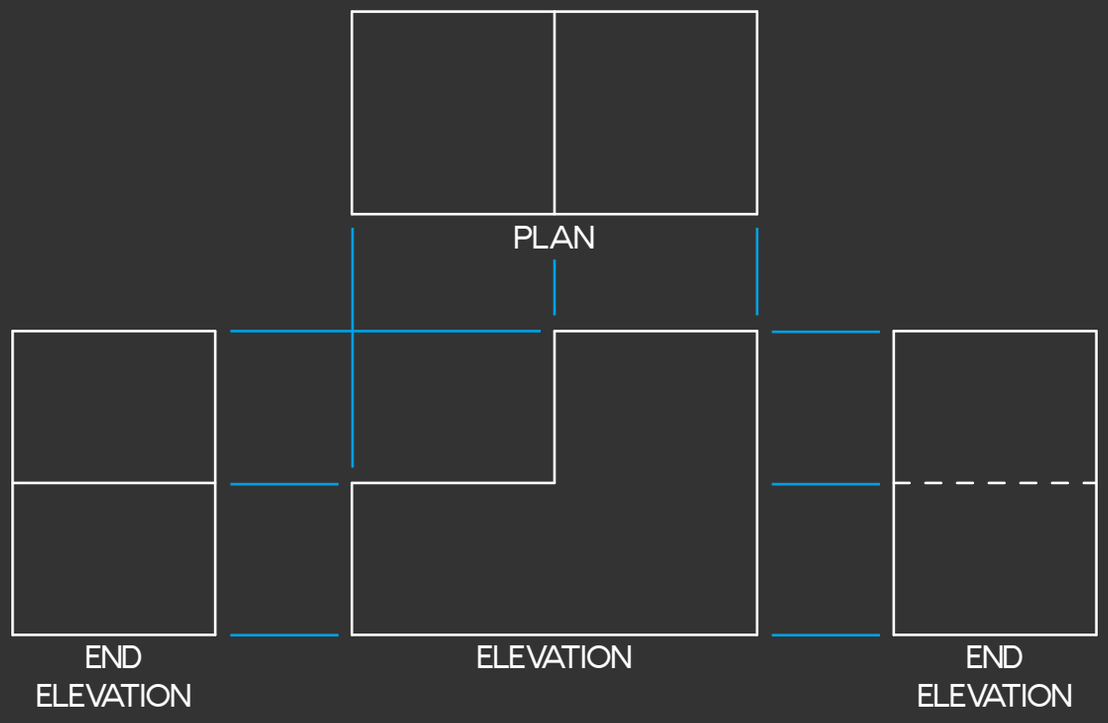
TYPES OF TECHNICAL GRAPHICS

ORTHOGRAPHICS

Orthographic stems from the Greek word, "Orthos", meaning 'straight', or 'true'.

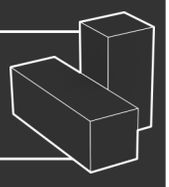
Orthographics represents an object as a series of 2D views where you look *straight-at* a particular view or face.

Most orthographic sketches or drawings will show this as a series of related views that are aligned with each other. These are particular drawing standards that you will need to learn, including types of line. These are covered later.



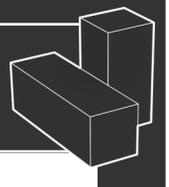
The 'Elevation" is typically considered the front of an object.
The term 'elevation' is given to any view that shows the height of the object. The sides of the object are called 'end elevations'.
The view from above is called the 'plan'.

PRACTICE TASK



Practicing creating orthographics is the best way to master the skill.
Download practice orthographic tasks from DesignClass.co.uk. Your teacher will mark your work.

QUESTION



Orthographics are a common way of presenting technical graphics.
Describe why it is good practice that views are aligned in orthographic drawings.

_____
_____
_____
_____
_____
_____(2 MARKS)

TYPES OF TECHNICAL GRAPHICS

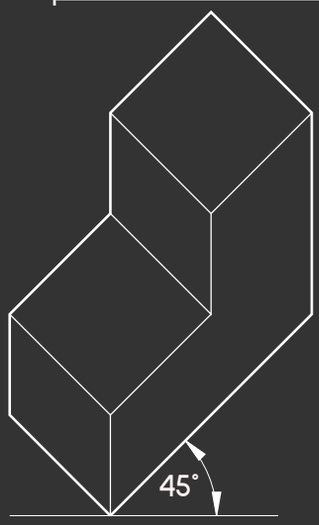
PICTORIAL

The term 'pictorials' derives from the word 'picture', which means to show the length, width and height of an object in one view.

These are not true '3D' graphics, as you can only see three faces, but cannot move them.

Designers and engineers call these views "2½ D"

There are several forms of pictorial technical graphic. The three you must know are shown below.

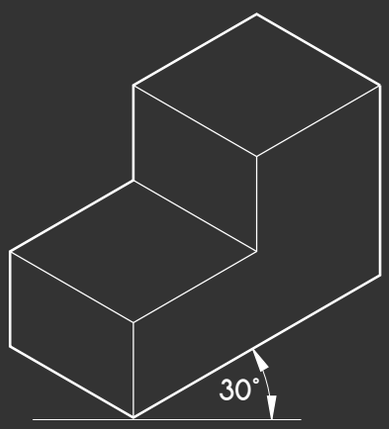


PLANOMETRIC

Planometric are biased toward the plan view. All sizes are 'true', meaning measurements can be taken directly from a scaled drawing.

Planometrics are typically drawn at an angel of 45°, but can also be shown at 30° or even 60°.

Planometrics are historically used by architects and interior designers to show room layouts. Planometric drawings are rarely used now.

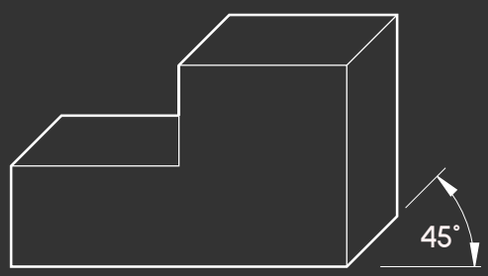


ISOMETRIC

Isometric views are drawn at 30° with all sizes 'true', allowing sizes to be taken directly from a scaled drawing.

Each face is shown with equal priority; no bias is given to any one face, unlike planometric or oblique.

Isometric views are still commonly used, especially for explaining how parts fit together or showing complex information to non-technical audiences.



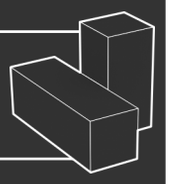
OBLIQUE

Oblique views are biased towards the elevation, with the depth projected back at .

Only the elevation has 'true' sizes and can have measurements taken from it. The sizes projected 'back' are usually half what they should be.

Oblique are very easy to draw, but not commonly used now that CAD has become common.

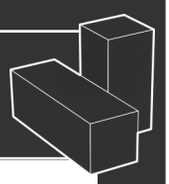
PRACTICE TASK



Practicing creating pictorial graphics is the best way to master the skills.

Download practice pictorial graphics tasks from DesignClass.co.uk. Your teacher will mark your work.

QUESTION



Pictorial graphics are particularly useful for non-technical audiences.

Describe two reasons why pictorial graphics are most suitable for non-technical audiences.

_____

_____

_____

_____

_____

_____(2 MARKS)

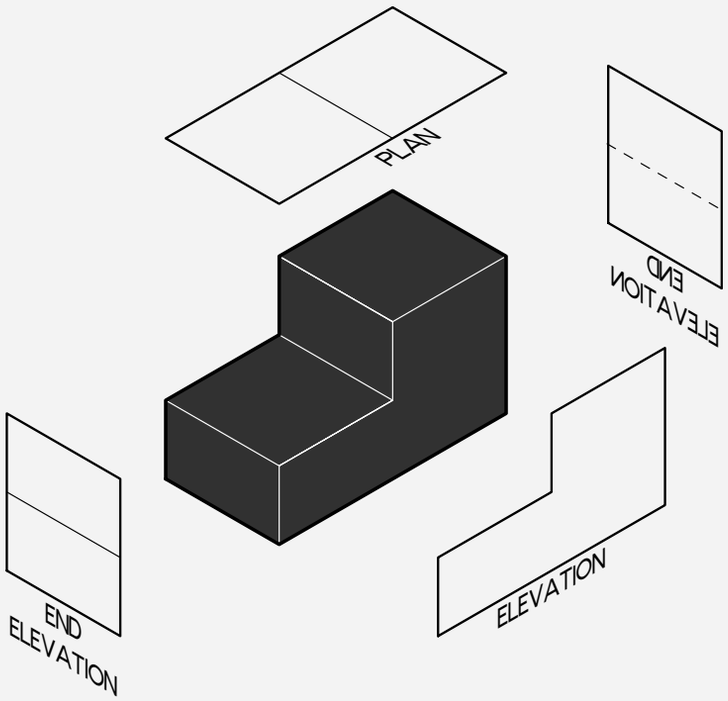
UNDERSTANDING PROJECTION

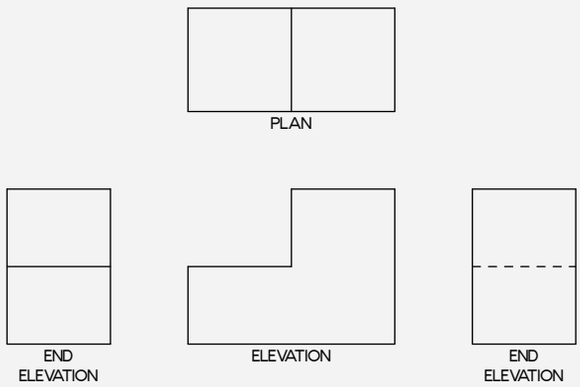
There are four different projection methods, named 1st, 2nd, 3rd and 4th angle projection.

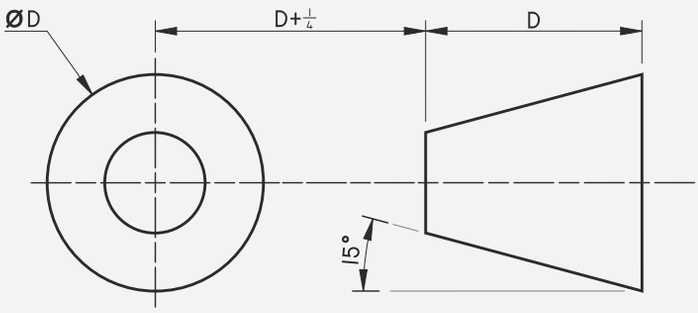
For many reasons, 2nd and 4th angle projection are never used. Only 1st and 3rd angle projection are used to create technical graphics.

We only use 3rd angle projection in the UK, and it is the only type you will use in Graphic Communication. You may want to research 1st angle projection in the future.

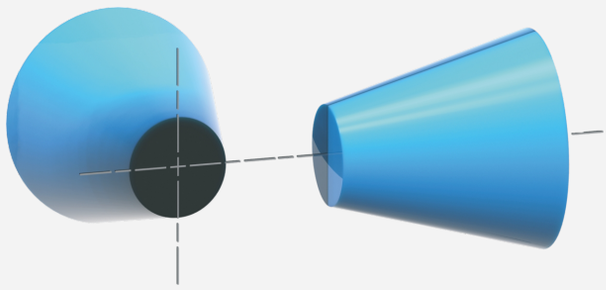
3rd angle projection is shown below.





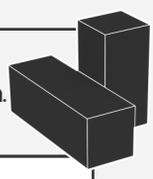


3rd ANGLE PROJECTION SYMBOL



3rd ANGLE PROJECTION SYMBOL MEANING

QUESTION



An angle projection symbol is shown on all orthographic drawings - in the UK this is 3rd angle projection.
Explain why orthographic drawings should have an angle projection symbol.

_____
_____
_____
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_____
_____(1 MARK)

BRITISH • STANDARDS • INSTITUTE

DRAWING STANDARDS

Every country has an organisation that will determine and define rules that all designers and engineers will follow. We call these rules, 'Standards', and they cover everything, from technical drawings to size of doorways in a house. These rules must be followed.

In the UK, we use British Standards Institute rules. The rules for technical drawings come from a document called BS.8888.

Every country has their own 'Standards' organisation, and they all work together, forming the International Standards Organisation (ISO).

UK

UNITED STATES

FRANCE

GERMANY

INTERNATIONAL STANDARDS ORGANISATION

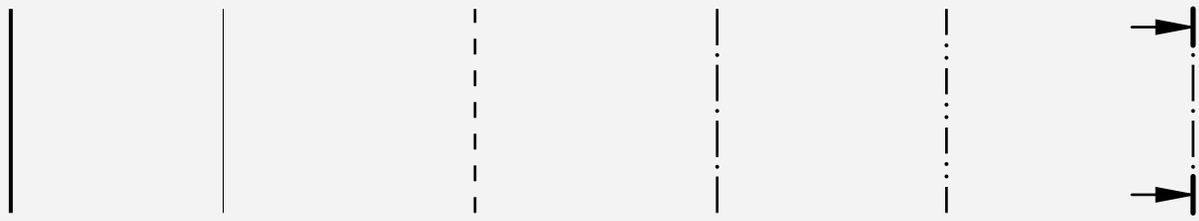
RESEARCH

The British Standards Institute defines and publishes rules for technical graphics, called BS8888.

Research the BSI and BS8888 and download a sample. How much does the full document cost?

LINE TYPES

BS8888 defines all aspects of technical graphics. The rules are very detailed and take some time to learn and master.
As part of Graphic Communication you need to learn part of the BS8888 rules, including type of line.
Different line types (and weights) are used to mean different things. These are the line types you must remember.
Your teacher will explain what each linetype means (but some are probably very obvious)



OUTLINE | PROJECTION | HIDDEN DETAIL | CENTRE LINE | FOLD LINE | CUTTING PLANE

QUESTION

The British Standards Institute have been defining the rules for technical graphics since 1918.

Explain why defining rules for technical graphics was important for industry and society.

_____
_____
_____
_____
_____
_____(2 MARKS)

TECHNICAL GRAPHICS LAYOUT

Technical graphics can be laid out differently, depending on the needs of the audience for those graphics. All the layouts should follow BS8888 standards.

You must consider your audience requirements.

Technical graphics can be very complex, so designers and engineers layout graphics to present information the end-use actually needs.

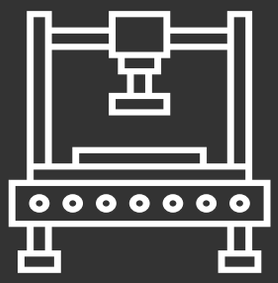
Below we consider four main purposes for technical graphics.

SHARING IDEAS

Technical graphics can be a great way of sharing ideas, as they can communicate shapes and sizes clearly and easily.

Orthographic sketches are a common method of sharing design ideas, as they are quick to create.

When sharing ideas using technical graphics, it is not usually necessary to explain every detail or size: only the specific information that communicates the design idea.



MANUFACTURING

Manufacturing requires specific information from technical graphic:

- Sizes for different components.
- Tolerances for each component part.
- Datum, or 'starting points' for taking key measurements.
- Surface finish.
- Materials.

Knowing how to make technical graphics for things to be manufactured can be amongst the most challenging to create, as you need to know about tools and machines. In industry, you will work closely with manufacturing engineers to get this right.

ASSEMBLY

Explaining how objects assemble is just as important as explaining how products are manufactured.

Assembly instructions need to be very clear, and often shown as a series of steps.

Remember, the person following the assembly instructions may not be confident with technology. Any assembly instructions should not leave anything to guess-work.

Exploded isometric views are excellent, along with 'sectional' views, revealing the insides of objects.

ANALYSING DESIGNS

Technical graphics can also be used to share complex information that explains how well a design would work.

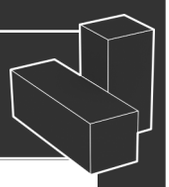
Three of the most common types of data that can be shared include:

- Aerodynamics
- Strength
- Centre of gravity

Depending on the product, this technical information may be useful. For instance, if designing a new type of wind-turbine, designers and engineers would test the strength and aerodynamics of a design using CAD and present the results within the technical graphic.

QUESTION

Aerodynamic and fluid-dyamic testing can be completed using CAD.
State the CAD name for testing aerodynamics and fluid-dyanmics on a computer.



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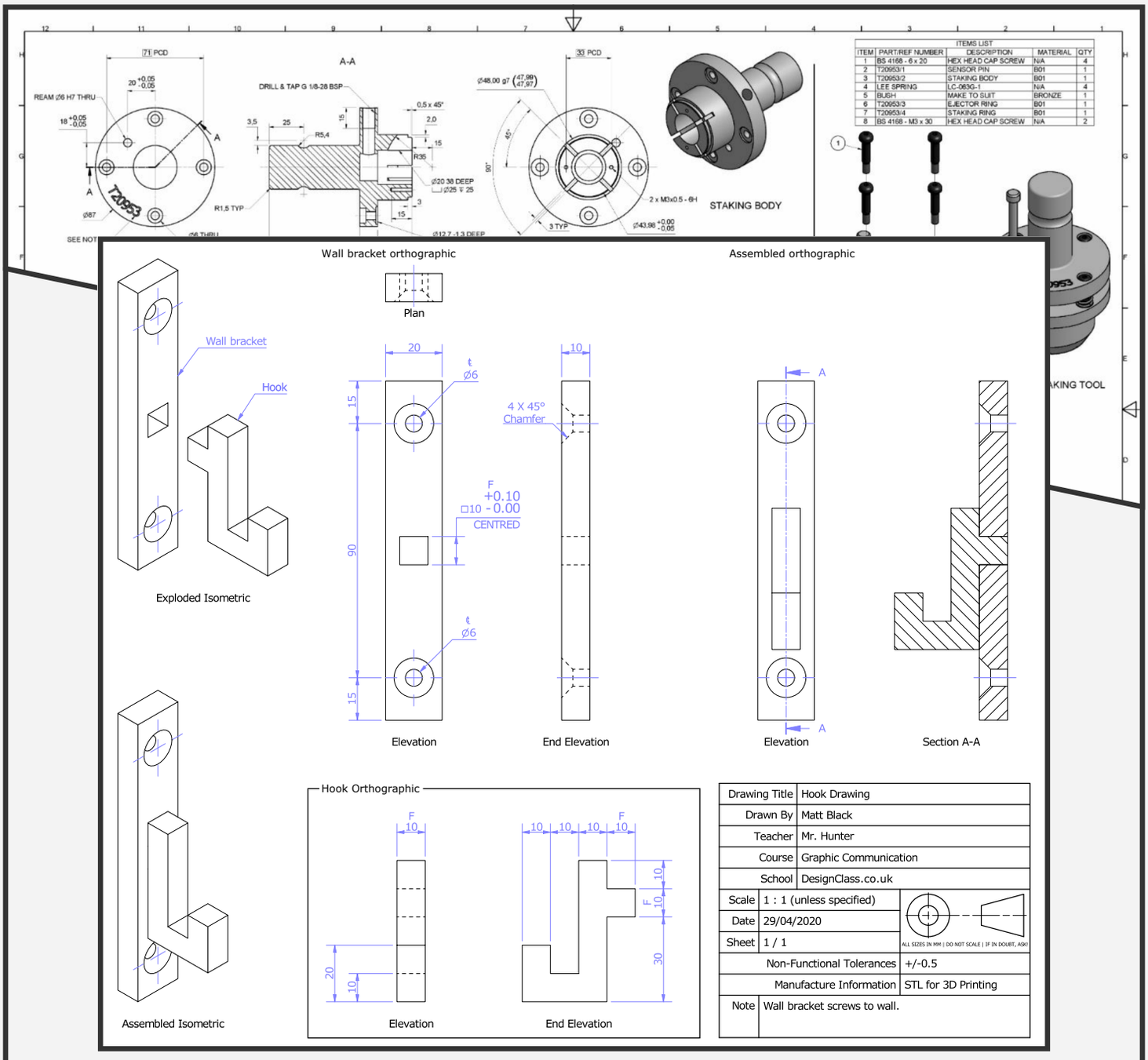
_____(1 MARK)



- ☑ Exploded isometric show how parts fit together and parts labelled.
- ☑ Component parts named.
- ☑ Assembled isometric.
- ☑ All views titled.
- ☑ All views aligned and components separated with white space.
- ☑ Chamfers shown.
- ☑ Centre lines shown.
- ☑ Square dimensions shown.
- ☑ Component parts fully dimensioned and dimensions aligned.
- ☑ Functional tolerances shown.
- ☑ Scale shown.
- ☑ Title block completed.

QUESTION

'White Space' is used in technical graphics

Describe 'white space', and why it is used within technical graphics.

_____

_____

_____

_____

_____

_____(2 MARKS)

MAKING TECHNICAL GRAPHICS

ORTHOGRAPHICS

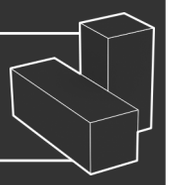
Orthographics are the back-bone of technical graphics used in manufacture. Knowing how to confidently creating orthographics is an valuable skill.

There are three ways of creating orthographics:

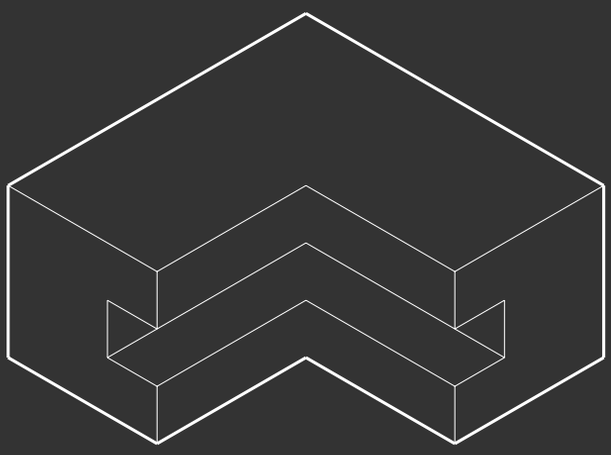
- Sketching orthographics.
- Using a drawing board.
- Using CAD.

Only sketching and using CAD is important in this course.

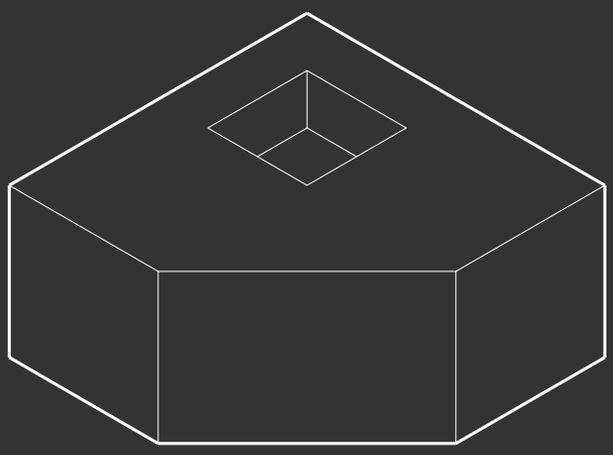
PRACTICE TASK



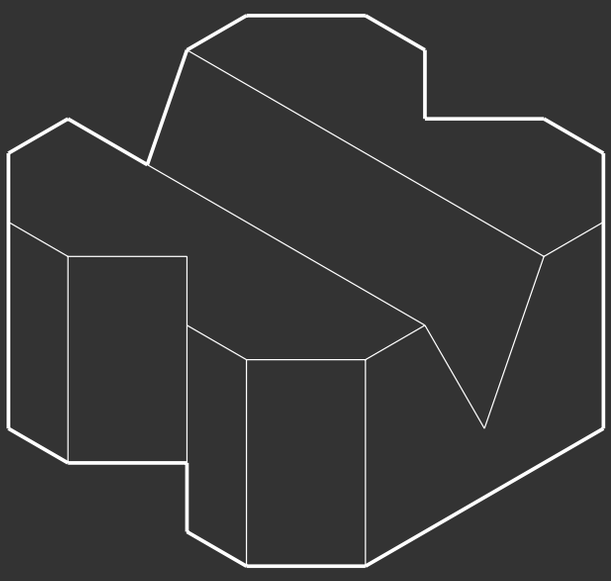
Create orthographic sketches of the blocks below. Be careful to get proportions correct and show hidden detail. As an extension, create orthographic drawings using CAD. Measure the blocks for sizes.



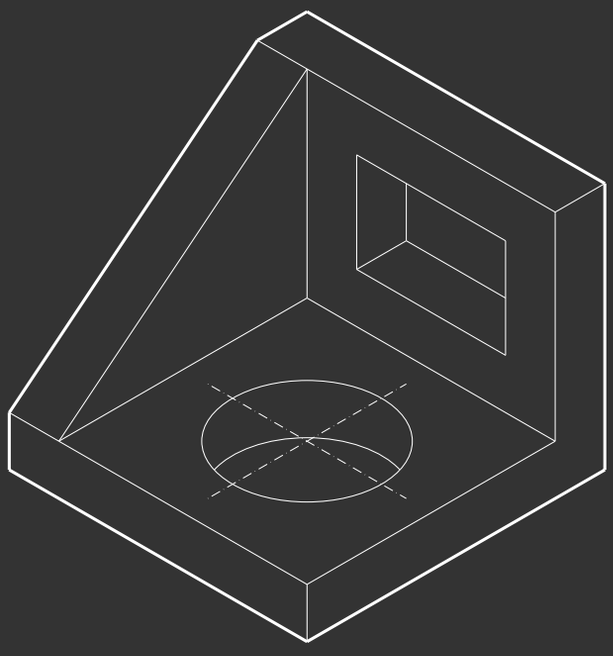
BLOCK 1 | ISOMETRIC



BLOCK 2 | ISOMETRIC

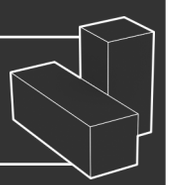


BLOCK 3 | ISOMETRIC



BLOCK 4 | ISOMETRIC

PRACTICE TASK



Practicing creating orthographics is the best way to master the skill.

Download practice orthographic tasks from DesignClass.co.uk. Your teacher will mark your work.

PICTORIAL

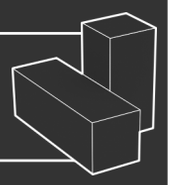
Reading orthographic drawings is equally valuable and can take some practice. Understanding how an item would look pictorially from a series of 2D views requires a detailed understanding of views and line-types.

Pictorial views can be created by:

- Freehand sketching
- Drawing board
- CAD

Practice freehand sketching and using CAD.

PRACTICE TASK



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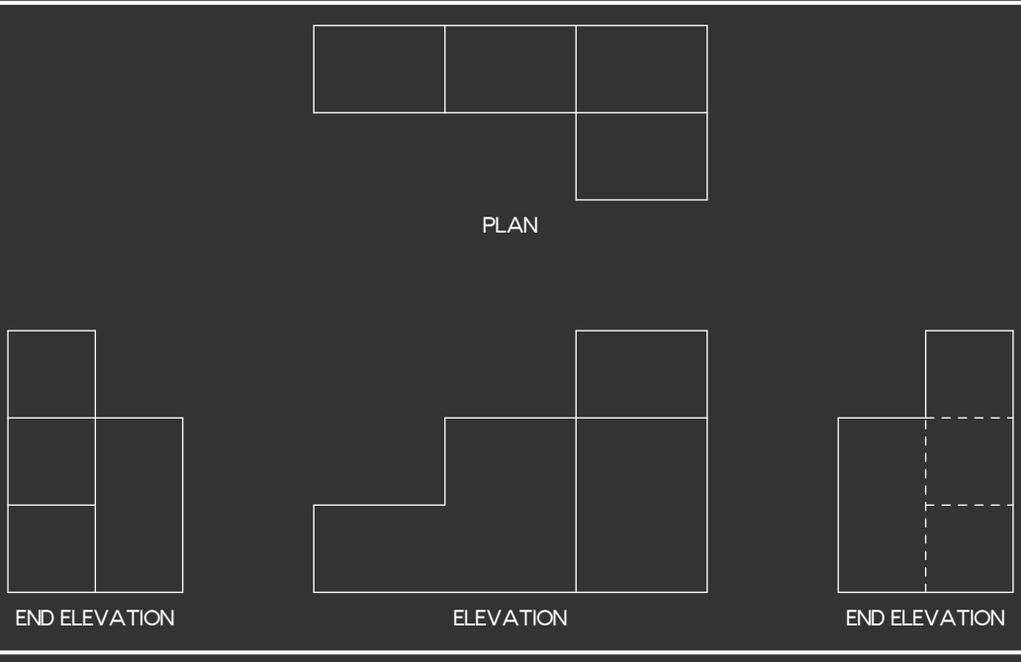
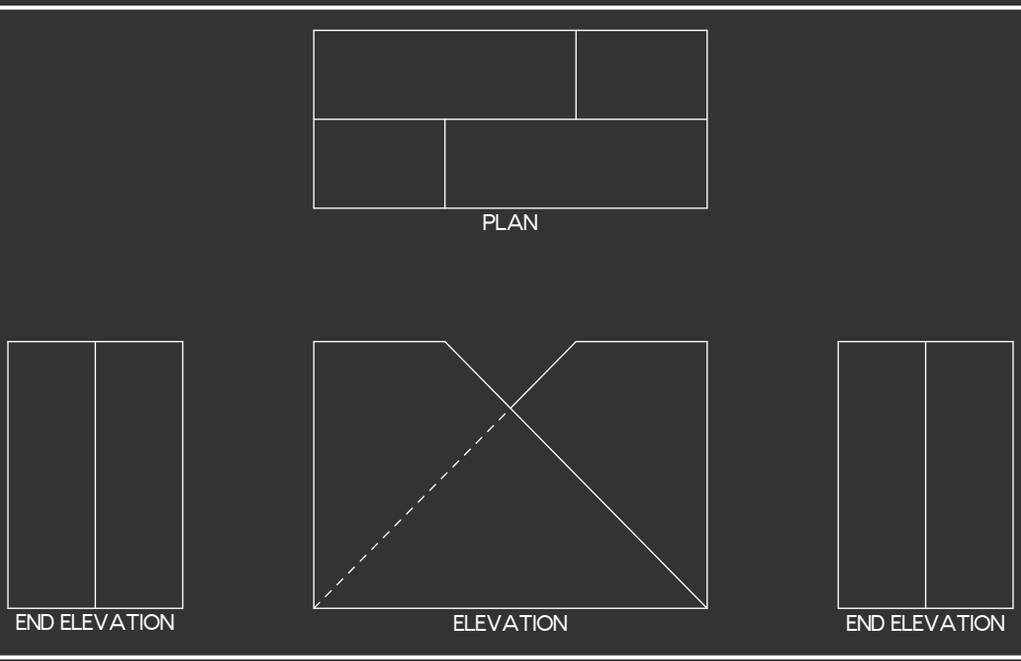
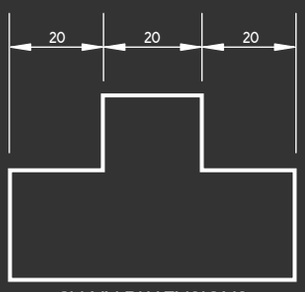
As an extension, create isometric drawings using CAD. Measure the blocks for sizes.



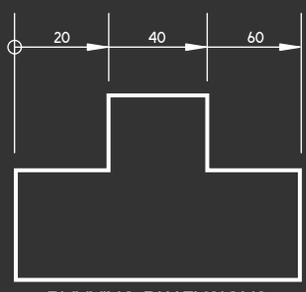


DIMENSIONING

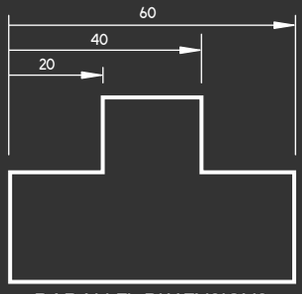
Technical graphics would be nothing without dimensioning - applying sizes - to the drawings. How designers and engineers show dimensions is also governed by BS8888. You must know the dimensioning types shown below and know how to add them to your orthographic sketches and drawings.



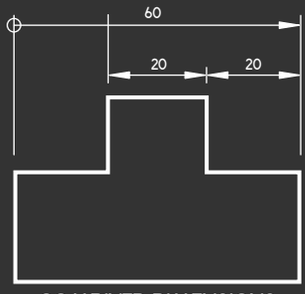
CHAIN DIMENSIONS



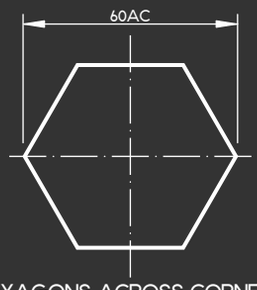
RUNNING DIMENSIONS



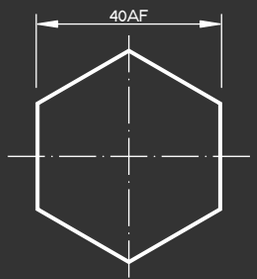
PARALLEL DIMENSIONS



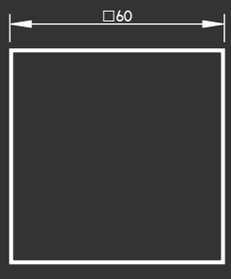
COMBINED DIMENSIONS



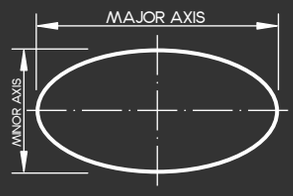
HEXAGONS ACROSS CORNERS



HEXAGONS ACROSS FLATS

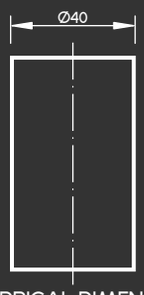


SQUARES

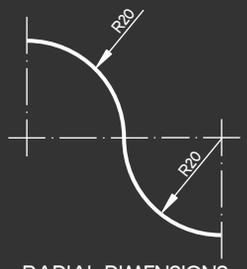


ELLIPSES

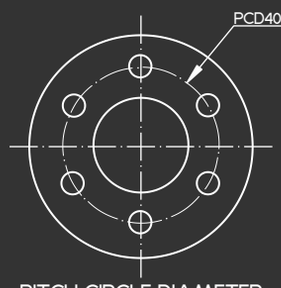
CIRCULAR DIMENSIONS



CYLINDRICAL DIMENSIONS

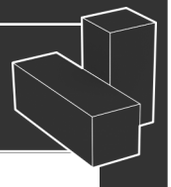


RADIAL DIMENSIONS



PITCH CIRCLE DIAMETER

QUESTION



'Parallel Dimensions' are preferred for woodwork and metalwork products.
Explain why Parallel Dimesnions are the preferred dimensioning type.

_____

_____

_____

_____

_____

_____(2 MARKS)

GRAPHICS AND SOCIETY

Technical graphics are essential for all aspects of our technological society: from buildings and ships, to cars and game-controllers, technical graphics are used.

How we create technical graphics has changed.

Above are 'drawing offices' from two car companies, from different eras. Drawing boards have been replaced by CAD and spaces are more creative and collaborative.

Can you imagine working in a space like this?

QUESTION

Modern drawing offices don't employ as many people as they once did.
Explain why modern drawing offices do not need to employ as many people.

_____
_____
_____
_____
_____
_____(2 MARKS)

QUESTION

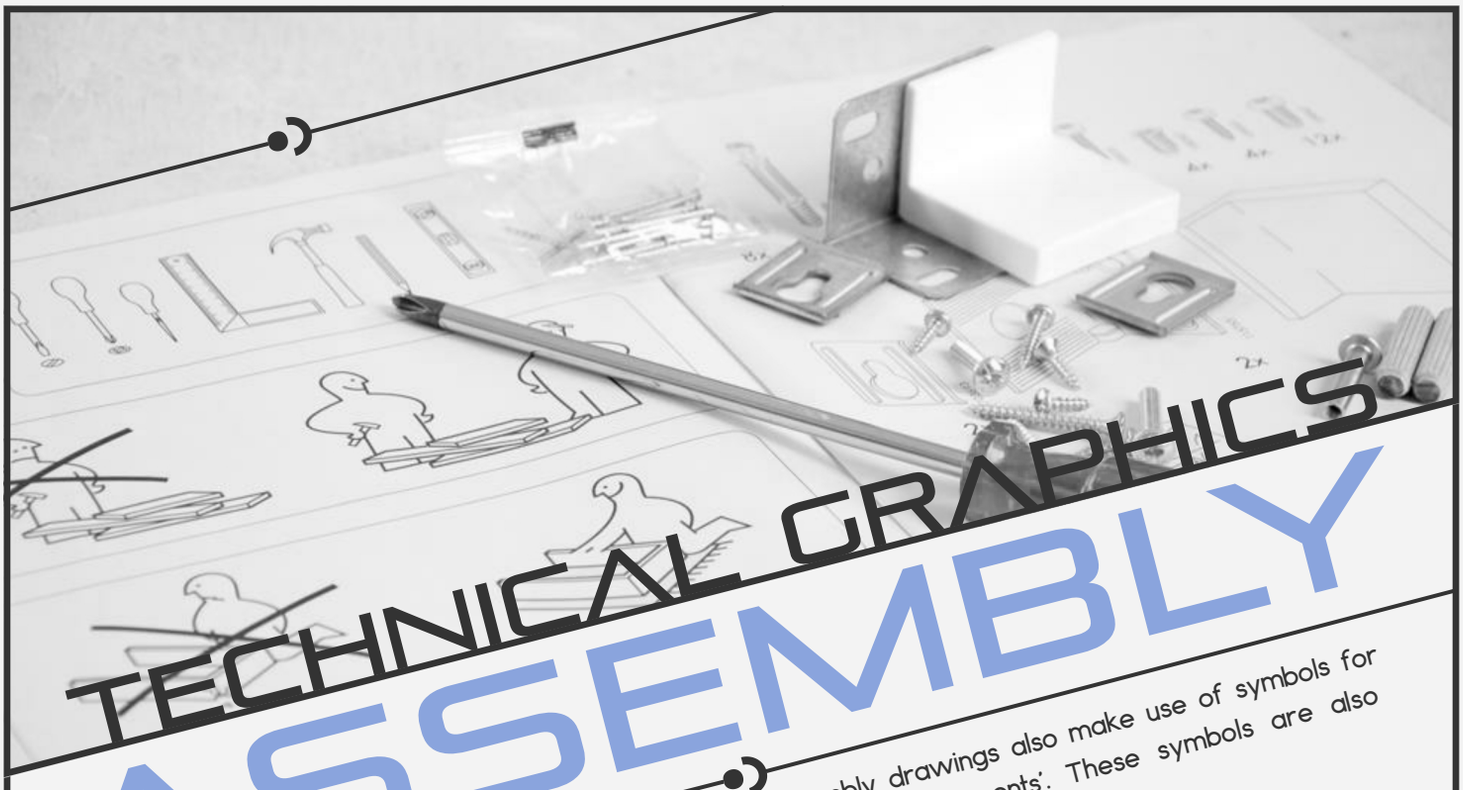
Printed technical graphics are becoming less common in favour of digital files.
Describe two advantages of digital files over printed technical graphics.

_____
_____
_____
_____
_____
_____(2 MARKS)

QUESTION

Designs and drawings are 'intellectual property' and can be very valuable to companies.
Describe two security concerns for companies with modern drawing offices.

_____
_____
_____
_____
_____
_____(2 MARKS)



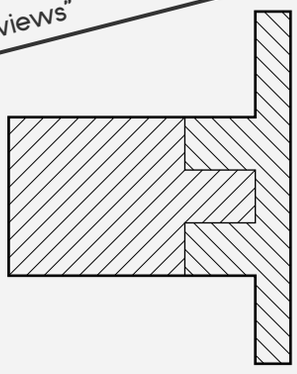
TECHNICAL GRAPHICS
ASSEMBLY

Most products are made from multiple parts - called components - that must be brought together, or 'assembled'. This can be something simple, like flat-pack furniture, to complex, such as a jet-engine.

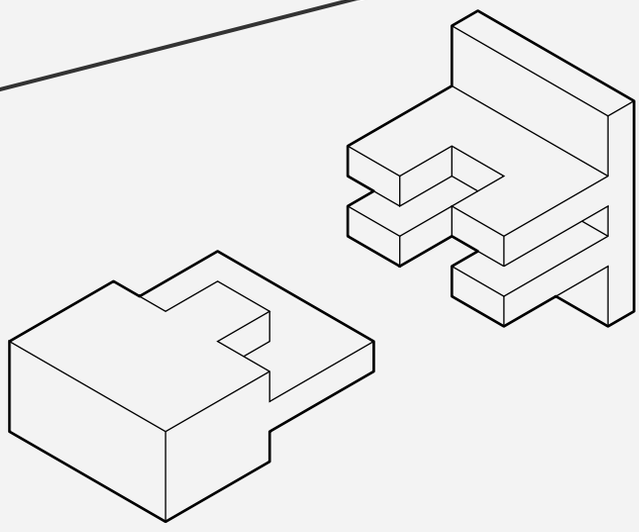
Knowing how to make assembly instructions is very important. There are two main types: "Exploded views" and "Sectionals views"

Assembly drawings also make use of symbols for 'standard components'. These symbols are also governed by BS8888.

You must understand exploded views, sectional views and the symbols for standard components.

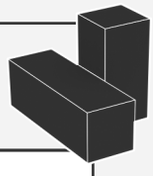


SECTIONAL ELEVATION



EXPLODED ISOMETRIC

QUESTION

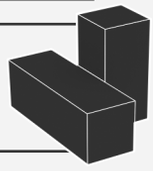


Exploded isometric graphics are amongst the most common assembly graphic types used.
State two places where you have seen exploded isometric graphics outside of school.

_____

_____(2 MARKS)

PRACTICE TASK



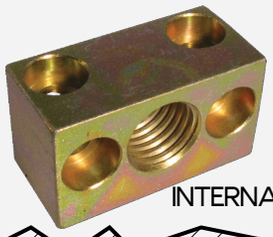
Practicing creating sectional drawing and exploded isometrics is the best way to master the skill.
Download practice assembly drawing tasks from DesignClass.co.uk.

RESEARCH

Find an item of assembly instructions that use graphics. Consider how clear they are, how easy are they to follow? Could they be improved? **Present** your research on 1 A3 page maximum.

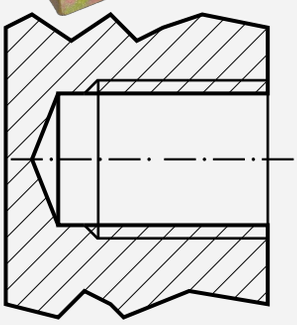
'Standard Components' are stock components or features that meet various BSI standards and rules. Some of these components are incredibly complex, or used very frequently within designs (some products, for instance, use lots of bolts or springs).

Shown below is the BS8888 symbol for four standard components. You must remember these symbols.

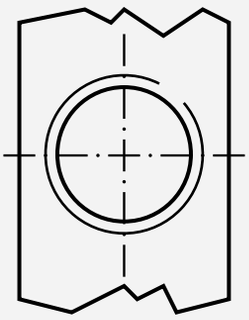


INTERNAL THREAD

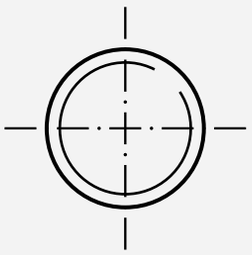
EXTERNAL THREAD



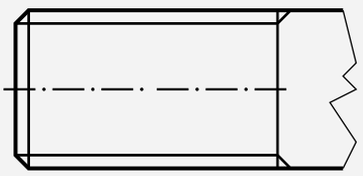
SECTIONAL END ELEVATION



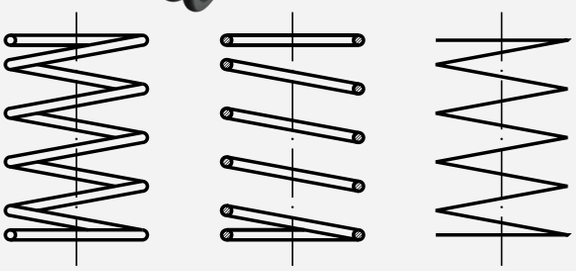
ELEVATION



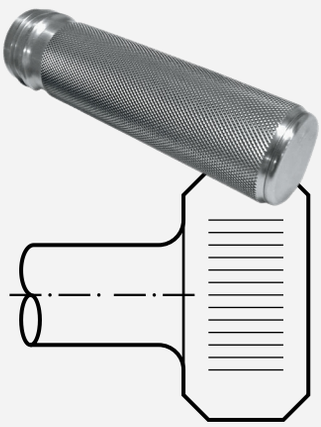
END ELEVATION



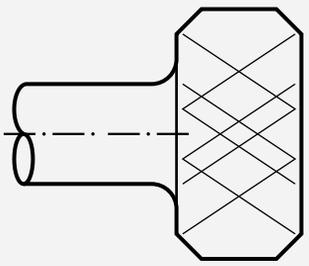
ELEVATION



SPRINGS



STRAIGHT KNURLING



DIAMOND KNURLING

QUESTION

'Stock Components' are often part of a CAD library.

Describe a CAD library and why it is useful for designer and engineers.

_____

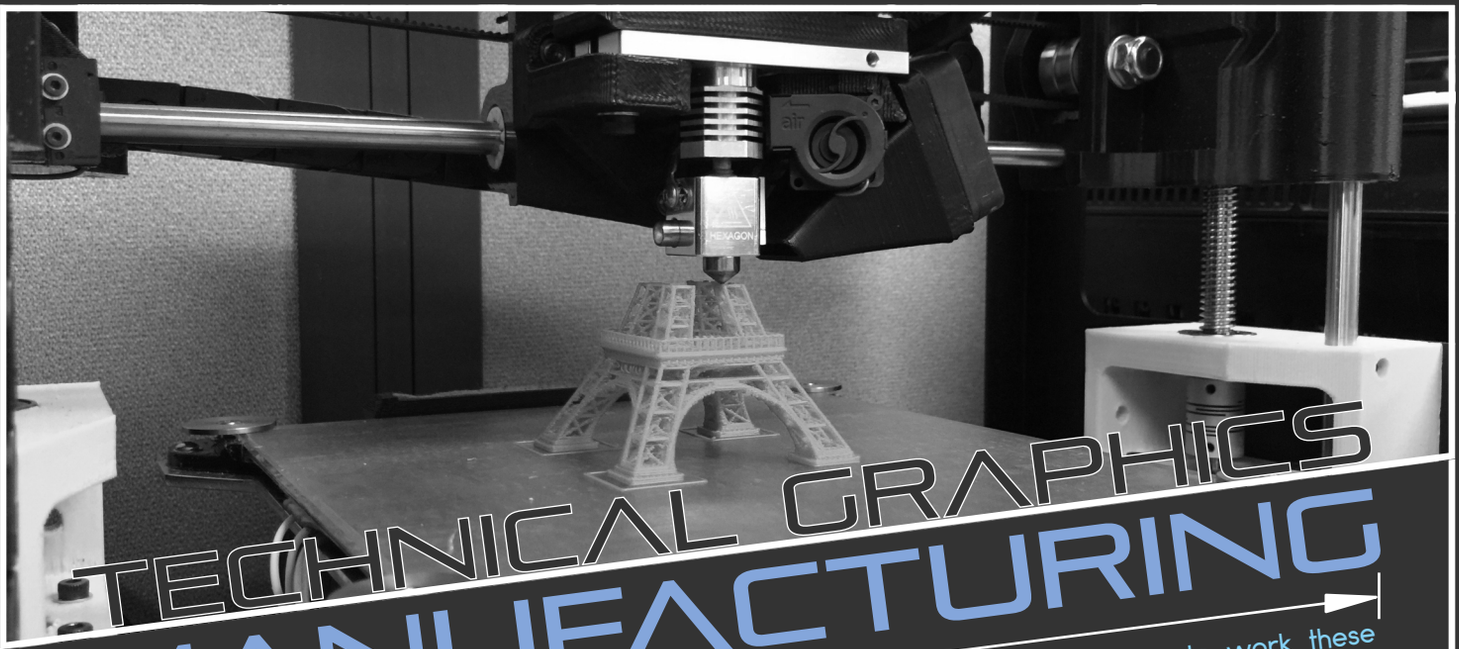
_____

_____

_____

_____

_____(2 MARKS)



TECHNICAL GRAPHICS MANUFACTURING

Technical graphics are an essential tool for making anything. Historically, drawings are created so that other people know what to make, and how.

Nowadays, drawings can be used to directly control manufacturing equipment. There are a huge range of computer controlled machines in industry.

You do not need to know how to work these machines as part of this course, however you do need to know that graphics can be used to control these tools. Besides, it can make your understanding of technical graphics much better if you understand how these tools work.

Below are four common machine tools.

CNC MACHINING

Computer Numeric Control (CNC) machines use a rotating tool to cut materials. CNC machines can cut wood, metal and plastics.

CNC machines can carve complex 3D objects, or simply cut 2D shapes out of sheet material.

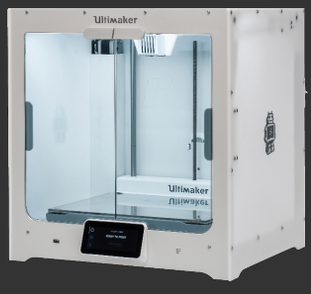
CNC machines are incredibly accurate: usually +/-0.01mm.

LASER CUTTING

Laser cutters use a beam of light to burn materials. They can etch images onto materials, or to cut through materials.

Laser cutter can only work on certain materials, such as wood, plastic and fabrics. The fumes can be toxic.

Laser are accurate: usually +/-0.05mm.



3D PRINTING

3D printers work by depositing and fusing material using heat or light (usually plastic, but metal 3D printers are available).

3D printers are slow, but can create objects that no other technology can achieve. They are also excellent for prototyping.

3D printers can vary in accuracy, usually +/-0.1mm.

VINYL CUTTING

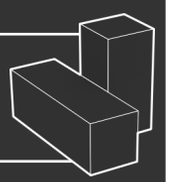
Vinyl cutters are simple machines, used for cutting sheet vinyl - sticky plastic, perfect for signage. Vinyl cutters can also cut card or paper.

Vinyl cutters use a computer controlled knife.

Vinyl cutters are accurate, but struggle to cut very small details, as vinyl can tear.

RESEARCH

3D Printers are useful tools for prototyping design ideas. However, they are not always accurate. Model a cube, 20x20x20mm and 3D print it. How accurate was the 3d printer on the X, Y and Z axis?



MAKING TECHNICAL GRAPHICS

TOLERANCES

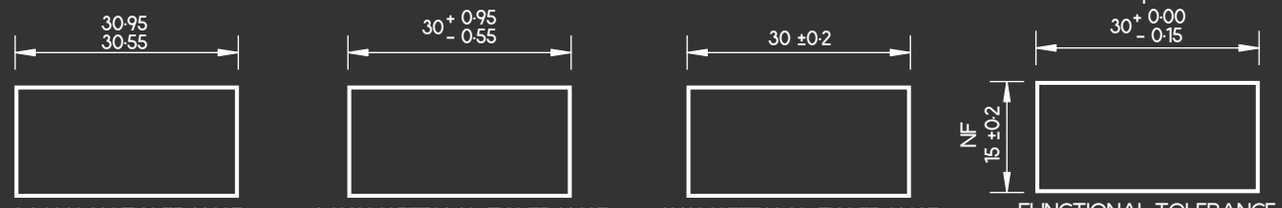
Drawings are perfect, real-life isn't. Technical graphics often state what a size should be, but it is impossible to manufacture an item precisely to those sizes, even with the most accurate of machines. The final object will always be slightly too big or too small, even if 0.001mm.

How accurate a component must be manufactured is called the 'tolerance'. The more accurate a tolerance, the more expensive a component will be to manufacture. For this reason, we often only state important features as having a 'functional', or accurate tolerance, and let less important features have lower tolerances.

There are different types of tolerance, depending on how important a part is. Important parts - usually those that must assemble with another part - have 'functional' tolerances. Less important parts have 'non-functional' tolerances.

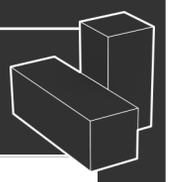
Sizes are stated, depending if a feature is allowed to be larger or smaller than the required dimension.

EXPLODED ISOMETRIC



COMMON TOLERANCE | ASYMMETRICAL TOLERANCE | SYMMETRICAL TOLERANCE | FUNCTIONAL TOLERANCE

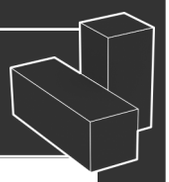
QUESTION



Computer controlled machines follow programmes generated from graphics.
Describe three advantages of computer controlled machines over manual manufacture.

_____
_____
_____
_____
_____
_____(3 MARKS)

QUESTION



Graphics for manufacturing products should specific information.
Describe the information a technical graphic intended for manufaturing a product should have.

_____
_____
_____
_____
_____
_____(3 MARKS)

COURSE NOTES V1.0