GCSE Graphics Revision Guide
Different types of papers include

**LAYOUT PAPER** which is semi-transparent and is used in the preparation of work. The paper is placed on top of work and correct parts are traced out. This continues until the layout is complete.

**BLEEDPROOF PAPER** is used when work needs to be coloured using marker pens. The paper has a special coating to stop the ink from spreading out (bleeding).

**GRID PAPER** is available in many different types, squared paper being the most obvious.

Other types include isometric paper (shown on the left) to help in the drawing of isometric shapes and perspective paper.
TRACING PAPER and COLOURED PAPER complete the papers, but the reader is assumed to know sufficient about these.

Card

As has already been mentioned, card can be sold in either density (gsm) or thickness (microns).

CORRUGATED CARD is the type of card commonly found in cardboard boxes and packaging. It is made from a layer of paper then a layer of corrugated paper then a layer of paper. The corrugated layer gives it more strength the paper/card whilst still making sure it is lightweight.

COATED CARD describes card that has one or both sides coated with another material. Two examples are plastic coated card (for example business cards) gloss coated card (for example leaflets and playing cards).
**OILED CARD** is a special card used almost exclusively in making stencils.

The next category of materials is those based on plastics.

**POLYSTYRENE** is most commonly associated with the white packaging material used to protect electrical equipment. However, **HIPS** or High Impact Polystyrene Sheet is another common material that you have used in vacuum forming and in container making. It is capable of withstanding high impacts (hence its name) and comes in a variety of colours and thicknesses (from 0.25mm to 6mm thick, with most coloured sheets coming between 1mm and 3mm).

Styrene is also available in sheet, rod, tube and various other shapes and is popular in model making.

The material is lightweight, easy to cut and join together and can be finished using a variety of brush or spray applied paints.
**CORRUFLUTE** is best described as plastic corrugated cardboard. Being plastic it is available in a wide range of colours and is more durable than corrugated card.

The most common item known to you that is made from corrufite is your grey graphics folder.
**LOW TACK MASKING FILM (FRISK FILM)** is used in the production of stencils for use primarily with spray paints (such as airbrushing).

It is easily cut using a scalpel (by hand) or by computer (CAM) and being low tack (not very sticky) means that it will peel off the work when finished with without tearing or damaging the work surface.

**MYLAR** is a thin sheet material that has is used to create, for example, glossy or matte attractive outsides of packaging and clear plastic sheet for photocopying (it withstands high temperatures). It can also be used to make stencils and can have a metal surface added to it which is common in celebration balloons, like the one shown on the right.

**VINYL** is a thin coloured sheet plastic that is commonly used to make signs and logos.

It is commonly cut using CAM (Computer Aided Manufacture) and is used to produce many of the company designs and logos seen on vans or cars.

Make sure that you know the process of converting a computer image into a completed vinyl sign.
The last category of material is those based on wood.

**FOAM** is a high-density polystyrene material (unlike the low-density traditional white polystyrene).

It is widely used in graphics and model making because it is lightweight, easily shaped into complex shapes and comes in a variety of thicknesses.

It is commonly joined with PVA glue but you cannot use spray paints without first coating with acrylic or poster paint (it will melt the foam if you don’t).

**FOAMBOARD** or Foamcore is a layer of polystyrene sandwiched between two layers of card.

It is often sold in white or black and it is lightweight and easily cut, but it does not bend without cracking or breaking.

The card surfaces also mean that graphic designs can be placed on either side. Although again care has to be taken using spray paints because of the concern of melting the foam.

The last category of material is those based on wood.

**BALSA WOOD** is a very lightweight material that is commonly used in model making.

It is easy to cut and join together and is useful if creating fast 3D prototypes of products, such as the design for a new Canon camera shown on the left.
MATERIALS

Paints and inks

Paints and inks give colour to a drawing, and some inks are also employed in printing. Paints come in various forms such as enamels, acrylics and watercolours. Inks are pigments that are mixed with other substances - resins, oils or solvents - called ink vehicles which determine how fluid the ink is. The type of ink and ink vehicle used, and how fluid the mix is, will depend on the process being done: inks for drawing will be thin, while those for printing will normally be pastes.

Below are the main types of paints and inks, and their uses.

- **Watercolours** are solid blocks of colour that can be used for applying a colourwash, but practice is needed for high-quality results. They can be used on paper and card.
- **Gouache paints** come in paste format. It is a water colour that has had white added to it to make the paint opaque. It can be used to paint opaque materials and as a colour wash. Gouache works on most materials including plastics.
- **Acrylic paints** are a plastic-based liquid paste. They are ideal for painting opaque materials and giving a colour wash. They can be used on paper and card, but in graphics they are most useful for painting plastic three-dimensional models.
- **Lithography and letterpress** printing inks are produced in paste form. This allows the inking rollers to transfer a thin film of ink to the image. The ink vehicle is slow-drying because the printing process is relatively slow.
- **Flexography and gravure inks** are liquid because the cells of the printing plate need to fill up with ink. The solvents used as the ink vehicle are fast drying.
- **Screen-printing inks** are in between the two inks described above. They have to be fluid while printing, but must dry quickly.
- **Writing or calligraphy ink** is applied by hand with a pen, and can be used for sketching, shading, colouring and lettering.
Adhesives

An adhesive is a substance that will bond surfaces together. There are a number of different types of adhesive products used when making graphic products. The table below shows the main adhesives and their uses.

<table>
<thead>
<tr>
<th>Adhesive product</th>
<th>Description</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyvinyl acetate [PVA]</td>
<td>General-purpose glue</td>
<td>Mainly for wood, but also paper, card, foam board and foam blocks</td>
</tr>
<tr>
<td>Epoxy resin</td>
<td>A two-part glue that has to be mixed together</td>
<td>Joining different materials</td>
</tr>
<tr>
<td>Spray adhesives</td>
<td>Adhesive in an aerosol can</td>
<td>Large areas of paper and card</td>
</tr>
<tr>
<td>Solvent cements</td>
<td>Comes in two forms: a stiff liquid in tubes or cans, or a thin water-like liquid</td>
<td>Joining plastics, especially polystyrene</td>
</tr>
<tr>
<td>Hot-melt glues</td>
<td>Adhesive comes in stick or pellet form for use in a glue gun</td>
<td>Joining different materials</td>
</tr>
<tr>
<td>Glue sticks</td>
<td>A solid stick of PVA-based adhesive in a tube</td>
<td>General purpose</td>
</tr>
<tr>
<td>Adhesive tape (clear)</td>
<td>Single and double-sided tape on a roll</td>
<td>Double-sided is useful for mounting work</td>
</tr>
<tr>
<td>Masking tape</td>
<td>Paper-based low-tack tape on a roll</td>
<td>Temporary fixing</td>
</tr>
<tr>
<td>Low-tack film</td>
<td>Adhesive film</td>
<td>Masks for spraying and airbrush work</td>
</tr>
</tbody>
</table>
Paper and board

The main materials used for making graphics products are paper and board (sometimes called card or cardboard).

- Paper thickness is measured in **grams per square metre (gsm)**. This is the weight of one square metre of the paper.
- Board thickness is measured in **microns**: one micron is one thousandth of one millimetre.
- Sometimes the thickness of board is given in sheets. This refers to the number of pieces of paper have been glued together to make a sheet of board.

Different types of paper and board have different uses, as shown in the table below:

<table>
<thead>
<tr>
<th>Material</th>
<th>Description</th>
<th>Uses</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Layout paper</strong></td>
<td>Lightweight thin white paper</td>
<td>Initial ideas; takes colour media quite well</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Tracing paper</strong></td>
<td>Thin translucent paper</td>
<td>Making copies of drawings to transfer to other paper/card</td>
<td>High</td>
</tr>
<tr>
<td><strong>Cartridge paper</strong></td>
<td>Good quality white paper; available in different weights</td>
<td>General purpose work and simple models</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Bleedproof paper</strong></td>
<td>A smooth, hard paper</td>
<td>Can be used with water-based and spirit-based felt-tip pens</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Coloured paper</strong></td>
<td>Different types are available in different thicknesses</td>
<td>Mounting finished work and applying coloured surfaces to models</td>
<td>Low to medium</td>
</tr>
<tr>
<td><strong>Grid paper</strong></td>
<td>Available with printed square and isometric grids in different sizes</td>
<td>A guide for quick sketches and model-making</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Board</strong></td>
<td>A range of thicknesses (from 300 microns to 650 microns) and colours, including metallic finishes</td>
<td>Model-making and many other uses: different applications use different thicknesses</td>
<td>Medium to high</td>
</tr>
<tr>
<td><strong>Mounting board</strong></td>
<td>Good quality thick card with coloured surface</td>
<td>Final models and mounting finished artwork</td>
<td>High</td>
</tr>
</tbody>
</table>
Modern materials used in graphics

Materials for making products are often improved and refined. Sometimes new materials are developed, or new uses are found for existing materials. An example of a new use for an existing material is high-density foam. It was developed as a packaging material but is now often used for three-dimensional models.

The development of new hardware often leads to a demand for new materials. An example of this is the development of new types of paper to be used in colour printers for printing digital photographic images.

These are the main types of modern materials.

- **Treated papers** are available for computer printers, especially for ink-jet printers. They absorb the ink and generate crisp colour reproduction.
- **Thermo chromatic pigments** are supplied in paste form and can be mixed with any type of **acrylic** paint. At normal room temperature the pigment shows its usual colour, but when heated above 27 °C the colour changes to black. When the temperature falls below 27 °C again the colour reappears.
- **Phosphorescent pigments** are pigments which glow in the dark, first absorbing light and then emitting it after the light source has been removed.
- **Thermocolour sheet** is a sheet material printed with thermo chromic liquid - that is, one that changes colour as the temperature changes.
- **Polymorph** is a plastic that becomes moldable at 62 °C. It can be used for **product-modeling**, especially where curved shapes are involved (for example handles), and for making simple moulds for **vacuum-forming**.
- **High-density modeling foam** is a foam-based material that is available in blocks. It can be shaped easily using hand and machine tools and takes fine detail well. It is often used on **CNC** milling machines.
Geometrical shapes

The main geometrical shapes used in graphics are triangles, quadrilaterals, regular polygons, circles and ellipses.

Here are some guidelines to help you when drawing these shapes.

<table>
<thead>
<tr>
<th>Polygons</th>
<th>are shapes with three or more straight sides.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regular polygons</strong></td>
<td>are polygons with all sides equal and all angles equal. Regular polygons with five sides are called <strong>pentagons</strong>, regular polygons with six sides are called <strong>hexagons</strong>, and regular polygons with eight sides are called <strong>octagons</strong>.</td>
</tr>
<tr>
<td><strong>Triangles</strong></td>
<td>are a type of polygon with three sides, with three angles adding up to 180°. There are three main types of triangle. Equilateral triangles have sides of equal size and all angles are 60°. Right-angled triangles have one 90° angle. Isosceles triangles have two sides and two angles that are equal.</td>
</tr>
<tr>
<td><strong>Quadrilaterals</strong></td>
<td>are a type of polygon with four sides, and four angles adding up to 360°. A quadrilateral where all the angles are 90°, the opposite sides are equal and the diagonals are of equal length is called a <strong>rectangle</strong>. A rectangle where all four sides are of equal length is called a <strong>square</strong>.</td>
</tr>
</tbody>
</table>

A quadrilateral where opposite sides are the same length, but none of the angles are 90°, is called a **parallelogram**. A parallelogram where all four sides are the same length is called a **rhombus**.

<table>
<thead>
<tr>
<th>Circles and ellipses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Circles</strong></td>
<td>are perfectly round and have the same <strong>diameter</strong> (the distance from side to side and top to bottom, through the middle of the circle. To draw a circle accurately, use a pair of compasses. Set the compasses to the <strong>radius</strong> of the circle (the radius is distance between the middle and the outside, it is half the diameter).</td>
</tr>
<tr>
<td><strong>Ellipses</strong></td>
<td>look like stretched circles. The diameter is not the same from top to bottom and right to left. These diameters are called the <strong>major axis</strong> and <strong>minor axis</strong> (the major axis is the longer one, the minor axis the shorter one). Here’s how to draw an ellipse by construction:</td>
</tr>
</tbody>
</table>

1. Draw the major and minor axes. Draw two circles with diameters equal to the major and minor axes. |
2. Divide up the circles into 12 equal segments |
3. Where the segment lines cross the smaller circle, draw a horizontal line. Where they cross the larger circle, draw a vertical line. |
4. Each intersection point between vertical and horizontal lines is a point on the curve of your ellipse.
5. Join the intersection points with a freehand curve.

**Geometrical solids**

The main geometrical solids used in representing graphic products are the cube, cuboids, triangular prism, hexagonal prism, square-based pyramid, cylinder and cone. Click on the solids below to see how to draw them.

Here are some guidelines to help you when drawing these solids.

**Cubes** have six faces. All faces are square, with equal-length sides and angles of 90°.

**Cuboids** have six rectangular faces. The opposite faces are equal and all the angles are right angles at 90°.

**Hexagonal prisms** have eight sides. The two ends are hexagons. The six sides are square or rectangular.

**Cylinders** have two ends that are circles and one continuous face around the outside. If this was opened out the flat side of a cylinder would be a large rectangle.

**Triangular prisms** have five sides. The two ends are triangles. The sides are square or rectangular.

**Cones** have a base that is a circle. One face goes all round and narrows towards a point at the top.

**Pyramids** are usually square-based. This square-based pyramid has five faces. The base of is a square. The four sides are triangles, which all meet at a point at the top. There are also triangle-based (with a triangle base and three sides) and hexagon-based pyramids (with a hexagon base and six sides), among other variations.
ICT in graphic design and production

Computer graphics software, computer printing and computer-controlled machinery are nowadays ubiquitous in all graphic design and making processes. ICT speeds up the whole design and production process, allows changes to be made much more easily, and enables designers to build simulations showing what the finished product will look like - and even how it will behave - while it’s still on the drawing-board.

There are two main ways in which ICT is used in graphics:

• **Computer-aided design** or **CAD** is used to help design products
• **Computer-aided manufacturing** or **CAM** is used to standardise and automate the manufacturing of products

Another term you will come across is **computer numerical control** or **CNC**, which simply means computerised control of machines used in design and manufacture. CNC machines use electronic data, which can of course be sent anywhere in the world by email - so that products designed in one country can be manufactured in another.

<table>
<thead>
<tr>
<th>Both CAD and CAM can be thought of as systems consisting of input devices, processes and output devices.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input devices</strong> include keyboards, computer mouses, scanners, digital cameras, drawing tablets and tracker balls</td>
</tr>
<tr>
<td><strong>Processes</strong> include <strong>CPUs</strong>, operating systems, memory and software</td>
</tr>
<tr>
<td><strong>Output devices</strong> include monitors, printers, plotters, cutters, CNC lathes, CNC milling machines and stereo lithography machines</td>
</tr>
</tbody>
</table>

Modelling and prototyping

One of the biggest benefits of ICT to designers is that it allows them to create 3D models and **prototypes** of their product without going to the trouble of making them physically, using the techniques of virtual prototyping and stereo lithography.

• **Virtual prototyping** software produces a three-dimensional on-screen representation of the product, which can be manipulated and viewed from any angle, just as if it were real.
• **Stereo lithography** software uses CNC to make a real-world 3D prototype from a specification stored in the computer. A detailed model of the product is first made on the computer, then 'sliced' into many very thin layers. Each slice is then cut into resin by a laser, and the resin slices assembled into a complete prototype.
Graphs and charts

Numerical data is often represented using graphs and charts. Some types of graph will be familiar to you from Maths:

- **Line graphs** are good for showing simple results over a period of time, for example, how well a product sells. For more complex data, bar graphs are clearer.
- **Bar graphs** are useful for showing numbers of people who choose various options, for example, colour choices. They can be done in 2D or 3D form. Different colours of bars can be used on the same graph.
- **Pie charts** are useful for showing fractions of a whole number. It is possible to create 3D pie charts and extract the segments.

Planning charts

Charts can be extremely useful in planning your work on a graphic design project. There are several types of planning chart.

1. Gantt charts

Gantt charts show the different tasks involved in making a product and whether there can be overlaps in different tasks. They are useful for complex planning where various tasks can be done at the same time, or where two or more people are working on the same product.

A gantt chart to show planning for an animal play

<table>
<thead>
<tr>
<th>Names</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
<th>Week 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>Write script</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Danny &amp; Jane</td>
<td>Design &amp; make animals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sue &amp; Brian</td>
<td>Design &amp; make theatre</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Danny &amp; Jane</td>
<td>Develop lighting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sue &amp; Brian</td>
<td>Rehearsal</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>Rehearsal</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

2. Flow charts

Flow charts describe in words the sequence of operations. Flow charts are useful for simple tasks. Arrows show direction. Different-shaped boxes signify different stages.

- A rectangle with rounded corners shows start and finish.
- A diamond is used for a decision.
- A rectangle represents process.
3. Sequence diagrams

These show the process of making something in words and pictures. They are useful if you need to tell someone else how to do a job or how to use something.
**Sketching**

**Sketching** is a way of putting ideas down on paper quickly. It is done freehand, but a piece of grid paper may be useful. Sketches may be two-dimensional (2D) or three-dimensional (3D).

For sketching complex shapes, a box or series of boxes can be used as a guide. This is called a crating or wire-frame drawing.

![Crating technique to draw a complex shape](image)

When sketching, use any medium with which you feel comfortable. Pencils and fine-line markers are particularly good. Limited colour may be used on quick sketches.

Use a level of detail sufficient to show the main points of an idea. Do not show unnecessary detail. Sketches should be sufficiently clear to allow other people to understand your ideas.

Sketch models can be quickly-made 3D models to show spaces or moving parts. They are made from suitable materials and will usually supplement paper-based sketches.
Enhancement techniques

There are a range of techniques for enhancing the appearance of a drawing, making it look more like the real object. The technique used will depend on the type of drawing and what you are trying to show.

1. Thick and thin lines

For this technique, thin lines are used in between adjoining surfaces. Thick lines are suitable when only one side can be seen. The drawing illustrates the idea.
2. Tone

Tone refers to different shades of the same colour. A lighter tone is called a tint and is made by adding white to the base colour. A darker tone is called a shade and is made by adding black to the base colour.

Tone can also be shown by using patterns of lines, dots, shading, reflections and highlights. It is also possible to obtain sheets of dry transfer material to represent different tones.

3. Texture

There are a number of ways of showing on paper the texture of materials used to make a product. These are intended to give an impression of the material, rather than represent it exactly. Some examples include drawing the grain on pieces of wood or drawing lines at angles to show reflected light on clear glass or plastics. Textures can be represented in shades of grey or colour.

The graphic shows an object that has been coloured and shaded on a computer to look like a 3D object of polished metal.
4. Colour

Colour is an important part of graphic design. You need to know the following facts about colour.

- The **primary colours** are red, yellow and blue.
- The **secondary colours** are made by mixing the primary colours as follows: red + yellow = orange; red + blue = violet; blue + yellow = green.
- Mixing primary and secondary colours together creates tertiary colours. These are dark browns, greens and greys.

The colour wheel illustrates how the colours relate to each other.

- The colours next to each other harmonise (go together). Use harmonising colours to make elements of a design look related to each other.
- Colours that are on opposite sides of the wheel contrast with each other (they are 'complementary' colours). Use contrasting colours to make elements of a design stand out from each other.
- Yellow, orange and red are 'warm' colours; green and blue are 'cold'. Warm colours appear to come towards you from the page, while cold colours appear to recede.
Isometric projection

In isometric projection all vertical lines on an object remain vertical while horizontal lines are drawn at $30^\circ$ to the horizontal. Isometric drawings are usually produced with drawing equipment to ensure accuracy.

Isometric projection distorts shapes slightly in order to keep all upright lines vertical (and because perspective is ignored). Their advantage is that they show the object's dimensions accurately and in correct proportion to each other, making it easy to draw the projection correctly to scale from a plan view.

Perspective drawing

In perspective drawing the forward face or edge of the object is drawn first, with the other lines receding away from the viewer and gradually approaching each other - just as they appear to do when you look at a real object. If the receding lines are extended they will meet at points that are called vanishing points. Perspective drawing can be done using drawing equipment or freehand.

Perspective drawing can use one, two or three vanishing points. One-point perspective is often used for room interiors. Two-point perspective has many applications for developing ideas in 3D. Three-point perspective is often used for drawings of tall buildings.

The advantage of perspective drawing is that it makes objects appear more realistic, as objects appear to get smaller as their distance from the observer increases.
**Working drawings**

Drawings which contain all the information needed to make the object you have designed, including dimensions and details of components, materials and assembly instructions, are called **working drawings**. Although working drawings for simple products may sometimes be done in isometric or planometric projection, the normal drawing technique for working drawings is **orthographic projection**.

Some products may need a **section drawing** to give extra structural information, or an **assembly drawing** to show how parts fit together.

1. **Orthographic projection**

Orthographic projection shows complex objects by doing a 2D drawing of each side to show the main features. Orthographic drawings usually consist of a front view, a side view and a **plan**, but more views may be shown for complex objects with lots of detail. A drawing board and parallel motion or T-square is used to project one view from another.

Orthographic drawing may be done using **first angle projection** or **third angle projection**. The graphic below shows the differences between the two.
2. Section drawings

Section drawings show the various parts of a product as if it had been sliced in half. (Sometimes they are called cross-sections.) The position of the imaginary cut is called a section plane, sometimes represented by a line consisting of long and short dashes.

The purpose of a section drawing is to make clear how a product is constructed. Parts of the object that are cut through are shaded with lines at 45° and spaced 4mm apart - called cross-hatching. If two parts of a product are touching, then the cross-hatching goes in opposite directions. Parts such as nuts and bolts and axles are not normally sectioned.
3. Assembly drawings

An assembly drawing shows the various parts of a product drawn to show exactly how they fit together. They are often used for products such as construction and model kits or flat-pack furniture, to show the user how to assemble the parts.

They can be drawn in two ways.

- A fitted assembly drawing shows the parts put together, and can be drawn in 2D or 3D.
- An exploded drawing shows the parts separated, but in the correct relationship for fitting together. Exploded views are usually drawn in 3D, as illustrated.