VCE Visual Communication Design Units 1 & 2

Chapter 5 — Designing three-dimensional objects

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Chapter 5 Designing three-dimensional objects — 5A Elements, principles & methods for objects

Theory

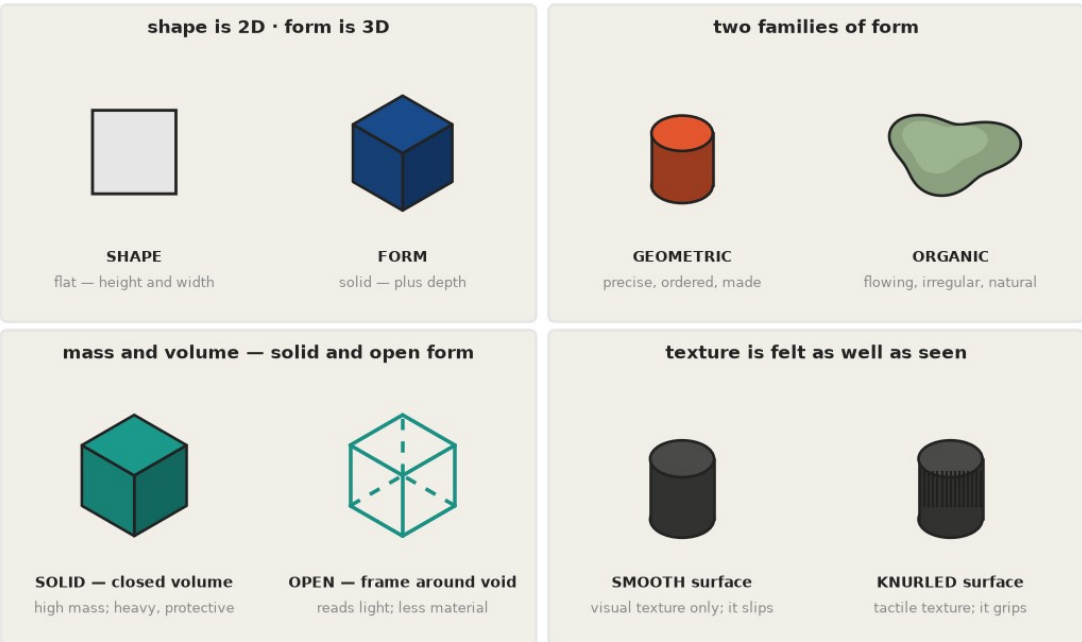
In Unit 1 Outcome 3 you develop a **sustainable three-dimensional object** in response to a brief. That is a different kind of design problem from the visual language you built in Chapter 2, because the thing you are designing is not printed on a surface — it **occupies space**. Someone will pick it up, turn it over, put a hand around it and set it down on a bench. The key knowledge for this subtopic is:

> manual and digital methods, design elements and principles relevant to the design of three-dimensional objects.

Two halves, then. First, **which elements and principles matter, and how they behave differently once the design has depth**. Second, **the drawing and making methods** you use to develop and communicate a form that only exists so far in your head. This subtopic covers both. Rendering — simulating surfaces, materials, texture and the direction of light — is 5B, and the technical conventions used on documentation drawings are 5C.

What changes when a design has depth. You met the eight design elements and the eight design principles in 2C. Nothing is deleted from those lists when you move to objects, but three things change.

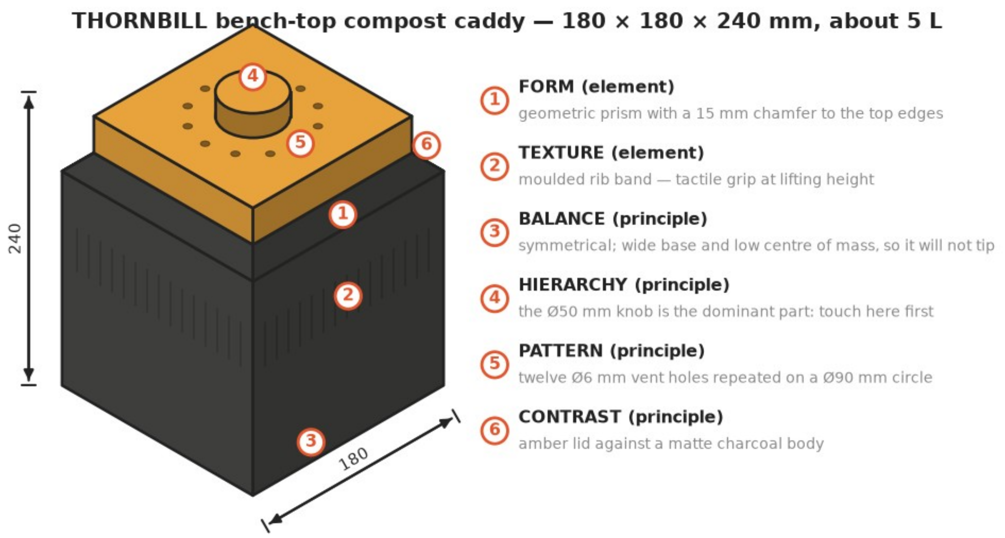
1. **Shape becomes form.** A **shape** is a two-dimensional enclosed area, with height and width only. A **form** is three-dimensional: height, width **and depth**. This is the single most common terminology error in this Area of Study, and it is easy to avoid — if the thing has depth, or you have drawn the illusion of depth, call it a form.
2. **The elements become physical, not only visual.** Texture on a poster is something you see; texture on a handle is something you *feel*, and it changes whether the object slips. Tone on a page is a grey you chose; tone on an object is what real light does to a real surface. Colour is no longer ink on paper but a property of the **material** itself.
3. **There is no single "front".** A poster has one viewpoint. An object is seen from above as it sits on a bench, from the side as you walk past, and from underneath when you pick it up. Every one of those viewpoints has to work.



The design elements, read in three dimensions. For each element, the *feature* is what it is; the *function* is the job it does on an object.

- **Point** — a single small mark or component: a fixing, a button, an indicator, a stud. On an object a point acts as a focal accent and, very often, as a **signal of where to press or touch**.
- **Line** — on an object, line is mostly *real*: an edge, a seam, a groove, a moulded rib, and above all the **silhouette** that separates the form from what is behind it. Line direction changes how the form is read — a horizontal groove makes an object look wider and lower; vertical grooves make it look taller.
- **Shape** — still useful, because the object's **outline seen from one viewpoint is a shape**, and that outline is what a user recognises from across a room before any detail is visible.
- **Form** — the central element here. Forms fall into two families: **geometric** (cubes, cylinders, cones, prisms — precise, ordered, and cheap to manufacture) and **organic** (flowing, irregular, asymmetrical — natural, soft, often more comfortable to hold). Forms are built two ways: **additive**, by joining parts together, and **subtractive**, by cutting material away.
- **Volume and mass** — properties of form rather than separate elements, but you need both words. **Volume** is the space a form encloses; **mass** is how heavy and solid it looks. A closed, solid form has high visual mass and reads as protective and permanent. An **open** form — a frame around a void — reads as light, and uses far less material, which matters to a sustainable brief. The **void** is a design decision, not leftover space.
- **Tone** — on an object, tone is produced by real light striking real surfaces. A curved surface gives a gradual tonal transition; a faceted or chamfered one gives an abrupt step. You use tone to make a drawn form read as solid (that is 5B).
- **Texture** — **tactile (actual)** texture is a real surface you can feel: a knurled grip, moulded ribs, a sandblasted finish, a woven cover. **Visual (implied)** texture is the illusion of a surface, drawn or printed. On an object, tactile texture usually does a **functional** job as well as a visual one — it grips, it resists slipping, it hides fingerprints, and it tells the hand where to hold.
- **Colour** — on an object, colour belongs to the **material or its finish**: moulded through the polymer, anodised, powder-coated, dyed, or left as the raw material's own colour. Colour codes parts (which bit moves, which bit is hot), signals function, and carries the brand.
- **Type** — moulded, embossed, engraved, printed or applied as a label. Type on an object must survive the surface it sits on: moulded type has no colour contrast at all, only the tonal contrast that light and shadow give it.

The design principles, read in three dimensions.



SCALE — 240 mm tall and 180 mm across, so it clears a 450 mm overhead-cupboard gap and two hands close around the body.
PROPORTION — body : lid assembly is about 4 : 1 (190 mm to 50 mm).

- **Proportion** — the size relationship **between the parts of the one object**, and between a part and the whole. On the THORNBILL caddy above, the body is about four times the height of the lid assembly. Unlike a poster, proportion on an object is also constrained by **function**: a handle must be long enough for four fingers whatever the drawing looks like.

- **Scale** — size measured **against something else**, and for an object that something else is usually the **human body** and the space the object lives in. A bench-top caddy has to clear the overhead cupboards — a gap of about **450–600 mm** in most Australian kitchens — and close inside two hands; a step stool has to be low enough for a five-year-old to step onto in one movement. You settle scale by **testing the object against a real user and the real space**, usually with a full-size low-fidelity prototype that can be held, lifted and stood on, not by scaling the drawing until it looks right on the page.
- **Balance** — an object has to satisfy balance **twice**. **Visual balance** is the distribution of visual weight (symmetrical, asymmetrical or radial), exactly as on a page. **Physical balance** is whether the thing actually stands up: a wide base and a low **centre of mass** make it stable, a narrow base and a heavy top make it tip. A design can be beautifully balanced visually and still fall over.
- **Contrast** — of form (a curve against a flat), of material (matte polymer against brushed metal), of colour, of tone, of texture. Contrast is what separates the parts a user **acts on** from the parts they only look at.
- **Hierarchy** — on an object, hierarchy ranks **parts by their importance to use**. The part the user should touch first is made the most visually dominant, by scale, colour or position. Done well, this is why a person can operate an object without being told how — the design itself says *hold here, lift this*.
- **Pattern (repetition and alternation)** — repeated ribs, perforations, flutes, slots. On an object a repeated element almost always earns its place twice: it creates rhythm and unity, **and** it ventilates, drains, grips or stiffens.
- **Figure–ground** — becomes the relationship between the **positive form** and the **negative space** around and through it: the hole cut for a finger, the gap under a handle, the silhouette against the wall behind.
- **Cropping** — applies less to the object than to how you **present** it: a cropped close-up view of one detail on a presentation board.

Units 3 & 4 preview — beyond the Units 1&2 study design. Professional designers settle the scale of an object using **ergonomics** — designing for comfortable, safe use — and **anthropometric data**, the measured dimensions of human bodies (grip diameters, reach, seat heights). They work to a percentile range, commonly the 5th to the 95th, so the object suits nearly everyone rather than the designer's own hand. Neither term belongs to the Units 1&2 key knowledge; both sit in the field of objects as it is studied in Units 3 & 4, and neither is required or assessed here. In Units 1 & 2, check scale the way this subtopic teaches it — against a real user, with a full-size prototype.

Choose principles that **do work for the brief**. A sustainable-object brief (Unit 1 Outcome 3) usually pushes you toward simple geometric forms that mould or fold cleanly, one material rather than a laminate of several, and open forms that use less of it — which is why proportion, pattern and balance tend to carry more weight than decoration. Circular design practices themselves are covered in 4C.

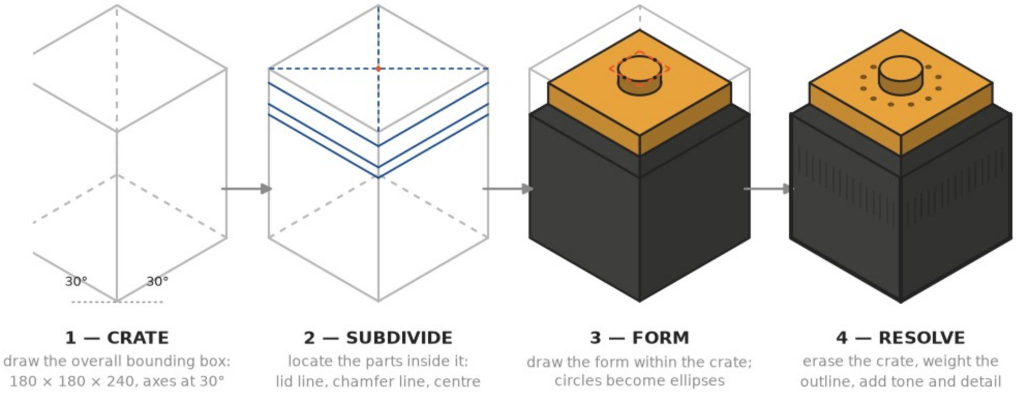
Units 3 & 4 preview — beyond the Units 1&2 study design. In Units 3 & 4 you will classify design work into **four fields of design practice** — messages, objects, environments and interactive experiences — and choose a drawing method appropriate to the field. The object work in this chapter is exactly the "objects" field, so the elements, principles and methods here carry straight over. The four-field framework itself is not part of the Units 1&2 study design and is not assessed here.

Manual methods for designing objects. A method is the process or technique you use (2C and 3B). These are the manual ones that do object work.

- **Ideation (thumbnail) sketching** — many small, fast, freehand drawings on layout bond. The point is quantity and divergence, not quality; a rough drawing still looks unfinished, so it still invites change.
- **Crating** — the technique the whole of object drawing rests on. You draw the simple box that the form would just fit inside, then subdivide that box to locate every part, and only then draw the form within it. Crating fixes the **proportions** before any detail exists, which is why a crated drawing looks right and a drawing built detail-first usually does not.
- **Paraline drawing** — a family of drawing systems in which **parallel edges on the object stay parallel on the page**. The one used for objects is **isometric**: the two receding axes are drawn at **30° to the horizontal**, verticals stay vertical, and measurements are taken **full size along all three axes**, so you can measure straight off the drawing. (**Planometric**, where the plan keeps its true shape, is the paraline system used for

environments — Chapter 7. **Oblique** draws the front face as a true shape with a single receding axis, usually at 45°.)

- **Perspective drawing** — edges **converge** to **vanishing points** on a **horizon line** set at eye level. **One-point** perspective keeps one face parallel to the picture plane and sends all depth lines to a single vanishing point; **two-point** perspective views the object at a corner and uses two vanishing points. Perspective looks the most like a photograph, which is why it persuades a client — but you cannot take a measurement off it.
- **Technical flats** — flat, straight-on two-dimensional outline drawings of the object from the front, side and top, drawn to true proportion with no perspective at all. They are the quickest way to work out real sizes, part positions and surface graphics, and the quickest way to show a maker what you mean.
- **Low-fidelity prototyping and model-making** — a mock-up in card, foam board, polystyrene, timber or modelling clay, at full size wherever possible. This is the only method that tests **grip, weight, stability and reach** honestly, because those are physical properties and no drawing contains them.



A circle drawn on any face of an isometric drawing becomes an **ellipse**. Its **major axis is about 1.22 times** the true diameter and its **minor axis about 0.71 times** it — a ratio of about 1.73 : 1 — and the **minor axis lies along the axis of the cylinder**, that is, perpendicular to the face the circle sits on. In practice you draw the isometric square that the circle fits inside, mark the midpoint of each of its four sides, and draw the ellipse through those four points; ellipse templates for this job are marked **35°**.

Digital methods for designing objects.

- **Digital sketching** on a tablet with a stylus — the speed of freehand with layers, undo, and the ability to trace over a photographed manual sketch on a new layer.
- **Vector drawing** — for technical flats and for any surface graphic that has to be reproduced exactly at any size.
- **3D CAD (computer-aided design) modelling** — you build the object as a digital solid. The model can then be rotated to any viewpoint, and isometric, orthogonal and perspective views can be generated from it automatically. It also *measures*: wall thickness, volume, mass and material usage, all of which matter to a sustainable brief.
- **Digital rendering** — applying materials, colour and lighting to the model (5B).
- **Digital fabrication** — exporting the model to a **3D printer** or laser cutter to produce a physical prototype, closing the loop between digital and manual.

Object-design methods — matched to the job they do

	GENERATE many rough ideas, fast and cheap	REFINE test proportion, scale and parts	RESOLVE & PRESENT one solution, communicated clearly
MANUAL	· thumbnail ideation sketches · quick crated roughs · freehand overlays on tracing paper	· crated isometric drawing · one- and two-point perspective · technical flats (front, side, top) · card / foam low-fi prototype	· resolved isometric or perspective presentation drawing · rendered by hand (5B) · documentation drawing (5C)
DIGITAL	· stylus sketching on a tablet · photographed sketches traced on a layer · digital mood and form boards	· 3D CAD model, rotated to any view · vector technical flats · measured wall thickness / volume · 3D-printed draft prototype	· CAD-generated isometric and perspective views · digitally rendered materials (5B) · dimensioned CAD documentation (5C)

media & materials for object work — graphite and layout bond · fineliner · marker and coloured pencil · isometric grid paper · ellipse template · card, foam board, masking tape · modelling clay · stylus and tablet · CAD software · PLA filament for draft prints

Digital is not automatically better. Digital gives precision, repeatability, measurement and instant change. It also forces you to commit to exact numbers before you have chosen an idea, and it makes a half-formed idea look finished, which quietly stops a critique group suggesting changes. For objects there is a further catch: **a screen cannot tell you what an object weighs, how it grips, or whether it tips.** Most professional object processes therefore run manual sketching → manual or card prototype → CAD, and go back and forth as needed.

> **Units 3 & 4 preview — beyond the Units 1&2 study design.** An **exploded paraline view** — the parts of an assembly pulled apart along common centre-lines so their order and fit can be read — is a presentation method commonly used for object designs in Units 3 & 4. It is not named in the Units 1&2 study design and is not required or assessed here; a standard isometric or a set of technical flats is what this course asks for.

Selecting and justifying — the move this subtopic is built on. The key skill is to *select and use appropriate manual and/or digital methods, media and materials to represent and render forms* and to *select appropriate design elements and principles when developing a sustainable object*. A selection earns full marks only when it is justified in three parts:

1. **Name the specific method, element or principle.** Not “digital” and not “I drew it” — “a crated isometric drawing in fineliner”, “the principle of proportion”, “tactile texture”.
2. **State the property that matters.** An isometric can be measured along its axes; a card prototype has real weight; a wide base lowers the centre of mass.
3. **Link that property to the stage, the brief, the user or the material.** So the moulder can take sizes straight off the drawing; so the team discovers the stool rocks before tooling is cut; so a five-year-old cannot tip it.

Miss step 3 and you have described a tool rather than justified a decision.

Annotating an object drawing. The key skill *annotate design ideas and concepts using design terminology* is assessed on your folio, and a strong annotation is short and does three jobs: it **names** the element or principle in correct terminology, **explains** the decision, and **evaluates** it against the brief or the criteria — including, where honest, a limitation.

> **Watch-out — shape is not form.** Use **shape** for a two-dimensional enclosed area and **form** for anything with depth. “The designer used an interesting shape for the stool” describes a flat drawing, not an object.
>
> **Watch-out — scale is not proportion. Proportion** is the relationship between the parts of the one object. **Scale** is size relative to something else — usually the human body. A stool can be well proportioned and still be the wrong scale for a five-year-old.
>
> **Watch-out — a paraline drawing has no vanishing points.** In isometric, parallel edges stay parallel. The moment you converge them you have drawn perspective, and you can no longer measure off the drawing. Do not mix the two systems in one drawing.

Watch-out — “digital” is not a method. Name the actual method, medium and material: “a 3D CAD model”, “vector technical flats”, “stylus sketching on a tablet”. The same applies to “I made a model” — say what of, and at what size.

Watch-out — balance in an object is physical as well as visual. If a question asks about balance on a three-dimensional object, deal with stability and centre of mass as well as with the distribution of visual weight.

Watch-out — match the method to the stage. A CAD model at the generation stage kills divergence, because you spend the hour on fillet radii instead of on the twentieth idea. Thumbnails first, measurement later.

Worked examples

Example 1 — scaffolded

The THORNBILL bench-top compost caddy is 180 × 180 mm on plan and 240 mm high overall. Its body is 175 mm high with a 15 mm chamfer to the top edges; a 150 × 150 × 30 mm lid slab sits at 190 mm, with a Ø50 × 20 mm knob centred on it. Using crating, describe how you would construct an isometric drawing of the caddy at 1 : 2 scale. (6 marks)

Working	Comment
Step 1 — set the system. Draw a light vertical for the front corner and two receding axes at **30° to the horizontal** from its base.	The 30° axes and the vertical are what make the drawing isometric. State the system first: a marker cannot award a paraline drawing that could be perspective.
Step 2 — scale once, at the start. At 1 : 2 every dimension is halved, so the crate is **90 × 90 × 120 mm** on the page. Body top 87.5, chamfer top 95, lid top 110, knob Ø25 × 10.	Convert every dimension before drawing anything. Converting mid-drawing is where proportion errors get in.
Step 3 — draw the crate. Measure 90 along each 30° axis from the front vertex and 120 vertically, then complete the box.	Measurements are taken **full size along the three axes** in an isometric *drawing*, so a ruler works directly. This is the whole reason to crate.
Step 4 — subdivide. Mark 87.5, 95 and 110 up the three vertical edges and rule the horizontal division lines parallel to the axes. Draw the diagonals of the top face to find its centre.	Locate every part **inside** the crate before drawing any detail — the diagonals give the exact centre for the knob without measuring.
Step 5 — cut the chamfer. Measure 7.5 mm in from each top edge **along the axes**, and join the inset square down to the body’s top edge.	An inset in isometric is measured along the drawing’s axes, never perpendicular to a drawn edge — that would foreshorten it twice.
Step 6 — the knob. Draw the isometric square of side 25 mm centred on the lid’s top face; the circle becomes an **ellipse** through the midpoints of its four sides, major axis 1.22 × 25 ≈ 30.5 mm, minor axis 0.71 × 25 ≈ 17.8 mm, with the **minor axis vertical**.	Circles never stay circles in a paraline drawing. Saying which axis is minor (it lies along the cylinder’s axis) shows you understand *why*, not just that ellipses appear.
Step 7 — resolve. Erase the crate, then weight the drawing: heavy line on the outline (silhouette), medium on the edges between visible faces, light on surface detail.	Line weight is what makes a paraline drawing read as a solid object rather than a wireframe.

Example 2 — scaffolded

The THORNBILL brief asks for a caddy that a household will actually empty each day, made from a single recyclable material. Select ONE design element and ONE design principle for the lid, justify each, and write an annotation of no more than three sentences explaining the decisions. (5 marks)

Working	Comment
Element — colour. The lid is moulded in a warm amber; the body is a matte charcoal.	Name the specific element. "The designer used colour well" names nothing and explains nothing.
Principle — contrast, used to build **hierarchy**. The warm, light amber against the dark, low-tone charcoal makes the lid the highest-contrast part of the object.	The principle is the *arrangement*, not the component. Contrast is the mechanism; hierarchy is the result.
Why it works. Warm hues advance against a dark, cool field, so the eye lands on the lid first and the hand follows it. The user's first action — lift the lid — is the one the design makes most obvious.	This cause-and-effect chain is where the marks are. An object that is obvious to open gets opened, and a caddy that gets opened gets emptied.
Link to the brief. The colour is **moulded through** the polypropylene rather than painted on, so the part is still a single, cleanly recyclable material.	Tie the decision back to the brief's constraint. Here the element choice and the sustainability requirement are settled by *one* decision.
Annotation (model). "The lid is moulded in warm amber against a matte charcoal body. This **contrast** of colour and tone puts the lid at the top of the object's **hierarchy**, so a first-time user reaches for it without instruction and the caddy is emptied daily as the brief requires. The colour is moulded through the polypropylene, so the part remains a single recyclable material — although the amber will show food staining more than the charcoal would."	An annotation names the terminology, explains the decision, and evaluates it against the brief. Including the honest limitation is what lifts an annotation from descriptive to evaluative.

Example 3 — unscaffolded

A design team is developing the SITTELLA step stool. Recommend one manual method and one digital method for the Develop stage, and one method for presenting the resolved concept to the school council. Justify each choice. (6 marks)

For the Develop stage the team should work **manually with crated isometric sketches in graphite on layout bond**. Crating fixes the proportions of the platform, the flare of the base and the position of the finger hole before any detail is drawn, and graphite on cheap bond is fast and erasable enough that the team can produce twenty variants of the taper in an hour — the divergence this stage of the work needs. Alongside it they should build a **3D CAD model**. CAD is the digital method that earns its place here because it *measures*: it reports the wall thickness, the volume of polypropylene and the position of the centre of mass, so the team can check that the base is wide enough for the stool to be stable and that the shell is not using more material than it needs.

To present the resolved concept to the school council, the team should use a **two-point perspective presentation drawing, rendered**. The council are not manufacturers; they need to picture the stool in a library, and a corner view with converging edges and rendered material reads almost like a photograph. A set of technical flats would be the wrong choice for this audience — accurate, but it communicates sizes rather than the experience of the object. The flats go to the moulder instead.

Example 4 — unscaffolded

Distinguish between an isometric drawing and a two-point perspective drawing of the same object, and explain when each is the better choice. (4 marks)

An **isometric** drawing is a **paraline** system: edges that are parallel on the object stay parallel on the page, the two receding axes are drawn at 30° to the horizontal, and all three axes are measured **full size**, so a size can be taken straight off the drawing. A **two-point perspective** drawing instead **converges** the two sets of horizontal edges to two **vanishing points** on a horizon line set at eye level, so the object appears to recede and nothing except the leading vertical can be measured. Isometric is therefore the better choice while a designer is **developing** an object and needs to control real proportions, and when the drawing has to go to someone who will build or mould the thing. Two-point perspective is the better choice for **presenting** a resolved concept to a client or user, because the converging edges match what the eye actually sees and make the object look real and desirable — at the cost of measurable accuracy.

Practice questions

Scaffolded

Q1. Using the figure of the design elements in three dimensions: (a) Name the design element that distinguishes the cube from the flat square. *(1 mark)* (b) Identify which of the two forms in the second panel is **organic**, and describe one quality that form communicates. *(2 marks)* (c) Explain one function that **tactile** texture performs on an object that visual texture cannot. *(2 marks)*

Q2. Using the annotated figure of the THORNBILL caddy: (a) Name the design principle marked **5**. *(1 mark)* (b) Name the design principle marked **6**. *(1 mark)* (c) Explain how the designer has used **hierarchy** so that a first-time user knows how to open the caddy. *(2 marks)*

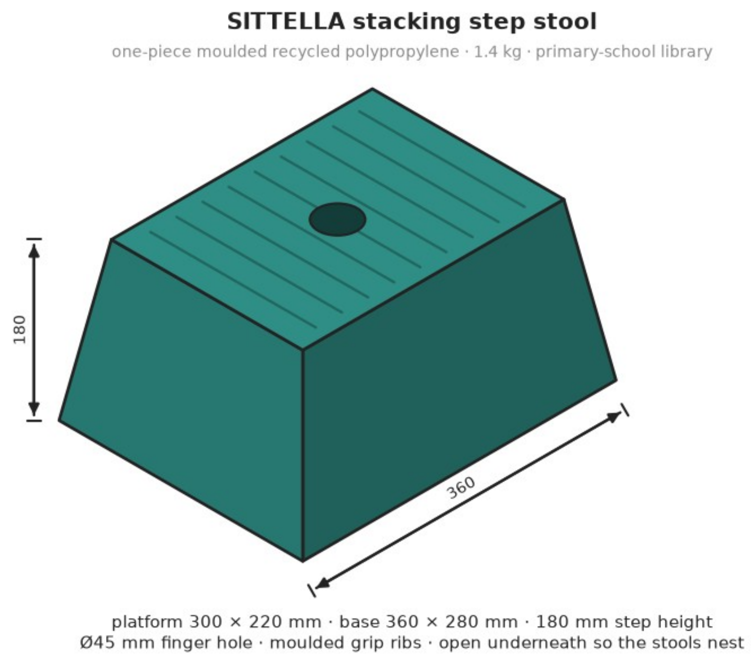
Q3. Using the crating sequence: (a) State the angle the two receding axes make with the horizontal in an isometric drawing. *(1 mark)* (b) State what the designer does at Stage 2, and why. *(2 marks)* (c) Explain one reason for drawing the crate before drawing any detail. *(2 marks)*

Q4. Using the object-design methods map: (a) Name one **manual** method suited to the generate stage. *(1 mark)* (b) Name one **digital** method suited to the refine stage. *(1 mark)* (c) Explain **two** things a full-size card prototype tells a designer that an isometric drawing cannot. *(2 marks)*

Q5. Scale and proportion: (a) Define **proportion** as it applies to a three-dimensional object. *(1 mark)* (b) Define **scale** as it applies to a three-dimensional object. *(1 mark)* (c) The THORNBILL lid knob is Ø50 mm. Explain how you would check that this is the right size for the user. *(2 marks)*

Q6. Drawing systems: (a) State one difference between a **paraline** drawing and a **perspective** drawing. *(1 mark)* (b) State what a circle drawn on the top face of an object becomes in an isometric drawing. *(1 mark)* (c) Explain when a **technical flat** is more useful than a two-point perspective drawing. *(2 marks)*

Unscaffolded



Questions 7–20 refer to the SITTELLA stacking step stool shown above, unless otherwise stated. The brief: a step stool for a primary-school library, for children aged 5–8, that stacks for storage, carries a 60 kg load and is made from a single recyclable material.

Q7. Identify the drawing method used for the SITTELLA drawing above and justify why it suits communicating the stool's proportions. *(3 marks)*

Q8. Analyse how the designer has used **three** design elements in the SITTELLA stool. *(6 marks)*

Q9. Explain how **proportion** and **scale** have each been applied to SITTELLA for a user aged 5–8. *(4 marks)*

Q10. Explain how the SITTELLA design addresses **balance** in both its physical and its visual sense. *(4 marks)*

Q11. Describe how you would use **crating** to draw SITTELLA so that the platform, the flared base and the finger hole are correctly located relative to one another. *(5 marks)*

Q12. SITTELLA's shell is a closed, tapered **volume** that is hollow and open underneath. Explain what that decision does to the stool's **visual mass** and to the material it uses, and state one thing the design would lose if the shell were an open frame instead. *(4 marks)*

Q13. The SITTELLA name is to be moulded into the side of the shell as a raised 40 mm high mark. Select and justify one **manual** and one **digital** method for developing that mark. *(4 marks)*

Q14. An object has no single "front". SITTELLA is looked down on by a child about to step up, seen from the side by an adult walking past, and seen from underneath when it is lifted onto a stack. Explain how designing for those three viewpoints changes the decisions the designer makes, and state what drawings the team needs so that no viewpoint is left undesigned. *(6 marks)*

Q15. Explain how **figure–ground** works on a three-dimensional object, using the Ø45 mm finger hole and the stool's outline as your two examples. *(4 marks)*

Q16. Explain how **contrast** and **hierarchy** could be used on SITTELLA so that a five-year-old knows where to put a foot without being told. *(4 marks)*

Q17. Write an **evaluative annotation** of no more than four sentences for the SITTELLA platform, identifying one strength and one limitation of the Ø45 mm finger hole against the brief. *(4 marks)*

Q18. Evaluate the decision to develop SITTELLA with manual sketching before building a 3D CAD model. *(6 marks)*

Q19. Distinguish between **tactile** and **visual** texture, giving one example of each from a three-dimensional object in this subtopic. *(3 marks)*

Q20. Explain how the decision to mould SITTELLA from a **single** material changes which design elements and principles are available to the designer. *(4 marks)*

Q21. TREECREEPER is a desk tidy to be folded from a single 0.8 mm sheet of recycled aluminium, for a shared studio desk where four people store pens, clips and cards. It must have no fasteners or glue, and must be flat-packed for delivery. Select and justify the **manual and digital methods**, and the **design elements and principles**, you would use to develop and present TREECREEPER. *(8 marks)*

Answers

Q1. (a) Form. (b) The right-hand form; flowing/natural/soft. (c) See solutions. **Q2.** (a) Pattern (repetition). (b) Contrast. (c) See solutions. **Q3.** (a) 30°. (b) Subdivide the crate to locate the parts. (c) See solutions. **Q4.** (a) Thumbnail ideation sketching (accept quick crated roughs). (b) 3D CAD modelling (accept vector technical flats, 3D-printed draft prototype). (c) See solutions. **Q5.** (a) The size relationship between the parts of the one object. (b) Size relative to something else — usually the human body. (c) See solutions. **Q6.** (a) Paraline keeps parallel edges parallel; perspective converges them to vanishing points. (b) An ellipse. (c) See solutions. **Q7.** Isometric (a paraline drawing). **Q8–Q21.** See fully-worked solutions.

Fully-worked solutions

Q1. (a) **Form** — the cube has depth as well as height and width, so it is three-dimensional; the square is a **shape**. (b) The **right-hand form is organic**: it is irregular, curved and asymmetrical, and it communicates a soft, natural, hand-made quality *(accept: friendly, comfortable to hold)*. (c) **Tactile texture is a real surface, so it changes how the object behaves in use.** A knurled or ribbed band physically increases friction, so the object does not slip in a wet or greasy hand, and the change in surface tells the hand where to grip without the user looking. Visual texture is only the illusion of a surface, so it can suggest grip but cannot provide it *(2 marks: the physical property + the effect on use).*

Q2. (a) **Pattern** (repetition). (b) **Contrast**. (c) Hierarchy ranks the parts of an object by their importance to use. On THORNBILL the Ø50 mm knob is given the highest rank — it is raised above every other surface, sits at the centre of the top face, and is the only cylindrical form on an otherwise rectangular object. Because it is the visually dominant part, a first-time user's hand goes to it, and lifting the knob is exactly the action needed to open the caddy *(2 marks: the ranking device identified + the effect on the user's action).*

Q3. (a) **30°**. (b) At Stage 2 the designer **subdivides the crate**, ruling the division lines that locate the top of the body, the chamfer and the lid, and drawing the diagonals of the top face to find its centre — so every part is positioned before any of it is drawn. (c) Crating fixes the **proportions** of the object first. Because the overall bounding box is drawn and measured before any detail exists, each part is located as a measured fraction of a box that is already correct, and the finished drawing cannot end up with a lid too large for its body — the error a detail-first drawing almost always makes *(2 marks: proportion fixed first + the consequence).*

Q4. (a) **Thumbnail ideation sketching** *(accept: quick crated roughs, freehand overlays on tracing paper).* (b) **3D CAD modelling** *(accept: vector technical flats, a 3D-printed draft prototype).* (c) **One:** it tells the designer what the object physically **weighs and how it grips** — whether a child can lift it, whether the hand slips. **Two:** it tells the designer whether the object is **stable** — whether it rocks or tips when weight is put on one edge. Both are physical properties of a real object in real space, and no drawing, however accurate, contains them *(2 marks: any two genuinely physical findings).*

Q5. (a) **Proportion** is the size relationship between the parts of the one object — part to part and part to whole. (b) **Scale** is size measured relative to something else: the other objects around it, the space it sits in, and above all the human body. (c) Scale is size measured against the user, so the check has to be made **against real hands rather than against the drawing**. Make the knob at full size — modelled in card, clay or foam and fixed to a mock lid — and have a range of people actually open the caddy with it, including with wet or greasy fingers, because that is how a compost caddy is opened in a kitchen. The knob is taken between finger and thumb, so what you are watching for is whether the smallest hands in that range can close on Ø50 mm securely and whether the largest can still pinch it comfortably; if either fails you change the diameter or the profile and retest before tooling is committed *(2 marks: testing at full size against a range of real users + what the result would change).*

Q6. (a) In a **paraline** drawing, edges that are parallel on the object remain parallel on the page; in a **perspective** drawing they **converge** to vanishing points on a horizon line. (b) An **ellipse**. (c) A technical flat is more useful whenever **real sizes and part positions** have to be communicated or worked out — for example when the drawing is going to a manufacturer, or when the designer is positioning a moulded logo. Because a flat is drawn straight on with no perspective and no foreshortening, every dimension on it is true, whereas nothing on a two-point perspective drawing can be measured *(2 marks: the situation + the reason).*

Q7. The drawing is an **isometric drawing** — a paraline method, with the two receding axes at 30° to the horizontal and verticals staying vertical. It suits communicating the stool's proportions because **parallel edges stay parallel and all three axes are drawn to the same, full-size scale**, so the relationship between the 300 mm platform, the 360 mm base and the 180 mm step height is shown truthfully and can be measured off the drawing. A perspective drawing of the same stool would foreshorten those edges by different amounts and the proportions could not be read *(3 marks: method named, the paraline property, the consequence for proportion).*

Q8. Form. SITTELLA is a single **geometric** form — a truncated pyramid, or frustum — moulded in one piece, with no separate parts to work loose and no joints to fail under load. The geometry is also what makes the stool stack: every face leans at the same angle, so one shell seats into the next and a row of stools takes up little more floor than one of them. **Texture.** Tactile texture is used on the platform as a set of moulded ribs. The ribs are the surface the foot lands on, so the texture is doing a safety job (slip resistance) as well as visually marking the platform as the part you stand on. **Line.** The four sloping silhouette edges are the strongest lines in the object; because they lean outward as they descend, they lead the eye down and out to the base and make the stool look planted rather than perched. **Colour** could equally be discussed: a single saturated teal, moulded through the polypropylene, is bright enough to be found in a busy library and needs no coating that would compromise recycling *(6 marks: three elements, each named and each linked to a specific feature and its effect — 2 marks each).*

Q9. Proportion is the relationship between SITTELLA's own parts: the 300 × 220 mm platform sits on a 360 × 280 mm base, so the shell flares 30 mm on every side, and the 180 mm height is about six-tenths of the platform's length. That is a wide, low set of proportions, which is what makes the stool look — and be — settled rather than tall. **Scale** is the stool measured against the child. A 180 mm step is below a five-year-old's knee height, so the child can step up in one movement without having to climb; the 300 mm platform is long enough for both feet side by side; and the Ø45 mm finger hole is sized for two or three small fingers rather than an adult hand. Proportion makes the object look right in itself; scale makes it fit the user *(4 marks: each term defined in the object's own terms and applied to a specific dimension — 2 marks each).*

Q10. Physically, SITTELLA is stable because the base (360 × 280 mm) is wider than the platform (300 × 220 mm) and the shell is a low, tapered volume, so its **centre of mass** is low and sits well inside the footprint. A child standing near one edge shifts the combined centre of mass, but the flare means it still falls inside the base, so the stool does not tip. **Visually**, the stool is **symmetrical** about both centre-lines, and the visual weight increases steadily from the light, ribbed platform down to the heavy, dark base. That downward-increasing weight reads as settled and reassuring, which matters for a five-year-old deciding whether to stand on it. ∴ the design satisfies balance twice — the flare that makes it physically stable is the same feature that makes it look stable *(4 marks: physical balance with the centre-of-mass mechanism + visual balance, and ideally the link between them).*

Q11. First, draw the **overall crate**: an isometric box 360 × 280 × 180 mm — the base footprint by the step height — with the two receding axes at 30° and measurements taken full size along all three axes. Second, **subdivide vertically**: the platform sits at the top of the crate, so rule the top face of the box as the 180 mm level. Third, **locate the platform inside the top face**: the platform is 300 × 220 mm, so measure the difference — (360 − 300) ÷ 2 = 30 mm on each side, and (280 − 220) ÷ 2 = 30 mm front and back — **along the axes**, and rule the smaller rectangle centred in the top face. Join its four corners down to the four corners of the base to produce the flared sides. Fourth, **find the centre** of the platform by ruling its diagonals; that intersection is the centre of the finger hole. Fifth, **draw the hole**: construct the 45 mm isometric square centred on that point and draw the ellipse through the midpoints of its four sides, keeping the minor axis vertical because the hole's axis is vertical. Finally erase the crate and weight the outline *(5 marks: overall crate, subdivision by measurement along the axes, the flare produced by joining corners, the centre found by diagonals, the circle constructed as an ellipse).*

Q12. Volume is the space a form encloses; **mass** is how heavy and solid that form looks. SITTELLA encloses its volume completely on the three sides anyone sees, so from every standing viewpoint the stool presents unbroken surfaces with no frame, no fixings and no gaps: it carries high **visual mass** and reads as solid, protective and permanent, which is the right reading for something a person is invited to put their whole weight on. The volume is enclosed but not filled. The shell is hollow and open underneath, so the object is a thin moulded wall around a **void** — 1.4 kg of polypropylene rather than the solid block the outside implies — and that void is a design decision, not leftover space: it is where the material saving lives, and the brief's single recyclable material has to stretch no further than the wall. Making the shell an **open frame** instead would use less material again and read lighter still, but the design would lose the continuous top surface the foot lands on and the closed sides that keep small fingers out from under a loaded stool. ∴ closed on the outside and hollow within is the version of the form that serves the 60 kg load and the material constraint at once *(4 marks: volume and mass distinguished, the visual effect of the closed form, the material consequence of the void, and a genuine loss on the open-frame alternative).*

Q13. Manual — freehand thumbnail sketching of the wordmark in fineliner on layout bond, drawn at the finished 40 mm height. Drawing the mark at actual size is the point: at 40 mm a letterform that looked fine enlarged on screen may close up, and the designer can generate twenty letterform variants in the time one digital version takes. **Digital — vector drawing.** The mark has to be moulded into a steel tool, so it must exist as an exact, resolution-independent outline that can be scaled and handed to the toolmaker without any loss of edge quality; a vector path also lets the designer thicken the strokes and open the counters, which is essential because a **moulded** mark has no colour contrast at all and is read only by the shadow its raised edges cast *(4 marks: one manual and one digital method, each named specifically and justified by a property linked to this job — 2 marks each).*

Q14. A poster has one viewpoint. An object has as many viewpoints as there are ways of standing near it, and each one carries different decisions. **Looked down on — the child's view.** This is the only viewpoint that shows the working surface, so it is designed functionally first: moulded ribs across the platform for slip resistance, the Ø45 mm hole placed where the diagonals cross so it reads as deliberate, and a surface finish visibly different from the smooth sides, so a child sees where the foot goes without being told. Nothing on this face is decoration. **From the side — the room's view.** This is what an adult sees walking past, and it is read as a silhouette: four edges leaning outward to a wider base, an unbroken tapered face and the moulded name mark. The decisions are about how the stool sits in the library as furniture, and about telling anyone at a glance which way up it goes. **From underneath — the view nobody photographs.** It is seen every time the stool is lifted onto a stack, and it decides whether the product works at all. This is where the team has to resolve the nesting recess, the stiffening the thin wall needs to carry 60 kg, the moulded material code that keeps the shell recyclable, and the radius on every edge a child's hand reaches under there. **The drawings needed.** One isometric shows the top and two sides at once but never the underside, so it cannot be the only drawing. The team needs a set of **technical flats or third-angle orthogonal views** — front, side, top *and* an underside view — and a **3D CAD model** that can be rotated to any viewpoint, backed by a physical prototype that can simply be picked up and turned over. ∴ a face that is never drawn is a face that is never designed *(6 marks: three viewpoints, each with a decision that belongs to that viewpoint alone, plus the drawings needed to cover the faces one isometric cannot show).*

Q15. On a page, figure–ground is the relationship between a shape and the space around it. On an object it becomes the relationship between the **positive form** and the **negative space** around and through it — and on an object that negative space is designed, not left over. **Through the form.** The Ø45 mm hole is negative space cut through the platform. Because it is centred where the diagonals cross and it is the only opening in a surface that is otherwise continuous, it reads as a figure against the platform's ground and a user takes it as an instruction — *lift here* — rather than as a hole left by the moulding. Move it off-centre, or add a second one, and that reading collapses into an accident. **Around the form.** From across the library the stool is read as an outline against the floor and the wall behind it: low, wide and tapering, recognised as a step stool before any rib, colour or moulded name can be made out. The designer protects that reading by keeping the sides unbroken and the silhouette simple, so nothing competes with it at a distance. ∴ figure–ground on a three-dimensional object is worked in two places at once — through the form and around it *(4 marks: the positive/negative relationship defined for three dimensions, the hole read as designed negative space, the silhouette read against its ground, and the point that both are deliberate — 2 marks each).*

Q16. Contrast would be used to separate the platform from the rest of the shell — for example by moulding the platform surface in a lighter tone or a visibly different texture from the smooth, darker sides. Because the eye is drawn to the point of greatest difference, the child looks at the platform first. **Hierarchy** then ranks the parts of the object by importance to use: the platform is made primary (the largest uninterrupted surface, the lightest tone, the only ribbed area), the finger hole secondary (a smaller, darker accent that says *lift here*), and the plain sides tertiary. Read together, the two principles mean the object itself instructs the child — the brightest, most textured horizontal surface is obviously the one to stand on, and no label or adult is required *(4 marks: contrast with its mechanism, hierarchy with its ranking, and the effect on the child's behaviour).*

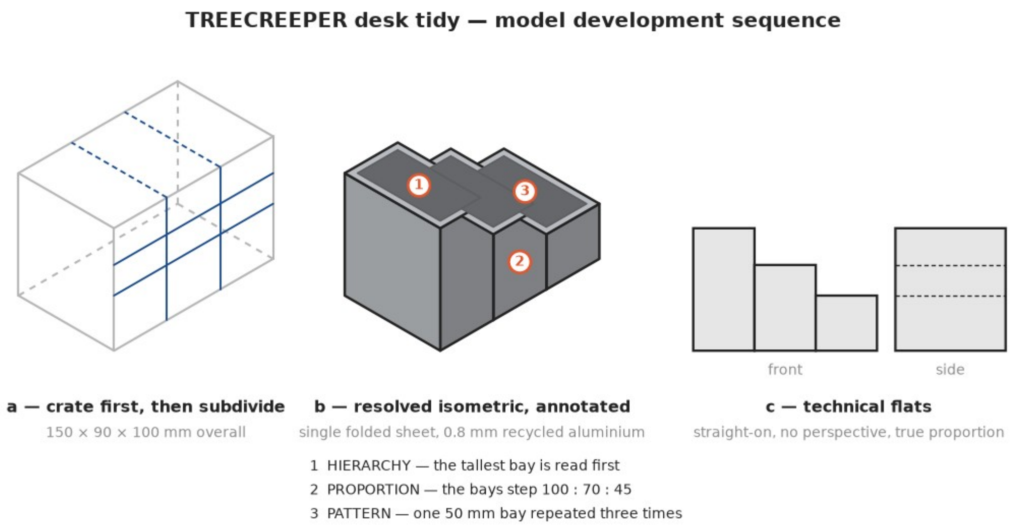
Q17. *(Model annotation — four sentences.)* "The Ø45 mm finger hole is cut through the centre of the platform, where the diagonals cross, so it reads as a deliberate focal **point** rather than a hole left over from moulding. **Strength:** at Ø45 mm it admits two or three small fingers, so the 1.4 kg stool can be lifted clear one-handed by a user in the 5–8 age band the brief names, which is the action the brief's *stacks for storage* requirement depends on. **Limitation:** the hole sits in the middle of the surface the child stands on, so a shoe can catch its rim, and the as-moulded edge is nearly square and will feel sharp against a small finger carrying 1.4 kg. **Next step:** radius the rim to at least 3 mm and test a prototype with the class before committing to tooling." *(4 marks: element/principle named in correct terminology, a strength tied to a brief requirement, an honest limitation, and a resulting design action.)*

Q18. Developing SITTELLA manually before modelling it in CAD was the right decision. **Strength one — divergence.** Freehand crated sketches cost almost nothing per idea, so the team could test many tapers, platform sizes and rib patterns quickly; in CAD the same hour would have gone into constraining one model. **Strength two — the rough drawing invites change.** A pencil sketch obviously is not finished, so a critique group will still suggest alterations to it, whereas a rendered CAD model looks resolved and quietly discourages criticism at exactly the stage when criticism is most useful. **Limitation.** Manual sketching cannot measure. It could not tell the team the volume of polypropylene in the shell, the wall thickness needed to carry a 60 kg load, or where the centre of mass sits — all of which the brief's 60 kg load and single-recyclable-material requirements depend on, and all of which CAD reports directly. **Judgement.** ∴ the sequence, rather than either method alone, is what works: manual for generating and choosing, CAD for verifying and documenting — and a full-size physical prototype after both, because neither method can tell the team what the stool feels like to lift *(6 marks: at least two strengths with mechanisms, a genuine limitation, and an overall judgement referenced to the brief).*

Q19. Tactile (actual) texture is a real physical surface that can be felt as well as seen — for example the moulded grip ribs on the SITTELLA platform, or the moulded rib band around the THORNBILL caddy body. **Visual (implied) texture** is the *illusion* of a surface, created by marks, pattern or rendering on something that is actually smooth — for example the drawn hatching a designer uses on an isometric to suggest a brushed-aluminium finish on TREECREEPER. The distinction matters on objects because only tactile texture can change how the object behaves in the hand *(3 marks: both defined, one correct example of each, ideally the consequence).*

Q20. Moulding SITTELLA from a single material removes the possibility of building meaning through **material contrast** — there is no metal-against-polymer or hard-against-soft to separate the parts. That loss has to be made up by the elements and principles that do not depend on a second material. **Form** carries more of the load: the taper, the flare and the recessed platform have to do the work that a change of material would otherwise do. **Texture** becomes the main way of differentiating surfaces, because ribs, stipple and gloss can all be moulded into one tool in one material. **Colour** is limited to a single moulded-through hue rather than a palette, so **tone** — the shadow that moulded relief casts — becomes the designer's contrast. ∴ the single-material constraint narrows the palette of elements but sharpens the design, since every distinction now has to be earned by the form itself *(4 marks: what is lost, and at least two elements or principles that must compensate, with reasons).*

Q21. *(Model response. The figure below shows the development sequence the answer describes.)*



Generate — manual. Begin with **thumbnail ideation sketches** in graphite on layout bond: twenty or thirty small crated roughs exploring how one flat sheet can be folded into bays. Graphite is fast, erasable and cheap enough that a rejected idea costs nothing, which is exactly what the generate stage needs. Because the object is made by folding, each thumbnail should be tested immediately with a **folded paper mock-up** — a fold that cannot be made in paper cannot be made in aluminium either, so this is the cheapest possible reality check.

Refine — manual and digital. Redraw the chosen idea as a **crated isometric** in fineliner: crate the overall 150 × 90 × 100 mm bounding box, subdivide it at 50 mm and 100 mm along the length to set the three bays, and rule the 100, 70 and 45 mm step heights before drawing any detail, so the proportions are correct before the drawing looks like anything. Then build a **3D CAD model** and use it to generate **vector technical flats** of the front, side and top — necessary because a folded-sheet object must also be drawn as a flat blank, and because CAD will report the sheet area used, which is the number the brief's single-material, no-fasteners requirement turns on.

Elements. Form is the primary element: three simple geometric bays, additive in appearance but subtractive in fact, since they are cut and folded from one blank. **Line** does the second job — the fold lines are real, visible edges and they read as crisp verticals that divide the object. **Texture** is left as the raw brushed finish of the recycled aluminium, so no coating is added that would compromise recycling; the brushing also hides the fingerprints inevitable on a shared desk. **Colour** is therefore the material's own, a neutral that will not fight four people's belongings.

Principles. Proportion governs the bays, which step 100 : 70 : 45 mm so that pens, clips and cards each sit at a height where they can be seen and picked out. **Hierarchy** follows from that stepping: the tallest bay is read first, which is correct because it holds the items used most. **Pattern** comes from repeating one 50 mm bay width three times, which unifies the object and, more practically, means the blank is a simple repeating development that nests efficiently on the sheet. **Balance** must be checked physically as well as visually: with the mass concentrated in the tall bay, the 150 × 90 mm footprint keeps the centre of mass low and well inside the base, so a full tidy does not tip when a pen is pulled from the top.

Present. Present the resolved concept as a **rendered isometric** with annotations, supported by the **technical flats** and the flat blank. The isometric is chosen over perspective because the studio users need to judge whether the bays are the right size for their own things, and only a paraline drawing keeps those sizes measurable. ∴ every choice — manual first for divergence, CAD for verification, isometric for a measurable presentation — is made because of what that method does, not because it is the method available *(8 marks: methods named and justified across generate, refine and present; at least two elements and two principles named and justified against the brief; the single-material and no-fastener constraints addressed; an overall rationale.)*

Theory

A drawing of a three-dimensional object starts with its **form** — the isometric, planometric or perspective drawing that says what shape it is and how big the parts are. This subtopic is about what you do *on top of* that drawing. The key knowledge is:

> rendering techniques used to simulate surfaces, materials, texture and form, and depict the direction of light, shade and shadow.

Rendering is the application of **tone**, **colour** and **texture** to a drawing so that a flat mark on a flat sheet reads as a solid object made of a particular material, standing in real light. An unrendered line drawing tells the viewer the *shape*. A rendered drawing tells the viewer three more things at once:

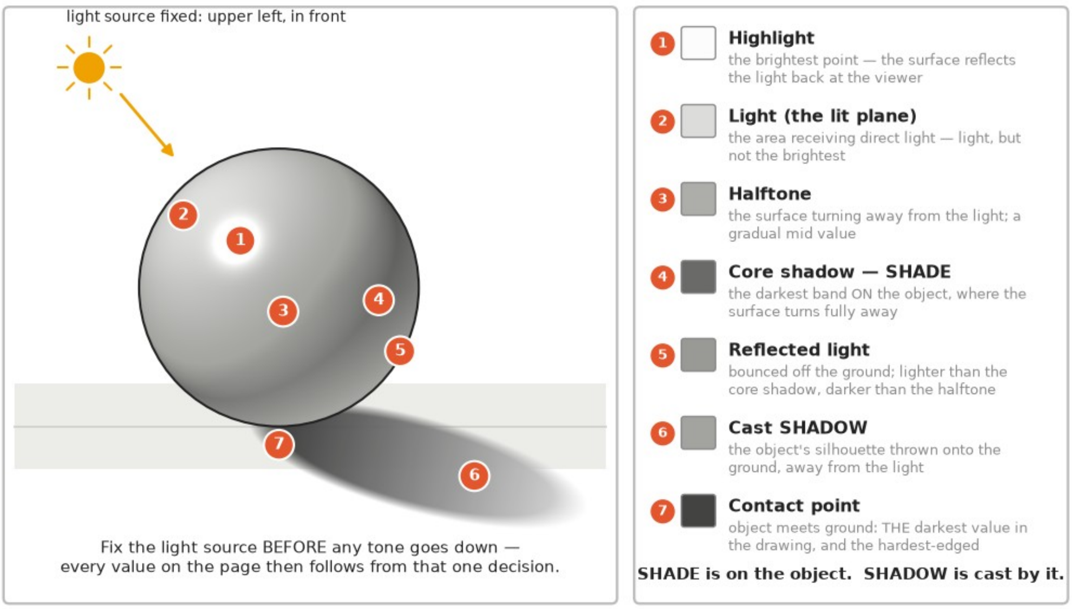
1. **What the form is** — whether the surface is flat, curved, faceted or hollow.
2. **What it is made of** — steel, stoneware, timber, glass, moulded polymer, cork, felt.
3. **Where the light is** — and therefore how the object sits in space, on a surface, at a moment.

That third item does most of the work, because the other two are read *from* it. A viewer works out the form and the material from how the light behaves on the surface, so **rendering begins with a decision about the light, not a decision about the pencil.**

Rendering is not decoration. In Unit 1 Area of Study 3 you are designing a **sustainable three-dimensional object** for a brief. When you hand a client two drawings of the same tumbler — one rendered as brushed stainless steel, one rendered as matte recycled polymer — you have not shown them one design twice. You have shown them **two different products**, with different costs, different lifespans and different end-of-life paths. The rendering *is* the material specification.

The first decision: fix the light source

Before any tone goes down, decide where the light is coming from and write it on the sheet — for example *upper left, in front*. Everything after that is determined: which planes are light, which are dark, which way the shadow falls, and how long it is. Fix it once and keep it identical across **every view and every object on the page**. Two objects on one sheet lit from opposite directions is the single most common and most obvious rendering fault, and a marker sees it instantly.



The figure above names the seven zones you must be able to identify and produce. Learn the words — the study design asks for *appropriate design terminology*, and these are the terms.

- **Highlight** — the brightest point, where the surface reflects the light straight back toward the viewer. On a **gloss** surface it is small and hard-edged; on a **matte** surface it is broad and soft, or absent altogether.
- **Light (the lit plane)** — the area receiving direct light. Light, but not the brightest point.
- **Halftone** — the surface turning away from the light. On a curved form the halftone is a wide, gradual band; on a flat plane it does not exist, because a flat plane has only one tone.
- **Core shadow**, also called **shade** — the darkest band **on the object itself**, where the surface has turned fully away from the light. It sits *just inside* the shadow-side edge, not at the edge.
- **Reflected light** — light bounced back off the ground and nearby surfaces into the shadow side. It is **lighter than the core shadow and darker than the halftone**. This is why the core shadow is a band rather than a slab of black running to the outline.
- **Cast shadow** — the object's silhouette thrown onto the ground or an adjacent surface, on the side **away from the light**.
- **Contact point** — where the object meets the ground. The cast shadow is at its **darkest and hardest-edged** here, and it softens and lightens as it travels away.

Shade is on the object. Shadow is cast by it. The study design names both. Using "shadow" for the dark side of the object throws away a mark you were given for free.

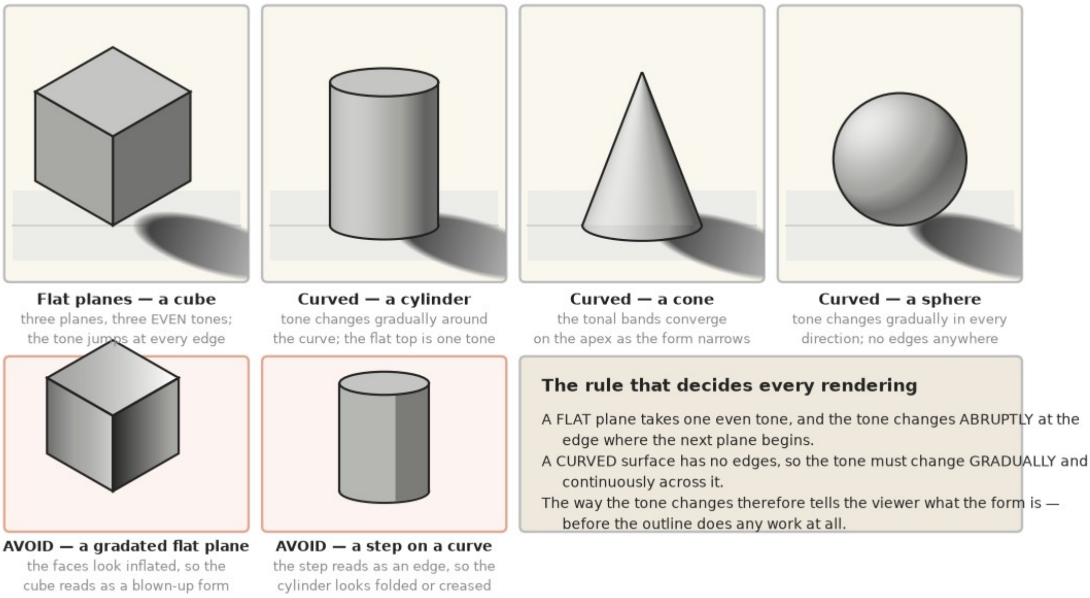
The cast shadow

A cast shadow does three jobs: it anchors the object to a surface, it confirms the light direction, and it gives the drawing its darkest value. To place one:

- **Direction.** The shadow runs *directly away* from the light. If the light is upper left, the shadow falls to the lower right. It cannot fall in two directions on one page.
- **Length.** The **lower** the light, the **longer** the shadow. A light high overhead gives a short shadow pooled under the object; a low, late-afternoon light throws a long one.
- **Shape.** The cast shadow is the object's **silhouette projected onto the receiving surface**, so it distorts with that surface — it stretches along the ground, and it bends and climbs where it meets a wall. It is not a generic oval blob placed under everything.
- **Edge and value.** Hard and dark at the contact point; softer and lighter the further it travels. Never render it as a flat area of black — a shadow is a surface with less light on it, not a hole.

How the tone changes tells the viewer what the form is

This is the single most important idea in the subtopic, and the one that separates a drawing that reads as solid from one that does not.



- A **flat plane** takes **one even tone** across its whole area, and the tone changes **abruptly** at the edge where the next plane begins. A cube showing three planes is rendered as three flat tones with hard steps between them — nothing more.
- A **curved surface** has no edges, so the tone must change **gradually and continuously** across it. A cylinder, a cone, a sphere and a dome are all rendered as smooth transitions.

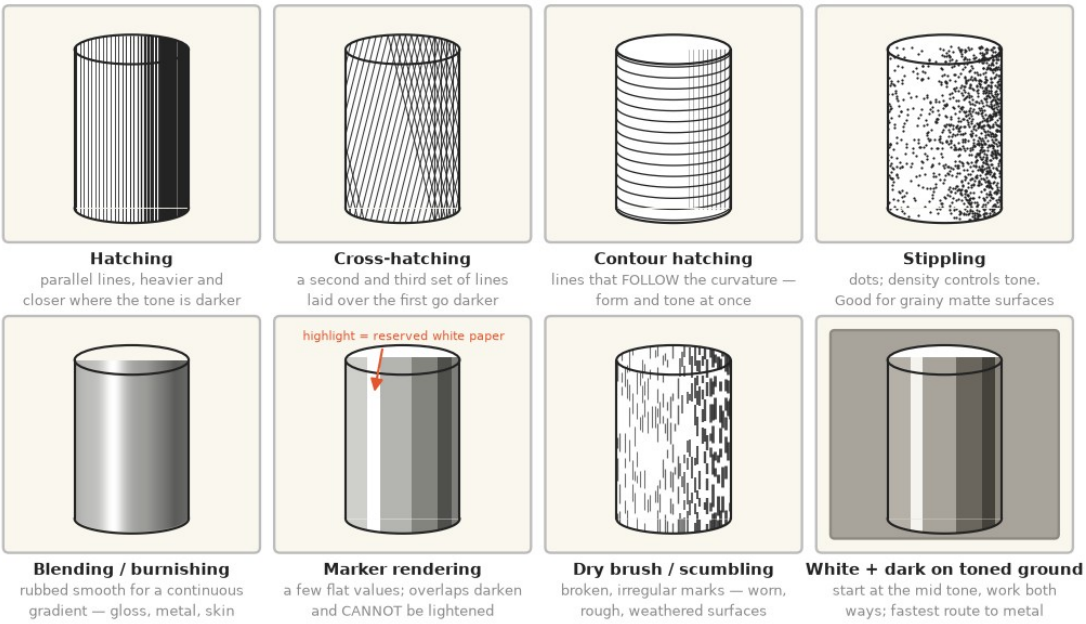
Get this backwards and the object changes shape. Gradate the faces of a cube and it looks inflated, like a cushion. Put a hard tonal step across a cylinder and the viewer reads that step as an edge — the cylinder now looks folded or creased. ∴ **the way the tone changes is doing more work than the outline is.** A viewer identifies the form from the tonal transitions before the outline is consciously read at all.

Two consequences worth stating:

- On a **cylinder**, the tone varies **across** the form and is constant **up** it, so the bands run parallel to the axis. The flat top is a separate, single, even tone.
- On a **cone**, the same bands **converge on the apex** as the surface narrows.

Manual rendering techniques

The key skill is to *select and use appropriate manual and/or digital methods, media and materials to represent and render forms*. These are the manual techniques worth having in your hand.



- **Hatching** — parallel lines. Tone is controlled by making the lines **heavier and closer together** where the surface is darker. Fast, and it keeps the drawing looking like a drawing.
- **Cross-hatching** — a second and third set of lines laid over the first at different angles. Each layer darkens the area, so a full tonal range is built without any blending.
- **Contour hatching** (cross-contour) — lines that **follow the curvature of the surface**, wrapping around a cylinder or over a dome. This is the most useful hand technique for curved forms, because the line direction describes the **form** at the same time as the line density describes the **tone**. Two jobs, one mark.
- **Stippling** — dots, with density controlling tone. Slow, but ideal for **grainy matte** surfaces such as unglazed ceramic, cast concrete or moulded pulp.
- **Blending and burnishing** — graphite, or layers of coloured pencil, rubbed smooth to give a continuous gradient with no visible marks. The technique for **gloss, polished metal and glass**, where the transitions are meant to be seamless.
- **Marker rendering** — a small number of **flat values** of one hue. Overlapping strokes darken, and marker **cannot be lightened**, so the highlight must be **reserved as untouched white paper** and planned before the first stroke.
- **Dry brush and scumbling** — broken, irregular marks that leave the paper showing through: worn, rough, weathered and recycled surfaces.
- **White pencil and dark pencil on a mid-toned ground** — start at the middle value and work in both directions. The quickest route to convincing **metal**, because metal is mostly extremes.
- **Erasing back** — lifting graphite with a sharp or kneadable eraser to cut a highlight into an area you have already toned. A subtractive technique, and the cleanest way to recover a highlight in an area that has already been toned.

A useful discipline: work with a **limited number of values** — about five, from the reserved white to the darkest dark. A rendering with fifteen slightly different greys reads as mud; one with five clearly separated values reads as solid.

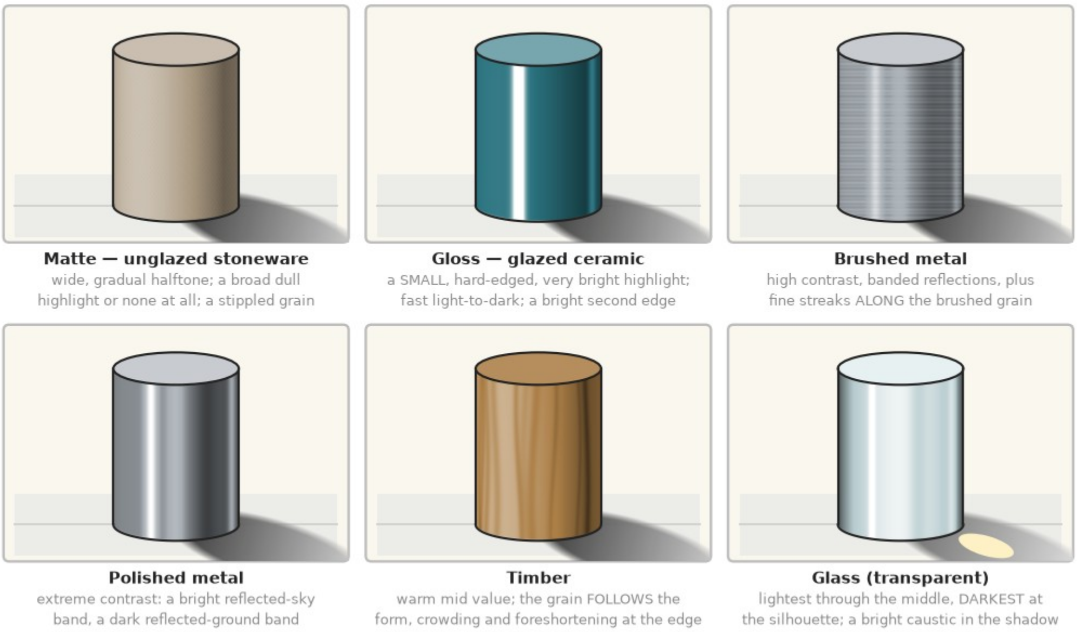
Digital rendering techniques

- **Soft-edge brush and gradient tools** over flat colour, with a **multiply layer** carrying the shade and the cast shadow so the underlying colour can be changed later without redoing the tone.
- **Layer opacity and masks**, so a rendering is **non-destructive** — the highlight can be moved, the shadow softened, the material swapped, without redrawing anything.
- **Texture and pattern fills**, including scanned textures, applied over the form and then distorted to follow it.
- **Three-dimensional modelling software**, where you set a **material** (matte, gloss, metallic, transparent) and a **light** (position, intensity, softness) and the software computes the tone.

Digital gives you exact repeatability, easy revision and the ability to **move the light after the drawing is finished**. Its cost is that software defaults produce a smooth, characterless, plastic surface that looks the same for every student, and that it is slow at the ideation stage where you want twenty quick roughs rather than one perfect one. Most professional object work is rendered by hand while the ideas are moving, and digitally once the concept is fixed.

Simulating specific materials

Every material handles light in its own way, and that behaviour is its **tonal signature**. Learn the signatures and you can render anything; learn only "shade the right-hand side" and every object you draw will be made of the same grey substance.



Material	Tonal signature to reproduce
Matte — unglazed stoneware, powder coat, felt, moulded pulp	Light is scattered, not mirrored: a **wide, gradual halftone**, a **broad, dull highlight** or none at all, low overall contrast. Stipple or blend gently.
Gloss — glazed ceramic, polished plastic	A **small, hard-edged, very bright highlight**; a **fast** jump from light to dark; a second bright edge low on the shadow side where the ground is reflected.
Brushed metal	High contrast and **banded** reflections, plus fine **streaks running along the direction of the grain**.
Polished metal	Extreme contrast, almost no gradual halftone: a **bright band** where the sky is reflected and a **dark band** where the ground is, meeting at a hard edge.
Timber	Warm mid value, matte, low contrast, with **grain that follows the form** — the lines crowd together and foreshorten as the surface turns away.
Glass — transparent	**Lightest through the middle**, where you see straight through it, and **darkest at the silhouette**, where the section is thickest. Hard specular strips, a bright rim, and a **caustic** — a bright patch — inside the cast shadow.
Rubber and soft-touch polymer	No distinct specular highlight, slightly softened edges, and a dark, even mid tone.

Two of these are counter-intuitive and are worth saying out loud. **Metal is not "grey"** — it is a mirror, so it shows bands of its surroundings rather than a smooth gradient, which is why an even blend always reads as plastic. **Glass is dark at the edges, not at the centre** — students almost always render it the other way round and produce something that looks like a ghost.

Texture

Texture is one of the design elements, and it comes in two kinds:

- **Actual texture** is the real, physical surface quality of an object — what it feels like under the hand. A prototype in cork, a sand-cast finish, a knurled grip.
- **Simulated (visual) texture** is the **illusion** of that surface created on a flat drawing. This is what rendering produces.

Whichever you are simulating, one rule governs it: **texture must follow the form.** A pattern laid flat over a curved object destroys the form you spent the drawing establishing. Instead:

- Wrap the texture **around** the curve, so the units narrow and crowd together toward the silhouette.
- Apply the **texture gradient**: a repeating texture appears **smaller and closer together** as the surface recedes from the viewer. That gradient is itself a depth cue, quite separate from the tone.
- Keep the texture inside the tonal structure. A grain, weave or stipple sits **on top of** the light, halftone and core shadow — it does not replace them.

Rendering as evidence of a design decision

The key skills for this outcome ask you to *select and use appropriate manual and/or digital methods, media and materials to represent and render forms* and to *annotate design ideas and concepts using design terminology*. So a rendering in your folio is expected to be accompanied by an annotation that **names the choice, gives the reason, and evaluates the result** — for example:

> *Brushed stainless steel body, rendered with a mid-toned ground, white pencil and a fineliner for the grain streaks. Chosen because banded reflections and the horizontal grain read instantly as metal, which supports the "buy once" claim in the brief. Strength: the material is unmistakable at a glance. Limitation: the high contrast pulls the eye away from the lid, which is the part the user actually interacts with — I will lower the contrast on the body in the next version.*

Note also the division of labour between drawings, which you will meet in 5C. A **documentation drawing** carries the technical conventions a maker builds from — symbols, dimensions and scales — so the **resolved** documentation drawing issued for manufacture is conventionally kept **line only**, because tone laid over it would obscure the dimensions and the line types. That is a convention, not a prohibition: the study design says that development **and** documentation drawings used to visualise, refine, test and evaluate design concepts *might be rendered to depict surfaces and textural finishes*, and it lists documentation drawings among the presentation formats. A **development or presentation drawing** is rendered as a matter of course, because its job is to communicate the material and the form to a client rather than to a manufacturer.

> **Units 3 & 4 preview — beyond the Units 1&2 study design.** Two things in this subtopic run ahead of Units 1&2 and are flagged so you know they are not assessed here.
>
> **(1) Constructing a cast shadow from a plotted light source in perspective.** In a formal perspective set-up the shadow is constructed geometrically: a **light vanishing point** is plotted above the horizon and a **shadow vanishing point** directly below it on the horizon, and every shadow edge is projected from the pair. That construction method belongs to Units 3 & 4. In Units 1 & 2 you establish the light direction by decision and keep it consistent by eye — which is what every question in this subtopic asks for.
>
> **(2) Analysing the rendering in someone else's design.** In Units 3 & 4 you are given design examples in an examination Resource Book and asked to analyse the **methods, media and materials** used in the **final presentation** of a solution, and to name its **presentation format**. That analytical task, and the term "presentation format", belong to Unit 3. Here you **produce** renderings of your own object instead, and read a rendering only to identify the technique used.

Watch-out — one light source, one direction, every drawing. Fix it before you start and state it on the sheet. Two objects on one page lit from opposite sides is the fault a marker finds first.

Watch-out — shade and shadow are different words. Shade is the dark side **on** the object; the shadow is **cast** by it onto something else. Use both correctly.

Watch-out — do not gradate a flat plane, and do not step a curve. Flat planes take one even tone with an abrupt change at the edge; curved surfaces change gradually. Swapping them changes what the object appears to be made of and shaped like.

Watch-out — leave the reflected light in. If the shadow side runs solid black all the way to the outline, the object stops being a solid form and becomes a flat cut-out shape. Keep a lighter band along the shadow-side edge and put your darkest band just inside it.

Watch-out — anchor the cast shadow. A shadow that is detached from the object, or missing altogether, leaves the object floating. It must touch at the contact point, and be darkest there.

Watch-out — plan the whites before you start. In marker, ink and watercolour you cannot get the white back. Decide where the highlight is, and simply do not put anything there.

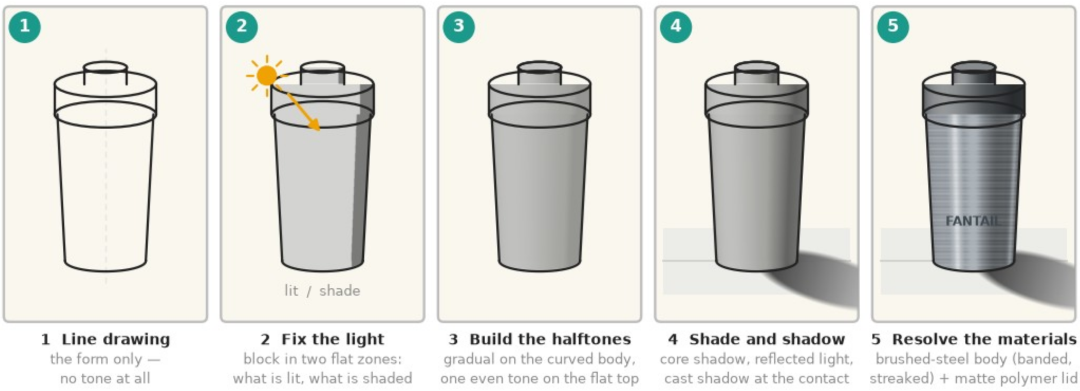
Watch-out — name the material, not just the tone. “I shaded it” earns nothing. “Rendered as brushed aluminium: banded reflection with fine streaks along the grain” earns the mark, because it names a material and the specific technique that simulates it.

Watch-out — render for a purpose, not everywhere equally. If every surface is rendered to the same intensity, the drawing has no focus. Resolve the part the brief and the user care about.

Worked examples

Example 1 — scaffolded

Using the FANTAIL refill tumbler shown below, describe the sequence you would follow to take the line drawing through to a resolved rendering, naming what you decide at each stage and one medium you would use. (6 marks)



FANTAIL refill tumbler — one drawing at five stages. The light direction is fixed at stage 2 and never changes again.

Working	Comment
Stage 1 — the line drawing. The tapered body, the lid band and the sipper are drawn as a paraline construction with correct ellipses. No tone at all yet.	Start by saying what is already there. Rendering is applied *to* a resolved form — toning a badly drawn ellipse only makes the error more visible.
Stage 2 — fix the light and block in two flat zones. I choose **upper left, in front**, note it on the sheet, and lay in just two values: everything the light reaches, and everything it does not. Medium: a mid-grey **marker** or a soft **graphite** pencil.	This is the stage students skip, and it is the one that decides the drawing. Two values first means every later decision is a refinement rather than a guess. Naming the direction earns the mark on its own.
Stage 3 — build the halftones. The **curved** body takes a gradual transition from the lit side across to the shadow side; the **flat** top of the sipper takes one even	The command is “describe the sequence”, so each stage needs a *what* and a *why*. Here the why is the flat-versus-curved rule: treat them the same and the tumbler stops

Working	Comment
tone with an abrupt change at its edge. Medium: **blended coloured pencil**, or contour hatching in fineliner.	reading as a cylinder with a cap.
Stage 4 — core shadow, reflected light and cast shadow. The darkest band goes *just inside* the shadow-side edge, with a lighter band of reflected light kept between it and the outline. The cast shadow runs to the lower right, hard and darkest at the contact point, softening as it goes.	Three separate marking points in one stage: the core shadow placed inside the edge, the reflected light kept, and the shadow anchored at the contact. Naming them separately is what earns them.
Stage 5 — resolve the materials. The body becomes **brushed stainless steel**: banded reflections with fine horizontal streaks along the grain, worked with white pencil over the mid tone. The lid becomes **matte polymer**: wide gradual halftone, no hard highlight.	The last stage is where the drawing stops being a grey cylinder and becomes a specified product. Naming two *different* materials in one object shows you can control the signature rather than shade by habit.
∴ the order runs **form → light → halftone → shade and shadow → material**, and the light direction fixed at stage 2 is never changed again.	Close with the sequence stated as a rule. The "never changed again" is the point the whole answer is built on.

Example 2 — scaffolded

The WHIPBIRD repairable desk lamp has a powder-coated aluminium shade, a turned hardwood stem and a brushed stainless steel base. Explain how you would render each material so that a client can tell the three apart. (6 marks)

Working	Comment
All three are lit from the **same** source — upper left, in front — so the differences the client sees come only from how each **material** handles that one light.	Say this first. It is the reason the answer works, and it dodges the commonest fault in one sentence.
Shade — matte powder-coated aluminium. A wide, gradual halftone right around the dome, a **broad soft highlight** upper left with no hard spot, and reflected light kept along the lower right edge. Blended coloured pencil, or contour hatching following the curve of the dome.	Matte means light is scattered, so the signature is *low contrast and no sharp highlight*. Contour hatching is worth naming because the dome is doubly curved.
Stem — turned hardwood. Warm mid value, matte, low contrast, with **grain that follows the form**: the lines crowd together and foreshorten toward the silhouette. A blended base with fine fineliner or sharp coloured-pencil lines over it.	The mark here is for grain *following the form*. Straight vertical grain lines of even spacing would flatten the stem into a stripe.
Base — brushed stainless steel. High contrast and **banded**: a bright reflected-sky band and a dark reflected-ground band, with fine **streaks along the direction of the grain**. White pencil worked on a mid-toned ground is the fastest route.	Metal is a mirror, not a grey. Banding plus streaks is what tells the client "this part is metal" without a label.
The contrast itself carries information: the base is the highest-contrast area, the shade the lowest. That difference alone lets the client separate the parts at a glance, even in a photocopy.	A strong answer says what the *comparison* between the three achieves, not just what each looks like on its own.
∴ one light, three tonal signatures — wide and soft for the matte shade, warm with directional grain for the timber, banded and streaked for the steel — communicates three different materials in one drawing.	The conclusion ties the three back to the question's actual demand: that a client can tell them apart.

Example 3 — unscaffolded

Explain why the way the tone changes across a surface tells a viewer whether a form is faceted or curved, using the cube and the cylinder as evidence. (4 marks)

A viewer reads form from **tonal transitions** before the outline is consciously read at all, because a change of tone is the visible evidence that the surface has changed its angle to the light.

On a **cube**, each face is a **flat plane**. Every point on one face sits at the same angle to the light source, so the whole face receives the same amount of light and takes **one even tone**. At an edge the surface angle changes instantly, so the tone changes **abruptly**: three visible faces become three flat tones with hard steps between them. The viewer reads each hard step as an edge, and therefore reads the object as faceted.

On a **cylinder**, the surface is **continuously curved**, so the angle to the light changes by a tiny amount at every point across the form. There are no edges, so there can be no steps: the tone must change **gradually and continuously** from the lit side, through the halftone, to the core shadow, and back up slightly into the reflected light at the far edge.

The test is what happens when the two are swapped. Gradate the faces of the cube and it reads as inflated and soft; put a hard tonal step across the cylinder and the viewer reads that step as an edge, so the cylinder appears folded or creased. ∴ the tonal transition, not the outline, is what declares the form — an abrupt change means a plane change, and a gradual change means a curve.

Example 4 — unscaffolded

The FANTAIL tumbler could be produced with a brushed stainless steel body or a matte recycled polymer body. Describe how the two renderings would differ, and explain what each communicates to the client about the product. (5 marks)

The form drawn is identical, so every difference the client sees comes from the tonal signature of the material, and each signature carries a different message.

Brushed stainless steel is rendered with **high contrast and banded reflections** — a bright band where the sky is reflected and a darker band where the ground is — with fine **streaks running along the direction of the grain** and a crisp, bright edge on the shadow side. Because metal is effectively a mirror, there is very little gradual halftone. This reads as precise, cold, manufactured and durable, and it supports a *buy-it-once, repairable, keep-it-for-a-decade* proposition — which matters in a brief about **sustainable** objects, where longevity is the environmental argument.

Matte recycled polymer is rendered with the opposite signature: a **wide, gradual halftone**, a **broad soft highlight** or none at all, low overall contrast, and a slightly broken, stippled or dry-brushed surface where the recycled flecks catch the light. This reads as warm, tactile, informal and honestly made from reclaimed material, and it supports a *closed-loop, low-embodied-energy* proposition instead.

There is also a practical difference in how the two are produced on the page: the steel version is fastest with white pencil on a mid-toned ground, because it is mostly extremes; the polymer version needs a blended base with a stipple laid over it, because it is mostly middle values.

∴ the rendering is doing the job of a material specification. The same drawing, given two signatures, presents the client with two genuinely different products and two different sustainability arguments — which is exactly why the rendering decision has to be justified in the annotation, not just made.

Practice questions

Scaffolded

Q1. Using the labelled sphere in the light-zones figure: (a) Name the zone labelled **4**. *(1 mark)* (b) State the direction the light is coming from, and name **two** of the numbered zones that would move if the light were shifted to the upper right. *(2 marks)* (c) Explain what **reflected light** is and why it must be kept in the rendering. *(2 marks)*

Q2. Using the flat-versus-curved figure: (a) State how the tone behaves on a flat plane, and how it behaves on a curved surface. *(2 marks)* (b) Name the error shown in each of the two AVOID panels. *(2 marks)* (c) Explain what a viewer wrongly reads from the stepped cylinder. *(2 marks)*

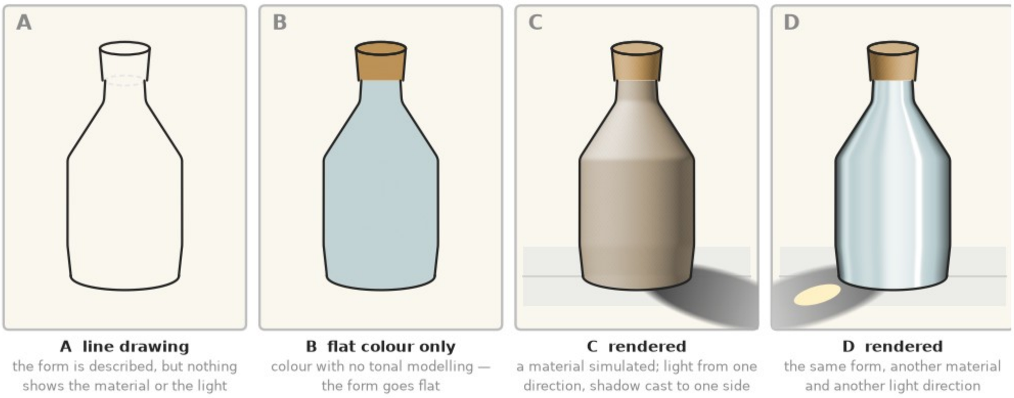
Q3. Using the manual techniques figure: (a) Name the technique in which the lines follow the curvature of the surface. *(1 mark)* (b) Name one technique well suited to a grainy, matte surface. *(1 mark)* (c) Explain why the highlight must be reserved as white paper in a marker rendering. *(2 marks)*

Q4. Using the materials figure: (a) Name the material shown with a small, hard-edged, very bright highlight. *(1 mark)* (b) Describe the tonal signature of matte unglazed stoneware. *(2 marks)* (c) Explain how a rendering of brushed metal differs from a rendering of polished metal. *(2 marks)*

Q5. Light, shade and shadow: (a) Distinguish between **shade** and **shadow**. *(2 marks)* (b) State where a cast shadow is darkest and hardest-edged, and explain why. *(2 marks)* (c) Describe what happens to the cast shadow when the light source is lowered. *(2 marks)*

Q6. Using the FANTAIL five-stage figure: (a) State what is decided at stage 2. *(1 mark)* (b) State the stage at which the cast shadow is added, and explain why it is not added earlier. *(2 marks)* (c) Name one manual medium suited to stage 3 and give one reason for the choice. *(2 marks)*

Unscaffolded



LYREBIRD refill carafe — four treatments of one drawing

Questions 7–21 refer to the LYREBIRD refill carafe, shown above as four treatments A–D of the same drawing, unless otherwise stated. Question 22 refers to the WHIPBIRD desk lamp described in Worked example 2.

Q7. State the direction of the light in panel **C**, and give **two** separate pieces of evidence from the drawing that support your answer. *(3 marks)*

Q8. Compare panels **A** and **B** with panel **C**. Explain what rendering communicates that a line drawing and a flat-colour drawing cannot. *(4 marks)*

Q9. Identify the material simulated for the carafe **body** in panel **C**, and justify your answer by referring to **three** features of its tonal signature. *(4 marks)*

Q10. Panel **D** shows the same body rendered as glass. Explain how transparency has been simulated, referring to the tone at the silhouette, the tone through the middle, and the cast shadow. *(4 marks)*

Q11. Compare the cast shadows in panels **C** and **D**. Explain what each one tells the viewer, and why the two cannot appear on the same sheet as one object. *(4 marks)*

Q12. Describe how you would decide the direction, length and shape of a cast shadow for the LYREBIRD carafe standing on a bench, and explain why the shadow must be anchored at the contact point. *(4 marks)*

Q13. Distinguish between **actual** texture and **simulated** texture. Using the carafe as an example, explain how a repeating texture must be handled so that it follows the form rather than flattening it. *(4 marks)*

Q14. LYREBIRD is considering two finishes for the carafe body: a **matte unglazed stoneware** and a **high-gloss glaze**. For each, select and justify the manual media and technique you would use to render it. *(6 marks)*

Q15. Describe **two** digital rendering techniques you could use for the carafe, and explain **one** strength and **one** limitation of rendering digitally rather than by hand at the development stage. *(5 marks)*

Q16. You are rendering the carafe in marker. Describe the order in which you would lay down the values, and explain why the rendering is built from a **small number of clearly separated values** rather than many similar ones. *(4 marks)*

Q17. A student submits a rendering of the carafe in which (i) the highlight is on the upper left but the cast shadow falls to the lower left, and (ii) the shadow side of the body is filled solid black right up to the outline. Identify the fault in each case and state the correction. *(4 marks)*

Q18. Write an evaluative annotation of no more than four sentences for the rendering in panel **C**, using appropriate design terminology. *(4 marks)*

Q19. Distinguish between **contour hatching** and **cross-hatching**, and state one situation in which each is the better choice. *(3 marks)*

Q20. (i) Explain how the tonal bands run on a **cylinder**, and how they differ on a **cone**. (ii) Explain why a **cast shadow** should not be rendered as a single flat black area. *(4 marks)*

Q21. The LYREBIRD cork stopper has a **flat circular top** and a **curved side**, meeting at a sharp edge. Explain how you would treat the tone on each, and what would go wrong if you blended across the edge between them. *(4 marks)*

Q22. Produce a complete rendering plan for the WHIPBIRD repairable desk lamp described in Worked example 2. Your response must state the light direction, describe how you would treat the form of the dome, specify the technique and media for each of the three materials, and explain how the cast shadow is placed. *(8 marks)*

Answers

Q1. (a) Core shadow (shade). (b) Upper left, in front; any two of zones 1–6 (only zone 7 stays). (c) See solutions. **Q2.** (a) Flat = one even tone, abrupt change at the edge; curved = gradual, continuous change. (b) Left = a flat plane gradated; right = a hard tonal step on a curve. (c) See solutions. **Q3.** (a) Contour (cross-contour) hatching. (b) Stippling. (c) See solutions. **Q4.** (a) Gloss glazed ceramic. (b) and (c) See solutions. **Q5.** (a) Shade is on the object; shadow is cast by it onto another surface. (b) At the contact point. (c) It gets longer. **Q6.** (a) The light direction (upper left, front) and the two flat lit/shade zones. (b) Stage 4. (c) Blended coloured pencil or contour hatching in fineliner — see solutions. **Q7–Q22.** See fully-worked solutions.

Fully-worked solutions

Q1. (a) The **core shadow**, also called the **shade** — the darkest band on the object itself. (b) The light comes from the **upper left, in front of** the object. Shift it to the upper right and everything but the contact point moves with it: the **highlight (1)** and the **lit plane (2)** cross to the upper right, the **halftone (3)**, the **core shadow (4)** and the **reflected light (5)** move to the left-hand side of the sphere, and the **cast shadow (6)** falls to the lower **left** instead of the lower right. Only the **contact point (7)** stays, because the sphere has not moved — which is exactly why the light direction is decided once and then left alone *(1 mark for the direction, 1 for any two zones correctly relocated).* (c) **Reflected light** is light that has bounced off the ground and nearby surfaces back onto the shadow side of the object. It must be kept because it is what separates the core shadow from the outline: if the shadow side is filled solid to the edge, the form loses its roundness and reads as a flat cut-out shape. Keeping a band that is lighter than the core shadow but darker than the halftone tells the viewer the surface is still curving away *(2 marks: definition + effect on the read of the form).*

Q2. (a) On a **flat plane** the tone is **one even value** across the whole face, and it changes **abruptly** at the edge where the next plane begins. On a **curved surface** the tone changes **gradually and continuously**, because the angle of the surface to the light changes by a small amount at every point and there are no edges. (b) The left panel gradates the tone **across a flat plane**; the right panel puts a **hard tonal step across a curved surface**. (c) The viewer reads the hard step as an **edge**, because an abrupt tonal change is the visual evidence of a plane change. The cylinder therefore appears to be folded or creased along that line rather than smoothly round — the rendering has changed the apparent form of the object *(2 marks: what is misread + why).*

Q3. (a) **Contour hatching** (cross-contour hatching). (b) **Stippling** (accept dry brush or scumbling for a rough matte surface). (c) Marker is a **transparent, layered** medium: overlapping strokes only ever darken, and there is no white marker that will restore the paper. The white of the paper is therefore the lightest value available, so the highlight has to be **reserved** — decided before the first stroke and simply left untouched. If it is covered, the rendering has no highlight at all and the surface reads as matte no matter what else is done to it *(2 marks: the medium cannot be lightened + the consequence for the highlight).*

Q4. (a) **Gloss** — the glazed ceramic. (b) Matte unglazed stoneware **scatters** light rather than mirroring it, so its signature is a **wide, gradual halftone** with **low overall contrast**, and a **broad, dull highlight** or no distinct highlight at all. A fine granular speckle over the tone simulates the unglazed grain *(2 marks: any two of the gradual transition, the low contrast, the broad or absent highlight, the granular surface).* (c) Both are metal, so both are rendered with **high contrast and banded reflections** rather than a smooth gradient. **Polished** metal is the more extreme: a hard bright band where the sky is reflected and a dark band where the ground is, meeting almost without transition. **Brushed** metal keeps that banding but softens it, and adds **fine streaks running along the direction of the brushed grain**, which is the feature that identifies it *(2 marks: the shared banding + the streaks along the grain as the distinguishing feature).*

Q5. (a) **Shade** is the dark area **on the object itself**, where the surface has turned away from the light — it includes the halftone and the core shadow. **Shadow** is **cast by** the object onto another surface, such as the ground or a wall, where the object blocks the light *(1 mark each).* (b) At the **contact point**, where the object meets the ground. Nothing can reach that gap — neither direct light nor bounced light — so it is the darkest value in the drawing, and because the object is right there the shadow's edge is at its hardest. As the shadow travels away it picks up bounced light and its edge softens *(2 marks).* (c) The shadow gets **longer** and stretches further from the object. It also usually softens along its length, because more of the shadow is now far from the contact point. A light directly overhead gives a short shadow pooled beneath the object; a low light throws a long one *(2 marks).*

Q6. (a) The **light direction** is fixed — upper left, in front — and the object is blocked in with just **two flat values**: what the light reaches and what it does not. (b) The cast shadow is added at **stage 4**. It is not added earlier because its direction and length are **determined by the light source**, which is not settled until stage 2, and because it has to be the darkest value in the drawing — you cannot judge how dark that is until the halftones and core shadow are in place at stage 3 *(2 marks: the stage + a valid reason).* (c) **Blended coloured pencil**, because it is layered and granular and so gives fine control over the gradual transition a curved body needs. *(Accept contour hatching in fineliner, because the line direction describes the curvature while the line density builds the tone; or graphite, because it is erasable while the halftones are still being judged.) (2 marks: a medium + a reason tied to what stage 3 is doing.)*

Q7. The light is coming from the **upper left, in front of** the carafe. **Evidence 1:** the lightest area, including the broad highlight, sits on the upper-left of the body and the stopper. **Evidence 2:** the cast shadow runs to the **lower right**, directly away from the light. *(Accept also: the core shadow band and the darkest part of the body are on the right-hand side.) (3 marks: the direction stated + two independent pieces of evidence.)*

Q8. Panel **A** is a line drawing: it describes the **shape and proportions** of the carafe, and nothing else. Panel **B** adds flat colour but no tonal modelling, so although it now has a hue it still reads as a flat silhouette — the colour is simply filling a shape. Panel **C** adds **tone**, and with it three pieces of information neither of the others carries. First, **form**: the gradual transition from light to core shadow tells the viewer the body is a smooth cylinder and not a flat disc. Second, **material**: the wide soft halftone and granular surface identify it as matte, unglazed stoneware. Third, **light and place**: the highlight and the anchored cast shadow tell the viewer where the light is and that the object is standing on a surface rather than floating. ∴ rendering converts a description of shape into a description of a real object in real light *(4 marks: what A and B each do + at least two things rendering adds, correctly reasoned).*

Q9. The material is a **matte, unglazed stoneware** (accept matte ceramic or a matte, uncoated surface). **Feature 1 — a wide, gradual halftone:** the tone moves slowly from the lit side across to the shadow side with no sudden jump, which is what happens when a surface **scatters** light rather than mirroring it. **Feature 2 — a broad, soft highlight with no hard bright spot:** a gloss surface would show a small, hard-edged specular highlight, and this does not. **Feature 3 — a fine granular speckle over the whole surface**, simulating an unglazed, slightly porous grain. **Feature 4 (accept):** overall contrast is low compared with a metal or glass rendering *(4 marks: the material named + three features, each tied to how the surface handles light).*

Q10. Transparency is simulated by **reversing the usual tonal logic**. **At the silhouette** the form is **darkest**, because at the edge you are looking through the greatest thickness of glass and the light is most bent and absorbed. **Through the middle** the form is **lightest**, because you are seeing straight through it to the background — there is very little material in the line of sight. Between them sit hard-edged **specular strips** where the light source is reflected off the front and back walls, and a **bright rim** on the shadow side. **In the cast shadow** there is a bright patch — a **caustic** — because light passing through the glass is bent and concentrated onto the bench, making part of the shadow bright rather than dark. ∴ glass is read as transparent because the tone contradicts what a solid form would do *(4 marks: dark silhouette, light centre, caustic in the shadow, each with a reason).*

Q11. In panel **C** the cast shadow runs to the **lower right**, so the viewer reads the light as coming from the upper **left**. In panel **D** the shadow runs to the **lower left**, so the light is read as coming from the upper **right**; that shadow also contains a bright **caustic**, which tells the viewer the object is transmitting light and is therefore transparent. Both shadows do the same two jobs — they confirm the light direction and anchor the object to the bench at the contact point. They cannot appear on the same sheet as one object because **one light source can only cast a shadow in one direction**; showing both would tell the viewer there are two suns, and the drawing would stop being a believable description of a real object in real light *(4 marks: a congruent two-sided treatment + the reason they are mutually exclusive).*

Q12. Direction: the shadow runs directly **away from the light**. Having fixed the light at upper left, front, the shadow is placed to the lower right, and every other object on the sheet gets the same treatment. **Length:** set by the **height of the light** — a high light gives a short shadow pooled under the carafe, a low light a long one. I would choose a moderately high light so the shadow is about the width of the base again, which anchors the object without dominating the drawing. **Shape:** the shadow is the carafe's **silhouette projected onto the bench**, so it carries the bulge of the body and the narrow neck, stretched along the direction of travel; it is not a generic oval. **Anchoring:** the shadow must touch the object at the **contact point** and be darkest and hardest-edged there, softening and lightening as it recedes. If it is detached, or missing, the carafe appears to float above the bench, because the contact shadow is the only evidence a viewer has that the two surfaces are actually touching *(4 marks: direction, length, shape, and the anchoring reason).*

Q13. Actual texture is the real, physical surface quality of an object — what your hand feels when you pick it up, such as the granular unglazed clay of the carafe body or the soft, crumbly cork of the stopper. **Simulated (visual) texture** is the **illusion** of that quality created on a flat drawing, using marks such as stipple, dry brush or fine hatching. To make a repeating texture follow the form: **wrap it around the curve**, so the units narrow and crowd together toward the silhouette where the surface turns away, and apply the **texture gradient** — the units appear smaller and closer together as the surface recedes. The texture must also sit **inside** the tonal structure, denser in the halftone and core shadow and sparse in the lit area, rather than being applied evenly. Laid on flat and evenly, a texture destroys the form the tone has just established, and the carafe collapses back into a patterned silhouette *(4 marks: both terms defined + wrapping/gradient + the consequence of getting it wrong).*

Q14. Matte unglazed stoneware. Technique: a **blended base** in coloured pencil or graphite to lay in the wide, gradual halftone, with **stippling** worked over it for the granular grain. Media: layered coloured pencil, because it is granular and layered and so gives fine control over slow transitions, plus a fine fineliner for the stipple. Justification: matte surfaces **scatter** light, so the rendering has to be low-contrast with a broad or absent highlight — a technique that produces gentle, controllable gradients is exactly what is required, and stipple supplies the surface quality without breaking the tone.

High-gloss glaze. Technique: **blending and burnishing** for the body, with the highlight **reserved** as untouched paper and cut back with an eraser if needed, plus a second bright edge added low on the shadow side. Media: burnished coloured pencil or marker over a smooth surface such as cartridge paper — marker is well suited because it lays flat, seamless values fast, provided the whites are planned first. Justification: gloss surfaces **mirror** the light, so the signature is a small, hard-edged, very bright highlight and a fast jump from light to dark; a technique that leaves visible marks (hatching, stipple) would read as texture and contradict the smooth glaze.

∴ the same object needs opposite techniques, because the technique has to reproduce how each surface handles light *(6 marks: 3 for each — technique named, media named, justification drawn from how that material behaves).*

Q15. Technique 1 — flat colour with a multiply layer. The carafe is filled with its base colour, and the shade and cast shadow are painted on a separate **multiply** layer above it, so the tone and the colour stay independent and either can be changed without redoing the other. **Technique 2 — soft-edge brush and gradient tools with layer masks**, used to build the halftone and then to lift the highlight back out; a scanned or generated **texture fill** can then be laid over the form and distorted to follow its curvature. **Strength:** digital rendering is **non-destructive** and exactly repeatable — the light can be moved, the material swapped and the contrast changed after the drawing is finished, and the same carafe can be presented in four finishes in minutes. **Limitation:** at the development stage it is **slow and premature** — the software makes you choose settings before you have chosen an idea, its defaults produce a smooth, characterless plastic surface, and a neatly rendered digital image looks finished, so a critique group offers fewer changes than they would to a hand rough *(5 marks: two techniques described + one genuine strength + one genuine limitation, each reasoned).*

Q16. Order of work: **(1)** fix the light and mark, lightly in pencil, where the reserved whites will be; **(2)** lay the **lightest** value over everything except those whites; **(3)** add the **mid** value over the halftone and shadow side; **(4)** add the **darkest** value in a narrow band for the core shadow, just inside the shadow-side edge, and for the cast shadow at the contact point; **(5)** finish with any fine detail in fineliner, and lift a crisp highlight with a white pencil or gouache only if one is still missing. ∴ marker is worked **light to dark**.

About **five** clearly separated values is the working limit. Marker lays **flat** values and every overlap is another step, so a rendering built from fifteen slightly different greys has its steps too close together for the eye to separate: the zones run into one another and the surface reads as an undifferentiated mid tone — mud — with the tonal structure that was describing the form lost inside it. Five well-spaced values instead keep the reserved white, the lit plane, the halftone, the core shadow and the cast shadow each readable as a **separate piece of information** about the form and the light, which is the whole reason the tone is there *(4 marks: a correct light-to-dark order + why a small, well-separated set of values reads as solid).*

Q17. (i) Fault: the light direction is **inconsistent**. The highlight places the light at the upper left, but a shadow falling to the lower left places it at the upper right — the drawing describes two light sources at once, which cannot happen, so the object stops being believable. **Correction:** decide one direction, note it on the sheet, and rebuild the shadow so it runs **directly away** from the light — with the highlight upper left, the cast shadow must fall to the lower right. **(ii) Fault:** the **darkest value has been put in the wrong place**. The core shadow has been run right out to the outline and the reflected light has gone with it, so the shadow side is one solid area instead of the sequence of values a turning surface produces. **Correction:** lift the outline edge back to a lighter band of **reflected light**, and re-place the darkest band *just inside* it as the **core shadow**, so that reading across the shadow side the values run halftone → core shadow → reflected light → outline *(4 marks: 2 for each fault correctly named and correctly corrected).*

Q18. *(Model annotation — four sentences.)* "Body rendered as matte unglazed stoneware with a blended coloured-pencil base and stipple over it; cork stopper rendered with a heavier, more broken stipple. Light fixed at upper left, front, with the core shadow set just inside the right-hand edge and reflected light kept along it, and the cast shadow anchored and darkest at the contact point. **Strength:** the wide, low-contrast halftone and granular surface identify the material immediately as unglazed ceramic, which supports the refill-and-keep intent of the brief. **Limitation:** the stopper is rendered at almost the same contrast as the body, so the part the user actually handles does not stand out — I will lift the contrast on the stopper and lower it slightly on the body in the next version." *(4 marks: media and technique named; light, shade and shadow described in correct terminology; at least one strength and one limitation, i.e. genuine evaluation rather than description; a stated next step.)*

Q19. In **cross-hatching**, successive sets of parallel lines are laid over each other at **different angles**, and the tone comes purely from how many layers overlap and how closely they are spaced. In **contour hatching**, the lines **follow the curvature of the surface** — wrapping around a cylinder or over a dome — so the direction of the line describes the **form** at the same time as its density describes the **tone**. **Cross-hatching is the better choice** on flat planes and for building deep, even darks quickly, where the line direction carries no information. **Contour hatching is the better choice** on a curved or doubly curved surface such as the carafe body or a lamp dome, where the lines can do the extra job of explaining which way the surface is turning *(3 marks: the distinction + one correct situation for each).*

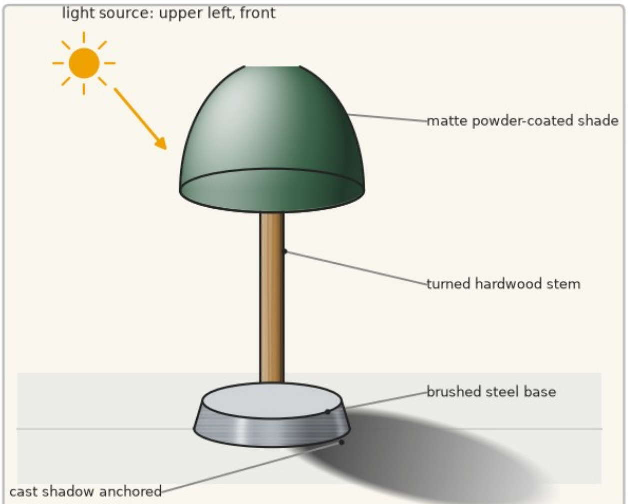
Q20. (i) A **cylinder** curves in one direction only. The angle of the surface to the light changes **across** the form but is identical all the way **up** it, so every point at the same position across the body takes the same value: the tonal bands run **parallel to the axis**, as straight strips of light, halftone, core shadow and reflected light, and each strip holds the same width from the base to the top. A **cone** narrows toward the apex, so the same bands **converge on the apex** — widest at the base and tapering to nothing at the point, because the whole surface is being squeezed into less and less width as it rises. That convergence is what tells the viewer the form is tapering; bands drawn parallel on a cone contradict the outline and the form stops reading *(2 marks: parallel to the axis on the cylinder + converging on the apex on the cone).*

(ii) A **cast shadow** should not be a single flat black area for two related reasons. First, a shadow is a **surface receiving less light**, not a hole — it still picks up bounced light, so it has its own range of values. Second, that range carries information: the shadow is darkest and hardest-edged at the **contact point** and lightens and softens as it travels away, and it is exactly this variation that anchors the object to the bench and tells the viewer how far the light has to travel. A flat black shape does neither, and reads as a piece of paper lying on the surface *(2 marks: a shadow is a lit surface with its own value range + that variation is what anchors the object).*

Q21. The **flat circular top** is a plane: every point on it sits at the same angle to the light, so it takes **one even tone** across its whole area — and because the top faces upward toward the light, that tone will be the lightest area of the stopper. The **curved side** has no edges, so its tone changes **gradually and continuously** around the form, from the lit side through the halftone to a core shadow band, with reflected light kept along the far edge. Where the two meet there is a real **edge**, so the tone must change **abruptly** at that line, with no transition between the two treatments.

If you blended across that edge, the abrupt tonal change that identifies the edge would disappear. The viewer would read the flat top and the curved side as one continuous curved surface, so the stopper would stop looking like a cylinder with a machined flat top and start looking like a soft, rounded dome or a bulb. The rendering would have changed the form of the object, and with it what a manufacturer would make *(4 marks: correct treatment of each surface + the abrupt change at the edge + the specific consequence of blending).*

Q22. *(Model response. The figure below shows the rendering the answer describes.)*



WHIPBIRD repairable desk lamp — one light source, three materials

SHADE — matte powder-coated aluminium

- wide, gradual halftone right around the dome
- broad, soft highlight upper left; no hard spot
- blended coloured pencil, or contour hatching following the curve of the dome
- reflected light kept along the lower right edge

STEM — turned hardwood

- warm mid value, matte, low contrast
- grain follows the form: the lines crowd together and foreshorten toward the silhouette
- fine fineliner or sharp coloured pencil worked over a blended base

BASE — brushed stainless steel

- high contrast and BANDED: a bright reflected-sky band and a dark reflected-ground band
- fine streaks along the direction of the grain
- white pencil on a mid-toned ground is quickest
- darkest, hardest-edged shadow at the contact point

Light direction. I fix a single light source at **upper left, in front of** the lamp, and note it on the sheet. Every tone on the drawing follows from that one decision, and it does not change between the three components or between views.

The form of the dome. The shade is a **doubly curved** surface, so its tone must change **gradually and continuously** in every direction — no hard steps anywhere. I would build it with **contour hatching in fineliner, or blended coloured pencil worked in arcs that follow the curve**, so the direction of the marks describes the dome while their density builds the tone. The broad soft highlight sits upper left, the core shadow runs as a band just inside the lower-right edge, and a lighter band of **reflected light** is kept between that band and the outline. The rim opening is a real edge, so the tone changes abruptly there.

Shade — matte powder-coated aluminium. Signature: a **wide, gradual halftone**, a **broad soft highlight with no hard spot**, and low overall contrast, because a powder coat **scatters** light. Media: layered coloured pencil blended smooth, with a fineliner for the contour hatching.

Stem — turned hardwood. Signature: a **warm mid value**, matte and low-contrast, with **grain that follows the form** — the lines crowd together and foreshorten as the surface turns toward the silhouette, which is what makes the stem read as round rather than as a striped strip. Media: a blended coloured-pencil base with fine fineliner or a sharp pencil for the grain.

Base — brushed stainless steel. Signature: **high contrast and banded** — a bright band where the sky is reflected, a dark band where the ground is — with **fine streaks running along the direction of the brushed grain**. Metal is a mirror, so there is very little gradual halftone; an even blend here would read as plastic. Media: **white pencil and a dark pencil on a mid-toned ground**, which is the fastest route because the material is mostly extremes.

The cast shadow. It runs to the **lower right**, directly away from the light, and its length is set by the height of the light — I would keep it to roughly the width of the base again, so the lamp is anchored without the shadow dominating. Its shape is the lamp's **silhouette projected onto the desk**, so it carries the wide dome and the narrow stem. It is **darkest and hardest-edged at the contact point** under the base, and lightens and softens as it travels, and it is the darkest value in the whole drawing.

∴ one light source, three tonal signatures and one anchored shadow let a client read the material of every component at a glance — which is what makes the rendering a specification rather than a decoration *(8 marks: light direction stated and held; the dome treated as a curved surface with a named technique; each of the three materials given a correct signature plus named media; the cast shadow given direction, length, shape and contact treatment; appropriate design terminology throughout. The perspective light-vanishing-point construction is Units 3 & 4 preview material and is not required for full marks.)*

Theory

In Unit 1 Outcome 3 you design a **sustainable three-dimensional object** in response to a given brief. Chapter 5A generated the ideas and 5B rendered them so a client can see the surface, the material and the form. This subtopic covers the last drawing you make: the one that lets somebody else **build the thing**.

Documentation drawings define and record the **technical specifications** needed to make and assemble a three-dimensional object. They are not persuasive drawings and they are not pictures — they are instructions. A rendered isometric answers the question *what will it look like?* A documentation drawing answers *how big is it, where does every feature sit, and how is it made?* Both belong in a resolved folio, and they do different jobs.

Documentation drawings come in two families:

- **Two-dimensional** — **third-angle orthogonal projection**, technical flats, packaging nets, and (for spaces) plans and elevations.
- **Three-dimensional** — paraline drawings such as **isometric** and **planometric**, and **perspective** drawings.

Whichever family a drawing belongs to, it carries **technical conventions**: **symbols**, **dimensions** and **scales**. Conventions are shared rules, not personal style. Their whole value is that a maker who has never met you can read your drawing and get the same object you designed.

The objects documented in this subtopic. Three original sustainable products run through the examples and questions.

Object	What it is	Size (mm, W × H × D)	Key features
BOWERBIRD	A card stand for a growers'-market stall, moulded in one recycled polymer so it can be re-ground at end of life.	90 × 45 × 40	Base flange 15 high; upright 30 wide; a 4 mm card slot 20 deep, running the full depth
FIGBIRD	A shelf-post bracket cut from off-cut aluminium sheet for a take-back shelving system.	100 × 60 × 20	Ø14 through-hole; 20 × 15 corner notch; R10 round
FRIARBIRD	A crate spacer re-moulded from returned delivery crates.	70 × 50 × 25	Ø20 through-hole; 20 × 15 corner notch

Orthogonal projection. An **orthogonal** (also called orthographic) drawing describes an object through a set of flat views, each looking squarely at one face. The lines of sight — the **projectors** — are parallel to each other and meet each view at right angles, so nothing converges and nothing foreshortens: every view shows the **true shape and true size** of the face it looks at. That is exactly what a maker needs and exactly what a perspective drawing cannot give.

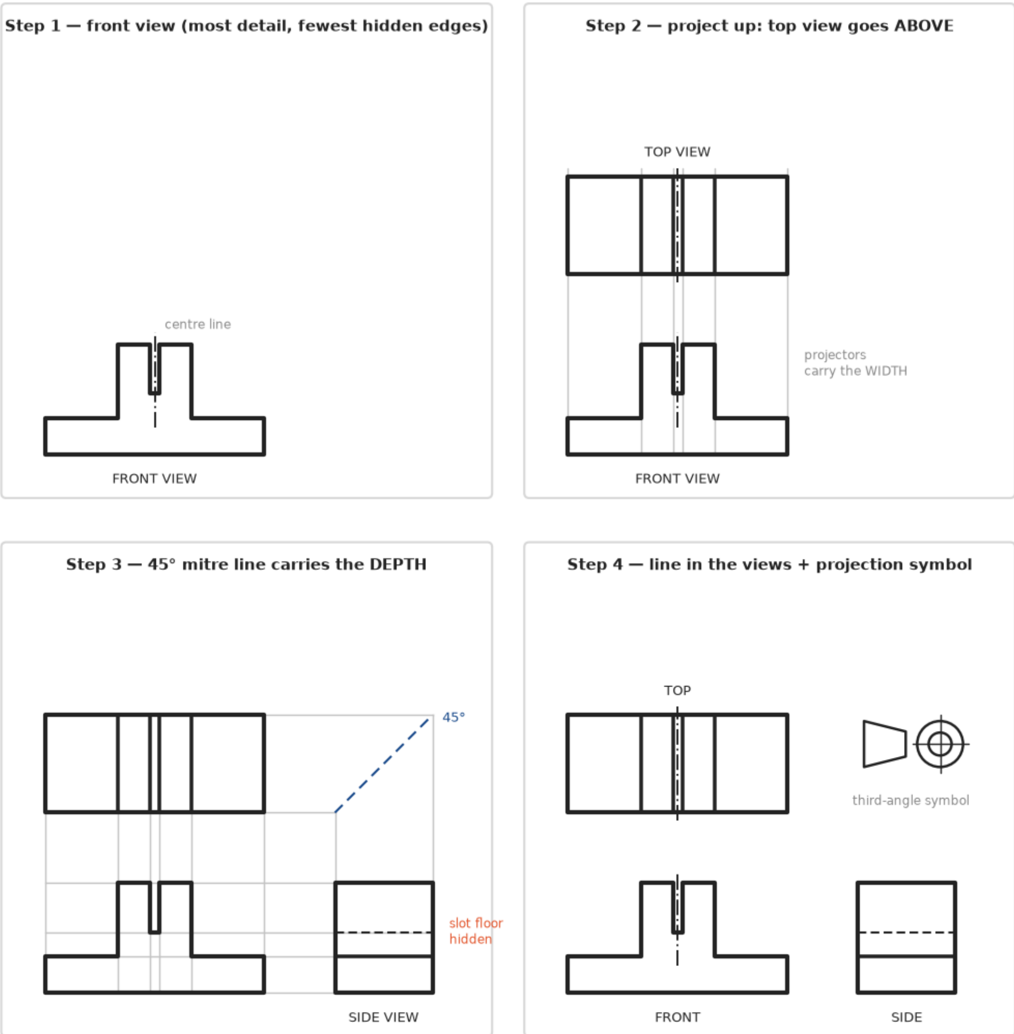
One view can never describe a solid on its own, so orthogonal projection uses **multiple views**. Three are usually enough — the **front view**, the **top view** and one **side view** — because between them they carry the three measurements of the object:

- the **front** and **top** views share the object's **width**;
- the **front** and **side** views share the object's **height**;
- the **top** and **side** views share the object's **depth**.

Third angle — where the views go. Australian technical drawing uses the **third-angle** convention (Australian Standard AS 1100). The rule is one sentence: **each view is placed on the same side of the front view as the**

direction you look from. Look down at the object, so the **top view goes above** the front view. Look at it from the right, so the **right-side view goes to the right**. (A left-side view goes to the left, a bottom view below.) The opposite arrangement is *first angle*, used in some other countries, and reading one as the other flips the object left-for-right.

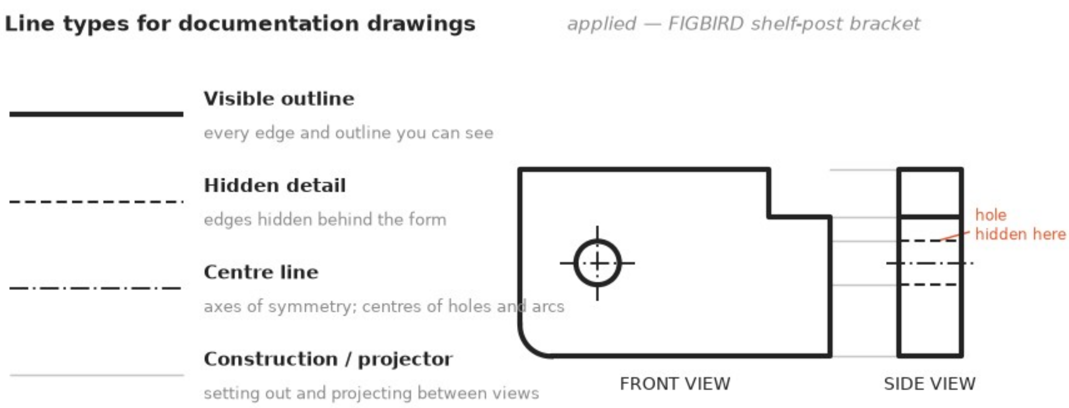
The views are not three separate drawings placed near each other — they are **locked together by projection**. Faint **projectors** drawn straight up hold the front and top views in vertical alignment; projectors drawn straight across hold the front and side views in horizontal alignment. Depth is the one measurement the top and side views share but cannot pass to each other in a straight line, so it is carried around a **45° mitre line**: a depth run horizontally out of the top view meets the mitre, turns through the right angle, and drops into the side view. Because the depth is *transferred* rather than measured twice, the two views cannot disagree.



The four panels above set out the BOWERBIRD card stand the way you should work. **Step 1** draws the **front view** first — the T-shaped face, because it shows the flange, the upright and the card slot with no hidden edges at all. **Step 2** projects straight up to build the **top view above**: a 90 × 40 rectangle carrying visible edges where the upright meets the flange (at 30 and 60) and where the slot walls run (at 43 and 47). **Step 3** projects across, draws the **45° mitre line**, and carries the 40 mm depth into the **side view** on the right. **Step 4** lines the three views in and adds the projection symbol. Notice that the slot floor, which is open to view from the front and from above, is **hidden** from the side behind the 13 mm wall of the upright — so in the side view it is drawn as a dashed line.

The third-angle symbol. So that a reader knows which convention was used, a documentation drawing carries the standard **third-angle symbol** near its title block: a small **truncated cone** drawn as a tapered profile beside its end view, which is **two concentric circles**, arranged in the third-angle relationship. It is not decoration. Without it, a maker on the other side of a supply chain has no way of knowing whether your side view is the right of the object or the left.

Line types. A documentation drawing carries a lot of information in a small space, so the *kind* of line does part of the talking. AS 1100 gives each job its own weight and style.



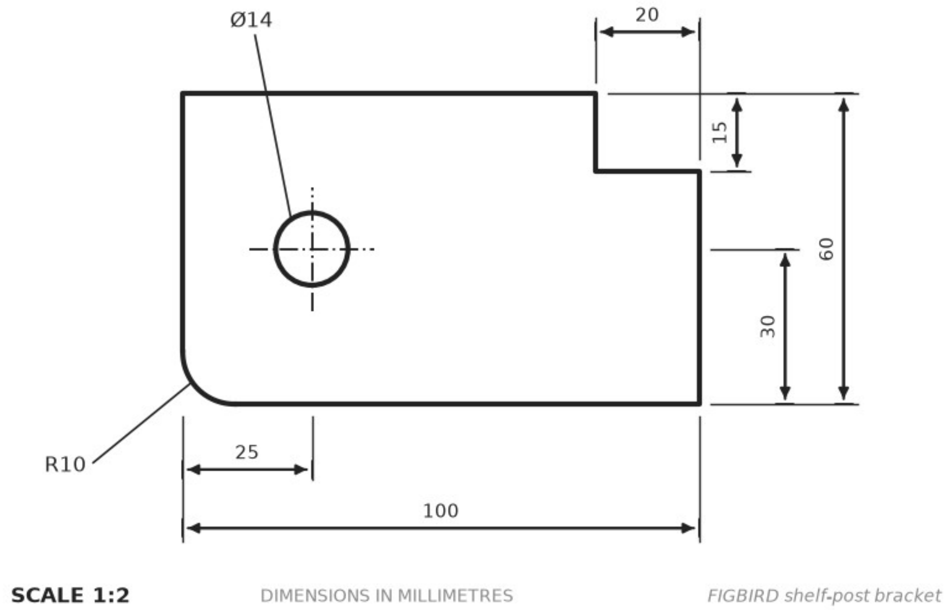
- **Visible outline** — a **thick continuous** line, for every edge and outline you can actually see in that view.
- **Hidden detail** — a **thin dashed** line, for edges that exist but are hidden behind the form. A hole, a slot floor or a step you cannot see from that direction is **shown**, not left out.
- **Centre line** — a **thin chain** line (long dash, short dash) marking axes of symmetry and the centres of circles, holes and arcs. Holes are located *from* their centre lines.
- **Construction / projection line** — a **thin, light** line used to set the drawing out and to project between views. It stays faint so it never competes with the object.

In the applied drawing above, the FIGBIRD bracket's outline and its Ø14 hole are thick visible outlines in the front view, and chain centre lines cross at the hole's centre. In the side view the same hole cannot be seen — solid metal stands between it and the viewer — so it appears as two thin dashed lines running the full 20 mm depth, with its centre line between them. Its axis lies **across** that view rather than into it, which is why it projects as a pair of parallel lines instead of a circle; the lines are dashed because the material in front of them hides them. The corner notch, which *is* open to the right, keeps a thick visible line.

Dimensioning. Dimensions record the measurements a maker needs. Each one is built from three parts:

- **Extension (projection) lines** — thin lines carried out from the feature being measured. Each begins with a **small gap** from the outline, so it can never be mistaken for an edge of the object, and runs a little past the dimension line.
- A **dimension line** — a thin line parallel to the feature, ending in **arrowheads** that touch the extension lines.
- The **figure** — the measurement itself, placed centrally and clear of the line, and readable from the bottom or the right of the sheet. Figures are in **millimetres**, noted once on the drawing.

Two **symbols** do the rest of the work: **Ø** before the size of a full circle or hole (Ø14), and **R** before the size of an arc, round or fillet (R10).

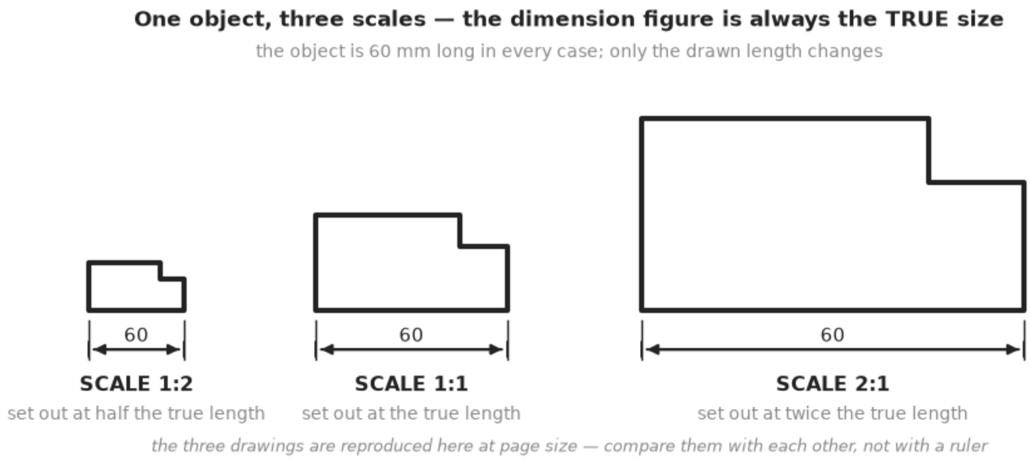


Good dimensioning is disciplined rather than generous. **Dimension each feature once** — a measurement given twice is a measurement that can contradict itself. Keep dimensions **outside the view** wherever you can. Dimension to **visible outlines**, not to hidden detail. Put the small dimensions nearest the view and the overall dimensions furthest out, so nothing crosses. And locate every hole from its **centre lines**, not from its edge.

Scale. A **scale** states the ratio between a length on the drawing and the true length on the object, written **drawing : object**.

- **1:1** is **full size** — the drawn length equals the real length.
- **1:2, 1:5, 1:10, 1:20, 1:50, 1:100** are **reductions** — the drawing is smaller than the object.
- **2:1, 5:1, 10:1** are **enlargements** — the drawing is larger than the object.

The scale is noted near the title block, for example **SCALE 1:2**. At **1:2** a bracket 100 mm wide is set out **50 mm** wide on the sheet — and the figure dimensioned against it still reads **100**.



That is the rule the whole system depends on: **the dimension figure always gives the true size of the object**, never the shortened or enlarged length on the paper. A maker reads the figures; they do not put a ruler on your drawing. Scale exists only so a large object fits a sheet and a small one fills it.

> **Watch-out — place the views the third-angle way.** In third angle the **top view goes above** the front view and the **right-side view goes to the right**. Putting the top view below is first angle, and a maker reading it as third angle builds a mirror image. Australia uses third angle (AS 1100), so show the symbol.

Watch-out — dimension the true size, once. The figure against a feature is the object's real size, not the drawn length. Give each measurement **once**, to a **visible** outline, and keep it off the view.

Watch-out — use the right line for the job. Thick continuous for a visible outline, thin dashed for hidden detail, thin chain for a centre line, thin and faint for construction. Drawing every line at the same weight — or leaving hidden detail out because you cannot see it — loses the conventions marks and misleads the maker.

Watch-out — Ø is not R. Use **Ø** for a full hole or circle and **R** for an arc, a round or a fillet. They are not interchangeable: Ø20 and R20 describe holes of very different sizes.

Watch-out — a documentation drawing is not a rendered drawing. Everything you learned in 5B — tone, shadow, texture, material simulation, colour — stays out of a documentation drawing. Rendering makes a form readable to a client; conventions make it buildable by a maker. Shading an orthogonal view does not add information, it hides the lines that carry it.

Watch-out — apply the conventions, do not write about them. These marks are earned by a drawing that *uses* the conventions — correct view placement, correct line types, complete dimensions, a scale note and the symbol. A neat drawing with a paragraph explaining what you would have done earns nothing.

Units 3 & 4 preview — beyond the Units 1&2 study design. In Units 3 and 4, documentation drawings must record the specifications required for the **assembly** of an object made from several separate parts. The method used is an **exploded assembly drawing**: the parts are drawn pulled apart along shared axes, each given a **balloon** (a numbered circle on a leader), and the numbers are keyed to a **parts list** stating the quantity and material of each item. In Units 1 and 2 you document a **single-part** object — a moulding, a cut plate, a folded sheet — so the exploded-assembly method and parts lists are **not required** and are not used in any question below.

Worked examples

Example 1 — scaffolded

*Set out the three principal views — front, top and right side — of the **BOWERBIRD card stand** in **third-angle orthogonal projection**. The stand is 90 mm wide, 45 mm high and 40 mm deep; a 15 mm base flange runs the full width, a 30 mm wide upright rises from the centre of it to the full 45 mm, and a 4 mm card slot is cut 20 mm down into the top of the upright, running the full depth. Show your projectors and a 45° mitre line. (6 marks)*

Working	Comment
Choose the **front view**: the T-shaped face, because it shows the flange, the upright and the slot together with no hidden edges. Draw it in **thick visible outline** — 90 wide and 15 high for the flange, the upright rising between 30 and 60 to a height of 45, with a 4 mm notch cut from the top down to 25.	The front view should carry the most detail with the fewest hidden edges. Getting this choice right decides how readable the whole sheet is.
Add a **thin chain centre line** down the middle of the front view at 45, through the slot.	The stand is symmetrical about that axis, and the slot is centred on it — that is exactly what a centre line is for.
Project up. Draw faint **vertical projectors** from every corner of the front view — 0, 30, 43, 47, 60 and 90 — and build the **top view directly above** it: a 90 × 40 rectangle, with visible edges at 30 and 60 where the upright meets the flange, and at 43 and 47 where the slot walls run the full depth.	Third angle places the top view **above**. The projectors carry the **width** and keep the two views in vertical alignment — draw them faint so they do not read as edges.
Project across. Draw faint **horizontal projectors** to the right, carrying the heights 0, 15, 25 and 45 into the side-view zone.	The front and side views share **height**, so horizontal projectors fix the vertical extents of the side view before anything is measured.
Draw a **45° mitre line** up to the right, and transfer the **depth**: run the top view's front and back edges across to the mitre and drop them into the side view. Line in the **right-side view** to the right of the front view — a 40	Depth is the measurement the top and side views share. The mitre converts a horizontal run into an equal vertical one, so the two views must agree. This is the step weak drawings skip.

Working	Comment
(depth) × 45 (height) rectangle with a **visible** line at 15 where the flange top runs.	
Add the slot floor at 25 as a **thin dashed hidden-detail line** across the side view — from the right it sits behind the 13 mm wall of the upright. Finish with the **third-angle symbol** near the title block.	Hidden features are shown, not omitted. The symbol tells the reader which convention was used; without it the sheet is ambiguous.

Example 2 — scaffolded

*Fully **dimension** the front view of the **FIGBIRD shelf-post bracket** using correct technical drawing conventions. The bracket is 100 mm wide and 60 mm high, with a Ø14 mm through-hole centred 25 mm from the left edge and 30 mm from the bottom, a 20 mm wide × 15 mm high notch removed from the top-right corner, and a 10 mm radius round on the bottom-left corner. The drawing is made at half size. (6 marks)*

Working	Comment
Draw **extension lines** out from the edges being measured and from the hole's centre lines. Each starts with a **small gap** from the outline and runs a little past where its dimension line will sit.	The gap is what stops an extension line being read as an edge of the object. Dimension to **visible** outlines, never to hidden detail.
Place the **overall dimensions furthest out**: **100** below the bracket and **60** to the right, each on a dimension line with **arrowheads** touching the extension lines and the figure centred and clear.	Overalls sit outermost, smaller dimensions nearer the view, so no two dimension lines cross. Keep them all **off** the view.
Nearer the view, locate the hole from its **centre lines**: **25** from the left edge and **30** from the bottom edge.	A hole is located from its centre, not from its rim. Give each position **once** — do not also dimension it from the opposite edge.
Dimension the notch **20** above the bracket and **15** on the right, between the notch floor and the top edge.	Every feature needs both of its sizes. The notch is a separate feature from the overall shape, so it gets its own pair of dimensions.
Label the hole **Ø14** on a leader taken off the circle, and the corner **R10** on a leader pointing toward the arc's centre.	**Ø** for the full hole, **R** for the round. Swapping them tells the maker to cut the wrong size.
Note **SCALE 1:2** and **DIMENSIONS IN MILLIMETRES** near the title block. Every figure stays the **true size** — 100, 60, 25, 30, Ø14, R10 — even though the bracket is drawn only 50 mm wide.	The scale note tells the reader the drawing is a reduction; the figures tell them the object. The two are independent, and that is the point.

Example 3 — unscaffolded

*The BOWERBIRD card stand (90 × 45 × 40 mm) is to be documented on an A4 sheet at **1:2**. State the drawn length of each of its three overall measurements, the figures that appear against them on the drawing, and the notes that must appear near the title block. (4 marks)*

At **1:2** every drawn length is **half** the true length, so the three views are set out from these: the 90 mm width is drawn **45 mm**, the 45 mm height is drawn **22.5 mm** and the 40 mm depth is drawn **20 mm**. The **figures dimensioned on the drawing are unchanged** — **90**, **45** and **40** — because a dimension always gives the true size of the object, not the length on the paper. Near the title block the sheet must carry **SCALE 1:2**, the note **DIMENSIONS IN MILLIMETRES**, and the **third-angle projection symbol**. ∴ the scale changes only how much paper the drawing occupies; the maker still reads 90, 45 and 40 and cuts the mould to those sizes.

Example 4 — unscaffolded

*Your folio already contains a rendered isometric of the BOWERBIRD stand. **Explain** why the moulder also needs a third-angle documentation drawing. (4 marks)*

The two drawings answer different questions, and only one of them can be built from. The rendered isometric shows the stand as a **single pictorial view**, with tone, texture and material simulation that let a client judge how it will look and feel — but it is set out on the 30° isometric axes, so **no face is shown at its true shape**: every face is skewed into a parallelogram and any circle on it into an ellipse. It gives one viewpoint only, so the back of the stand and the floor of the card slot sit hidden behind the form with nothing to record them. Lengths *along* the three axes are true — that is the paraline property — but the drawing carries **no dimension figures at all**, and it uses none of the conventions: nothing on it states how wide the base is, how far down the card slot is cut, or how thick the upright wall is. A **third-angle orthogonal drawing** does all of that: because the projectors are parallel and strike each view at right angles, the front, top and side views each show one face at true size, and between them they carry the width, the height and the depth. Its **conventions** then remove the remaining ambiguity — line types separate the visible edges from the slot floor hidden behind the upright, dimensions record each feature once at its true size, a scale note explains the reduction, and the projection symbol tells the moulder which way round the views are read. ∴ the isometric sells the design and the documentation drawing specifies it; the moulder cannot cut a tool from the first, and the client cannot see the object in the second.

Practice questions

Scaffolded

Q1. (a) State what a **documentation drawing** does. *(1 mark)* (b) Name **two** two-dimensional and **two** three-dimensional documentation drawing types. *(2 marks)* (c) Name the three kinds of **technical convention** a documentation drawing carries. *(1 mark)*

Q2. Third-angle arrangement: (a) Name the three principal views used to describe an object. *(1 mark)* (b) State where the **top view** and the **right-side view** are placed relative to the front view. *(2 marks)* (c) Which measurement do the top and side views share, and how is it carried between them? *(2 marks)*

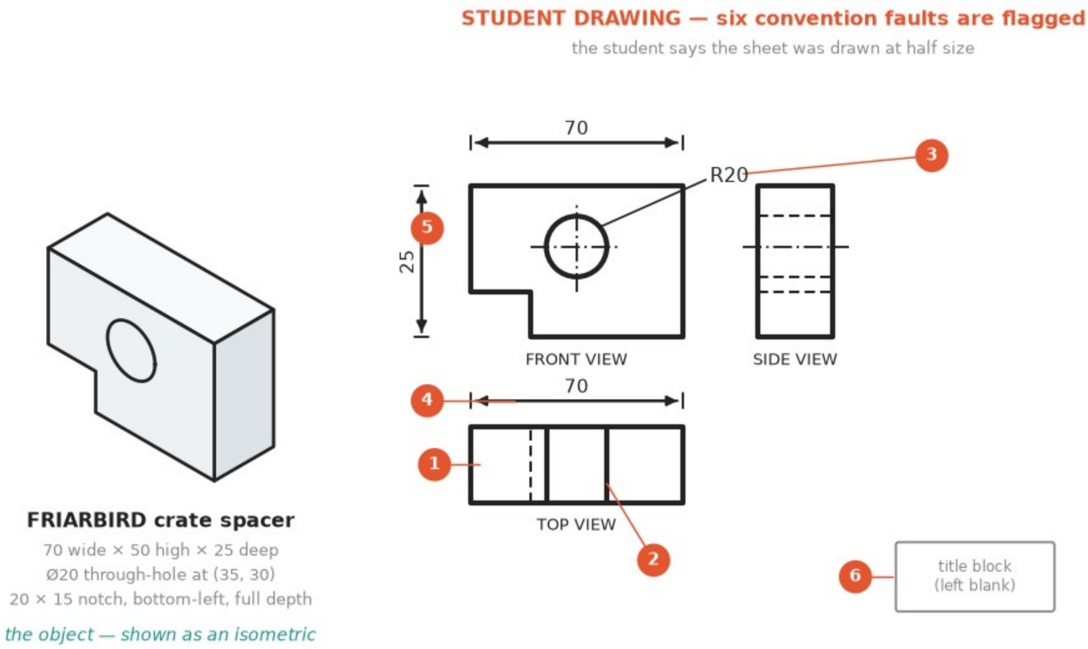
Q3. Using the line-types diagram: (a) Name the line type used for a **visible outline** and the line type used for **hidden detail**. *(2 marks)* (b) State what a **centre line** marks. *(1 mark)* (c) State what **construction / projection lines** are used for and how they should appear. *(2 marks)*

Q4. Using the dimensioned FIGBIRD bracket: (a) Name the two kinds of line used to place a dimension. *(2 marks)* (b) Describe how an **extension line** should start and finish. *(2 marks)* (c) State what **Ø** and **R** mean. *(2 marks)*

Q5. Scale: (a) State what a **scale** tells the reader of a drawing. *(1 mark)* (b) State whether each of **1:1**, **1:5** and **5:1** is full size, a reduction or an enlargement. *(3 marks)* (c) A drawing is made at **1:5**, and a feature on it is set out **24 mm** long. Give the feature's **true length** on the object and the figure written against it. *(2 marks)*

Q6. Setting out: (a) State one rule for choosing which face to draw as the **front view**. *(1 mark)* (b) State how an edge that is **hidden** behind the form is shown in a view. *(1 mark)* (c) Explain why the three views must be drawn to the **same scale** and kept in **alignment**. *(2 marks)*

Unscaffolded



Questions 7–21 refer to the FRIARBIRD crate spacer and the student documentation drawing shown above, unless otherwise stated. The spacer is 70 mm wide, 50 mm high and 25 mm deep, with a Ø20 mm through-hole centred 35 mm from the left and 30 mm from the bottom, and a 20 mm × 15 mm notch removed from the bottom-left corner, running the full depth. The student's sheet was drawn at half size.

Q7. Identify and correct each of the six convention faults flagged on the student's drawing. *(6 marks)*

Q8. Set out the three principal views of the FRIARBIRD spacer correctly in **third-angle orthogonal projection**, showing your projectors and a 45° mitre line. State what each view contains. *(6 marks)*

Q9. Dimension the front view of the FRIARBIRD spacer fully, using correct conventions, and state the notes you would add near the title block. *(4 marks)*

Q10. Describe how the **Ø20 through-hole** appears in each of the three principal views, naming the line type used in each. *(4 marks)*

Q11. Scale: (a) A FIGBIRD fixing clip is 18 mm long and is documented at **2:1**. Give its drawn length and the figure dimensioned against it. *(2 marks)* (b) A 900 mm shelving upright is to be documented on an A4 sheet. Choose a suitable **standard scale** and give the drawn length at that scale. *(2 marks)*

Q12. Explain why **hidden detail** is drawn on a documentation drawing rather than left out because it cannot be seen. *(3 marks)*

Q13. State where **centre lines** should appear on the FIGBIRD bracket drawing, and explain why they are used. *(3 marks)*

Q14. Explain, with reference to the **45° mitre line**, why the top and side views of an object must agree on its depth. *(3 marks)*

Q15. The BOWERBIRD stand could have been drawn with its 40 mm end face as the front view. **Justify** the choice of the T-shaped face instead. *(3 marks)*

Q16. Distinguish between the **Ø** and **R** symbols, and show how you would dimension a hole 16 mm across and a corner rounded to an 8 mm radius. *(3 marks)*

Q17. A classmate says, *"If I need a size I'll just measure the drawing with a ruler."* Explain why a maker reads the dimension figures instead. *(3 marks)*

Q18. The FRIARBIRD spacer is re-moulded from returned delivery crates as a single-material part so it can be re-ground at end of life. **Discuss** how its documentation drawing supports that sustainable intention. *(4 marks)*

Q19. Explain why a documentation drawing must carry **both** a scale note and the **third-angle projection symbol**. *(3 marks)*

Q20. A cable-tidy block is 60 mm wide, 40 mm high and 25 mm deep. It has a **Ø10** through-hole centred 40 mm from the left and 20 mm from the bottom, and a 15 mm × 10 mm notch removed from the **top-left** corner, running the full depth. Produce a complete **third-angle documentation drawing** at **1:1**, showing the three views correctly arranged and aligned, correct **line types**, full **dimensions**, a **scale note** and the **projection symbol**. *(8 marks)*

Q21. Evaluate the student's FRIARBIRD drawing as a documentation drawing — that is, on how well it would let a maker produce the spacer. *(6 marks)*

Answers

Q1. (a) Defines and records the technical specifications needed to make/assemble the object. (b) 2D: orthogonal projection, technical flat, packaging net, plan/elevation. 3D: isometric, planometric, perspective. (c) Symbols, dimensions and scales. **Q2.** (a) Front, top and side. (b) Top view above the front view; right-side view to the right of it. (c) Depth; carried around a 45° mitre line. **Q3.** (a) Visible outline = thick continuous; hidden detail = thin dashed. (b) Axes of symmetry and the centres of circles, holes and arcs. (c) Setting out and projecting between views; thin and faint. **Q4.** (a) Extension (projection) lines and the dimension line. (b) Starts with a small gap from the outline, finishes a little past the dimension line. (c) Ø = diameter of a full circle or hole; R = radius of an arc, round or fillet. **Q5.** (a) The ratio of a drawn length to the true length (drawing : object). (b) 1:1 full size; 1:5 reduction; 5:1 enlargement. (c) True length 120 mm; the figure written is **120**. **Q6.** (a) The face showing the most detail with the fewest hidden edges. (b) As a thin dashed hidden-detail line. (c) See solutions. **Q7.** (i) Top view goes above, not below. (ii) The hole in the top view is hidden — thin dashed, not thick. (iii) Ø20, not R20. (iv) Delete the duplicate 70. (v) The height figure is 50 (true size), not 25 (drawn). (vi) Add SCALE 1:2 and the third-angle symbol. **Q8.** Front = 70 × 50 with the corner notch and the visible Ø20 circle; top (above) = 70 × 25 with the hole and notch wall hidden; side (right) = 25 × 50 with the hole and notch floor hidden. See solutions. **Q9.** Overalls 70 and 50 outermost; 35 and 30 to the hole's centre lines; 20 and 15 on the notch; Ø20 on a leader; SCALE 1:2 and DIMENSIONS IN MILLIMETRES. **Q10.** Front = a visible circle with centre lines; top = two hidden dashed lines the full depth plus a centre line; side = two hidden dashed lines the full depth plus a centre line. **Q11.** (a) Drawn 36 mm; figure dimensioned **18**. (b) 1:10, drawn 90 mm (accept 1:5, drawn 180 mm). **Q12.** The maker must cut features they cannot see from that direction; omitting them loses information the object needs. See solutions. **Q13.** Through the Ø14 hole both ways in the front view, and along the hole's axis in the side view — to mark the axis and to dimension the hole's position from. **Q14.** Both views describe the same solid, so the depth must match; the mitre converts a horizontal run into an equal vertical one, so the depth is transferred rather than measured twice. **Q15.** The T-face shows the flange, upright and slot with no hidden edges; the end face is a plain rectangle in which the flange shows only as a single line and the slot only as hidden detail. **Q16.** Ø = full circle or hole; R = arc, round or fillet. Label **Ø16** on a leader off the circle and **R8** on a leader pointing toward the arc's centre. **Q17.** The drawing is at a scale and paper distorts; the figures give the true size. See solutions. **Q18–Q21.** See fully-worked solutions.

Fully-worked solutions

Q1. (a) A documentation drawing **defines and records the technical specifications** required to make and assemble a three-dimensional object *(1 mark).* (b) Two-dimensional: **third-angle orthogonal projection** and a **technical flat** (also accept a packaging net, or a plan or elevation). Three-dimensional: **isometric** and **perspective** (also accept planometric) *(1 mark per pair).* (c) **Symbols**, **dimensions** and **scales** *(1 mark for all three).*

Q2. (a) The **front view**, the **top view** and a **side view**. (b) In third angle each view is placed on the same side of the front view as the direction it is seen from, so the **top view sits directly above** the front view and the **right-side view sits to the right** of it *(1 mark each).* (c) They share the object's **depth**. It is carried between them around a **45° mitre line**: a depth run horizontally out of the top view meets the mitre, turns through the right angle and drops into the side view *(2 marks: depth named + the mitre method).*

Q3. (a) A **visible outline** is a **thick continuous** line; **hidden detail** is a **thin dashed** line. (b) A **centre line** marks **axes of symmetry** and the **centres of circles, holes and arcs**. (c) **Construction / projection lines** are used to **set the drawing out and to project between the views**; they must be **thin and faint** so they do not compete with the object's outline *(2 marks: use + appearance).*

Q4. (a) **Extension (projection) lines** and a **dimension line** *(1 mark each).* (b) An extension line **starts with a small gap** from the outline of the feature — so it is never read as an edge of the object — and **finishes a little past** the dimension line *(2 marks).* (c) **Ø** is the **diameter** symbol, written before the size of a **full circle or hole** (Ø20); **R** is the **radius** symbol, written before the size of an **arc, round or fillet** (R10) *(1 mark each).*

Q5. (a) A scale states the **ratio of a length on the drawing to the true length on the object**, written drawing : object. (b) **1:1** is **full size**; **1:5** is a **reduction**; **5:1** is an **enlargement** *(1 mark each).* (c) At **1:5** every drawn length is a **fifth** of the true length, so the feature set out 24 mm long is **24 × 5 = 120 mm** on the object; the figure written against it is **120**, because a dimension always gives the **true size** of the object, never the length on the paper *(2 marks: 120 mm + the figure 120).*

Q6. (a) Choose the face showing the **most detail with the fewest hidden edges** — the most characteristic shape of the object *(1 mark).* (b) As a **thin dashed hidden-detail line** *(1 mark).* (c) The three views describe **one object**, and each shares a measurement with the next — width with the top view, height with the side view, depth between top and side. If they are drawn to different scales those shared measurements no longer match, and if they are not aligned the reader cannot move between them along a projector to find the same feature in two views. Alignment and one scale are what turn three separate rectangles into a description of a single solid *(2 marks: shared measurements must correspond + the views must be readable together).*

Q7. *(1 mark per fault identified and corrected.)* **(1) The top view is placed below the front view.** That is first-angle placement; in **third angle** the top view goes **directly above** the front view. Move it above and re-project the widths. **(2) The through-hole in the top view is drawn as a thick continuous outline.** The hole cannot be seen from above — it is behind the solid top face — so it must be drawn as **two thin dashed hidden-detail lines** running the full 25 mm depth, with a centre line between them. **(3) The hole is labelled R20.** Twenty millimetres is its **diameter**, so it must be labelled **Ø20**. Labelled R20 the maker would cut a 40 mm hole. **(4) The overall width 70 is dimensioned twice** — once above the front view and once below it. Each feature is **dimensioned once only**; delete one of them, keeping the clearer placement. **(5) The height is dimensioned 25.** That is the *drawn* length at half size. A dimension gives the object's **true size**, so the figure must read **50**. **(6) The title block is blank.** A documentation drawing must state its **scale — SCALE 1:2** — and carry the **third-angle projection symbol** (with DIMENSIONS IN MILLIMETRES); without them the reader cannot know the reduction or which convention the views follow.

Q8. Draw the **front view** first, because it shows the notch and the hole together with no hidden edges: a **70 × 50** outline in thick visible line with the **20 × 15 notch** removed from the bottom-left corner, the **Ø20 circle** drawn as a visible outline, and **thin chain centre lines** crossing at its centre (35 from the left, 30 from the bottom). **Project up** with faint vertical projectors to the **top view directly above**: a **70 × 25** rectangle (width × depth). Both features are hidden from above, so the hole appears as **two thin dashed lines** at 25 and 45 running the full depth with a centre line between them, and the notch's wall appears as a single **thin dashed line** at 20. **Project across** with horizontal projectors, draw a **45° mitre line**, and transfer the 25 mm depth into the **right-side view to the right**: a **25 × 50** rectangle. The hole is again hidden, appearing as **two thin dashed lines** at 20 and 40 running the full depth with a centre line between them, and the notch floor appears as a **thin dashed line** at 15, because from the right it sits behind the solid part of the block. Keep all three views to one scale and in alignment, and add the **third-angle symbol** *(6 marks: correct front view with the notch and visible circle; top view above, built by projection; side view to the right, built via the mitre; hidden detail correct in both; alignment; symbol).*

Q9. Place the **overall dimensions furthest out** — **70** below the front view and **50** to the right — each with **extension lines** starting a small gap from the outline, a **dimension line** with **arrowheads**, and the figure centred and clear. Nearer the view, locate the hole from its **centre lines**: **35** from the left edge and **30** from the bottom edge, each given **once**. Dimension the notch **20** (its width, from the left edge) and **15** (its height, from the bottom edge). Label the hole **Ø20** on a leader taken off the circle. Near the title block note **SCALE 1:2**, **DIMENSIONS IN MILLIMETRES** and add the **third-angle projection symbol** — and keep every figure at the object's **true size**, not the drawn length *(4 marks: overalls outermost; hole located from its centre lines with no duplication; the notch dimensioned; Ø on the hole plus the title-block notes).*

Q10. In the **front view** the hole is looked straight into, so it is drawn as a **visible outline** — a full circle of the true diameter — with **thin chain centre lines** crossing at its centre and running a little past the circle. In the **top view** the hole's axis lies across the sheet rather than into it — which is why it projects as a pair of parallel lines — but the **solid top face covers it**, so those lines are drawn as **two thin dashed hidden-detail lines**, one at each side of the hole, at 25 and 45 from the left, each running the **full 25 mm depth** of the view, with a **centre line** between them. In the **right-side view** the hole is buried the same way, this time behind the solid right-hand part of the block: **two thin dashed hidden-detail lines**, at 20 and 40 above the base, running the full depth, with a **centre line** between them. ∴ one feature drawn three ways — visible in one view, hidden in the other two — decided entirely by whether solid material stands between it and the viewer *(4 marks: front visible circle + centre lines; top hidden pair; side hidden pair; the full-depth extent and the line type named in each).*

Q11. (a) At **2:1** the drawing is **twice** the true size, so the clip is drawn **36 mm** long; the figure dimensioned against it is **18**, because dimensions always give the object's true size *(2 marks).* (b) A suitable standard **reduction** is **1:10**, which draws the 900 mm upright **90 mm** long — comfortably inside an A4 sheet with room for three views, dimensions and a title block. *(Accept **1:5**, drawn **180 mm**, if the candidate notes that it still fits; do not accept a non-standard ratio such as 1:9.) (2 marks: a standard scale + the correct drawn length.)*

Q12. A documentation drawing is read by someone who has to **make** the object, and features they cannot see from one direction still have to be cut. The FRIARBIRD hole is invisible from above and from the side, but it is drilled right through the block; if it were omitted from those views the drawing would describe a solid block, and the two views would contradict the front view. Showing it as **thin dashed** rather than thick keeps the distinction the reader needs — *this edge exists, but it is behind the form* — so hidden features are recorded without being confused with visible outlines. ∴ hidden detail is the difference between a drawing that describes a solid and a drawing that only describes its silhouette *(3 marks: the maker needs unseen features + the views would otherwise disagree + the dashed line preserves the visible/hidden distinction).*

Q13. On the FIGBIRD bracket, **thin chain centre lines** should cross at the centre of the **Ø14 hole in the front view** — one horizontal and one vertical, each running a little past the circle — and a further centre line should run **along the hole's axis in the side view**, between the two hidden lines that represent it. They are used for two reasons. First, they mark the **axis or centre** of a circular feature, telling the reader that the hole is round and where its centre lies. Second, they are what the hole's **position is dimensioned from**: the 25 and 30 dimensions are taken to the centre lines, not to the rim, because a maker sets a drill on a centre. *(Also accept a centre line marking an axis of symmetry.) (3 marks: where they go + marking the axis/centre + dimensioning is taken from them.)*

Q14. The top and side views describe the **same solid**, so the depth seen from above must equal the depth seen from the side — if they disagree, the drawing describes two different objects and the maker cannot tell which is right. The **45° mitre line** removes the possibility. A depth taken from the **top view** is run **horizontally** out to the mitre; because the mitre is at 45°, that horizontal run is converted into an **equal vertical run**, which then drops into the **side view** (and the reverse for depths taken from the side). The depth is therefore **transferred** from one view to the other rather than measured twice, so the two views cannot disagree *(3 marks: the views share depth + the mitre converts horizontal to equal vertical + transfer rather than re-measurement).*

Q15. The **front view should show the most detail with the fewest hidden edges**, and the T-shaped face does exactly that. Seen from the front, the 90 mm flange, the 30 mm upright and the 4 mm card slot cut 20 mm down into it are **all visible outlines** — the whole character of the stand is in one view, and there is no hidden detail at all. The 40 mm end face, by contrast, is only a plain 40 × 45 rectangle: the flange would show as a single line and the slot would appear only as a **hidden dashed line**, so the reader would have to reconstruct the shape from the other two views. ∴ choosing the T-face puts the information where it is read first and keeps the sheet legible *(3 marks: the rule stated + what the T-face shows + what the end face would fail to show).*

Q16. The **diameter symbol Ø** is used for a **complete circle or hole** and is written before the size; the **radius symbol R** is used for **anything less than a full circle** — an arc, a round or a fillet — and is also written before the size. The difference matters because a hole is fully defined by its diameter, whereas a curved corner is defined by the radius that struck it, so the same figure means two different sizes under the two symbols. A hole 16 mm across is therefore labelled **Ø16**, on a leader taken off the circle, with centre lines through it; a corner rounded to an 8 mm radius is labelled **R8**, on a leader pointing toward the arc's centre *(3 marks: Ø for the full circle + R for the arc/round + both examples correctly labelled and placed).*

Q17. The drawing is made at a **scale**, so a ruler laid on the paper gives the drawn length, not the object — on a 1:2 sheet every measurement taken that way would be **half** the true size, and on a 2:1 sheet twice it. Even at 1:1 the paper is unreliable: printing, photocopying and reproduction all change the drawn size slightly, so a measured length carries an error that a written figure does not. The **dimension figures** are the specification — they state the true size directly, they are given once, and they are readable no matter how the sheet has been reproduced. ∴ the figures are the information and the drawn shape is only the picture that carries them *(3 marks: scale means drawn ≠ true + reproduction changes the paper + the figure is the specification).*

Q18. The documentation drawing is what turns a sustainable *intention* into a sustainable *specification*. First, it names the material once, for the whole part: because the spacer is a **single-part moulding**, one material note on the drawing covers the entire object, and a maker reading it cannot add a fastener, an insert or a second material that would have to be separated before the spacer could be re-ground. Second, the **dimensions record the true sizes**, so a replacement moulded in five years' time from a later batch of returned crates will fit the same crates as the original — the drawing outlives the first production run, which is what lets the part be remade rather than redesigned. Third, the drawing documents the features that make re-grinding possible — the full-depth notch and the plain through-hole are forms that can be moulded and released without inserts, and the drawing's line types and dimensions are what prove that to the maker before any tooling is cut. ∴ the conventions are not merely tidy: dimensioning once, at true size, on a single-material part is the mechanism by which the object can be reproduced and recovered *(4 marks: at least three specific links between a convention or feature of the drawing and the circular intention, with a clear conclusion).*

Q19. They answer two different questions, and a drawing missing either one is ambiguous. The **scale note** tells the reader the relationship between the drawn lengths and the object, so they know the sheet is a reduction or an enlargement rather than full size — without it, a reader who measured the paper would take the drawn sizes as real, and a drawing reproduced at a different size could not be checked at all. The **third-angle projection symbol** tells the reader which convention governs the *arrangement* of the views — that the view above is the top and the view to the right is the right-hand side. Without it the same three rectangles could be read as a first-angle drawing, in which those positions are reversed, and the object would be built **mirror-reversed**. ∴ the scale note governs how the drawing is measured and the symbol governs how it is read; both are needed before a single dimension can be trusted *(3 marks: what each note does + the specific failure each prevents).*

Q20. *(Model.)* Draw the **front view** first, as the face carrying both features with no hidden edges: a **60 × 40** outline in **thick visible line** with the **15 × 10 notch** removed from the **top-left** corner, and the **Ø10 hole** drawn as a visible circle centred 40 from the left and 20 from the bottom, with **thin chain centre lines** crossing at its centre. **Project up** with faint vertical projectors to the **top view directly above**: a **60 × 25** rectangle. The notch is open to the top, so the wall at its right-hand edge is seen from above as a **visible** line at 15; the hole is covered by the top face, so it appears as **two thin dashed lines** at 35 and 45 running the full 25 mm depth, with a centre line between them. **Project across**, draw a **45° mitre line** and transfer the 25 mm depth into the **right-side view to the right**: a **25 × 40** rectangle, in which the notch floor is hidden behind the solid right-hand part of the block and so appears as a **thin dashed line** at 30, and the hole appears as **two thin dashed lines** at 15 and 25 running the full depth with a centre line between them. **Dimension** the overalls furthest out — 60, 40 and 25 — with the notch (15 and 10) and the hole's position (40 and 20, taken to its centre lines) nearer the views, each figure given **once**, to visible outlines, with extension lines, arrowheads and figures in millimetres; label the hole **Ø10** on a leader. Note **SCALE 1:1** and **DIMENSIONS IN MILLIMETRES** near the title block and draw the **third-angle projection symbol** beside them *(8 marks: three views correctly arranged and aligned, built by projection and mitre; correct line types, including the visible notch edge in the top view and hidden detail in both other views; complete, non-duplicated dimensions located from centre lines; scale note; projection symbol).*

Q21. The drawing **would not let a maker produce the spacer**, although it is not without merit. Its **strengths** are real: the front view is well chosen, showing the notch and the hole together with no hidden edges; the hole's centre is correctly marked by **thin chain centre lines** in that view; and the side view is both correctly placed to the right and correctly drawn, with the hole and the notch floor shown as **thin dashed hidden detail**. That is enough to show the student understands what the conventions are for. The **limitations**, however, are the kind that stop production. The top view is placed **below** the front view, which is first-angle arrangement; a maker following AS 1100 would read the sheet as third angle and build the object **mirror-reversed**. The hole in that view is drawn as a **thick continuous outline**, so a feature that is hidden is presented as a visible edge, and the top view now contradicts the side view. The hole is labelled **R20** instead of Ø20, which specifies a hole of twice the intended size. The overall width is dimensioned **twice**, so two figures can disagree, and the height figure reads **25** — the drawn length at half size — rather than the true **50**, so a maker working from the figures would cut the block half as tall as designed. The title block is blank, so there is **no scale note and no projection symbol**: nothing on the sheet tells the reader that it is a reduction or which convention the views follow, which is precisely the information needed to catch the first fault. And the sheet is **not fully dimensioned** — the only figures on it are the two 70s, the height and the hole's own label, so nothing locates the hole (the **35** and **30** to its centre lines), nothing sizes the notch (**20** and **15**) and no view carries the **25 mm depth**. ∴ judged against its purpose — recording the technical specifications required to make the object — the drawing **fails**, because at least three of its faults (the placement, the R20 label and the 25 figure) would each on their own produce the wrong part. Correcting those faults and filling in the title block would remove the errors, but the sheet would still not be buildable until the missing dimensions were added: a documentation drawing has to be **complete** as well as correct *(6 marks: specific strengths and limitations drawn from the drawing itself, each tied to the consequence for the maker, and an overall judgement referenced to the purpose of a documentation drawing).*