designclass
design | engineering | technology

BGE · S1–S3 · COURSE NOTES



PRODUCT DESIGN · DESIGN & MANUFACTURE

EarBuddy

Design it. Prototype it. Make it. A 12-lesson product design project.

METAL · WOOD · ACRYLIC · CAD/CAM LASER

NAME

CLASS

TEACHER

WELCOME, DESIGNER

Your mission: design an EarBuddy

Earbuds are everywhere — wired and wireless. Wired earbuds get **tangled** in pockets and bags. Wireless earbuds and their charging cases get **lost**, dropped or left in a blazer that goes through the wash.

In this project you will work like a real product designer. You will follow the **design process** to design, prototype and make your own EarBuddy.



A finished EarBuddy made by an S1 pupil

The Design Brief

Design and make an **EarBuddy**: a product that stores and protects a person's earbuds (wired **or** wireless) when they are not being used. It must be made from **one sheet material** — aluminium, plywood or acrylic — using **hand tools and a pillar drill**, or by **laser cutting** acrylic.

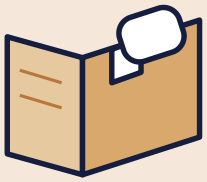
Ideas to get you thinking



Cable winder
for wired earbuds



Case keyring
for a wireless case



Desk stand
slot-together parts



Laser-cut winder
engraved with a name

Your 12-lesson journey

LESSON 1 · p3 Product design & the design process	LESSON 2 · p4 Design brief & design factors	LESSON 3 · p5 Research	LESSON 4 · p6 Design specification	LESSON 5 · p7 Sketching concepts & annotation	LESSON 6 · p8 Developing & presenting your idea
LESSON 7 · p9 Prototyping with card	END OF LESSON 7 Design Thinking exam	LESSON 8 · p10 Planning manufacture: choose your route	LESSONS 9–11 Workshop: mark out, cut, shape, drill, finish — use your route worksheet	LESSON 12 Evaluate your EarBuddy	LESSON 12 Making exam

How to use this booklet

Each page is one lesson. Read the **Knowledge** boxes, then complete every **Your Turn** task.

Exam-style questions

Grey boxes practise the kind of questions you will meet in National 5. Look at the **command word** and the **marks**.

How you are assessed

Your folio work, your finished EarBuddy, the Design Thinking exam and a making exam.

LESSON 1

THE BIG PICTURE

What is product design?

LEARNING INTENTION

Understand what product designers do and the stages of the design process.

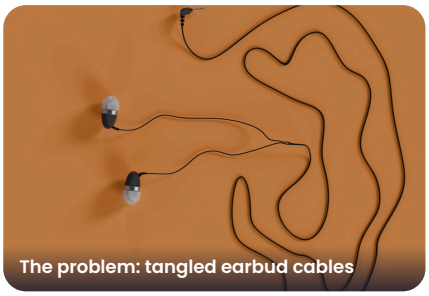
SUCCESS CRITERIA · I can…

- ☐ describe what a product designer does
- ☐ put the design process stages in order
- ☐ explain why designers follow a design process

KNOWLEDGE

Every product you use was **designed** by someone — from a pencil sharpener to a phone. **Product designers** solve problems for people. They think about:

- how the product **works** and who will **use** it
- how it **looks** and feels
- how to make it **safe**
- how it will be **made**, what it **costs** and its effect on the **planet**

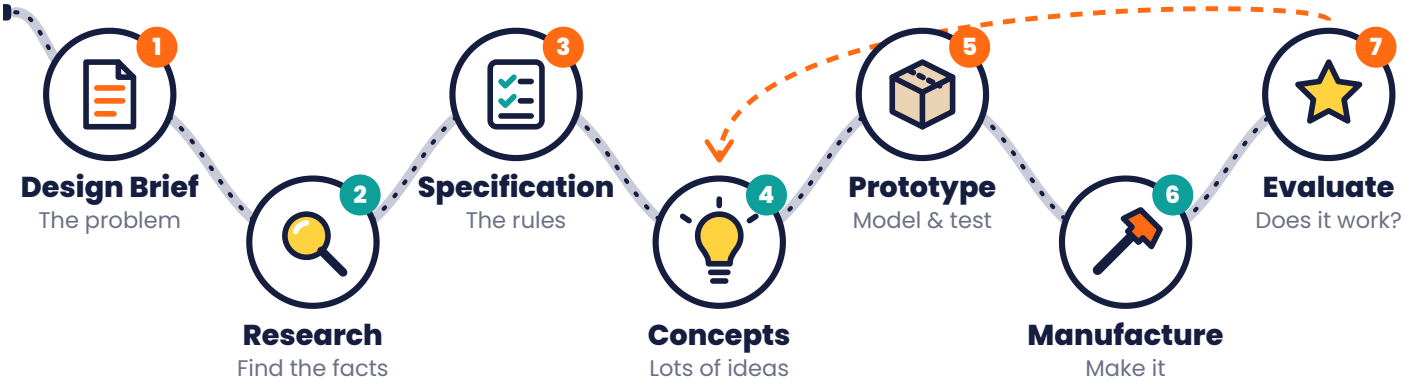


The problem: tangled earbud cables

The Design Process

Designers follow the same **stages** every time. Each stage gives you the information you need for the next. Real design is **not a straight line** — designers often go back to an earlier stage to improve their idea. This is called **iteration**.

go back & improve = iteration



YOUR TURN

1 **Spot the design. Look around the room and pick one product. What problem does it solve?**

Product: _____

YOUR TURN

2 **Close the diagram. Write the stage that matches each job.**

Making a quick card model to test an idea	
Writing the rules the design must meet	
Finding facts, sizes and opinions	
Checking if the product works	

EXAM-STYLE QUESTION

Explain why designers follow a design process. **2 marks**

Tip: "Explain" means give a **reason**. Use the word **because**.

LESSON 2

STAGE 1 · THE PROBLEM

Design brief & design factors

LEARNING INTENTION

Understand what a design brief is and the four design factors designers think about.

SUCCESS CRITERIA · I can…

- ☐ explain what a design brief is
- ☐ describe function, aesthetics, safety and performance
- ☐ analyse a product using the design factors

KNOWLEDGE

A **design brief** is a short statement that starts the design process. It tells the designer:

- **the problem** that needs solving
- **who** the product is for (the user)
- **what** the product must do or achieve

A brief does **not** give the answer — that is the designer's job!

YOUR TURN

1 **Read the EarBuddy brief on page 2. Fill in the three parts.**

Problem:

User:

Must:

The four design factors

Designers judge every idea against **design factors**. You will use these four through the whole project.

Function

What the product **does** — its job. The **main** job is the **primary function**. Extra jobs are **secondary functions**.

Aesthetics

How it **looks and feels**: shape, form, colour, texture and pattern. Does it appeal to the user?

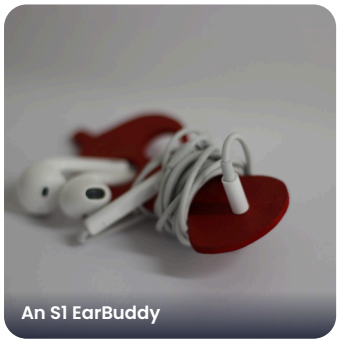
Safety

Can it hurt anyone? Check for **sharp edges** and corners, small parts that could be swallowed and unsafe materials.

Performance

How **well** it works and how **long** it lasts: strength, durability, ease of use and care.

YOUR TURN



An S1 EarBuddy

2 **Be a product detective. Analyse this EarBuddy using the four design factors.**

Function — what is its primary function?

Aesthetics — describe how it looks.

Safety — how has it been made safe?

Performance — would it last? Why?

EXAM-STYLE QUESTION

Describe two features that would make an EarBuddy **safe** to use. **2 marks**

LESSON 3

STAGE 2 · RESEARCH

Find out the facts

LEARNING INTENTION

Learn how designers research to gather useful information for a product.

SUCCESS CRITERIA · I can…

- ☐ describe desk research and field research
- ☐ explain what a target market is
- ☐ measure critical sizes accurately in mm

KNOWLEDGE

Desk research

Using information **someone else** has already gathered: websites, books, magazines, product reviews and online shops. It is quick, but may not be about **your** users.

Field research

Collecting **new** information yourself: **questionnaires**, **interviews**, **measuring** real products and **user trips** (watching someone use a product step by step and noting problems).

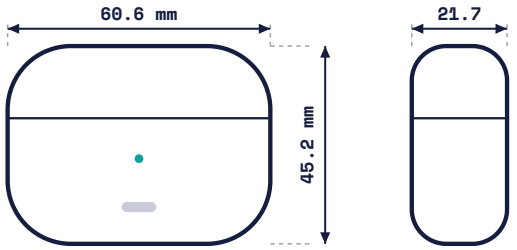
KNOWLEDGE

Target market

The **target market** is the group of people a product is aimed at. Describe it using **age**, **interests**, **lifestyle** and **how much they can spend**.

Facts or opinions?

Objective data can be measured — "the case is 60.6 mm wide". **Subjective** data is an opinion — "I like bright colours". Good research collects both.



Critical sizes

A **critical size** is a size your design **must** fit. The wireless earbud case on the left (AirPods Pro 2) is 60.6 × 45.2 × 21.7 mm. Every brand is different, so **measure the real thing** with a steel rule — always in **millimetres (mm)**.

YOUR TURN

1 Desk or field? Tick one for each.

Research method	Desk	Field
Asking 10 pupils a questionnaire	☐	☐
Reading reviews on a shop website	☐	☐
Measuring a friend's earbud case	☐	☐
Watching someone wind up a cable	☐	☐

YOUR TURN

2 Measure your own (or a partner's) earbuds or case.

What I measured	Size (mm)

YOUR TURN

3 Describe the target market for **your** EarBuddy (age, interests, lifestyle).

EXAM-STYLE QUESTION

Explain the difference between desk research and field research. **2 marks**

LESSON 4

STAGE 3 · THE RULES

The design specification

LEARNING INTENTION

Learn how to write a design specification using your research.

SUCCESS CRITERIA · I can…

- ☐ explain what a specification is and why designers use one
- ☐ write clear, measurable specification points
- ☐ use a specification to check an idea

KNOWLEDGE

A **design specification** is a list of **rules** that the product must meet. Each rule comes from your **research**.

Designers use the specification **twice**: to guide their ideas **while designing**, and to test the product **at the end** (evaluation). Write at least one point for each design factor.

MAKE IT MEASURABLE

A good specification point is **specific** and can be **tested**.

× "It must be small."

✓ "It must be no bigger than 80 × 70 mm so it fits in a blazer pocket."

Start each point with "The EarBuddy must…" and add "because…"

YOUR TURN

1 Write the specification for your EarBuddy. Use your research from Lesson 3.

Design factor	The EarBuddy must…
Function What must it do?	
Aesthetics How must it look?	
Safety How will it be safe?	
Performance How well / how long?	
Size Critical sizes (mm)	

YOUR TURN

2 Fix it! Rewrite each weak point so it is specific and measurable.

"It should look nice."	"It must be strong."	"It must hold the earbuds."

EXAM-STYLE QUESTION

Explain why designers use a design specification. **2 marks**

LESSON 5

STAGE 4 · CONCEPTS

Sketch it. Annotate it.

LEARNING INTENTION

Generate a range of different ideas and communicate them clearly with sketches and annotation.

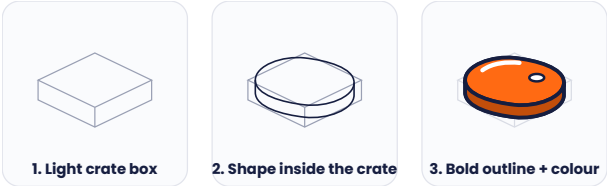
SUCCESS CRITERIA · I can…

- ☐ sketch at least four different ideas
- ☐ use crating, line weight and colour
- ☐ annotate ideas with a feature and a reason

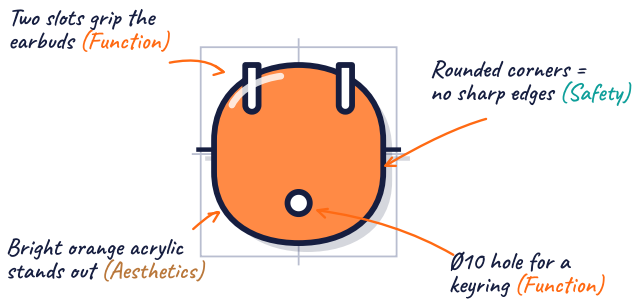
KNOWLEDGE

Design sketching is not art — it is how designers **communicate** ideas to clients, engineers and other designers. Sketches should be quick, clear and big enough to read.

- **Crating** — draw a light box first, then sketch the shape inside it.
- **Line weight** — thin, light construction lines; a bold outline at the end.
- **Colour** — show the material and make the idea stand out.



1. Light crate box
2. Shape inside the crate
3. Bold outline + colour



Annotation

Annotations are short notes with arrows. They explain the parts of your idea that a sketch cannot show.

Good annotation = feature + reason. Link it to a design factor or specification point.

✕ "hole" ✓ "Ø10 hole so it clips on to a keyring"

YOUR TURN

1 **Mix it up! Choose one item from each column to create a new idea. Circle your choices, then try another mix.**

Theme / shape	How it holds the earbuds	Extra feature
Animal or character	Slots grip the earbuds	Keyring hole
Geometric (hexagon, star)	Cable wraps round the middle	Engraved name or pattern
Sport or hobby logo	Case slides into a cradle	Stands up on a desk

YOUR TURN

2 **Quick-sketch two different ideas. Add at least two annotations to each. (Do more on your A3 concept sheet.)**

IDEA A

IDEA B

LESSON 6

STAGE 4 · DEVELOP

Choose, develop & present

LEARNING INTENTION

Evaluate concepts against the specification, then develop and present the best idea.

SUCCESS CRITERIA · I can…

- ☐ score my concepts against my specification
- ☐ develop my chosen idea with sizes in mm
- ☐ present my final design clearly for manufacture

KNOWLEDGE

1. Evaluate. Score each idea against your specification. The idea that meets the most points is usually the best one to develop.

2. Develop. Improve the chosen idea: check the critical sizes, refine the shape, pick a material and add **dimensions**.

3. Present. A clear final drawing shows the manufacturer exactly what to make: a 2D drawing with sizes, a 3D colour sketch and annotations.

DIMENSION SYMBOLS

Ø10 — a hole 10 mm in **diameter**

R5 — a curve with a 5 mm **radius**

60 — all sizes are in **mm**; you don't write "mm" on each one

Arrows touch the extension lines. Numbers sit **above** the line.

YOUR TURN

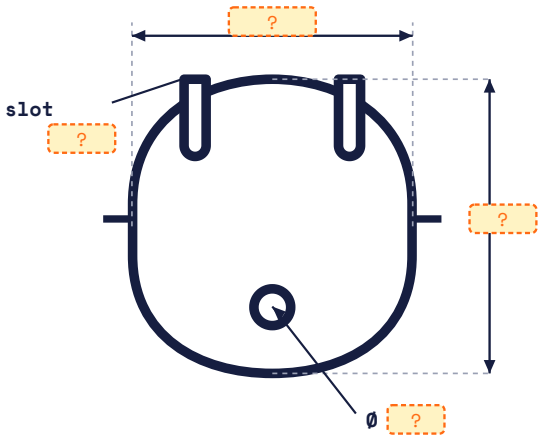
1 **Score your three best ideas: 2 = meets the point fully, 1 = partly, 0 = not at all.**

Specification point	Idea A	Idea B	Idea C
Function			
Aesthetics			
Safety			
Performance			
Size			
TOTAL /10			

I will develop idea _____ **because**

YOUR TURN

2 **Add the missing dimensions to this template, using the sizes from your own design.**



All sizes in mm · Not to scale

EXAM-STYLE QUESTION

Explain why a final design drawing must show dimensions. **2 marks**

LESSON 7

STAGE 5 · PROTOTYPE

Model it. Test it.

LEARNING INTENTION

Build a card prototype to test and improve my design before making it for real.

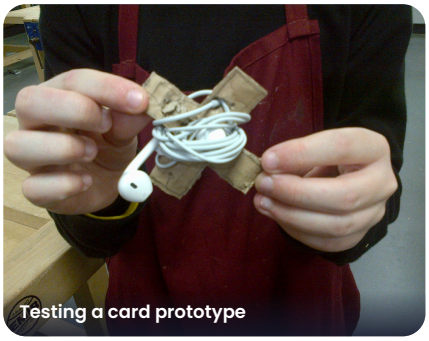
SUCCESS CRITERIA · I can…

- ☐ use card-modelling tools safely
- ☐ build an accurate prototype from my template
- ☐ test my prototype and record improvements

KNOWLEDGE

A **prototype** is a quick model of an idea. Designers make prototypes to **test** an idea, find problems and **improve** it before spending money on real materials.

Card is great for prototypes because it is cheap, quick to cut, easy to change and can be recycled. A card prototype at full size (1:1) lets you test it with real earbuds.



Testing a card prototype



Cutting mat
protects the desk



Safety rule
guards your fingers



Craft knife
for straight cuts



Scissors
for curves

SAFETY RULES — CRAFT KNIFE

- Always cut on a **cutting mat**.
- Use a **safety rule** and keep fingers behind its raised edge.
- Cut **away** from your body.
- Make several light cuts rather than one hard cut.
- Cover or retract the blade when you put it down.
- Carry the knife with the blade pointing **down**.

YOUR TURN

1 **Test your prototype with real earbuds or a case. Record what happened and how you will improve it.**

Test	What happened?	Improvement
Does it fit the earbuds / case?		
Does the cable or case stay put?		
Is it comfortable to hold / carry?		
Any weak or thin parts?		

EXAM-STYLE QUESTION

Explain why designers make prototypes before making the final product. **2 marks**

LESSON 8

STAGE 6 · PLAN TO MAKE

Choose your route

LEARNING INTENTION

Choose a suitable material and plan how to manufacture my EarBuddy safely.

SUCCESS CRITERIA · I can…

- ☐ compare aluminium, plywood and acrylic
- ☐ choose a route and justify my choice
- ☐ write a sequence of operations with tools and safety

KNOWLEDGE



Aluminium · 1 mm

A **non-ferrous metal**. Lightweight, does not rust and can be bent. Cut with tin snips. Edges must be filed smooth. Finish: polish.



Birch plywood · 6 mm

A **manufactured board** made of thin layers glued together. Strong and stable. Cut with a coping saw. Finish: paint, wax or varnish.



Acrylic · 3 mm

A **thermoplastic**. Bright colours and a glossy finish. Can crack if forced. Cut by hand or with a **laser cutter**. Finish: polish the edges.

The four making routes

ROUTE A	ROUTE B	ROUTE C	ROUTE D
Metal by hand	**Wood by hand**	**Acrylic by hand**	**Acrylic · CAD/CAM**
Worksheet 7	Worksheet 8	Worksheet 9	Worksheet 10

A **sequence of operations** is a step-by-step plan for making a product. For each step, list the **tools** and the **safety** precautions. Most hand-made EarBuddies follow this order:

mark out → cut → shape → drill → finish → check

YOUR TURN

1 **My route is:**

☐ A Metal ☐ B Wood ☐ C Acrylic ☐ D Laser

because

YOUR TURN

2 **Plan the first five steps of making your EarBuddy. Your route worksheet will help.**

#	What I will do	Tools & equipment	Safety
1			
2			
3			
4			
5			

EXAM-STYLE QUESTION

Explain one reason why you chose your material for your EarBuddy. **2 marks**

TALK LIKE A DESIGNER

Key words & command words

Command words — what is the question asking?

In National 5 exams, the **command word** tells you what kind of answer to give. Learn these now and you'll pick up easy marks later.

State

Give a short fact or name. No reason needed.
"State one finish for plywood."

Describe

Say what something is like or what happens, with detail.
"Describe field research."

Explain

Give a reason — say **why** or **how**. Use "because".
"Explain why prototypes are useful."

Compare

Say how two things are similar or different — talk about **both**.
"Compare the two products."

Glossary

Aesthetics — how a product looks and feels: shape, colour, texture, pattern.

Annotation — a short note with an arrow that explains a feature of a sketch.

CAD / CAM — Computer-Aided Design / Computer-Aided Manufacture.

Critical size — a size the product must fit, e.g. the size of an earbud case.

Crating — drawing a light box first and sketching a shape inside it.

Design brief — a short statement of the problem, the user and what the product must do.

Design factors — things designers consider, e.g. function, aesthetics, safety, performance.

Design specification — a list of measurable rules the product must meet.

Desk research — using information others have gathered, e.g. websites and books.

Dimension — a size on a drawing, in millimetres.

Evaluation — testing the finished product against the specification.

Field research — collecting new information yourself, e.g. questionnaires, measuring.

Function — the job a product does. Primary = main job; secondary = extra jobs.

Iteration — going back to an earlier stage to improve a design.

Manufactured board — a man-made board such as plywood or MDF.

Non-ferrous metal — a metal with no iron in it, e.g. aluminium. It does not rust.

Performance — how well a product works and how long it lasts.

Prototype — a model used to test and improve an idea.

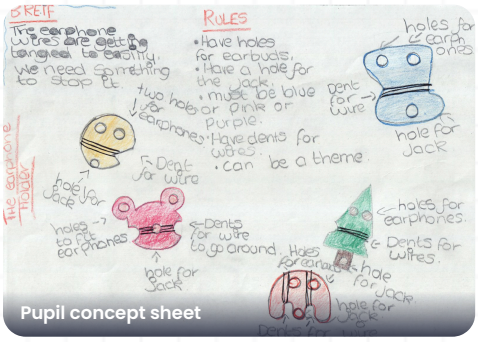
Sequence of operations — the steps for making a product, in order, with tools and safety.

Target market — the group of people a product is aimed at.

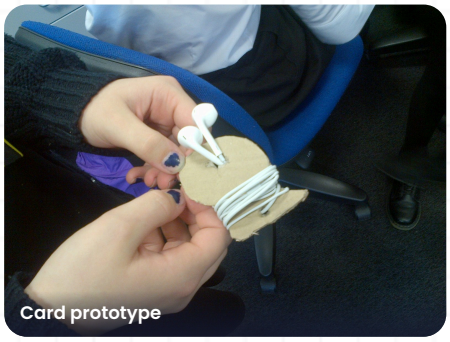
Thermoplastic — a plastic that softens when heated and can be reshaped, e.g. acrylic.

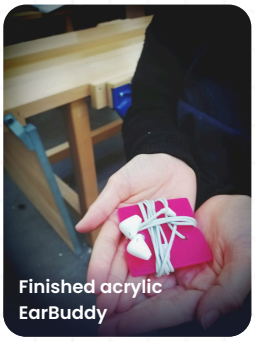
User trip — watching someone use a product step by step to find problems.

Vector — a drawing made of lines and points, which a laser cutter can follow.



Pupil concept sheet


Card prototype


Finished acrylic EarBuddy

HOW AM I DOING?

My progress tracker

At the end of each lesson, colour or tick a circle: **Got it** **Nearly** **Need help**

Lesson	Success criteria	Got it · Nearly · Help
1	I can put the design process stages in order and explain why designers use it	☐ ☐ ☐
2	I can describe function, aesthetics, safety and performance	☐ ☐ ☐
3	I can describe desk and field research and measure critical sizes	☐ ☐ ☐
4	I can write measurable specification points	☐ ☐ ☐
5	I can sketch and annotate four different ideas	☐ ☐ ☐
6	I can score ideas against my specification and add dimensions	☐ ☐ ☐
7	I can build and test a card prototype safely	☐ ☐ ☐
8	I can choose a route and plan a sequence of operations	☐ ☐ ☐
9	I can mark out my material accurately (or draw it in Affinity)	☐ ☐ ☐
10	I can cut, shape and drill safely (or prepare it for the laser cutter)	☐ ☐ ☐
11	I can finish my EarBuddy to a high quality	☐ ☐ ☐
12	I can evaluate my EarBuddy against my specification	☐ ☐ ☐

REFLECT

What am I most proud of in this project?

REFLECT

What would I do differently next time?

Exam scores

Design Thinking exam: _____ / 20

Making exam: _____ / 20

Teacher comment

Where next?

Design & Manufacture, Graphic Communication, Practical Woodworking and Practical Metalworking are all National 5 courses. The skills you used here — research, specifications, sketching, prototyping and making — are the skills those courses build on.