Soldering Learning Guide

Meet your kit, master the basics, then build four real projects.



7 video lessons ↗ · 4 hands-on exercises

2026 Edition

Getting Started

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Getting Started · How to use this guide

Welcome to soldering

Soldering joins metal parts with melted solder to make an electrical and mechanical connection. This kit teaches it step by step.

Soldering 101

A three-part video series

1 · Components ↗
Your Kit · 9:03

2 · Safety & Setup ↗
Safety & Care · 4:09

3 · How to Solder ↗
Soldering 101 · 8:00

Plus a walkthrough video for each of the four exercises.

Scan a QR code or tap any underlined title to watch. Open the full playlist ↗

Look for these

- Video lesson
- Pro tip
- Caution
- Safety

1 Learn

Sections 01–03: your tools, how soldering works, and how to stay safe.

2 Practise

Section 04: the core technique, one clear step at a time.

3 Build

Sections 05–06: four exercises, then challenges of your own.

Safety

Adults: read Section 03 before the iron is switched on

Younger users should solder only with an adult supervising. The iron runs at several hundred degrees and stays hot after it is turned off.

Getting Started · Check your kit

What’s in the box

Everything you need to start soldering. Check each item off before you begin.



Digital soldering iron
Display, power switch, +/− buttons, 6 tips, stand & sponge



Lead-free solder
Rosin core · Sn96.5 Ag3.0 Cu0.5 · 0.8 mm · 25 g



PCB multipack
Practice boards in several sizes



24 AWG stranded wire
Six colours



Wire stripper / cutter
Strips and cuts 24 AWG



Helping hands
Clips and a magnifier



Tweezers
ESD-13, fine point



Safety glasses
Wear whenever the iron is on



Breakaway headers
Male and female pin strips

Not included: fume extractor or fan, desoldering pump or wick. For testing the exercises you’ll use the multimeter from your Breadboard kit.

Section 01

Pages 05–10

01 Your Kit

Every tool in your kit — what it is, what it does, and how to set it up before you start.

Your journey

Your Kit · Background · Safety · Solder 101 · Exercises · Challenges

You'll be able to

- Name every tool in the kit
- Set up the iron, stand and sponge
- Choose the right tip for a joint
- Strip wire without cutting strands

In this section

06 The soldering iron

07 Tips, stand & sponge

08 Solder & PCBs

09 Wire & wire stripper

10 Hands, tweezers, glasses & headers

Video lesson · 9:03

Soldering 101 · 1: Components ↗

Every item in the kit, what it's for, and how to set up the iron and stand.

Your Kit · Know every part

The soldering iron

Your main tool. It heats the metal parts so the solder can melt and flow into the joint.



Digital display
Shows the set temperature

Power switch
On the handle — off whenever you stop

+ and − buttons
Set 300–400 °C in small steps

Heating element & tip
The only part that should touch the work

Stand & sponge
Holds the hot iron; cleans the tip

350 °C
Start here with the kit's solder

300–400 °C
Adjustable range

570–750 °F
The same range in Fahrenheit

Safety

The tip stays hot after you switch off

It can take several minutes to cool. Always return the iron to its stand, and never touch the metal shaft or tip.

Your Kit · Pick the right tip

Tips, stand & sponge

Your kit includes six tips — two of them conical. Different shapes suit different sizes of joint.

Shape	Tip	Best for
	Chisel	Most joints — our pick for the exercises **Recommended**
	Conical ×2	General work and small pads
	Fine point	Very small parts and tight spaces
	Bevel	Large pads and tinning wires
	Knife	Dragging along header rows

Tip shapes in your kit may vary slightly. Rule of thumb: use the largest tip that fits the joint comfortably — it moves heat faster.

Set up the stand

1. **Screw one nut onto the coil holder**
   Thread it on a few turns.
2. **Push it through the base, add the second nut**
   Tighten so the two nuts sandwich the base.
3. **Dampen the cellulose sponge**
   Wet it, squeeze it out, then set it in the tray.
4. **Park the iron whenever you let go**
   Never lay a hot iron on the bench.

⚠ Caution

Change tips only when cold

Switch off, let the iron cool completely, then unscrew the tip. Never force a hot tip.

Pro tip

Damp, not dripping

A soaking sponge cools the tip too much and can crack the plating.

Your Kit · Know your materials

Solder & PCBs

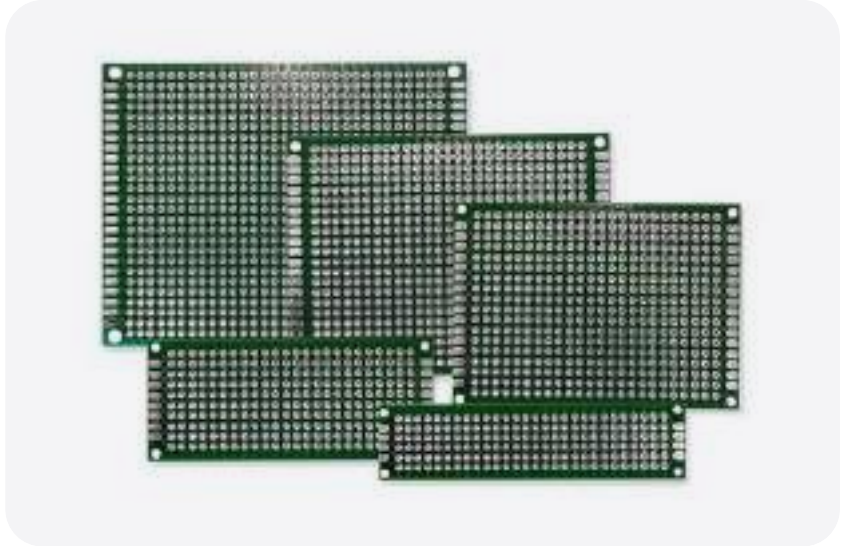
Solder is the metal that forms the connection. The PCB is what you connect things to.



Lead-free solder

Alloy	Sn96.5 / Ag3.0 / Cu0.5 (tin, silver, copper)
Core	Rosin flux inside the wire
Diameter	1.2 mm
Weight	50 g
Melts at	about 217–220 °C

The flux inside cleans the metal as the solder melts, so it can flow and bond.



PCB multipack

A printed circuit board (PCB) holds parts in place and connects them. These practice boards are perfboards: a grid of holes, each ringed with a copper pad.

- Pads — copper rings the solder bonds to
- Holes — where wires, leads and header pins go through
- Spare boards — practise a few joints first

Pro tip

Lead-free needs a little more heat

That's why we start at 350 °C. Wash your hands after soldering and keep food and drinks away from the bench.

Your Kit · Strip wire cleanly

Wire & wire stripper

Flexible wire for connections, and the tool that cuts and strips it cleanly.



24 AWG stranded wire

AWG means American Wire Gauge. The bigger the number, the thinner the wire. 24 AWG is a common size for breadboards and hobby electronics.

Stranded wire is made of many fine strands, so it bends without snapping.

Power (+)	Ground (–)	Signal
Signal	Signal	Other



Wire stripper / cutter

1. **Use the 24 AWG notch**
   Too small a notch cuts strands.
2. **Strip about 5 mm**
   Close, twist slightly, pull off the insulation.
3. **Inspect and twist**
   No cut or loose strands, then twist them neatly.

⚠ Caution

Colour is for organisation only

Wire colour doesn’t change how a wire works — it only keeps things organised. Most people use red for power and black for ground; pick a scheme and stick to it.

Your Kit · Use the helpers

Holding, protecting & connecting

Four small items that make soldering easier and safer.



Helping hands with magnifier

Clips hold a PCB, wire or part still so both hands are free. The magnifier helps you check joints.

Keep parts still — a joint that moves while cooling fails.



Tweezers (ESD-13)

Position and hold small parts and wires precisely.

Parts and wires get hot — use tweezers, not fingers.



Safety glasses

Wear them whenever the iron is on or you are clipping leads.

Protects against solder splatter and flying lead ends.



Breakaway pin headers

Rows of male pins and female sockets. Snap off as many as you need, then solder them to a board.

Male headers snap at the notch; to cut female headers, sacrifice one socket.

Section 02

Pages 11–13

02 Background

What soldering actually is, why it works, and how it grew from ancient metalwork into modern electronics.

Your journey

Your Kit · **Background** · Safety · Solder 101 · Exercises · Challenges

You'll be able to

- Explain what soldering is
- Describe how solder wets and bonds
- Explain what flux does
- Name where soldering is used today

In this section

12 What soldering is ›

13 A short history ›

Background · Explain how a joint forms

What soldering is

Soldering joins metal parts with a filler metal — solder — that melts at a lower temperature than the parts themselves.

Electrical connection

Current can flow from one part to the other.

Mechanical connection

The joint also holds the part firmly in place.

1

Heat

The iron heats the pad and the lead together.

2

Melt

Solder touches the hot metal and melts.

3

Wet

It flows and spreads across both surfaces.

4

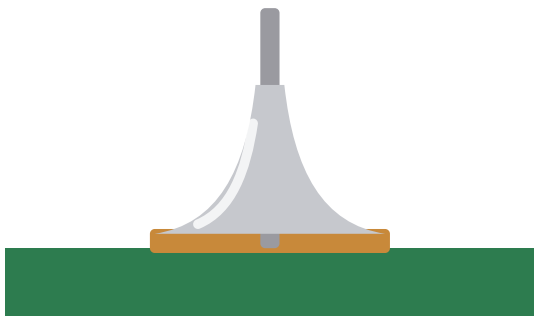
Cool

It turns solid — the joint is finished.

The golden rule

Heat the joint, not the solder.

Touch the iron to both metal parts first, then feed solder into the joint. If you melt solder onto the iron and carry it over, the flux burns off and the solder balls up instead of bonding.



A good through-hole joint (a lead or pin through the board) is smooth, shiny and shaped like a small volcano.

Good to know

What flux does

Metal surfaces quickly grow a thin layer of oxide that solder won’t stick to. Flux cleans it away as it heats. Your kit’s solder has flux inside the wire, so you rarely need to add more.

Background · See how we got here

A short history

People have soldered metal for thousands of years. Electricity made it essential.

Ancient times	Metalworkers join jewellery, tools and pipes with soft, low-melting metals.
1800s	Telegraphs and early electrical devices need reliable wire connections.
Early 1900s	Electrically heated soldering irons replace irons warmed in a fire.
1920s–50s	Radios, then TVs, are wired and soldered by hand, point to point.
1940s–60s	Printed circuit boards spread — and machines start soldering them.
2000s	Rules such as the EU's RoHS (2006) push electronics toward lead-free solder.
Today	Robots and reflow ovens solder phones and computers by the million.

Where you'll find solder today

- Computers
- Phones
- Cars
- Drones
- Appliances
- LED lights
- Robots
- Medical devices

Why it's still worth learning

- ✓ Build and prototype your own circuits
- ✓ Repair cables, toys and gadgets
- ✓ A core skill for engineers and technicians

5,000+ yrs
People have been soldering metal

1936
Paul Eisler builds an early printed circuit board

2006
EU RoHS rules push electronics to lead-free

Section 03

Pages 14–17

03

Safety & Care

Safe habits come first. Set up your bench, protect your eyes and lungs, and look after your iron.

Your journey

Your Kit | Background | **Safety** | Solder 101 | Exercises | Challenges

You'll be able to

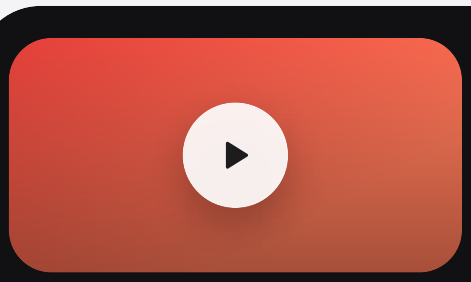
- Set up a safe, tidy workspace
- Handle a hot iron safely
- Keep flux fumes away from your face
- Clean, tin and store the iron

In this section

15 A safe workspace ›

16 Fumes, eyes & supervision ›

17 Cleaning, care & shutdown ›



Video lesson · 4:09

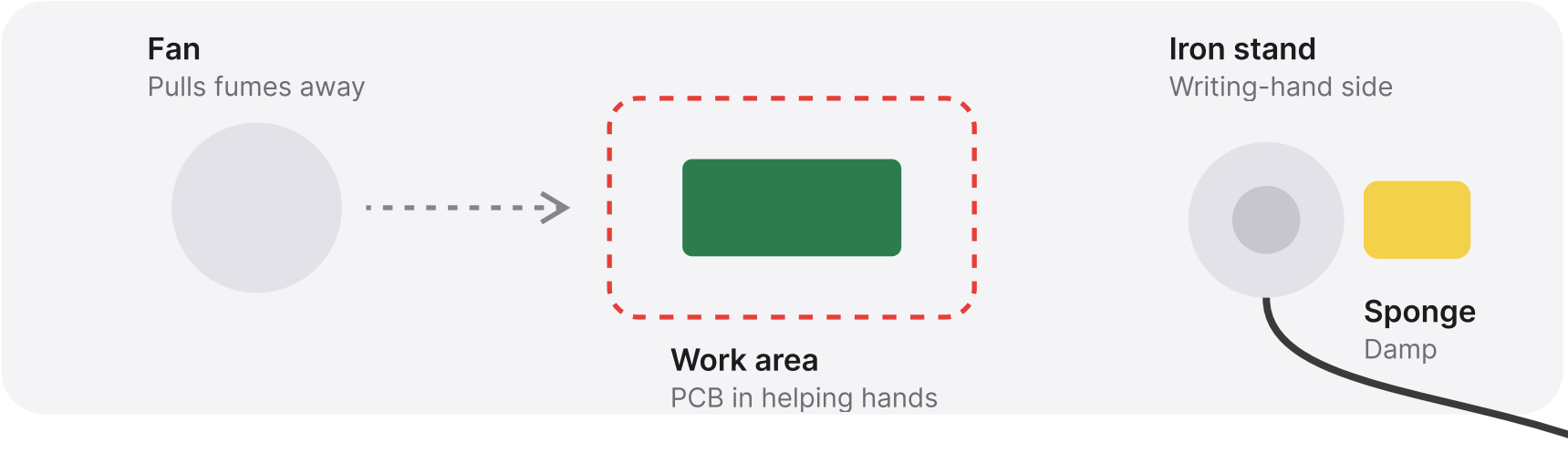
Soldering 101 · 2: Safety & Setup ↗

Workspace setup, heat and fume safety, and how to clean, tin and store your iron.

Safety & Care · Set up before you switch on

A safe workspace

Most soldering accidents come from a cluttered bench or a misplaced iron.



Workspace setup

- Clean, stable, uncluttered surface
- Paper, plastic and drinks moved away
- Stand within easy reach
- Cord can’t snag or be pulled
- Bright light on the work

Heat rules

- Never touch the shaft or tip
- Always park the iron in its stand
- Never leave a powered iron alone
- Wires, pads and leads get hot too
- Let parts cool before you touch them

Safety

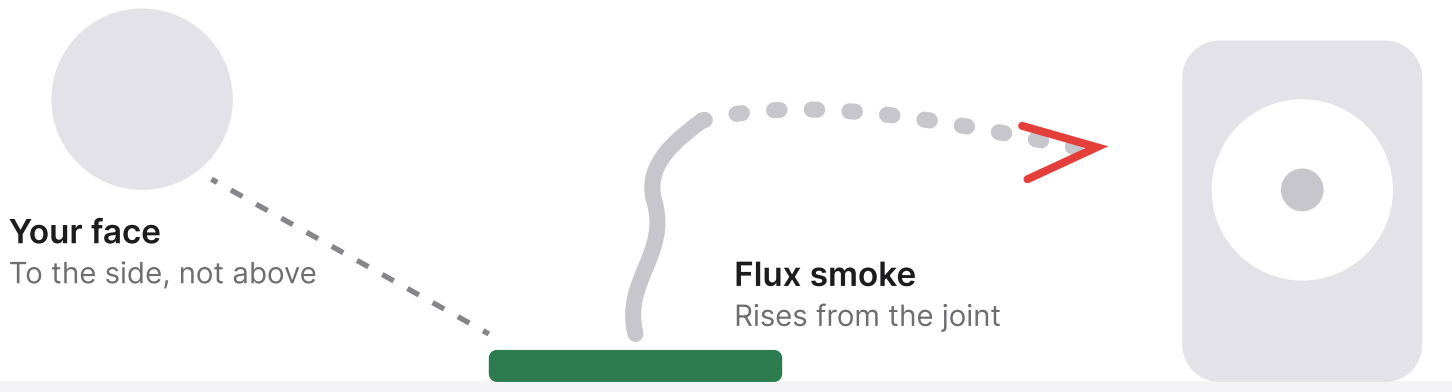
If you get a burn

Cool it under cool running water for 20 minutes, then tell an adult. Get medical help for anything larger than a small spot.

Safety & Care · Breathe clean air

Fumes, eyes & supervision

Heated flux makes smoke. Keep it out of your face, protect your eyes, and work with an adult nearby.



Ventilation

- Work in a well-ventilated room
- Place a fan or fume extractor beside the work
- Keep your face out of the smoke
- Take a short break every 20–30 minutes

A fume extractor isn't included. A small desk fan works — set it to draw the smoke away from you.

Eye protection



- Glasses on whenever the iron is on
- Solder can spit when flux boils
- Hold leads when you clip them — the ends fly

Safety

Younger users need an adult present

Children and new beginners should solder only with adult supervision. Treat the iron as hot whenever it is on — and while it cools.

*North Star Scientific is not responsible for any injuries or damages that occur during the soldering process.

Safety & Care · Keep your tip shiny

Cleaning, care & shutdown

A clean, tinned tip heats faster and lasts much longer.

Tinned
Shiny silver — moves heat well



Oxidised
Dark and dull — solder won't stick

Clean & re-tin when needed

1. **Wipe the hot tip on the sponge**
   Only when there's debris or heat transfers slowly — over-cleaning oxidises the tip faster.
2. **Melt a little fresh solder on it**
   A thin, even coat.
3. **Check it's shiny all over**
   The coat protects the tip from oxide.

Shut down & store

1. **Coat the tip with a thin layer**
   It protects the tip while it cools.
2. **Switch off and park the iron**
   Back in the stand, tip down.
3. **Let it cool completely**
   Only then change tips or pack away.

Keep the bench tidy

- ✓ Wires and parts sorted
- ✓ Iron away from plastic
- ✓ Clipped leads binned
- ✓ No food or drink
- ✓ Wash hands after

⚠ Caution

Never sand, file or scrape the tip

Tips are plated. Scraping removes the plating and ruins the tip. If it's dull, clean and re-tin it instead.

ⓘ Good to know

When to replace a tip

If a tip is pitted, worn through, or still won't take solder after cleaning and re-tinning, swap it for one of the spares — once the iron is cold.

Section 04

Pages 18–23

04

Soldering 101

The core technique, one step at a time — from setting up to inspecting a finished joint.

Your journey

Your Kit · Background · Safety · **Solder 101** · Exercises · Challenges

You'll be able to

- Set the temperature and tin the tip
- Strip and tin a wire
- Make a clean joint on a PCB
- Spot and fix common faults

In this section

19 Get ready to solder

20 Strip & tin a wire

21 Solder a joint on a PCB

22 Inspect your joint

23 Fix mistakes & finish up

Video lesson · 8:00

Soldering 101 · 3: How to Solder ↗

The full process — set-up, tinning, your first joint, inspection and fixes.

Soldering 101 · Prepare, set and tin

Get ready to solder

Five minutes of set-up makes every joint easier.

1 Prepare the bench

- Safety glasses on
- Fan or extractor running
- Iron in its stand, sponge damp
- Board, wire, solder and tools in reach

2 Choose a tip

- Use the chisel tip for the exercises
- Largest tip that fits = faster heat
- Fit tips only while the iron is cold

3 Set the temperature

- Switch on at the handle
- Set 350 °C with + and −
- Wait for the display to settle

4 Clean & tin the tip

- Wipe the hot tip on the sponge
- Melt a little solder onto it
- Shiny all over = ready

Temperature guide

Start at 350 °C



300 °C	350 °C	400 °C
Small pads, fine parts	Kit solder, most joints	Big pads, thick wire

Pro tip

Hotter isn’t better

If solder won’t flow, check that the tip is clean and touching both parts before you turn the heat up. Too much heat can lift pads off the board.

Soldering 101 · Tin a wire end

Strip & tin a wire

Tinning coats the strands with solder so they hold together and solder easily.



1 · Stripped
≈ 5 mm bare

2 · Twisted
Strands neat

3 · Tinned
Smooth & silver

Strip

1. **Cut the wire to length**
   Leave a little extra.
2. **Use the 24 AWG notch**
   Strip only about 5 mm.
3. **Inspect the strands**
   None cut or broken.
4. **Twist them together**
   Clockwise, firm and neat.

Tin

1. **Clamp the wire**
   In the helping hands.
2. **Heat the strands**
   Iron underneath the bare end.
3. **Feed solder into the strands**
   Not onto the iron. Let it wick in.
4. **Solder off, then iron off**
   Keep still while it cools.

Caution

Avoid a solder ball

Just enough to soak in — you should still see the strand pattern. A blob makes the end too thick for breadboard holes.

Pro tip

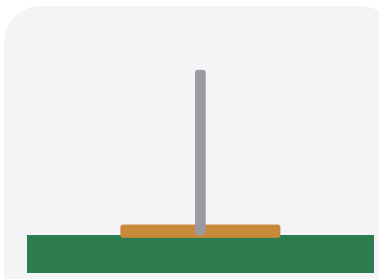
You'll use this in Exercise 1

Tinned ends push neatly into breadboard holes — that's exactly how you'll make your own jumper wires on page 25.

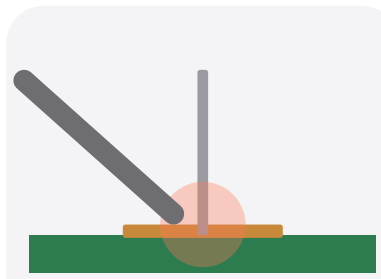
Soldering 101 · Make a clean joint

Solder a joint on a PCB

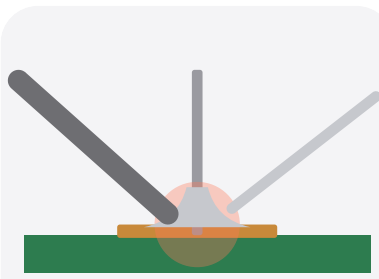
The core skill. Every exercise in this kit builds on it.



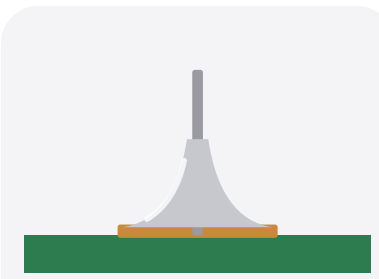
1 Position



2 Heat both



3 Feed solder



4 Solder off, iron off

1. **Position and secure the part**
   Lead through the hole; board held in the helping hands.
2. **Touch the tip to pad and lead together**
   Heat both for 1–2 seconds.
3. **Feed solder into the joint**
   On the side opposite the iron — not onto the tip.
4. **Let it flow around the lead**
   Use just enough to cover the pad.
5. **Remove the solder, then the iron**
   Solder first, iron second.
6. **Hold still while it cools**
   2–3 seconds. Movement causes a weak joint.

3–5 s
for a typical joint, start to finish

Remember

Heat the joint. Feed the solder. Solder off, iron off.

Pro tip

Bend the leads to hold parts

Splay the leads slightly on the back of the board so the part can’t drop out while you solder.

Caution

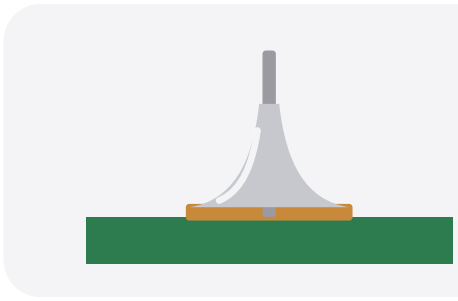
Don’t press hard

Pressure doesn’t add heat — contact does. Pressing can lift pads or bend the tip.

Soldering 101 · Spot good and bad joints

Inspect your joint

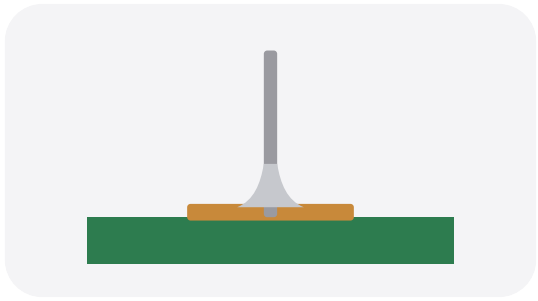
Check every joint before moving on. Good ones are easy to spot once you know what to look for.



✓ Good joint

Through-hole: smooth, shiny, concave — a small volcano around the lead.

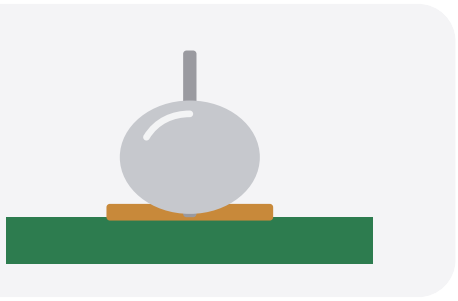
Cause: Heat and solder just right.



✕ Too little solder

Pad only partly covered; lead barely wetted.

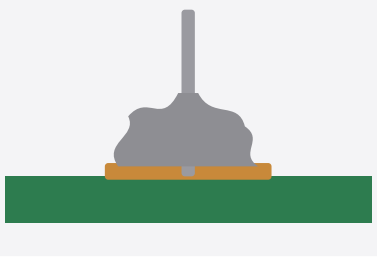
Cause: Fed too little or pulled away early.



✕ Too much solder

A round ball that hides the pad.

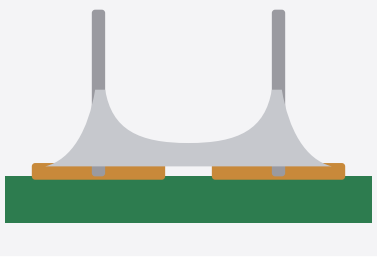
Cause: Kept feeding after it flowed.



✕ Cold joint

Dull, grainy and lumpy.

Cause: Not enough heat, or moved while cooling.



✕ Solder bridge

Solder joins two pads that should be separate.

Cause: Too much solder on close pads.

Use the magnifier

Look from the side and from above. Turn the board under a bright light — shiny joints reflect it evenly.

Good to know

Why it matters

A cold joint or a bridge might work at first, then fail later — or short two connections together. Fixing it now takes seconds.

Soldering 101 · Rework and shut down

Fix mistakes & finish up

Most bad joints can be fixed in seconds.

Reflow

Cold or dull joint

Touch a little fresh solder to the tip, reheat the joint until it flows, then lift the iron.

Add solder

Too little solder

Heat the joint again and feed in a small amount more.

Remove solder

Too much, or a bridge

Drag the excess away with a clean tip. For bigger fixes, use desoldering wick or a pump (optional extras).

Finishing up

1. **Inspect every joint**
   Fix anything dull, balled or bridged.
2. **Clean the tip and coat it**
   A thin layer of fresh solder protects it.
3. **Switch off and park it**
   Let it cool completely in the stand.

While you work

- Clean the tip only when it needs it
- Don’t leave a bare tip sitting hot
- Unplug when you step away

The core sequence

Prepare › Heat the joint › Apply solder › Solder off › Iron off › Cool › Inspect

Good to know

Useful extras (not in the kit)

Desoldering wick soaks up solder like a sponge; a solder pump sucks it away. You’ll test the exercises with the multimeter from your Breadboard kit.

Section 05

Pages 24–35

05 Exercises

Four builds on perfboard — two for your Breadboard kit and two for your Embedded Systems kit. Each has written steps and a walkthrough video.

Your journey

Your Kit · Background · Safety · Solder 101 · **Exercises** · Challenges

You'll be able to

- Plan parts and underside wiring first
- Solder headers straight and square
- Test your work with a multimeter
- Program a Teensy to make sound

In this section

25 — 1 · Push button module · Easy — Video ↗

27 — 2 · Teensy socket board · Easy — Video ↗

29 — 3 · Push button LED board · Medium — Video ↗

32 — 4 · Add sound to the Teensy · Medium — Video ↗

Good to know

Before every build

Each plated hole connects only its own two sides — neighbouring pads stay separate until you join them with wire or leads. Plan placement and underside routes first, and mark one edge so you recognise it when the board is flipped.

Exercises · Exercise 1

Push button module

Solder a button and a 2-pin header to perfboard to make a plug-in switch for your breadboard.

Easy · Breadboard kit

What you'll make

You'll mount a push button and a two-pin header, then join them with two short wire links. The finished module is open between T1 and T2 when released, and connected when pressed.

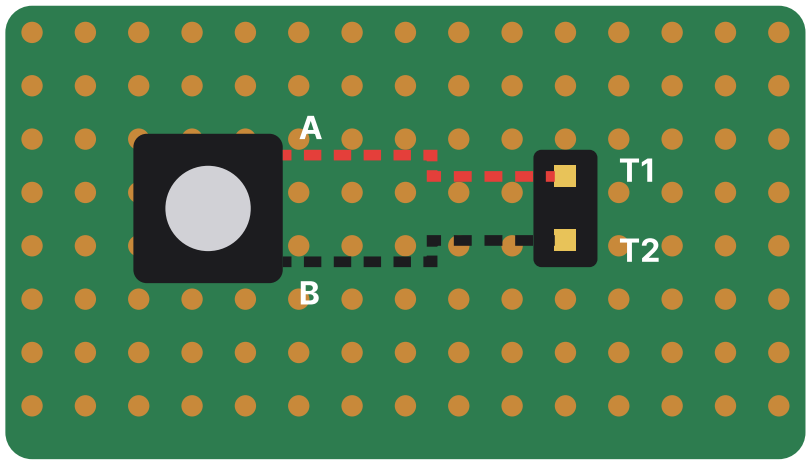
Learning objectives

- Find a button's switched contacts with a meter
- Solder component leads and a short header
- Make two clean wire links on the underside

Difficulty	Time	Video
Easy	30 min	3:44 ↗

You'll need

Push button	BB kit
Small perfboard	Kit
2-pin male header	Kit
2 short 24 AWG wires	Kit
Multimeter	BB kit



Dashed = wires on the underside



Released: open · Pressed: connected

Video lesson · 3:44

Exercise 1 · Push Button Module ↗

Finding the switched contacts, soldering the button and header, and testing with a meter.

Exercises · Push button module

Exercise 1 · Step by step

1 Identify the switched contacts
Meter in continuity or Ω mode: find two sides that are open when released and connected when pressed. Mark them A and B.

2 Trial-fit the button and header
Header near an edge; label its pins T1 and T2. Sketch wire A → T1 and B → T2.

3 Solder the button
Set up safely, fit it in your recorded orientation, solder each lead to its own pad. Check for bridges.

4 Solder the 2-pin header
Solder one pin, check it's straight, then the other. Keep solder off the long pins.

5 Prepare two short wires
Measure, cut, strip and lightly tin. No bare wire near other pads.

6 Connect T1
Solder a wire from button side A to the T1 pad.

7 Connect T2
Solder a wire from side B to the T2 pad. Compare with your sketch.

8 Test at the header
Board disconnected. Probe T1 and T2: silent when released, a beep (or near-zero Ω) when pressed.

9 Repeat and finish
Press several times. Always low = bridge or joined legs. Always open = wrong contact pair or route.

Check your work

- A and B are the switched sides
- Header straight, long pins clean
- No bridge between A and B
- Each wire on the right pin

Test it

Meter on T1 and T2: silence when released, a beep when pressed — every time. Then follow the shutdown routine.

Pro tip

Four legs, two sides

On a four-leg button some legs are permanently joined inside. That's why you test before soldering.

Exercises · Exercise 2

Teensy socket board

Solder two 24-pin socket rows so your Teensy 4.1 plugs in and out — the base for Exercise 4.

Easy · Embedded kit

What you'll make

You'll practise 48 similar header joints and accurate alignment. The finished board has two straight socket rows with separate contacts and no bridges. No wiring or power is needed yet.

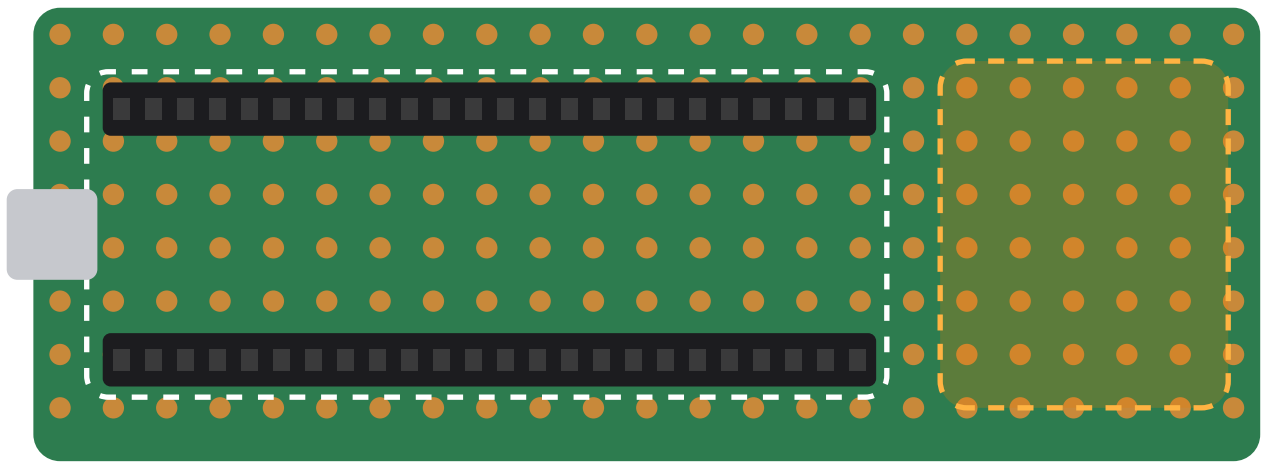
Learning objectives

- Make many consistent header joints
- Keep long header rows straight and square
- Check for bridges with a meter

Difficulty	Time	Video
Easy	45 min	2:21 ↗

You'll need

Teensy 4.1, pins fitted	ES kit
Perfboard	Kit
2 × 24-position female headers	Kit
Spare male pin	Kit
Multimeter	BB kit



USB end
Mark both faces

2 × 24 sockets
Straight and flush

Exercise 4 area
Keep it free

Video lesson · 2:21

Exercise 2 · Teensy Socket Board ↗

Cutting the headers, aligning the rows and checking for bridges.

Exercises · Teensy socket board

Exercise 2 · Step by step

1. **Disconnect and choose the board**
   Unplug all supplies. Pick a board with room for both rows plus Exercise 4's parts; USB end near an edge.
2. **Prepare two 24-socket rows**
   Separate the female headers and count usable sockets after cutting. Clear any fragments.
3. **Trial-fit, unpowered**
   Fit headers onto the Teensy, tails through the board. Rows straight and flush. Mark the USB end on both faces.
4. **Solder one end of each row**
   Remove the Teensy first. Hold the rows flush and solder one end pin of each.
5. **Check alignment**
   Once cool, trial-fit the Teensy. Fix any tilt, then solder the opposite end pins.
6. **Solder the remaining pins**
   Heat tail and pad together; inspect every few joints. No wire links yet.
7. **Test for bridges**
   Teensy out, no power. Probe neighbouring tails and across rows: expect no beep.
8. **Check the socket contacts**
   Push a spare male pin into each socket and probe it to its tail: expect a beep. Never force meter probes into sockets.

Check your work

- Both rows straight and flush
- 48 shiny, separate joints
- No beeps between neighbours
- Teensy fits without bending pins

Test it

Trial-fit the unpowered Teensy — every pin should slide in without bending. Keep this board: you'll add sound to it in Exercise 4.

⚠ Caution

Teensy out while you solder

Heat can damage it and solder can wick into the sockets. Solder only with the Teensy removed.

Exercises · Exercise 3

Push button LED board

An LED that lights while you hold a button — powered by your four-AA pack through a screw terminal.

Medium · Breadboard kit

What you'll make

You'll mount an LED, a push button, a 4.7 kΩ resistor and a screw terminal, then join them with four links on the underside. Polarity matters on this one.

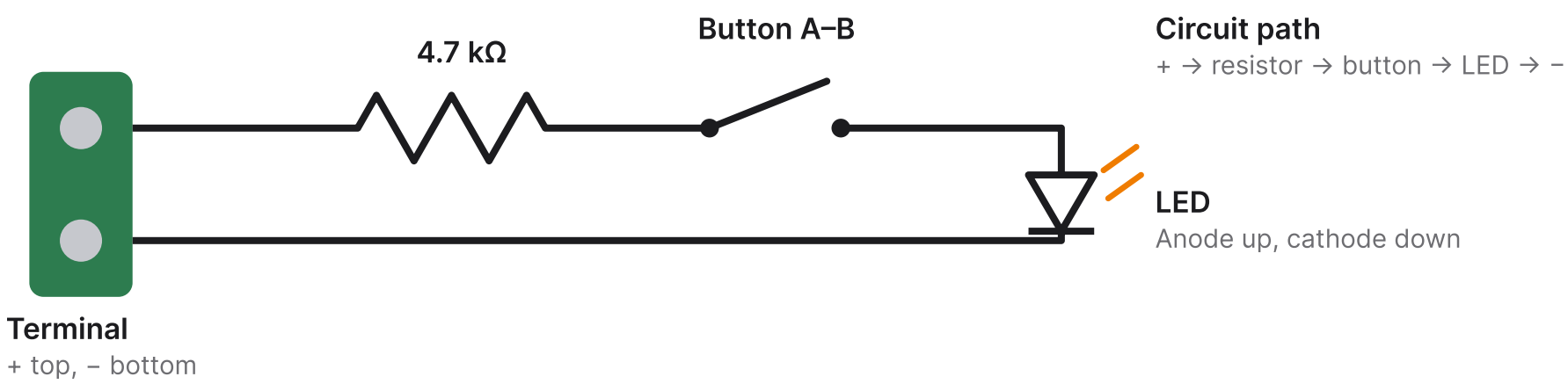
Learning objectives

- Identify LED polarity and check a resistor value
- Mount several different component types
- Route and check four wire links

Difficulty	Time	Video
Medium	60 min	5:51 ↗

You'll need

LED & push button	BB kit
4.7 kΩ resistor	BB kit
Four-AA battery pack	BB kit
2-position screw terminal	Kit
Perfboard & 4 wires	Kit
Multimeter	BB kit



Video lesson · 5:51

Exercise 3 · Push Button LED Board ↗

LED polarity, mounting four parts, the wire routes and a powered test.

Exercises · Mount the parts

Exercise 3 · Steps 1–8

1. **Identify the LED direction**
   Long lead = anode (+). Short lead and flat edge = cathode (–). Mark the cathode on your sketch.

2. **Find the button’s switched sides**
   Meter test as in Exercise 1. Record sides A and B.

3. **Check the resistor**
   Measure it: about 4,700 Ω (4.7 kΩ). Either direction is fine.

4. **Trial-fit and mark the parts**
   Button easy to press, LED visible, terminal openings at the edge. Mark +, – and the cathode. The underside view is mirrored.

5. **Mount the resistor**
   Solder each lead to its own pad, let it cool, then trim.

6. **Mount the LED**
   Cathode in its marked hole. Check direction, solder, and trim after cooling.

7. **Mount the button and terminal**
   Don’t bridge the switched sides. Mark terminal + and –. Battery stays disconnected.

8. **Prepare four wires**
   Measure, cut, strip only what’s needed, and lightly tin.

Wire connections

1. **Terminal +**
   → one resistor end
2. **Other resistor end**
   → button side A
3. **Button side B**
   → LED anode (+)
4. **LED cathode (–)**
   → terminal –

⚠ Caution

Mind the LED

Backwards, it won’t light. Check the cathode mark twice before soldering.

Exercises · Wire, check and power

Exercise 3 · Steps 9–15

9 Solder wire 1
Terminal + → one resistor end.

10 Solder wire 2
Other resistor end → button side A. Not the same resistor end!

11 Solder wire 3
Button side B → LED anode.

12 Solder wire 4
LED cathode → terminal −. Compare all four routes with your sketch.

13 Check without power
Each route beeps; the button opens and closes; no short between + and −.

14 Attach the battery wires
Pack off. Positive into +, negative into −. Clamp on bare conductor, not insulation.

15 Power and test
Press: LED on. Release: LED off. Disconnect power before any fix.

Test it

Hold the button — the LED lights. Let go — it turns off. Then follow the shutdown routine.

If something doesn’t work

Symptom	Check
LED never lights	Battery connection, LED direction, resistor value, each wire route
LED stays on	Contacts A and B may be joined inside the button, or a bridge bypasses it
LED flickers when moved	Loose terminal wires, damaged strands, or poor joints

Exercises · Exercise 4

Add sound to the Teensy board

Add a transistor-driven buzzer to your Exercise 2 board, then program the Teensy to play two alternating tones.

Medium · Embedded kit

What you'll make

You'll add a 1 kΩ resistor, a 2N2222 transistor and a passive buzzer beside the sockets, wire them with five links, then upload a program that plays two alternating tones through the buzzer.

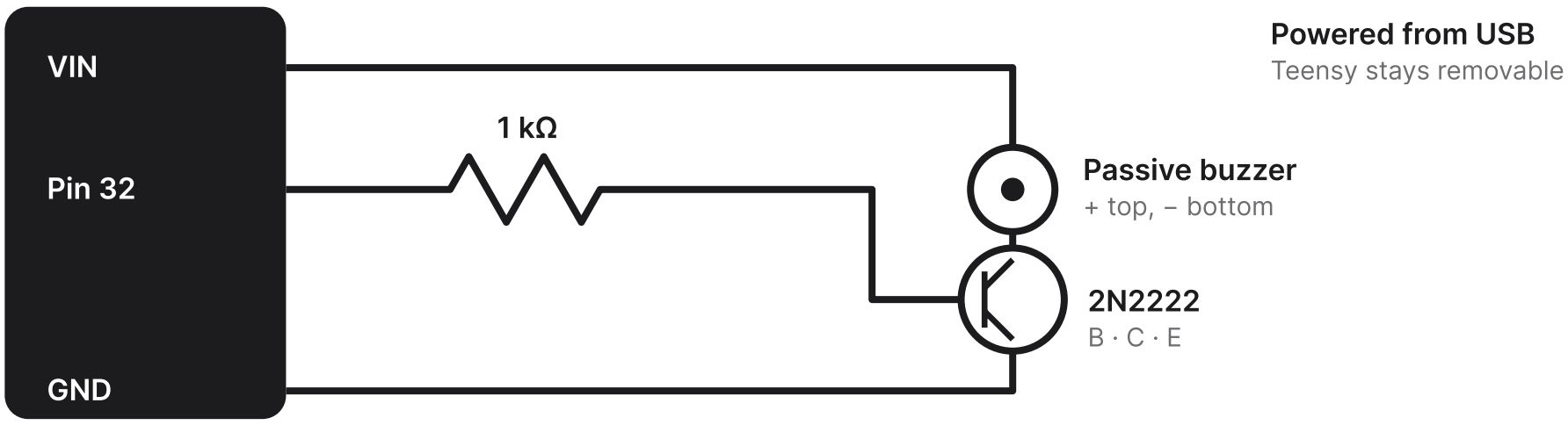
Learning objectives

- Identify transistor pins from its datasheet
- Wire a transistor to drive a buzzer
- Upload and edit an Arduino sketch

Difficulty	Time	Video
Medium	80 min	4:48 ↗

You'll need

Exercise 2 board + Teensy	Ex 2
Passive buzzer	ES kit
2N2222 transistor	ES kit
1 kΩ resistor	ES kit
5 wires & USB data cable	Kit



Video lesson · 4:48

Exercise 4 · Add Sound to the Teensy ↗

Mounting the resistor, transistor and buzzer, wiring the socket tails and uploading the sketch.

Exercises · Build the circuit

Exercise 4 · Steps 1–8

1. **Remove the Teensy, identify parts**
   Unplug everything. Resistor ≈ 1 kΩ. Find B, C and E from the datasheet — don’t guess. Find buzzer + and –.
2. **Mark the socket connections**
   Use the pinout card and USB mark to find the tails for pin 32, GND and VIN. VIN is not 3.3 V or VBAT.
3. **Mount the resistor and transistor**
   Beside the sockets, marked tails still reachable. Each lead to its own pad.
4. **Mount the buzzer**
   Buzzer opening clear and polarity marked. Keep it away from the USB plug and program button.
5. **Prepare five short wires**
   Measure, cut, strip and lightly tin. Don’t force two wires into one hole.
6. **Solder the five links in order**
   One route at a time, following the list. Teensy stays out.
7. **Check links with power off**
   Each route beeps; the resistor path reads about 1 kΩ.
8. **Check before programming**
   Confirm socket labels, transistor pins and buzzer polarity. Investigate any near-zero VIN–GND reading.

Wire connections

1. **Socket tail · pin 32**
   → one resistor end
2. **Other resistor end**
   → transistor base B
3. **Transistor emitter E**
   → socket tail · GND
4. **Transistor collector C**
   → buzzer –
5. **Buzzer +**
   → socket tail · VIN

Safety

Never wire the buzzer to pin 32

The transistor carries the buzzer current. Pin 32 only switches it through the resistor.

Exercises · Program the Teensy

Exercise 4 · Steps 9–12

9 Install Arduino IDE and Teensy support

Arduino IDE 2.x from arduino.cc/en/software. In Preferences (Settings on macOS), add the URL below to Additional boards manager URLs, then install “Teensy” in Boards Manager.

10 Connect the loose Teensy

Out of the socket board, on a non-conductive surface. Tools → Board: Teensy 4.1, pick its Port, USB Type: Serial. Use a data cable.

11 Create and verify the sketch

New sketch, delete the starter text, paste the code, save as Teensy_Sound_Board, then click Verify (✓).

12 Upload

Click Upload (→); press the program button if prompted. No sound yet — the Teensy isn’t on the board.

Boards URL `https://www.pjrc.com/teensy/package_teensy_index.json`

Teensy_Sound_Board.ino Arduino

```
#include <Arduino.h>

const int buzzerPin = 32;

void setup() {
  pinMode(buzzerPin, OUTPUT);
  digitalWrite(buzzerPin, LOW);
}

void loop() {
  tone(buzzerPin, 1000);
  delay(300);
  noTone(buzzerPin);
  digitalWrite(buzzerPin, LOW);
  delay(200);

  tone(buzzerPin, 2000);
  delay(300);
  noTone(buzzerPin);
  digitalWrite(buzzerPin, LOW);
  delay(1000);
}
```


Exported with Typeport

Exercises · Run the sound board

Exercise 4 · Steps 13–16

13 Unplug USB and insert the Teensy
Match its USB end to the board mark. Every pin in a socket — none shifted by one. Never insert or remove it while powered.

14 Power from USB and listen
Board on a non-conductive surface. A low beep, then a high beep, then a one-second pause — repeating. Unplug USB to stop.

15 Change the sound
Edit 1000 or 2000 in tone() — higher number, higher pitch — or a delay() value. Upload again.

16 Finish
Unplug USB. Shut down the iron. Power off before removing the Teensy for another project.

Test it

Plug in and it starts right away: low beep, high beep, short pause, repeat. Unplug USB to stop.

If something doesn't work

Symptom	Check
No Teensy 4.1 in the Board menu	Install the Teensy package with the PJRC URL
Upload fails or no port	Data cable and board selection; press the program button if asked
No sound	Pin 32 → resistor → base route; transistor B · C · E orientation
Quiet, or only clicks	VIN → buzzer + and collector → buzzer – routes; buzzer polarity
Board resets or a part gets hot	Unplug immediately. Look for bridges, wrong socket fit, reversed parts or shorts

Section 06

Page 36

Challenges

Ready for more? Try these on your own — no step-by-step this time.

Second button module

Easy

Build another Exercise 1 module so two players can each have their own button in a breadboard game.

Servo extension lead

Easy

A 3-wire male-to-female lead so a servo can reach further from the board.

Two-button melody

Medium

Add a push button on another pin so your sound board only beeps while the button is held.

Traffic-light module

Medium

Red, yellow and green LEDs with resistors on perfboard, driven by three Teensy pins.

Night-light board

Hard

A photoresistor and transistor switch an LED on when it gets dark.

Your own design

Hard

Pick any circuit from your Embedded guide and make it permanent on perfboard.

Share what you build

Post a photo in the North Star Scientific Discord — we love seeing your boards.

Reference · Fix it fast

Troubleshooting

Find the symptom, check the likely cause, try the fix.

Problem	Likely cause	Fix
Solder won’t melt or flow	Dirty tip, or iron too cool	Clean and re-tin; check it’s at 350 °C and touching both parts
Solder balls up	Melting solder on the iron, not the joint	Heat pad and lead first, then feed solder into the joint
Dull, grainy joint	Cold joint — moved while cooling	Reflow with a touch of fresh solder; hold still
Tip is black and won’t tin	Oxidised tip	Wipe and re-tin straight away. Never file it
Two pins joined	Solder bridge	Drag the excess away with a clean tip, or use wick
Pad lifted off the board	Too much heat for too long	Lower the heat, work faster; repair with a short wire
Header leans	All pins soldered at once	Reheat one pin and straighten it
Insulation melts back	Iron near the insulation too long	Strip a little more; keep joints quick
Iron won’t heat	Switch off or not plugged in	Check the handle switch and plug; wait for the display
LED won’t light	Backwards, cold joint or bridge	Check the long leg, reflow joints, look for bridges

Pro tip

Still stuck?

Re-watch the video for that step, compare your joints with page 22, or ask in the North Star Scientific Discord.

Reference · Quick reference

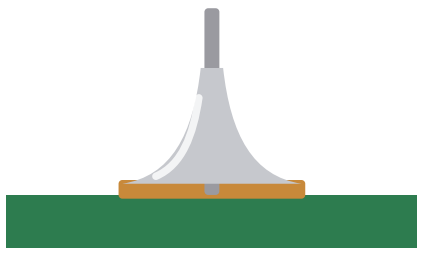
Cheat sheet

Everything on one page. Keep it next to your bench.

Set to

350 °C

Lead-free kit solder · range 300–400 °C



Through-hole joint: smooth · shiny · volcano

The core sequence

Prepare › Heat the joint › Apply solder › Solder off › Iron off › Cool › Inspect

5 mm	3–5 s	24 AWG	0.8 mm
Strip length	Per joint	Wire size	Solder

Every session

- Glasses on
- Fan pulling fumes away
- Iron always in the stand
- Switch off when you step away

Tip care

- Damp sponge, not wet
- Clean only when needed
- Thin coat of solder before switching off
- Change tips only when cold

Where to look

Safety · p. 15–17 · Temperature · p. 19 · Tinning a wire · p. 20 · Making a joint · p. 21 · Inspecting · p. 22 · Fixing mistakes · p. 23 · Troubleshooting · p. 37

Reference · Plan a unit

For educators

How this kit supports the 2019 Minnesota K–12 Academic Standards in Science, plus notes for the classroom.

MN science strand	What students do	Pages
1 · Exploring phenomena or engineering problems	Ask why joints fail; define what a good joint must do	12, 22
2 · Looking at data and empirical evidence	Test every build with a multimeter and record readings	22, 25–35
3 · Developing explanations or designing solutions	Explain wetting, flux and heat transfer; plan perfboard layouts	12, 24, 29, 36
4 · Communicating reasons, arguments and ideas	Explain fixes; document and share builds	36–37

Also connects to **Energy & heat transfer** **Matter & melting points** **Electricity & circuits** **Engineering design**

⚠ Caution

Benchmark codes — to be confirmed

Strand-level alignment is shown. Specific benchmark codes should be confirmed against MDE's 2019 science benchmarks before release.

Pacing · 5 × 50 min

Day	Focus	Pages
1	Kit & background	03–13
2	Safety & Soldering 101	14–23
3	Exercises 1–2	24–28
4	Exercise 3	29–31
5	Exercise 4 & challenges	32–36

Station checklist

- ✓ Fan or extractor at every iron
- ✓ A multimeter at each station
- ✓ Glasses for everyone at the bench
- ✓ Cool running water nearby
- ✓ Irons unplugged before cleanup

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You've got the skills. Take them further with more electronics kits, robotics projects and STEM resources.

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