ELECTRONIC PROJECT KIT

First Light

Batteries, resistors, LEDs and the loop that joins them.

21 IN ONE

OHMSVILLE.COM/MANUALS/LEVEL-1

Contents

THE FIVE YOU ARE GRADED ON

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- № 3 · Two-transistor flasher — ohmsville.com/bench#a=exp-3
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First Light

Batteries, resistors, LEDs and the loop that joins them.

Everything in this booklet runs on the parts already screwed to the board: a battery, some resistors, two LEDs, two transistors, a couple of capacitors and the switches. No drawer, no chips, nothing to unlock. That is the point. The five projects the shop teacher grades you on teach you the loop; these are what the same handful of parts will do once you stop wiring them the one obvious way.

Ohm's law, by eye

WHAT YOU SHOULD SEE

The LED glows dimmer through 1 kΩ than through 330 Ω. Swap in 10 kΩ and it barely shows.

PARTS

9 V battery, 1 kΩ resistor, red LED

THE SHOP TEACHER'S NOTE

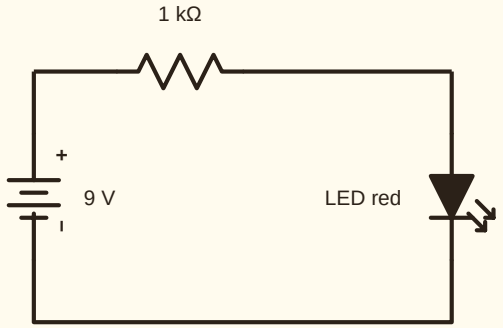
Same 9 V, three resistors: 330 Ω lets about 21 mA through, 1 kΩ about 7 mA, 10 kΩ under 1 mA. Brightness follows current, and current is volts divided by ohms.

WIRING

1. 1 → 9
2. 10 → 28
3. 29 → 2

Open it on the bench: ohmsville.com/bench#a=ohms-law

SCHEMATIC



Smoke test

WHAT YOU SHOULD SEE

Put 100 Ω straight across 9 V and watch it burn in a blink.

PARTS

9 V battery, 100 Ω resistor

THE SHOP TEACHER'S NOTE

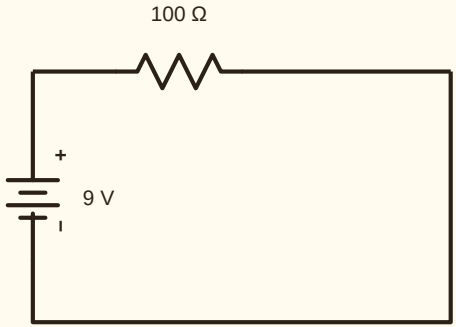
9 V across 100 Ω is 90 mA, and 9 V × 0.09 A is 0.81 W. This is a ¼ W resistor. That number on a part is a promise about heat, and we just broke it. Reset kit brings it back.

WIRING

1. 1 → 3
2. 4 → 2

Open it on the bench: ohmsville.com/bench#a=smoke-test

SCHEMATIC



Tiny current, big current

WHAT YOU SHOULD SEE

Under a tenth of a milliamp into the base lights the LED with about 8 mA.

PARTS

9 V battery, 100 kΩ, Q1, 330 Ω, red LED

THE SHOP TEACHER'S NOTE

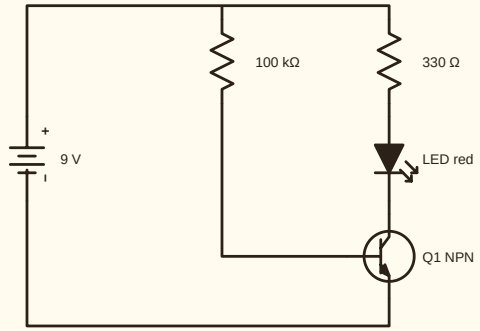
100 kΩ from 9 V lets only 83 µA into the base. The transistor lets roughly 100 times that flow from collector to emitter. That ratio is called beta. Hover the 100 kΩ and the LED and compare the readings.

WIRING

1. 1 → 15
2. 16 → 33
3. 1 → 5
4. 6 → 28
5. 29 → 32
6. 34 → 2

Open it on the bench: ohmsville.com/bench#a=tiny-current

SCHEMATIC



Voltage divider

WHAT YOU SHOULD SEE

Hover spring 18 and turn the knob: the voltage slides from 9 V down to 0.

PARTS

9 V battery, 10 kΩ pot

THE SHOP TEACHER'S NOTE

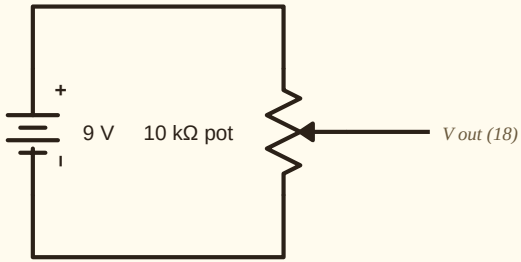
Two resistances in a row split the battery voltage in proportion. The wiper is the split point. Every volume knob and sensor readout starts here.

WIRING

1. 1 → 17
2. 19 → 2

Open it on the bench: ohmsville.com/bench#a=divider

SCHEMATIC



Two switches in series

WHAT YOU SHOULD SEE

The LED lights only when the slide is ON and the button is held.

PARTS

9 V battery, pushbutton, slide switch, 330 Ω, red LED

THE SHOP TEACHER'S NOTE

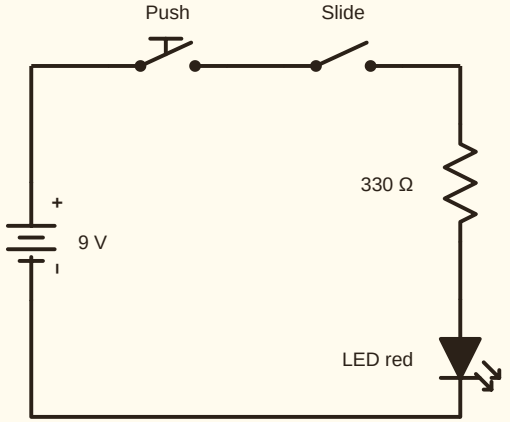
In series, both switches sit in the same loop, so both must be closed. Computers call this AND.

WIRING

1. 1 → 38
2. 39 → 40
3. 41 → 5
4. 6 → 28
5. 29 → 2

Open it on the bench: ohmsville.com/bench#a=series-switches

SCHEMATIC



Two switches in parallel

WHAT YOU SHOULD SEE

Either the slide or the button lights the LED.

PARTS

9 V battery, pushbutton, slide switch, 330 Ω, red LED

THE SHOP TEACHER'S NOTE

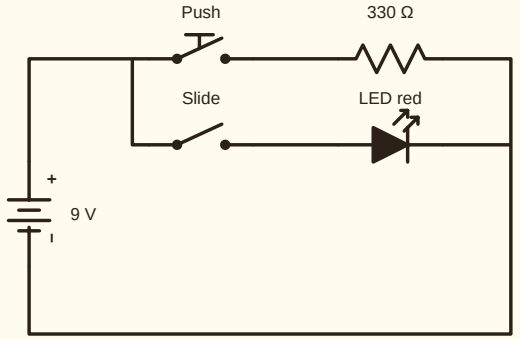
In parallel, each switch is its own path around the other. One closed path is enough. Computers call this OR.

WIRING

1. 1 → 38
2. 1 → 40
3. 39 → 5
4. 41 → 5
5. 6 → 28
6. 29 → 2

Open it on the bench: ohmsville.com/bench#a=parallel-switches

SCHEMATIC



Light meter

WHAT YOU SHOULD SEE

The LED glows with the light slider toward the sun and goes dark toward the moon; or turn on the camera and cover it.

PARTS

9 V battery, CdS photocell, 330 Ω, red LED

THE SHOP TEACHER'S NOTE

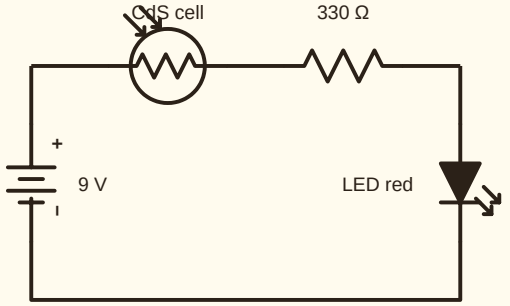
The photocell is a resistor set by light: about 1 kΩ bright, hundreds of kΩ dark. In series with the LED it is a dimmer that light turns.

WIRING

1. 1 → 44
2. 45 → 5
3. 6 → 28
4. 29 → 2

Open it on the bench: ohmsville.com/bench#a=light-meter

SCHEMATIC



Night light

WHAT YOU SHOULD SEE

Slide the light under the CdS cell toward the moon: the LED comes on in the dark and goes off in the light.

PARTS

9 V battery, 100 kΩ, CdS photocell, Q1, 330 Ω, red LED

THE SHOP TEACHER'S NOTE

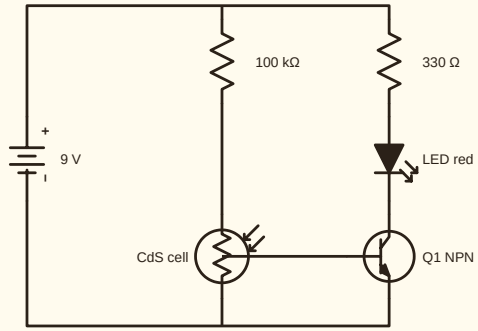
100 kΩ tries to pull Q1's base up; the photocell pulls it down. In light the photocell wins (1 kΩ) and Q1 stays off. In the dark it lets go and the base rises, so Q1 switches the LED on. A sensor plus a transistor is a whole automatic device.

WIRING

1. 1 → 15
2. 16 → 33
3. 33 → 44
4. 45 → 2
5. 1 → 5
6. 6 → 28
7. 29 → 32
8. 34 → 2

Open it on the bench: ohmsville.com/bench#a=night-light

SCHEMATIC



Make it click

WHAT YOU SHOULD SEE

Turn the speaker on, then tap the button: a click on press and another on release.

PARTS

9 V battery, pushbutton, 330 Ω, speaker

THE SHOP TEACHER'S NOTE

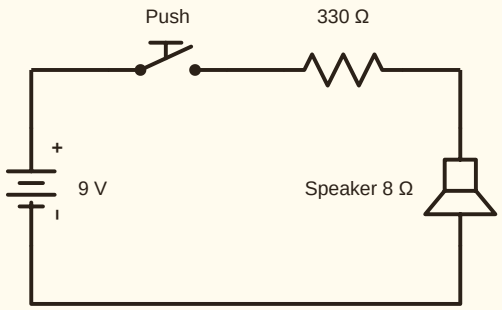
A speaker only makes sound when its current changes. A steady 27 mA is silent; the jump from 0 to 27 mA is a click. Do that 700 times a second and it is a tone.

WIRING

1. 1 → 38
2. 39 → 5
3. 6 → 42
4. 43 → 2

Open it on the bench: ohmsville.com/bench#a=click

SCHEMATIC



Light the lamp

WHAT YOU SHOULD SEE

Hold the button and the lamp lights — and watch the current: it starts near 560 mA and settles at 63 mA.

PARTS

9 V battery, pushbutton, lamp from the drawer

THE SHOP TEACHER'S NOTE

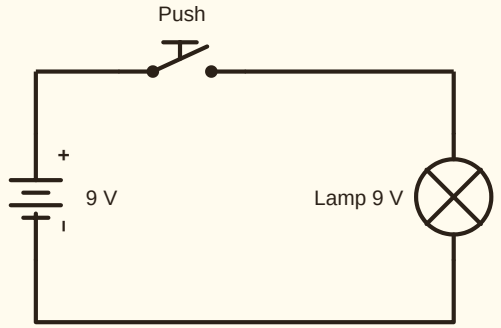
Cold tungsten is 15 Ω, so the instant it switches on it pulls nearly ten times its running current; hot it settles at about 143 Ω. A lamp is a resistor that changes while you watch it, over about fifty milliseconds.

WIRING

1. 1 → 38
2. 39 → 46
3. 47 → 2

Open it on the bench: ohmsville.com/bench#a=light-the-lamp

SCHEMATIC



The Backwards Lamp

WHAT YOU SHOULD SEE

The lamp burns steadily until you press the key, and goes out for as long as you hold it.

PARTS

9 V battery, 330 Ω, 10 kΩ, red LED, Q1, pushbutton

WHY IT WORKS

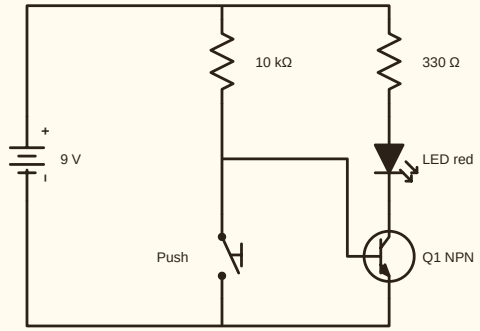
One transistor, wired so that the key and the lamp disagree. The 10 kΩ pours about 0.8 mA into the base all the time, four times what the transistor needs to carry the LED, so at rest it is hard on and the lamp is at full brightness. The key sits straight across the base and the emitter. Press it and the base has nowhere to sit but the minus rail: the 10 kΩ now empties into ground instead of into the base, the transistor shuts, and the lamp dies. Input up, output down. That is a NOT gate, and one transistor is the whole of it — the bench's other inverter needs a logic chip you do not meet until Level 5.

WIRING

1. 1 → 5
2. 6 → 28
3. 29 → 32
4. 34 → 2
5. 1 → 11
6. 12 → 33
7. 33 → 38
8. 39 → 2

Open it on the bench: ohmsville.com/bench#a=heritage-backwards-lamp

SCHEMATIC



After *Science Fair 200-in-1 Electronic Project Kit* (Cat. No. 28-249, 1981), project 63, "An Inverter Circuit". This is our circuit and our words; read the original at https://archive.org/details/science-fair-200-in-1-electronic-project-kit.

The Loop Alarm

WHAT YOU SHOULD SEE

With the loop closed the speaker says nothing. Open the loop and it howls until you close it again.

PARTS

9 V battery, two 330 Ω, two 10 kΩ, two 0.1 µF, Q1, Q2, speaker, slide switch

SLIDE SWITCH ON.

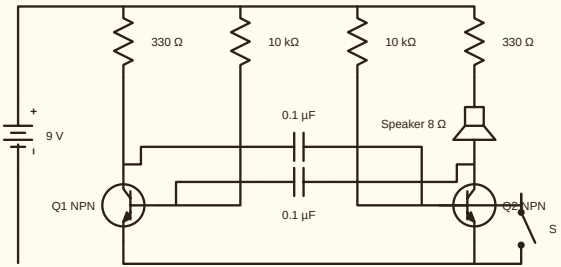
WHY IT WORKS

The first fourteen wires are an ordinary two-transistor tone generator: each collector is coupled through a 0.1 µF to the other base, the 10 kΩ resistors refill those capacitors, and the pair flips about seven hundred times a second into the speaker. The last two wires are the sensor. The slide switch stands in for a long loop of wire run around whatever you are guarding, and while it is closed it pins Q2's base to the minus rail. A base that cannot rise cannot switch, so the whole oscillator is held still and the speaker branch carries nine billionths of an amp. Pull the loop out and the base is free; the circuit starts on its own within a few milliseconds. The interesting part is the sign: breaking a circuit is what *starts* this one.

WIRING

1. 1 → 5
2. 6 → 32
3. 1 → 7
10. 32 → 24
11. 25 → 36
12. 35 → 26

SCHEMATIC



The Circuit That Sulks

WHAT YOU SHOULD SEE

The lamp is on when you power up. Tap the key once and it goes out — and stays out, however long you wait.

PARTS

9 V battery, 330 Ω, two 10 kΩ, 100 kΩ, red LED, Q1, Q2, pushbutton

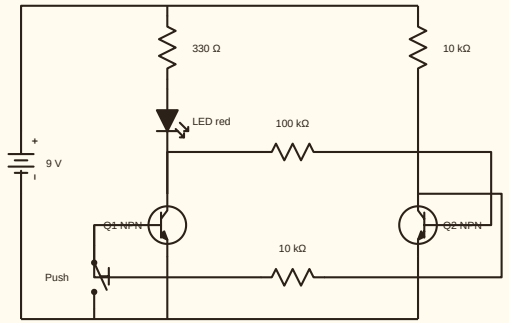
WHY IT WORKS

Two transistors feeding each other's bases through resistors, with no capacitors anywhere. Nothing times it, so it simply keeps whichever of its two states it fell into. Q1 carries the lamp; Q2 carries only a 10 kΩ. Q1's collector reaches Q2's base through 100 kΩ, and Q2's collector reaches Q1's base through 10 kΩ. On power-up the low-resistance path wins, so Q1 turns on first, its collector drops to a fifth of a volt, that is all Q2's base ever sees, and Q2 stays off — which keeps Q1 on. Press the key and Q1's base is pulled to ground; Q1 lets go, its collector rises, Q2 finally gets what it needs and switches on, and Q2 now holds Q1's base down by itself. Release the key and nothing changes, because the key was never what was holding it. Two transistors and four resistors is one bit of memory, and you have it at Level 1 — the relay latch is four levels away.

WIRING

1. 1 → 5
2. 6 → 28
3. 29 → 32
8. 32 → 15
9. 16 → 36
10. 35 → 13

SCHEMATIC



The Daylight Switch

WHAT YOU SHOULD SEE

The lamp comes on when you light the cell and goes out when you shade it — the opposite way round from the night light.

PARTS

9 V battery, CdS cell, 10 kΩ, 330 Ω, red LED, Q1

WHY IT WORKS

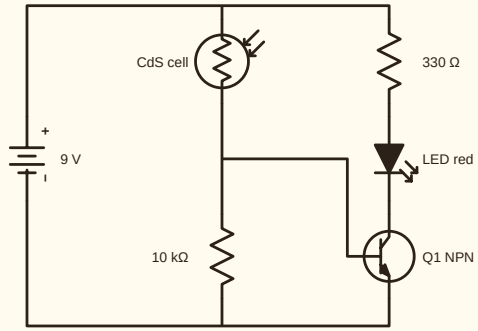
Exactly the night light's parts with the two halves of the divider exchanged. There the fixed resistor pulled the base up and the cell pulled it down; here the cell pulls the base up from the plus rail and a 10 kΩ pulls it down to the minus. In bright light the cell falls to about a kilohm and beats the 10 kΩ easily, so the base sits well above the six-tenths of a volt a silicon junction needs and the transistor switches the lamp on hard. In the dark the cell climbs to three hundred kilohms, the 10 kΩ wins thirty to one, the base sits near a quarter of a volt and the lamp is out. Which side of the divider your sensor sits on decides the sign of the whole circuit. The 10 kΩ rather than the night light's 100 kΩ is deliberate: with 100 kΩ down there the dark divider still leaves 2.25 V on the base and the lamp never goes out at all.

WIRING

1. 1 → 44
2. 45 → 33
3. 33 → 11
4. 12 → 2
5. 1 → 5
6. 6 → 28
7. 29 → 32
8. 34 → 2

Open it on the bench: ohmsville.com/bench#a=heritage-daylight-switch

SCHEMATIC



After *Science Fair 200-in-1 Electronic Project Kit* (Cat. No. 28-249, 1981), project 51, "The Light Switch". This is our circuit and our words; read the original at https://archive.org/details/science-fair-200-in-1-electronic-project-kit.

The Popping Lamp

WHAT YOU SHOULD SEE

The lamp winks about one and a half times a second, and the speaker pops on the same beat.

PARTS

9 V battery, two 330 Ω, 10 kΩ, 1 kΩ, two 100 µF, red LED, speaker, Q1, Q2

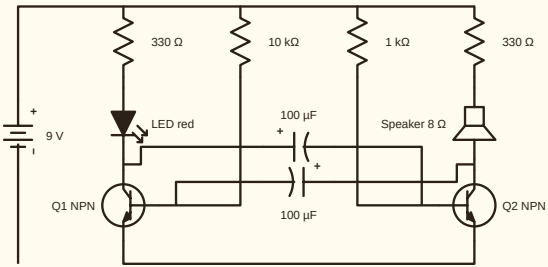
WHY IT WORKS

One flip-flop with two outputs. It is the tone circuit with the small capacitors traded for the 100 µF pair, so instead of flipping seven hundred times a second it flips about one and a half. The red LED hangs on Q1's collector and the speaker on Q2's, and because the two transistors are always in opposite states, every flip does both jobs at once: the lamp dies at the instant the speaker branch comes alive, and the other way round a moment later. The two halves are deliberately unequal — 10 kΩ refilling one capacitor and 1 kΩ the other — which gives a long lit stretch broken by a short dark one, and a click on every edge. This is what a slow multivibrator sounds like as well as what it looks like. Hanging both on the *same* collector, so they are literally in step, is the obvious thing to try and it wedges the solver; opposite collectors is the arrangement that runs.

WIRING

1. 1 → 5
2. 6 → 28
3. 29 → 32
9. 1 → 9
10. 10 → 36
11. 32 → 20

SCHEMATIC



Two Notes, One Switch

WHAT YOU SHOULD SEE

Slide the switch and the tone jumps to a second note about an octave up, and stays there.

PARTS

9 V battery, two 330 Ω, 1 kΩ, two 10 kΩ, two 0.1 µF, Q1, Q2, speaker, slide switch

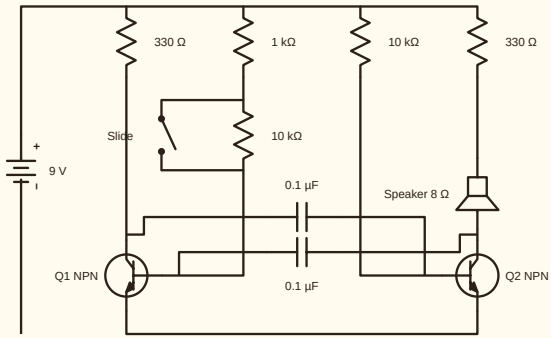
WHY IT WORKS

Q1's base is fed by two resistors in a row, 1 kΩ then 10 kΩ, so eleven thousand ohms decide how fast that half of the cycle refills. The slide switch is wired straight across the 10 kΩ. Close it and you have handed the current a wire instead of a resistor: the 10 kΩ drops out of the sum, that half of the period collapses to about a fourteenth of what it was, and the note jumps. The other half, set by the fixed 10 kΩ on Q2, never moves — which is why the pitch roughly doubles rather than going up elevenfold. You only shortened one of the two strokes. Shorting a resistor out is the cheapest way there is to change its value, because it changes it all the way to nothing.

WIRING

1. 1 → 5
2. 6 → 32
3. 1 → 7
4. 8 → 42
5. 43 → 35
6. 1 → 9
10. 41 → 12
11. 1 → 13
12. 14 → 36
13. 32 → 24
14. 25 → 36
15. 35 → 26

SCHEMATIC



Colophon

Generated from the modules the bench runs on: every circuit in this booklet is the circuit the simulator solves, and every word beside it is the word the manual panel prints.

Built 2026-09-15 from commit 953a47e.

HERITAGE

The Heritage builds in this booklet re-express ideas from vintage Radio Shack “Science Fair” kit manuals. Those manuals are the work of Tandy Corporation; the circuits, drawings and words here are ours. Read the originals:

- Science Fair 200-in-1 Electronic Project Kit (Cat. No. 28-249, 1981) — https://archive.org/details/science-fair-200-in-1-electronic-project-kit